The influence of standardisation and regulation on the development of intelligent networks

Thesis

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THE INFLUENCE OF STANDARDISATION AND REGULATION ON THE DEVELOPMENT OF INTELLIGENT NETWORKS

John William Shepherd

MBA BA(Hons)

Submitted for the degree of Doctor of Philosophy

Department of Telematics

Faculty of Technology

Open University

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Abstract

In today's global economy a flexible and responsive telecommunications infrastructure is essential to the maintenance and development of a country's economy. Within a free market, such an infrastructure depends upon the use of common standards; either imposed as a consequence of regulation or evolved through the operation of the market. This thesis investigates the influence of regulation and standardisation on Intelligent Network telecommunications technology by addressing the hypothesis:

> *Tight architecture-based regulation is inappropriate for a rapidly changing telecommunications environment, since that environment is continually challenging and redefining the boundaries of technological change.*

The multi-method approach adopted is based upon triangulation to identify multiple viewpoints. A Stakeholder Analysis was employed to help categorise those with an interest in Intelligent Networks and provide a basis for data collection. The primary data was gathered using a combination of surveys and interviews.

The thesis illustrates a wide range of original research. A unique analysis framework was constructed to identify a number of factors, including technical and commercial influences and their impact on the choice of IN architecture and the implementation of regulations. This framework offers a new perspective with which to view IN architectures; leading to the development and implementation of alternative IN architecture models. A number of these architectures have been constructed, together with some novel services, to demonstrate what could be achieved by employing flexible, less detailed standards, or making use of proprietary protocols.

The research concludes that tight regulation is not appropriate for Intelligent Network technology. Instead, encouragement for implementation and interconnection is better shaped through the development and adoption of de-jure standards.

Acknowledgements

I would like to thank all those who have assisted me in the completion of this research:

Nick Heap and Dave Wield my supervisors for their guidance, patience and continuous positive support;

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my mother Betty, father Stan (who was unable to see me complete this research) and mother-in-law Jacqueline;

and finally my wife Liz and daughters Jenny, Rachael and Sarah who have never known their Daddy not to be studying. Thank you for your support and here's a promise to see you more at bedtime.

Publications

As the topic of my research has become known, I was invited to talk about my work and the impact of IN architectures at a number of conferences (listed below); thus some of the original material resulting from the research for this thesis, has been published in Conference proceedings:

> 'Examining the Current Status and Future Development of IN Architectures', 4th Annual Congress – IN '97', IIR, London, January 1997
>
> 'The Development of IN Architectures', IN 1998, IIR, Rome, Italy, October 1997
>
> 'Examining Alternative IN Architectures', Intelligent Networks, VIB, Brussels, Belgium, December 1997
>
> 'Developing Effective Strategies for the Interworking of IN and CTI', Intelligent Networks '98 ...Madrid', IIR, Madrid, Spain, November 1998

Similarly I was asked to contribute to an Institution of Electrical Engineers book on Intelligent Networks:

> 'Intelligent Networks: Principles and Applications', John Anderson, IEE, London, 2002

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1 Introduction

1.1 Background

In 1993, the UK telecommunications industry was nearing the end of its first decade of private ownership; a decade of rapid change and major innovation. The previous seventy years had seen the introduction of direct dialling and international dialling but little else of obvious significance to the consumer. Behind the scenes the technology had changed, making the service more efficient, with the introduction of crossbar and electronic exchanges, digital links, and satellite communications. The years since UK telecommunications liberalisation (1984) had heralded a vast number of changes for consumers, including the private ownership of telephone apparatus, the introduction of exchange-based services, touch-tone dialling, better quality transmission, and most importantly competition for the monopoly operator British Telecommunications (BT).

As the UK's monopoly supplier, British Telecommunication's (BT) perspective was different. Policies and paradigms that had been followed over a long period had to be rethought at short notice and the workforce (still predominantly regarding itself part of the government workforce) re-educated. As the incumbent monopoly supplier, BT could only lose market share and hence there was a real danger that income would decrease if new products and services were not implemented quickly to counter this loss. Although the introduction of competition and lower prices were the key drivers, competitors who offered better customer service could tempt customers away from BT, resulting in a more rapid loss of market share. This shifting climate required that all new services be justified on the basis of revenue generation, rather than the general benefit to UK consumers. The necessary changes were enabled by BT's freedom to act independently of the Treasury, a consequence of privatisation. The Treasury was no longer able to claim a share of the profits above normal taxation (EIU 1995), limit re-investment, or dictate pricing policy.

The EU, observing the general success of the UK, US and Finnish privatisation programmes, was proposing to liberalise the European telecommunications market.

> 'A liberalised market is also a flexible one. Telecommunications is a domain characterised by constant change and rapid technological progress' (EU 1995).

A liberalised telecommunications market would be aided by applying the Open Network Provision (ONP) [1] directive to telecommunications networks. In particular, there was the potential to apply the ONP directive to specific technologies such as Intelligent Networks.

The Intelligent Network (IN) concept was conceived in the US. The essential idea is to provide a central store for network routing information, which is interrogated whenever a call is routed between two local exchanges. Although each routing request to the central location increases the call set-up time, it was found to be a cost effective way of implementing selective innovative services.

Whilst working for Concert (a British Telecommunications joint venture), I had direct experience of designing network architectures conforming to regulations and I was aware of the restrictions some regulation imposed on the level of service that could be offered to the customer. I also became aware that a comprehensive opening of IN interfaces, as was implied by the application of the ONP directive, could potentially reduce the level of service offered to customers using IN technology.

The research described in this thesis was prompted by two events; a survey undertaken by the EU (ETCO 1990), and a consultation paper published by the Department of Trade and Industry (DTI 1992). The responses to these events formed part of the EU's assessment of the application of the ONP directive to INs, by investigating the feasibility of opening the various interfaces of an Intelligent Network. Opening these interfaces would allow competing telephone companies greater control and access to information.

This thesis offers a study of the issues surrounding the possible introduction of regulations. It relates specifically to Intelligent Networks in the public switched telephone network, based upon research undertaken between 1994 and 2000.

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1 ONP is a European Directive (EU 1990), which identifies that for certain areas (e.g. voice telephony services), Operators must be allowed to interconnect and inter-work. For this to be achievable, those telecommunications interfaces must be open and declared. This allows Suppliers to develop equipment enabling interconnection and ultimately brings consumer choice to that market segment.

1.2 Hypothesis

Regulations and rulings in the EU have traditionally been preceded by information-gathering activities and research studies. It was therefore likely that when the EU, and then the DTI, undertook exercises on opening up the Intelligent Network architecture, regulation in support of legislation was likely to be applied to Operators deploying INs.

The European Technical Standards Institute (ETSI) had been working to develop acceptable IN standards in Europe. In the UK, licensing conditions imposed an obligation on Operators to adopt standard interfaces for the technologies they used. The Network Interfaces Co-ordination Committee of OFTEL had said:

> '...public systems must inter-work coherently to provide network services...inter-working and interaction require the use of well defined interfaces...such interfaces cannot be defined by any one party in isolation from others' (OFTEL 1993 p1).

Within the EU, Memorandums of Commitment were used to encourage the implementation of inter-network interfaces to an agreed timescale, thus allowing ease of interconnection and the widest geographical coverage of services. Within the UK a licence condition required Operators to allow interconnection to certain interface types so as to encourage the introduction and spread of new services.

There was a good chance that INs would have had such conditions applied to them. This could have disadvantaged Operators implementing a proprietary IN solution, since they might have been forced to update their technology to conform to new standards. Alternatively, if upgrading was not mandatory, an Operator might resist relinquishing their proprietary solution, concerned by the potential loss of business as a result of other Operators utilising their standardised interfaces. Either way, Operators might choose to delay the implementation of INs.

The converse strategy would be to allow the market to shape both the technology and the associated standards:

> 'Technical innovation would be driven by the demands of service providers and consumers as well as by the threat of competition from alternative technologies such as wireless and satellite' (EIU 1995 Summary).

The view held at the time was that if a technology were successful, the market would quickly demand standardisation and the opening of appropriate points of interconnection, so as to facilitate the development of service offerings. However, left to market forces, Operators will naturally optimise such developments to best suit their own business strategy.

There appeared to be very little published material addressing the issues associated with the interconnection of Intelligent Networks by competitors, at anything other than the basic network transport level. The lack of analysis in such a significant area was one of the reasons the research was undertaken.

These observations, in the context of the emergence of INs, led to the development of the following hypothesis:

> *Tight architecture-based regulation is inappropriate for a rapidly changing*[2] *telecommunications environment, since that environment is continually challenging and redefining the boundaries of technological change.*

History has shown that regulations formulated for one situation often have to expand to embrace other situations not envisaged at the time the regulations were conceived, with the result that the regulations could be far from ideal for these new situations. It was therefore arguable that if the regulation of INs was not carefully articulated, it would effectively restrict the type and flexibility of the services offered to customers.

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[2] 'Rapidly changing' in this context indicates the continuous demand for new innovative telecommunication services overlaid with the frequent arrival of new technology. A compromise is always being sought for the benefits it brings and its potential longevity, versus developing what exists to meet market needs.

Consideration of the hypothesis and the paucity of literature led to the development of five key research questions:

- Are INs a service in themselves or simply a means to deliver services?
- Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?
- Is legislative regulation the appropriate means to shape a technology in rapid change?
- How can it be ensured that robust technical and architectural models exist before standards are ratified?
- Do the members of the standardisation bodies (often the employees of the incumbent monopolies) subvert the goals of the regulators?

The goal of this thesis is to address these questions and contribute to the debate that surrounds them. To this end a series of interviews, together with two surveys, have been undertaken with key players and stakeholders associated with the development of INs.

The outcome of the research is a series of recommendations. These address both the micro level, such as the architecture of Intelligent Networks (INs) and the focus of standardisation organisations, as well as the macro level, such as the standardisation framework.

1.3 Themes

In analysing the hypothesis a number of themes emerge as key to the research.

Intelligent Network Architecture

There are differences in the IN standards implemented in the US and Europe and hence subtle variations in the operation of the architecture. These operational differences are being continually challenged and slowly evolved, as evidenced by conference papers, standardisation bodies' submissions and the resulting standards. Both US and European architectures conform to the ITU-T standard, which is based upon a specific architectural model. However, this model does not appear to have been rigorously tested before it was used to evolve standards.

Some of the evolving standards for INs facilitate inter-working with other technologies. In this respect, the Intelligent Network appears to be an 'enabling technology', in that other technologies are required to work with it in order to gain acceptance and stand a chance of being implemented by Operators in their telecommunications networks. The standardisation of INs thus far, is premised on the assumption that the existing IN architecture is the most appropriate. This thesis questions such an assumption and explores the implications of alternative architectures and their associated regulatory implications.

Industry Dynamics

There has been little work specifically centred on INs and their impact/influence upon the telecommunications industry. Robin Mansell is one of a few writers to address the '...implications of the strategies and tactics of the telecommunications supplier, user and policy community', using Intelligent Networks as a common technology for comparison purposes (Mansell 1993). The interaction between the different players in the telecommunications industry impacts upon the equipment produced, how it works and the services offered. It is therefore useful to understand who the dominant players are (if any) and their level of interaction/influence over the others.

Standardisation

There is a very large number of interest and sub-interest groups contributing directly, or indirectly, to the standardisation organisations. These groups document roles and responsibilities, interactions and information flows within their organisations, but the interrelationships between standardisation bodies (e.g. ITU-T and IETF), and between the bodies and industry is less well identified. The members of these groups, their sponsors, and how they interact in the context of standards setting, are important factors from a regulatory perspective. The thesis identifies these relationships and assesses their impact upon the process of regulation.

Regulatory Environment

The thesis does not attempt to argue the case for competition; a number of people (Beesley 1981, Baldwin et al. 1984) have already done so. Legislation originating at either the EU or national level creates a framework that is applied by means of regulation. In the UK, regulation is often applied by conditions embodied within an Operator's licence and has a major impact on the way Operators interact in the competitive environment. This thesis accepts the EU strategy for promoting competition, but tries to align the way the strategy is implemented with the many other drivers of technical innovation. The thesis does this by concentrating on those aspects of the regulatory environment specific to INs.

1.4 Research Boundaries

As with any research, boundaries need to be defined so as to constrain and focus the scope of the activities undertaken. The key boundaries established for this research are those of geography and technology.

The geographical area to be studied was identified according to the following criteria:

- standards bodies within a region were taking a particular interest in Intelligent Network standards;
- a number of telecommunications service providers within the region were using/implementing Intelligent Network technology; and
- the ease of data collection.

The areas initially chosen were North America, Europe and the Pacific Rim (Figure 1.1).

Figure 1.1 Areas of Interest

Although the first IN standards were developed and implemented in North America, by the start of this research the technology deployed in North America was only marginally more advanced than that being deployed by European Operators and hence the North American influence on standards-setting was on a par with Europe. The influence of the Pacific Rim countries in the development of the IN standards was not significant at that time.

Partially for this reason, but owing more to the ease of collecting information and data, the main geographical focus areas for this research is Europe, and hence European regulations. However evidence and information is drawn from North America and the Pacific Rim regions where appropriate.

Within the areas of IN implementation, there have been two different realisations of IN, each with their own standards. These are the fixed network and the mobile network. The fixed network is the telecommunications system providing connectivity to telephones linked by a wire traceable back to a local telephone exchange. The mobile network is the telecommunications system providing connectivity to mobile telephones, that allow people to make and receive telephone calls whilst on the move away from their home or office.

The most widely implemented standardised IN mobile technology is termed Global System for Mobile (GSM). At the commencement of this research, GSM was an emerging mobile technology, with a significant level of preliminary standardisation work already undertaken in Europe, discussing and defining appropriate architectures and methods of interconnection.

This research has focussed on the implementation of fixed network INs, since it was the regulation of fixed network INs that the EU and DTI were considering in their studies, the lessons being learned from GSM[3] indicating that a co-ordinated EU approach would aid interworking, flexibility and competition.

While fixed networks have evolved to employ different technologies (e.g. Voice Over Internet Protocol), mobile network evolution has essentially retained the same technological architecture model. The continued evolution of INs in the mobile network and a large legacy base of IN in the fixed network, ensure that the findings of this research are valid in the current telecommunications environment.

When this study commenced, a primary goal of Operators was to offer data and voice services via common links (EIU 1996), thereby providing customers with integrated access and a single bill. Intelligent Networks could have been used to facilitate such a migration. However the thesis does not discuss the use of the IN concept to aid the integration of voice services with those of data, since any initial regulation of IN interfaces was unlikely to impact this area.

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[3] GSM technology was regulatory driven, following the findings of an EU (1987) study which identified that with no action, Member States would use a variety of systems. A variety of systems would result in reduced inter-working, flexibility, and competition. Consequentially, EU sponsored discussions took place, and the resulting standards became Memorandum of Understandings (MOUs) and then European Technical Standards Institute (ETSI) standards. The majority of the regulatory issues surrounding the GSM technology had therefore been addressed from the outset and effectively resolved before the technology was implemented.

1.5 Thesis Structure

The Intelligent Network Development and Research Methods review (Chapter 2) was undertaken to develop knowledge of Intelligent Networks and IN Standards. This identified the operation and issues associated with INs (conceptualising the problem), achieved a level of understanding to aid discussion with the experts, and allowed meaningful questionnaires to be formulated. Sources of information were interviews with experts, practitioners and those interested in the area, the reading of primary source material such as technical specifications, and secondary source material such as conference papers and books. The technology and standardisation research areas also benefited from some grey literature (not fully available in the public domain), such as internal BT documents and EU/ETSI working party papers.

Little information was found relating to the research methods employed to gather the data used in the literature. As a consequence, the literature review was expanded to include research methods that might be applicable, or adaptable, to IN technology and standardisation. Sources were informal interviews with practitioners, secondary sources such as books and to a certain extent, my own expertise gained from undergraduate, post graduate and work-related research.

The Research Design chapter (Chapter 3) identifies the structure and planning of the research, the research methods adopted or adapted to meet the needs of the research, and justification for the courses of action taken. It allowed the production of a plan detailing what work needed to be undertaken for the research and the systematic way it should be undertaken.

The material for this chapter derived from the research methods material identified in the previous chapter, suitably selected as being directly applicable, or able to be developed into a useful capability.

The Evolution of Intelligent Network Technology chapter (Chapter 4) discusses Intelligent Network technology in detail. It provides an understanding of how it is currently used in a public telecommunications network and the types of service it allows to be offered, together with its advantages and disadvantages over a traditional telecommunications network architecture. This allows the thesis to investigate the development and exploration of alternative services and architectures. It sets the scene to better understand the findings from the surveys detailed in a later chapter.

Research for this chapter was based on primary sources in the form of ETSI technical specifications, together with interviews of ETSI working group attendees. Later stages of the research benefited from my own experience/expertise, discussion with colleagues and analysis of data derived from BT's network. The outcome of this was the development of a series of new architecture models used as the basis of Survey 1. Additionally a framework was evolved for the consideration of the choice of IN architecture. Secondary data included technical articles, books, conference papers and BT documentation on Intelligent Network architectures and operation.

Chapter 5 on The Evolution of Regulation and Standardisation Policies in Regulation, examines the history of regulation in the UK and identifies parallels and lessons that can be learnt from history. It examines the current regulatory environment and identifies the structure of regulation within the EU, particularly in the UK. Where appropriate, it draws upon contrasting examples from North America and the Pacific Rim. The work for this chapter developed an understanding of how regulation was evolving and applied in the UK and EU and how the ETSI standards institution operated. This resulted in the development of information flow diagrams and an understanding of the major influencers at different stages in the processes.

The research for this chapter was based on primary material from OFTEL, interviews with staff at the DTI, OFTEL, Norwegian Regulatory Authority, ETSI policy working group leaders and attendees, European Commission representatives, together with my analysis of the UK Operator licences and the UK telecommunication acts. Secondary sources were books relating to the function of the EU and the history of UK telecommunications.

Chapter 6 addresses Stakeholder Attitudes and Concerns. It summarises the analysis of the two surveys undertaken for this research (in 1996 & 1998) in order to address a number of the questions arising from the research hypothesis. The first survey addressed three core areas:

- stakeholder reaction to some alternative IN architectures developed as part of the research;
- an assessment of the initial research findings regarding the issues associated with the implementation and interconnection of Intelligent Networks; and
- collected the opinions of interested parties.

The second survey, undertaken a few years later, introduced topics more relevant to 1998 than 1996 (e.g. interconnection to the Internet) and aimed to determine how stakeholder perception of the key areas of concern had changed. (Copies of the questionnaires are given in Appendices A and B).

The Implications and Issues for the Regulation and Standardisation of Different Intelligent Network Models (Chapter 7), assimilates the findings from the individual chapters relating to the hypothesis questions and draws out the lessons to be learnt. It discusses this in relation to the appropriateness of the European Union's (EU) and OFTEL's actions, formulating the issues that need to be addressed, together with recommendations for their future focus. The chapter reviews the appropriateness, or otherwise, of the hypothesis and suggests areas in which further study could be undertaken to progress the research.

The Appendices contain reference material related to the questionnaires (A & B), supplementary material detailing the types and classes of telecommunications licence available in the UK (C), a summary of the operating structure of the EU (D), an example of the documentation produced in the development of EU legislation (E), and a list of people interviewed for this research (F).

Information gained from interviews is not contained within a particular section but is referenced from the various sections as appropriate.

A Glossary of acronyms is provided and where appropriate, an explanation of their context.

References given in the text are listed at the end of each chapter.

The thesis draws on more than 20 years of the author's professional experience in the telecommunications industry, which has played a key part in identifying the issues associated with the practical implementation of 'regulation'. Early work showed a deficiency in the research literature regarding the policy issues associated with Intelligent Networks. The thesis therefore focused on Intelligent Network Technology and details the pressures and issues associated with the regulation of this technology.

1.6 Chapter 1 References

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2 Intelligent Network Development and Research Methods

2.1 Introduction

Intelligent Networks (INs) provide a specific solution to the problem of providing voice telephony services. INs per se, are unique to large networks, interconnecting with several Operators, requiring specific standardisation and regulatory frameworks. At the same time, INs are just another form of telecommunications infrastructure and as such, are amenable to many of the research strategies and methods previously employed by researchers.

This chapter offers a study of the literature pertaining to Intelligent Networks. Researching this literature allowed a review of existing knowledge as well as giving insights into how that knowledge was obtained, i.e. the research methods used. This review divides conveniently into two parts, one associated with technological development (which focuses on IN architecture, standardisation and regulatory frameworks), and the other for the research methods.

The former part identifies the literature applicable to the operation and architecture of Intelligent Networks. It highlights the bodies and individuals associated with the evolution of the IN architecture, the standardisation process, the regulatory environment and the telecommunications industry. As such, it is key to understanding the various issues raised by the development and implementation of INs. Knowledge from interviews undertaken for this research are reported here in order to assist understanding the knowledge context of the research.

As will be seen however, the technical literature review identifies little relevant published material, with the result that this research places greater emphasis upon primary material. This led to the need to consider basic data-gathering research techniques, the subject of the latter part of this chapter, which identifies the strategies and techniques that have been employed by researchers gathering knowledge for other studies. It introduces the components of the research and presents the terminology used in the data-gathering process. It also offers support for the course of action adopted, based upon the specific research activity, (although how this process may have been adapted/developed for the particular needs of this thesis is explored in Chapter 3). Broader requirements, which help avoid mistakes or errors (e.g. validity-seeking research), are also defined.

2.2 Knowledge Review

I work for British Telecommunications (BT) as a 'Systems Design Authority', leading the design of new technology and its introduction into BT's telecommunications network. Prior to commencing this research, I had an extremely limited knowledge of Intelligent Networks, but had responsibility for developing international conferencing services for Concert (one of BT's subsidiary companies at the time).

Since the start of the research, I have replaced BT's proprietary IN network elements, have worked on the design of mmO$_2$'s third generation mobile network, itself an IN-type architecture[1] and am currently undertaking a design study into the viability of introducing an Intelligence Platform into the BT broadband network.

I have therefore applied to this research, my experience of the types of issues affecting the introduction of new technology, the interconnection of networks and network elements and the implementation of services.

Intelligent Network Architecture[2]

The concept of Intelligent Networks was introduced by Bellcore (the United States telecommunications research body (since renamed 'Telcordia'), which was jointly funded by the seven Regional Bell Operating Companies (RBOCs) in the USA in 1984, when AT&T's monopoly was broken and the telecommunications industry became deregulated (Ungerer 1990). The Intelligent Network comprised of a central computer, which held customer related information and routeing data. When a call was placed to a destination, a query was transmitted from the local exchange to the central computer requesting routing information for that destination. The routeing information was returned to the querying Exchange permitting completion of the call set-up (Figure 2.1). The major benefit was that routeing data was held at a single location in the network and could be updated quickly and cheaply, rather than requiring updates to be carried out at all exchanges. The net result was

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[1] See Chapter 1 for a description of the differences between mobile and fixed Intelligent Networks.

that call routeing became dynamic and new services, or previously uneconomic services (e.g. non geographic routeing), became viable.

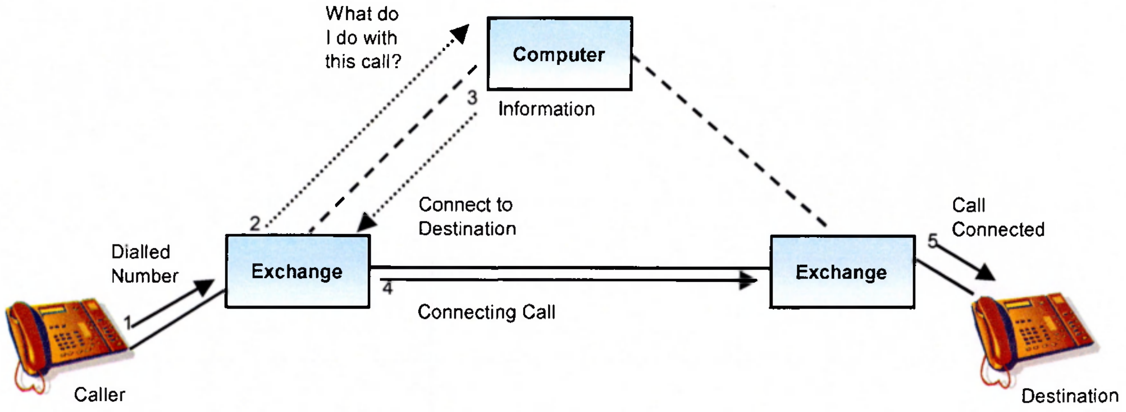

Figure 2.1 Basic Intelligent Network Architecture

The progressive adoption of INs in the late 1980s and early 1990s, led to the standardisation of the basic architecture and interfaces in 1993 (ITU-T 1993c). Both the ANSI organisation in the USA and ETSI in the EU produced their own regional variants of these standards, termed the Advanced Intelligent Network (AIN) and the IN Capability Set (CS)[3] respectively. ETSI appeared to follow the ITU-T standards more closely than ANSI, possibly due to the legacy of (Bellcore) Intelligent Network systems influence in the USA on the US regional standard; this was not the case in Europe. This led to essentially two key standardised Call State Models[4] being implemented world-wide, thus limiting the potential for interworking of services between networks utilising the differing standards. The assumption that the IN architecture adopted by the standardisation bodies is actually the most appropriate, is one that this research has challenged. A number of alternative architectures were developed and used as the basis of the first survey to test their appropriateness to different groups of stakeholders. These models and related aspects of

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[2] The research considers the term 'Architecture' in the context of an Intelligent Network, as the ITU-T theoretical conceptual operation of an IN; i.e. that Service Control and Call Control are separated. The term 'model' describes the differing physical implementations of that concept.

[3] Sometimes the ETSI variant was termed the IN Application Part (i.e. ETSI INAP), but the ETSI INAP standards were re-submitted to the ITU-T for formal recognition, forming an ITU-T Capability Set (CS) release. Thus ETSI closely followed the ITU-T IN standard because frequently it was the same (due to this re-submission) and hence ETSI tended to use the same terminology as the ITU-T i.e. 'Capability Set'.

[4] The Call State Model is the part of the IN standard specification which indicates at what point in a telephone call queries can be made to the centralised intelligence.

the survey findings have been presented and published in conference proceedings (Shepherd 1997 a, b, c) and are presented and discussed in Chapter 4.

The primary material for the review of IN technology took the form of experts involved in the development of standards, standardisation body Working Group discussion notes (e.g. ITU-T 1995) and the standards themselves. Secondary material existed in the form of telecommunication journal articles, conference papers, published papers, etc. Such papers were either factual, or proposals based upon the author's thoughts with little or no supportive evidence (e.g. Chang et al. 1997, El-Gendy et al. 1995, ICIN 1996).

The CS1 Intelligent Network Conceptual Model consists of four levels. These are the Service Plane, Global Functional Plane, Distributed Functional Plane and Physical Plane (ITU-T 1993a). The Service Plane presents a high level view of the service as seen by the service user. The Global Functional Plane provides visibility of the different functions[5] of the Intelligent Network. The Global Functional Plane additionally contains the call model, which essentially determines the points in the call from which actions can be instigated. It is the operation within this plane that is fundamentally different in the ANSI IN and ETSI CS implementations. The Distributed Functional Plane provides visibility of the distributed functions of the Intelligent Network, which are defined as Functional Entity Actions (FEAs) (e.g. call processing). The Physical Plane models the physical parts of the Intelligent Network, these being known as Physical Entities (e.g. an exchange) and the protocols they use to communicate.

The two planes key to this research and hence addressed in this thesis, are the Distributed Functional Plane and the Physical Plane.

The contents of the Distributed Functional Plane are shown in Figure 2.2 and are explained in detail in Chapter 4.

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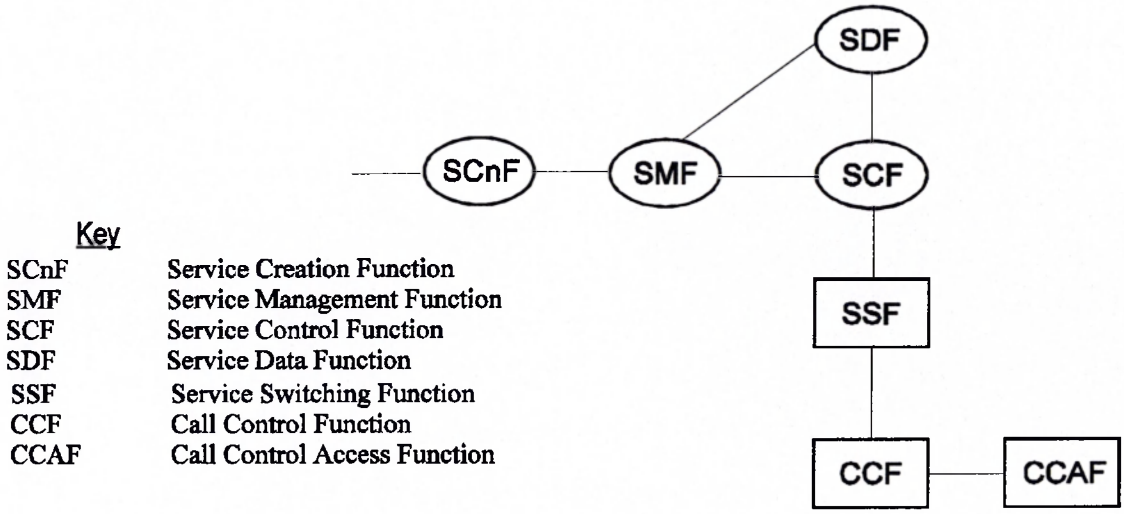
[5] The different functions take the form of Service Independent building Blocks (SIBs). A service is provided by a combination of one or more SIBs.

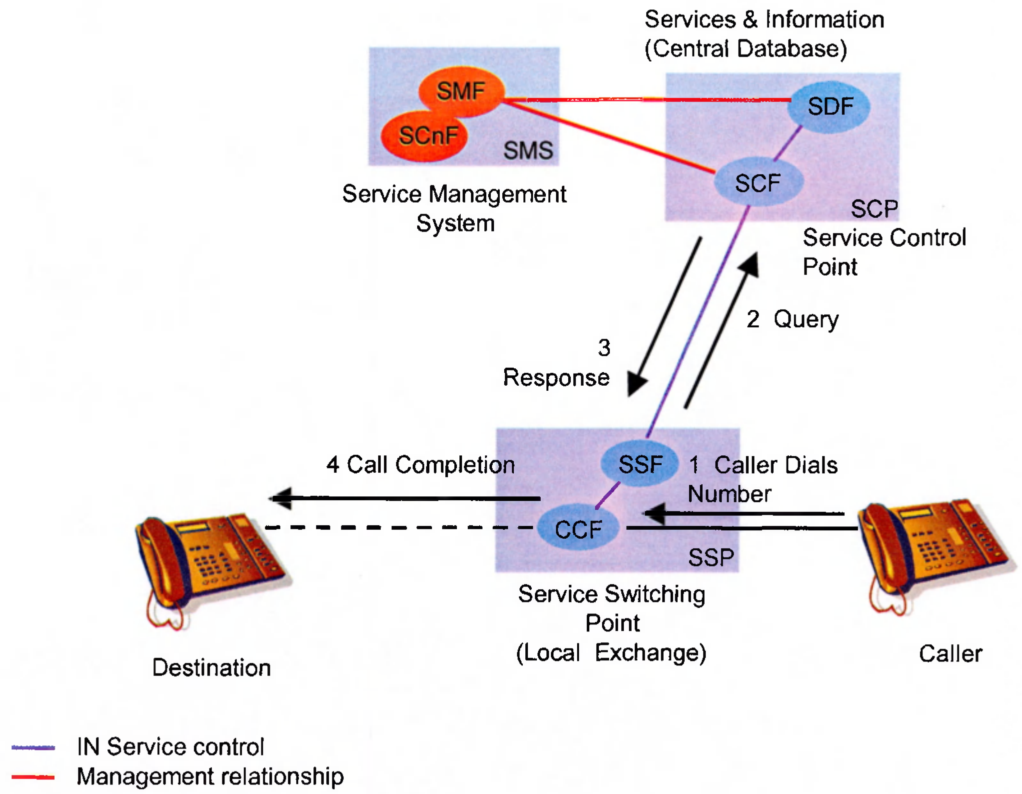


Key

SCnF	Service Creation Function
SMF	Service Management Function
SCF	Service Control Function
SDF	Service Data Function
SSF	Service Switching Function
CCF	Call Control Function
CCAF	Call Control Access Function

Figure 2.2 ITU-T Intelligent Architecture Functional Model (CS1)

Thanyneberge et al. (1997) discussed the ITU-T model with reference to AIN standards and in particular the development of the AT&T IN standards. Magedanz et al. (1996) offered coverage with an American emphasis, but additionally introduced the concept of Intelligent Agents (moving software entities from one place to another to find information). Exchange Suppliers were a further source of information, several of which produced summaries of IN technology for prospective customers. These emphasised the benefits of their products (which may or may not have aligned with standards) and often replaced the standardised terms of key elements with company specific product names (e.g. Northern Telecom 1993). The texts suggested ways of mapping distributed functions onto functional entities. The most common is reflected in Figure 2.3, the others being minor variations of this.



(Note: to aid clarity, not all
the links are shown)

Figure 2.3 A Typical Mapping of the Functions to Physical Entities

The mapping of functions to Physical Entities shown in Figure 2.3, essentially reflects the physical model of the ITU-T CS1 standard architecture. For instance, only the interfaces between the physical elements such as the Service Switching Point (SSP) to Service Control Point (SCP) interface were defined, whilst those within an element, (CCF to SSF in this example), were left undefined because most Suppliers had already implemented such interfaces in a proprietary manner.

The research was also interested in the ways different Telecommunications Operators had implemented Intelligent Networks within their networks. Jabbari's work not only duplicated the discussions of other authors on the generic structure of INs (e.g. Jabbari 1993b), but additionally provided an insight into the structure of Operators' INs (e.g. Jabbari 1993a). Dufour (1998), Li et al. (1993) and Mansell (1993), similarly offer insights into Operators' IN implementations. However, specific implementation details, although freely available in the early 1990s, had proved difficult to obtain by about 1996. This was probably due to the increased level of competition resulting from the proposed liberalised EU telecommunications market in 1998 (interview Ward 1993). Information relating to Operators' implementations of Intelligent Networks during this later period, could only be gleaned by piecing together information in articles, press releases and interviews (e.g. interview Cullen 1996), with Dufour's (1998) book, being an exception.

Early technological literature therefore covered the fundamentals of the Intelligent Network architecture, but most restricted their coverage to one implementation style, either Bellcore or the subsequent Advanced Intelligent Network (AIN) standard and implementation, or the International Telecommunication Union - Telecommunications (ITU-T) Capability Set (CS) standards and implementation.

More recent literature has focused on developing the basic IN concept as a means to satisfy the demand for greater bandwidth (Venieris et al.1998) and mobility (Christensen et al. 2000). Unfortunately the American/European divide continues to be apparent. For instance Christensen et al.'s (2000) book 'Wireless Intelligent Networking', concentrates upon the American National Standards Institute (ANSI) equivalent of the European Technical Standards Institute's (ETSI's) Customised Application for Mobile Enhanced Logic (CAMEL) architecture[6].

There appeared to be very little published material regarding the issues surrounding interconnection by competitors at anything other than the basic network transport level. The exceptions were the studies undertaken by the European Telecommunications Consultancy Organisation (ETCO) on behalf of the European Union (EU) (ETCO 1990), KPMG's report (KPMG 1993) and the collated responses to the Department of Trade and Industry consultative document (DTI 1992). Other elements of information in this area were gained from interviews (e.g. interview Leeson 1995). These activities identified that interconnect at levels other than the IN transport level were being trialled in the United States of America. The capability was termed the Mediated Access Function (MAF) and allowed Service Control Point (SCP) access to third parties. Bell South implemented this capability on the SCP and allowed access via a system called SKY (interview Thomas

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[6] Camel is an IN architecture, the nomenclature being based upon fixed network INs, but being used in the mobile environment to allow (typically) pre-pay mobile telephony.

1994b), whereas BellCanada integrated the MAF as part of the Signalling Transfer Point (STP) (interview Cullen 1996) (Figure 2.4).

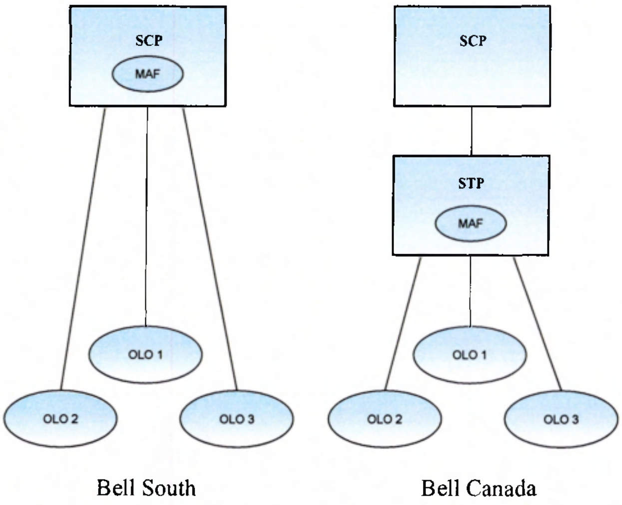

Figure 2.4 North American implementation of the Mediated Access Function

As time has progressed, other technologies have evolved to challenge INs (e.g. the Internet Protocol). David Isenberg was one of the first to confront what was considered the paradigm[7] of Intelligent Networks as an ongoing network architecture, (with others following in the same vein e.g. Waesche 1999). Isenberg's (1998a) article summarised a paper entitled 'The Rise of the Stupid Network' that he had circulated on the Internet. This was written while he worked for a major US telecommunications provider and effectively challenged the thinking of his company (and arguably every other major telecommunications provider) at the time. In it he challenged the assumption that Operators should control networks by building in centrally managed intelligence. He argued that

> 'The cost of infrastructure has been falling at a much faster rate than carriers have been able to depreciate and replace their legacy networks. As a result, new entrants are technologically better placed to succeed in the liberalised telecoms environment. This is especially true in Europe, where for years the incumbent

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[7] The Intelligent Network Paradigm was that 'Intelligent Networks was the telecommunications technology to use for voice services'. No one had considered/challenged that paradigm to discuss what technology would replace Intelligent Networks, or when that was likely to be.

> national carriers have built up centralised, proprietary, intelligent networks.' (ibid 1998a)

This, he said, put the incumbent carriers at a disadvantage. To counter this disadvantage he introduced the idea of a 'Stupid Network', which encouraged intelligence at the end terminals.

The challenge provoked a response by Ericsson's vice President, Per Jomer (Jomer 1998), in which Jomer undertook to counter Isenberg's argument but conceded that 'intelligence was moving from the connectivity network out to the terminals'.

Isenberg countered with another article, (Isenberg 1998b) in which he criticised Jomer for failing to acknowledge that the separation of the network layer from the service layer would increase the rate of innovation and 'tends to put distance between the source of innovation and established telecoms equipment and service providers'. That is to say the very act of separating the services from the network, as in an IN, would allow the introduction of third party service developers and providers. This would create a situation where services no longer need to be centralised, pushing the services out to the edge of the network. The act of introducing one architecture, the IN, would create a situation where another architecture evolves, or is more appropriate. Taken to its extreme, the services no longer need to reside in the Operator's network, but could be migrated to the customer's premises within the Customer Premise Equipment - hence the term 'Stupid Networks'[8].

From a research perspective, Isenberg's summary of the need for intelligence to devolve towards the terminals could be addressed by an alternative IN model, thus challenging the idea of the traditional IN architecture being sacrosanct. This concept of intelligence on the customer premises, is one that I described at an IN conference (Shepherd 1997a), by developing a 'Distributed Service Control Functions (SCFs) & Service Data Functions (SDFs)' model and indicating that the SCFs & SDFs could be pushed out of the network into the Customer Premise Equipment (CPE). The CPE querying the SCP for network

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[8] The radicalism of Isenberg's article can perhaps be deduced from the actions of his employer. It was reported that Isenberg was initially dismissed by his company and then, following the level of public interest and discussion of his thoughts, he was subsequently re-instated. It was as though his company themselves had begun to recognise the importance of what he was saying and that they should begin considering technologies beyond Intelligent Networks (Cukier 1998).

routing instructions or even determining if the destination were free, before initiating a call into the Operator's network. The network model therefore progresses from a 'service model' to a more 'product-oriented model' encouraging third party and user-controlled services.

With time and reflection upon how technology in general has progressed, I feel that Isenberg (1998a, 1998b) was actually sounding the start of the end for Intelligent Networks, by indicating how market & technology requirements could not be addressed effectively by Intelligent Networks and that other technologies need to be explored. For example, it could also be argued that Isenberg's model resembled that of an Internet Protocol network, where much of the intelligence resides in the User's Personal Computer.

Standardisation

A review of the literature relating to standardisation falls naturally into two parts. The first identifies the international bodies that have been key in producing Intelligent Network standards and outlines what standards are available. (This is discussed in greater detail in Chapter 4). The second part examines the process of creating standards and is key to the discussion in Chapter 5.

Intelligent Network Standards

The primary technical literature is associated with those organisations responsible for developing and implementing the standards. Bellcore's literature detailed the early IN standards (e.g. Bellcore 1986, Bellcore 1992) and its implementation (Ameritech 1989, Bell Atlantic 1992, Gerads 1995). As the technology developed and became internationally standardised, the ITU-T and ETSI produced their own global (e.g. ITU-T 1993b) and European (e.g. ETSI 1993) standards respectively.

Other primary sources include discussion documents produced by experts involved in the development of standards and published at conferences (e.g. Sridar 1997) and papers produced for ETSI and the ITU-T working groups discussions (e.g. ETSI 1996, ITU-T 1995, ITU-T 1996).

Secondary sources exist in the form of conference papers, published papers, journal articles etc. The journal articles were frequently more interesting, offering a broader perspective on technological development (e.g. Oliver 1991, Aiken 1997).

At the start of the research, INs were still evolving and, with my professional judgement and experience, I could see that despite the theory behind their open architecture, there were fundamental problems, particularly with the interconnection of third parties at the higher levels. This was particularly evident with the early implementations of INs, based on Supplier's proprietary protocols (making evolution difficult). This incompatibility was carried forward into the standards arena by the drive from both sides of the Atlantic resulting in two different sets of standards (AIN & CS), with associated interconnect and interworking problems. There was however, a drive within the ITU to align the ANSI AIN and ITU-T CS standards by the time CS4+ was achieved. (ETSI standards being a sub-set of the ITU-T standards were already closely aligned[9] (interview Guram 1995, interview Anderson 1999)).

The Standardisation Process

Examination of almost any currently implementable telecommunications standard, (i.e. not one implemented solely to interface with obsolete technology), shows it to be dynamic, with ongoing development and refinement in the standardisation forum (e.g. CCITT No. 7). Hawkins (1995a citing Tassey 1991 and Hawkins 1995c) suggested that this was

> '...not to define discrete conditions as fixed in time, but ... to determine on a dynamic basis the benchmark below which the parallel development of technology is perceived to be inefficient and/or technology-based competition is perceived to be redundant'.

The truth is most probably a mixture of the two, in as much as subsequent releases of a standard specify an increasing capability, thus maintaining a technology's usefulness by combating competition from other emerging technologies. From an Operator's perspective, it is of course extending the life of existing fixed investments, maximising Return on Investment (ROI). Thus it is appropriate

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[9] Both the ANSI AIN and ETSI's CS standards follow the ITU-T standards. However ETSI's standards align more closely. For instance ETSI's version of CS1 was called 'Core INAP' and was adopted by the ITU-T as CS1refined (CS1r).

> '...to perceive standards as 'living documents' and standardisation as an ongoing and dynamic process of information exchange between competing firms' (Hawkins 1995a citing the OECD 1995).

Hawkins (1995a) determined that during the 1980s the ITU recognised the establishment of three key standardisation organisations covering differing regions of the world. These were the American National Standards Institute (ANSI), covering North America, the Telecommunications Technology Committee (TTC) covering the Pacific Rim and the European Telecommunications Standards Institute (ETSI)[10]. The role of these bodies is to co-ordinate the regional standardisation activities and feed into the global ITU process, making the latter more efficient and more responsive. Support for this regional-global regime was reported to be strongest among the telecommunication equipment Suppliers. Hawkins (1995a) indicates,

> 'High and costly R&D intensities, related both to existing and new product lines, are increasing the pressures to open up new international markets' (ibid. 1995a).

Designing products to internationally formulated standards is a major step toward achieving this.

Hawkins (1995a citing Barry 1990) noted that the European Union (EU) has always had a focussed approach to standardisation policy in the communication technology sector. Furthermore, '...the EU has imposed virtual production quotas on the European standards development mechanism', which had resulted in a multiplication of standards. As a consequence some standards had been produced ahead of an identified need and hence they failed to meet the strategic requirements of European firms, leading to their non-adoption.

The potential for the development of inappropriate standards was also raised by the OECD (1995), concerned by the reluctance on the part of some companies to support voluntary standards initiatives. Generally speaking, the voluntary uptake of standards give less cause for concern, since they are unlikely to be widely implemented. Concern is greatest where

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[10] ETSI was created and initially sponsored and directed by the EU, with a view to co-ordinating the development and adaptation of telecommunications standards in the EU. This is discussed in detail in Chapter 5.

standards have to be implemented, perhaps following the implementation of some legislation, as is possible with EU produced standards. One of the OECD's key issues relates to the domination of the standardisation process by the incumbent contributors (OECD 1995).

The advent of the liberalised European telecommunications market in 1998 highlighted further concerns regarding the responsiveness of the standardisation organisations (OECD 1995) and that

> '..."the market" might not yield the appropriate standards in a timely enough way to support the new regulatory objectives focused on encouraging liberalised conditions for entry into telecommunication markets' (Hawkins 1995a).

Whilst acknowledging the role of standards in the liberalised market, Thomas (interview 1994b) expressed a similar warning that it is important that standards do not obstruct the development of new markets/market segments.

Hawkins proposed that using consortia and restricting their scope to a focused range of technologies, could increase the speed of standardisation. However he warned that

> '...evidence is accumulating that consortia are in many cases no more or less efficient than committees in the already established standards development organisations' (Hawkins 1995a).

The appropriateness and timeliness of IN related standards is one strand of the current research.

Agreement for the liberalisation of the EU telecommunications services in 1998, saw a shift in the foci of the Member State's policy from preserving monopoly structures to discouraging them and public policy-makers actively began to promote the elimination of technical idiosyncrasies in national public networks (Hawkins 1995a). The national public Network Operators faced the dilemma that:

> 'On the one hand they have a considerable interest in promoting standards that continue to protect their established sources of revenue, or that gave them advantages over new entrants in expanding the service base. On the other hand,

> increasing opportunities to become involved in international market ventures provide incentives to opt for more 'open' network structures' (Hawkins 1995a).

Although Hawkins did not recommend one course as being more appropriate than the other, there is ample evidence from company strategies at the time that the predominant course of action by the major EU telecommunications Operators, was that of predator; encouraging the opening of network structures to allow them to enter other Member State's markets (CI 1996).

In the United Kingdom, telephony standardisation can be traced back to 1922, when under pressure from the Telephone Division of the British Post Office, Suppliers were made to pool their Strowger technology-related patents in order to allow the optimum definition of the standard switch (BT 1993). This set a precedent that continued for the next 60 or so years, until the Post Offices Telephone Division's successor, British Telecom (BT), was made a public limited company in 1984. From this point on BT progressively lost control of telecommunications standardisation, until in 1991 the process was completed when the Office of Telecommunications (OFTEL) created the Network Interface Co-ordination Committee (NICC) to take on the role of formal ratification of network interfaces for the UK Telecommunications industry.

The way standardisation has developed in the UK has therefore resulted in the preservation of national idiosyncrasies in the technical configuration of the public network, despite it being based on international standards (Hawkins 1995a).

Hawkins (1995a citing Hawkins 1993) suggested that there was a lack of perspective concerning the nature of the institutional relationships between standardisation organisations and industry, standardisation organisations and government and between themselves. This situation was exacerbated by a proliferation of standardisation organisations at national, regional and international levels. The result was a major co-ordination problem, accentuated by the globalisation of telecommunications and the shift to supra-national standardisation organisations. An example of the consequences of a lack of co-ordination within the telecommunications industry, is in the area of Computer Telephony Integration (CTI), where many standards have developed diluting ETSI's and hence the EU's influence in this area (Shepherd 1998, Shepherd 1999).

The situation appears worse between industries. Whilst the boundaries between the telecommunication and computer industry sectors are blurring, Hawkins (1995a) has suggested that co-operation between the two areas in the definition of standards is impossible. He highlighted that many of the computer industry's standards stemmed from a proprietary or informal standardisation process which caused relationship problems and that it was undesirable that this culture of working should be reflected into the telecommunications arena.

Not withstanding the problems between standardisation organisations, there is a similar lack of perspective demonstrated within the organisations. Whilst they define their own internal process for producing standards, they appear to fail to define the communications between the working groups for different technologies (ETSI 1995, ETSI 2002, ITU-T 2002[11],Ungerer 1990).

In summary, standardisation is a dynamic process. Initially a national activity, then a nationally co-ordinated international activity, the development of regional bodies, such as ETSI, has shifted the emphasis to a regionally co-ordinated international activity, but with some national variants. Two specific concerns expressed arising from the review are: a) the lack of communication and mutual consideration between standardisation organisations and b) that standardisation is reliant on input from technology specialists who are employed by the very companies that have vested interests in the outcome of standardisation. Where standards are established in support of legislative processes, such as in the EU, these vested interests may work against the legislative interests.

Industry Dynamics

The standardisation of INs has had a significant impact on the traditional relationships between Operators and Suppliers; relationships built over many years and underpinned by the deployment of proprietary equipment. Few authors seem to have addressed the issues arising from the breakdown of these relationships and what little there is provides an important foundation for this research.

Mansell is one of the few authors to have addressed the influence that Intelligent Network technology can have. In her 1990 article she discusses the impact of INs upon company structure. She identifies that the standardisation bodies act as:

> '...active contributors to the resolution...*of the disagreement*...between technology and institutions' (Mansell 1990).

In essence, the value of telecommunications technology as a tool for a company increases when it is standardised. Mansell suggested that to maximise its benefit, the technology should be integrated into the way the company does things, such as the company (administrative and financial) restructuring to reflect the telecommunications technology used. Others see similar benefits with Intelligent Networks, e.g. '...intelligence in the network is a weapon' (PN 1996).

One of the points Mansell identified was that (at the time of writing) the US emphasis was on regulation not technology; possibly a reference to the cost model applicable to the telecommunications environment in the US at the time. This took the form of a penalty tax applied to Operators who were making excess profits, with a view to encouraging lower customer charges (Bishop et al. 1995). The policy may have achieved this to a limited extent, but also encouraged internal inefficiencies with the result that the US eventually altered its regulatory cost model to one that more closely aligned with those appearing in Europe. However the policy also encouraged investment in the areas of technological development, such as INs.

From an end-user company perspective, IN technology has never really captured their imagination (interview Russell 1995). Results from a study undertaken by the Economist Intelligence Unit showed that companies did not feel IN was a very important technology impacting upon their telecommunication requirements, placing it after ATM, ISDN, wireless and Computer Telephony Integration (CTI) (EIU 1996). The architecture of CTI however, although using totally different (mainly proprietary) standards, looks extremely similar to INs, having centralised intelligence and databases (Shepherd 1998, Shepherd 1999). Melody (1995) felt that INs, together with Microsoft's drive in the personal computer applications market, could be the incentive needed to merge the two technologies

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[11] The 2002 references for ETSI and the ITU-T, present the latest organisational structure of these

and bring greater control to the user. In practice Microsoft's Telephony Applications Programming Interface (TAPI) interface has never made real in-roads into the CTI market, let alone the IN applications market and has been developed by Microsoft to offer their own Internet based telephony service.

In a subsequent study, Mansell proposed two models with which to analyse the alternative views of the trends in telecommunications (Mansell 1993). These were the:

- Idealist Model - a demand-led industry, stimulating collaboration and free market;
- Strategic Model - where technology is not sufficient to drive a competitive market and regulation is introduced.

The work included a review of the implementation of the INs being developed in key European countries and discussed the various Operator viewpoints and where their strategies appeared to be taking them. This study was of benefit in that it acted as a historical reference source for the deployment of INs, indicating the importance of considering the impact of proprietary legacy networks in the new standards-driven environment.

It was decided for this research, to develop elements of Mansell's book to another level, i.e. that regulation via a standardised model was not the ideal basis of analysis, since it assumes as a baseline that the model will be adopted by all. If other models were preferred and implemented two key points would arise; either companies would be made to force-fit the model, i.e. they would be made to apply an IN model inappropriate to their company strategy, or the model they had already adopted might not fit the regulation and they could find themselves force-fitting the legislation, i.e. they would be developing interfaces solely to meet the needs of legislation.

Regulatory Environment

Much has been published regarding regulatory environments, for example Baldwin 1938, Robertson 1947, Beesley et al. 1989, Davies et al. 1990, TMA 1989, all providing valuable insights into the UK regulatory framework. Of special importance is OFTEL's annual

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organisations.

management plan (e.g. OFTEL 2001) that summarised the previous year's work and identified the areas under study in the coming year. For a number of years (1994 - 1996) the management plan identified INs as an important area of study, but ultimately nothing strategic was achieved (interview Newman 1997).

Information pertaining to open interfaces and interconnection was contained within the UK Operator licences of which (until 1998) there were three major variants: the BT licence (DTI 1991a); the Mercury licence (now Cable & Wireless) (DTI 1991b); and the Cable TV company licences (e.g. DTI 1993). Long (1988) has analysed the BT and Mercury licences in detail, however the 1998 Competition Act has made many sections superfluous and these have been omitted from the later amended licences.

As far as this study was concerned, the key sections of the licences were B3 and B5. Section B3 gave the Director General of Telecommunications (DGT) the power to specify the interconnection interfaces between telecommunication networks that Oftel considered to be essential for interoperability. The interfaces had to be to an international, European or other (DGT specified) standard and had to ensure that network security was not compromised, services not degraded and any intellectual property rights protected.

However, Section B5 stated that the Licensee was not obliged to conform, if it would necessitate the Licensee purchasing equipment incompatible with their existing network elements. However, the Licensee should incorporate the introduction of the interface into its development plans provided the cost is not excessive compared to the accompanying benefits.

The implications of these conditions were that OFTEL could have denoted IN interfaces as a suitable point of interconnection and compelled Operators to open them. However Operators with proprietary IN designs and not wanting to upgrade, could have used generic arguments, such as compromising their network security, to resist such an action[12].

The EU holds a large amount of reference material, both in its resolutions and the minutes of numerous meetings, which gave an idea of what was being considered and discussed.

For instance EU (1993b) summarised the position of the Council of Ministers on the proposal to mutually recognise telecommunications licences operated by other countries as something to work towards, but not being immediately achievable.

Without mutual licence recognition the process of expanding a telecommunications network operation into another country would be slow. More importantly, the inequalities in licence conditions between the EU Member States could have given an unfair advantage to some Operators. For example, BT in the UK was not allowed to offer TV services over its local loop (with a few exceptions), whereas Deutsche Bundespost Telekom (DBT) in Germany was. Thus if DBT attempted to enter the UK Cable TV market in the UK they would not have been in competition with the dominant legacy telecommunications Operator. However, if BT entered the German cable TV market, it would be in direct competition with DBT, the dominant legacy Operator in Germany[13].

In 1990 the EU commissioned a study with a view to determining the case for a pan European IN (ETCO 1990). The study sought Operators and Suppliers views regarding the importance of INs and the feasibility of opening interfaces in line with the EU Open Network Provision (ONP) directive (EU 1990)[14].The study recommended opening the Service Control Point to Service Data Point, Service Management System to Service Control Point and Intelligent Peripheral to Service Switching Point interfaces (reference Figure 2.2). Another recommendation was that ETSI should concentrate on standardising the operation of three basic services with a common EU wide access code to these services. The study also identified that a standardised IN would not be available until about 1996, by which time there would have been substantial investment in proprietary INs and thus a reluctance by the Operators to migrate towards a standard IN, despite its advantages. These proprietary INs would be mutually incompatible (ETCO 1990). The study went on to say:

> 'Even at that time no regulation could take place, because of the huge investment that will have been already made. Therefore ONP cannot be applied to network architectures or interfaces for an intelligent network' (ETCO 1990 p68),

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[12] Some Operator did use this argument, although not on an individual basis, but in response to the DTI (1991) survey.

[13] In practice DBT was made to separate its cable TV business from its telephony business by the late 1990s.

[14] The Open Network Provision directive was developed as an evolution of Article 100 of the Treaty of Rome. It comprised a programme of regulation to allow access (i.e. interconnection) to public telecommunications networks. The directive prompted a review of the telecommunications sector and ultimately resulted in a Resolution to liberalise EU voice services by 1st January 1998 (EU 1993).

and finally,

> 'Opening one interface is a political matter, which has to be thought of independently of the completion of (the) standard' (ETCO 1990 p69).

Looking at the recommendations made and how the working-group structure and standards progressed within ETSI, it appeared that those recommendations made by the ETCO (1990) survey, for concentrating on standardising selected interfaces and services, was followed.

In 1992, in preparation for EU discussions on the topic, the DTI sought stakeholder views concerning IN interfaces to be opened and why (DTI 1992). The general findings of the report were that:

- Service Providers saw no problem in opening the higher level interfaces;
- BT (the incumbent Operator) did not want to open such interfaces if resilience issues were not addressed;
- Other Operators and Suppliers took a position between these two.

Three areas (both explicit and implicit) of the report gave cause for concern. Firstly, the survey adopted the ITU-T standard IN architecture model as the basis of discussion, ignoring other variations that Operators might wish to implement. Secondly, some Suppliers' IN architectures (e.g. AT&T Technologies, now Lucent) incorporated proprietary interfaces even though they conformed to the standardised model. Hence regulations to compel an Operator to open a particular interface might be impossible if the Supplier did not want to make it open. Opening any proprietary interface for inter-connection or inter-networking would have required substantial investment[15]. A third area of concern was that if an Operator did implement a standards-based IN, then opening interfaces could have created security and resilience issues. Inappropriate messages passed

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[15] A licence condition effectively states that Operators should not be made to open interfaces that infringe IPRs. However, as will be explained in Chapter 5, new services categorised as Supplementary Services Business (SSB) by OFTEL, had to have an open interface to allow other Operators to similarly offer the service. If the product implementation was via a proprietary IN, then assuming the supplier would have allowed the interface to be opened, interworking would have been difficult owing to its proprietary nature. This would have negated the purpose of opening it. If the interface did not provide an open interface, the new product was likely to be blocked by OFTEL.

over that interface, such as the improper arming of SSP triggers, could have caused an Operator's network to fail (interview Spindley 2003).

Alwyn Thomas (a leading member of the team that wrote and evaluated the responses to the 1992 DTI document), stated during an interview (1994b):

> 'What we *(the government)* want is open access and for the customer to be able to buy from a range of providers. We want ETSI to develop standards on points of interconnect; it is not the government's role to open the SCP, we want the facility to do this'.

At another point in the interview he said that

> '...the EU *(DG12)* have given a mandate to ETSI on ONP to study and develop suitable interfaces, which includes IN....the government enable standards to allow interconnect to happen'

This view of the EU mandating ETSI was confirmed by Banfield (interview Banfield 1994).

IN 1993, KPMG were commissioned by the EU to continue the 1990 ETCO work (ETCO 1990) and to provide:

> 'A clear architectural model of the INs in Europe...based on the current state of technological development and standardisation work' (KPMG 1993).

The report made a number of recommendations covering standardised open interfaces, target dates for the implementation of common services and the application of full open standards by 2002. However, the most radical element of the report was the regulatory IN model proposed, which defined a relationship between the different stakeholders and the different types of services offered (KPMG 1993). The inference was that categories in the regulatory model could be mapped to areas in the architecture model.

It has been difficult to determine how the KPMG report was received, even though the DTI convened a special meeting to consider it. John Leeson (BT) (interview 1995) suggested that the report was fundamentally flawed. He felt that the rigid definition of which interfaces should act in support of Regulation, was inappropriate for a variable operating model. For example, stakeholders would not fall neatly into the categories defined in the report. Their categorisation would vary according to their products and as their strategy changed.

In the years following these studies, regulatory work into the opening of IN interfaces decreased. For this reason I interviewed representatives of both OFTEL and the EU telecommunications directorate to determine their latest thinking.

Dr. David Newman (interview 1997), Oftel's Deputy Technical Director, stated that

> '…it is not usually the case that the internal network configurations of regulated entities are a subject of regulatory intervention, only the end product',

and

> 'Any requirements to provide interconnection of such services could be argued to reduce the incentive to innovate, since the benefits of a company's innovation are distributed across other network Operators'.

However he went on to say that this only applied to non Co-operative Network Services[16] (such as 'Call Waiting'). Co-operative Services (such as 'Ring Back when Free') required a co-operative capability between the call's originating and terminating networks, including at the point of interconnect. 'OFTEL believes that this category of service should be subject to continued interconnect regulation' (interview Newman 1997). Given that the Economist Intelligence Unit felt that 'As network intelligence advances, the distinction between "network" and "services" is becoming increasingly blurred' (EIU 1996 p75), this course of action might not remain appropriate in the long term, but it does indicate that by 1997 OFTEL did not think it appropriate to open 'internal' IN interfaces except to ensure specific service interworking.

It was also within OFTEL's remit to ensure an Operator's network integrity was not compromised from either internal failure or external attack. In Europe this was known as an 'essential requirement' (Walker 2001). Knowledge in this area was mainly subjective. Should an Operator have used this argument for not wanting to open an IN interface, the outcome would probably depend on how much OFTEL wished to believe them. OFTEL therefore needed to achieve a balance between encouraging competition and protecting network integrity. The problem of opening interfaces yet ensuring reliable network operation, was one the research sought to investigate.

In practice, OFTEL did not retrospectively force the opening of IN interfaces to existing services. However new service offerings that were judged to fall within the Co-operative Network Service, or Value Added Service categories, were required to have an open declared interface approved by the Network Interface Co-ordination Committee (NICC)[17], so as to allow for interconnection by other Operators. Over time, it has been found that this mechanism has encouraged Operators to voluntarily open IN interfaces. Network integrity is ensured by restricting messages to just those required to implement the service.

Given a large number of services, each with a corresponding set of permitted messages, there is no way to guarantee network integrity. Messages permitted for one service could be applied and hence permitted for another service which may not require it. For instance, a message retrieval service requires digit capture in order to communicate with the messaging service. If the request for digit capture is applied to a 'least cost connect' call, then there is a potential security problem should that customer be using the call to access an automated banking service. A Service Provider offering both services could apply a capability from one service inappropriately to a second service, whether by accident or for fraudulent reasons. Stakeholder views on the question of network integrity formed part of this research and are addressed in subsequent chapters.

The liberalisation of the European telecommunications market in 1998 caused other Member State Operators (such as France Telecom) to enter the UK market. The NICC allowed their contribution to UK technical discussions in the same way as any other UK network Operator. It is unclear however, how the NICC would have reacted to a potential contribution of an Operator or Regulator from a Member State, who did not have an

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[16] Non co-operative network services were those where although a telephone call may span more than one Operator's network, information was not required from the second network to allow it to work.

[17] The NICC was set up by Oftel to agree national standards and national variants of European standards (which themselves were typically European variants of International (e.g. ITU-T) standards). By this means, the NICC was part of the European Regulatory process. Chapter 5 discusses the role of the NICC in more detail.

interest in directly interconnecting to a UK Operator, but who would be seeking to harmonise the standards in the two countries.

The EU stance appears more liberal than Oftel's. Dr Peter Scott, Director of the Telecommunications Regulatory unit in Brussels, indicated that the regulatory framework to be put in place for the 1998 liberalisation of the telecommunications sector in Europe, was basically neutral with regard to the underlying technologies used. The EU legislation made no specific mention of Intelligent Networks (interview Scott 1997).

Hawkins (1995a) identified that for standards to be used to support liberalisation, they should be guided and imposed. Although voluntary standardisation could achieve the same end, they increased the 'measures of uncertainty as to the possible outcomes' (Hawkins 1995a citing Breyer 1982 & Reddy 1990). The reason for this was that voluntary standardisation was

> '...frequently subject to a range of internal and external pressures that are beyond the direct control of governments and publicly accountable regulatory agencies' (Hawkins 1995b).

Those applying the regulation may find that a less than ideal outcome produced via voluntary standardisation would not be correctable (Baggott 1986). A strong case can therefore be made for de jure standardisation in support of regulation.

With the liberalisation of telecommunications, regulation of the telecommunications sector within the European Union has shifted focus from administrative and operational matters to commercial practices and market structures.

Hawkins (1995a) described the EU Telecommunications liberalisation situation as

> '...a set of regulatory institutions...now being constructed in order to 'regulate' for the first time a set of new or evolving commercial and industrial relationships.'

This statement led to the question of whether the regulatory institutions (the EU Member State telecommunications Regulators), operated in harmony with the EU's best interests, or acted for their own individual Member State interests.

The EU Commission however, began to take-on this role from a Supra-national level. European trans-border alliances between dominant Operators were used by the EU to force the removal of a particular country's dispensation[18] (where one existed) to delay liberalising of their networks beyond 1998 (interview Corkerry 1997). This is of interest since the Member States who applied for and were granted, the dispensation by the EU were effectively in conflict with (typically) their dominant provider who wanted the dispensation dropped and liberalisation applied on time, in order that the EU would approve their joint venture. Similarly, the Federal Communications Commission (FCC) in the US forced the EU's hand by demanding open interfaces for US companies in Europe, before EU companies (e.g. Concert) were allowed access to the US Telecommunications market (interview Guram 1995). These 'tit for tat' negotiations were eventually superseded by the World Trade Organisation's telecommunications sector agreement, the arrival of the liberalised market in 1998 and a downturn in the 'bull-market' prevalent at the time, making joint ventures less attractive.

Summary

The public literature provides extensive coverage of the basic operation of INs, whereas details of the discussions leading to the key decisions can only be found within the 'grey' literature. All this literature however, is premised on the ITU-T standardised IN model, Unsurprisingly, the ITU has based all the development of its standards upon it. The research investigates the assumption that the ITU-T IN model is the most appropriate.

The literature additionally discusses the operation of the model's standardised interfaces and their capabilities, but lacks discussion on the operation of these interfaces in a 'hostile' environment. That is, one where a third party, not directly suffering the consequences of its action, might be careless in the messages passed across that interface, or how they use that interface.

Material relating to the standardisation process and the use of standardisation in supporting regulation was weak. With the increasing influence of the EU, the standardisation process essentially moved from a National to Supra-National level, with Europe developing its

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[18] Dispensation granted by the EU Commission, allowed a number of Member States to delay implementation of the 1998 telecommunications service industry liberalisation process until beyond the year 2000.

variants of international standards. Ironically, this did not negate the need of Member States to produce their own variant as before, so the process has effectively inserted another level of bureaucracy rather than replacing an existing level.

Working documents pertaining to the interest groups of the standardisation bodies (e.g. ESTI, ITU-T) show that these groups are dependent upon the technology specialists released by the telecommunications companies. This raises the question as to whether these specialists are able to act independently of the vested interests of their employers and therefore whether the resulting standards might frustrate the goals of the regulators.

Little of the public literature directly addresses the key questions relating to regulatory policy issues associated with Intelligent Networks. As a consequence more basic data collection techniques have been employed, or adapted, to gather evidence in support of this research. The research literature and methods are discussed in the following section.

2.3 Research Methods

The literature covering research methods is extensive, hence the approach adopted is to provide an overview of the strategies and categorisations that might be applied to this research and to review the most promising material in greater depth.

Postal surveys and interviews emerge as the most suitable methods of data collection. This raises the related questions of identifying appropriate candidates for interviews and surveys such as to ensure a representative cross-section of interest groups and ensuring data validity.

Overall Strategy

An important outcome of the literature review was the clear mismatch between the views of the regulators and practitioners as regards the ease of interconnection of Intelligent Networks. Thus the goal was to identify and understand techniques that would allow the diagnosis and exploration of the issues associated with interconnection, determine how they were manifest and how they were addressed within the regulatory decision-making process. This would lead to identifying the consequences of inappropriate implementations.

In reviewing the research methods literature, it was found that a number of standard research texts contained extensive treatment of relevant methodologies. As such these form the basis of the discussion presented here, supplemented by the findings from other authors where appropriate. Given the vast range of techniques available, only those that might be relevant to the research area are discussed in this section.

One of the standard research texts identified is that by Bailey et al. (1995). They use the terms ‘pure’ and ‘applied’ to distinguish between research that ‘finds things out’ and research that makes a ‘recommendation for action’. Whilst this research may well ‘find things out’, that is not its primary goal, as established by the hypothesis set out in the introduction. Rather this is ‘applied’ research that will define a set of ‘recommendations for action’, even though it lacks a specific customer to implement such actions.

The idea of the consideration of variables is explored by Bailey et al. (1995). These include:

- The Independent variables - assumed to be part of the cause of a dependant variable;
- Intervening variables - acting between the independent and dependent variables.

Identifying the variables of the research helps to identify the areas which need to be investigated. For instance, the Independent variables could be identified as being the Value Chain elements, telecommunications market sectors etc. (i.e. equipment Suppliers through to product user); Intervening Variables would include the standardisation and regulations bodies.

Yin (1988) considered a number of definitions of research designs. He summarised this simply as '...what questions to study, what data are relevant, what data to collect and how to analyse the results' (ibid p29). By way of example, he identified that studying an organisation necessitates expanding the boundaries of the research to other organisations to gather meaningful data and by comparison with the actions of the other organisations, decide if the actions of the organisation being studied are appropriate.

A parallel can be drawn with the Intelligent Network technology that forms the basis of this research. It has two key Call Models developing world-wide, the ITU Capability Set (CS) and ANSI's Advanced Intelligent Network (AIN). Doing what Yin suggests and examining the forces influencing both models, would double the quantity of work and increase the scope of the research. It is therefore better to draw appropriate comparisons with the US AIN model, rather than replicate the whole study.

Howard et al. (1989) introduced the terms Primary and Secondary Data to distinguish between that collected by the researcher directly from the source (Primary Data) and that published or collected for another reason, such as for previous research (Secondary Data). In relation to the thesis, the literary review (Secondary Data) was used to develop an Hypothesis and Primary data used to contribute to the debate surrounding that hypothesis.

Bell (1989) identified a number of styles of research, including Experimental Style. Typically this is where a model is developed and tested to determine if it meets specified criteria. She suggested that such research can determine cause and effect, but has to be treated with caution. Elements of this style are relevant here, in that this research set out to test alternatives to the standardised IN model, using a questionnaire survey. The aim was to determine stakeholder acceptance of the model, not causal factors, so Bell's caution is not apposite.

Case Studies are another technique Bell (1989) discusses, typically for researching a situation that has occurred and hence able to be well defined. They are used to determine the interaction of factors which caused the situation to occur and hence are a means of identifying key issues. Yin (1988) splits Case Studies into three categorises. He describes these as:

- Descriptive - describing the sequence of events over time;
- Explanatory - investigating a situation identifying the causal relationships;
- Exploratory - investigating a situation to develop ideas for further study.

Thus the literary review - gathering background material, is essentially Exploratory research, used to develop a hypothesis.

Yin (1988) followed the three purposes for Case Studies with six composition structures appropriate to one or more of the three purposes. Two of the composition structures proposed were:

- Linear Analytic - the standard method of stating the problem being studied, the methodology, the data collected and the conclusions etc. He explains that in the case of an Exploratory purpose, it would cover '...the issue of the problem being explored, the method of exploration, the findings from the exploration and the conclusions' (ibid p138);
- Theory Building Structures - where each section contributes a part to the theoretical argument.

The traditional structure of a thesis follows the Linear Analytic composition structure, this being identified as appropriate for an Exploratory approach. However within this a 'Theory

Building' Structure was used, in which each chapter addresses a new part of the theoretical argument being made.

Survey Questionnaires

Bell (1989) identified Surveys as a valid research tool to gather primary data, through the answering of questions. The data can be gathered in a structured manner, allowing quantitative analysis to be undertaken, trends identified and comparisons made. She indicated the importance that:

> '...all respondents will be asked the same questions in, as far as possible, the same circumstances...*and*...careful piloting is necessary to ensure that all questions mean the same to all respondents' (ibid p8).

She adds a caution that the technique often fails to identify causal relationships.

Bailey et al. (1995) similarly discussed data gathering through the use of questionnaires and their value in addressing a large sample. They introduce and discuss the difference between open and closed questions, with closed questions having a scalable response, allowing subsequent quantitative analysis. Check questions are mentioned, enabling a check on representativeness and also the need to pilot the questionnaire to check that the questions are easily understood and are likely to achieve their aim. They identified that postal questionnaires

> '...result in low rates of return, often below 10 per cent. What's worse is that the people who do complete and return the questionnaires are usually unrepresentative of the sample from whom you wanted to collect information. The only time you should use postal questionnaires is where you have already gained a firm commitment from the respondents to complete them' (ibid. p21).

Unfortunately telecommunication exchange Suppliers are global companies with their areas of expertise spread around the world. It would not be practical to physically visit them and there would be language barriers to overcome. Despite Bailey et al.'s recommendation against using postal questionnaires, it was considered appropriate to use them as a primary source of information gathering, owing to the ease with which many suitable people in different countries, speaking different languages, can be contacted.

This Survey Questionnaires section therefore examines the various aspects of using questionnaire based postal surveys as a means of data-gathering. It discusses means of identifying appropriate participants from the different interested parties, (this information also proving helpful in identifying suitable interviewees). The layout of questionnaires is discussed, as are various means of encouraging the return of questionnaires, together with the validity of the number of responses and subsequent data analysis.

Content & Layout

Bailey et al. (1995) provided a lot of useful information on the structure and use of questionnaires. A key message is that questions should be '…designed to produce information on which future decisions can be based' (ibid. p42). They discuss the use of open and closed questions, identifying that open questions allow freedom of response without imposition, but produce answers that are difficult to categorise; closed questions having the reverse effect. They also indicated that the number of options a question response should have, should be considered with the number of respondents in mind (i.e. the size of the sample). As an example they suggest that 30 'profession' options in answer to the question 'What is your job?' is likely to be meaningless if the survey sample comprises 50 respondents.

Scott (1961) does not give much advice on the structure of questions, but cites an example to illustrate the potential gains of closed versus open question types.

> 'When the question "Where did you go for your vacation this summer?" was replaced by "Did you visit New Hampshire this summer?", response increased significantly from 17 per cent to 28 per cent' (Scott 1961 citing Heath 1950).

The postal questionnaire survey was aiming to gather data relating to the importance of different architectures and IN interfaces and hence quantitative analysis derived from closed questions was determined as the most suitable approach. However the problem with closed questions, is that an important point may be missed, so respondents were also given the opportunity to add their own answer if there was not one close enough from the selection given. This was considered to be a good compromise between gathering data able to be easily analysed and yet not missing any of the key points.

Similarly the number of options in answer to a question were considered and minimised or worded such that they could be grouped into higher level categories at the analysis stage.

Bailey et al. (1995), Bell (1989) and Raimond (1993) all suggested piloting questionnaires so as to identify problems arising from omissions, misinterpretations, confusion and length and to validate responses against expected outcomes.

Trialling was conducted in two stages. The first stage was to trial a draft questionnaire with a small number of people with knowledge of Intelligent Networks, but who would not form part of the final sample. This checked clarity, content and length of the questionnaire and allowed changes to be made without invalidating any responses from the sample. The second stage, or final check, was a pilot survey with a small selection drawn from the sample population. The idea was that if no changes were needed, their answers could be considered with the responses from the sample population as a whole.

Scott (1961) interestingly, identified no apparent benefit in varying the length of a questionnaire, but cited other experiments that indicated that questions capturing the respondent's interest encouraged completion, allowing a longer questionnaire to be used (Clausen & Ford 1947).

Scott (1961) also discussed the format of the covering letter with the questionnaire. Although he did not note any effect from the font and type size, he concluded that a

> '...two page questionnaire attracts a better response than a single page (94.8% compared to 93.6%), this improving again if the questionnaire was put on the reverse side of the covering letter (95.8%)' (ibid.1961).

He cited Seitz (1944) as also finding a two-page questionnaire more responsive than a single page.

It was therefore decided to keep the length of the questionnaire to two pages, as suggested by Scott and to space the questions fairly generously to encourage responses. Although Scott did not find a reduced response from longer questionnaires, more than two pages was thought to look daunting. A further thought was to use folded A3 paper for the questionnaire, this looking neater than stapled A4, but this was rejected owing to the inability to fax the responses.

Encouraging a Response

Scott (1961) identified the best way to encourage a response to a postal questionnaire was to '…convince the recipient that his response is really needed' and then

> 'The more interested, or concerned recipients will reply…earlier…but only if they have about the same amount of work to perform in responding as the uninterested' (ibid. p164).

However, he did reject the notion that it is essential to arouse the recipient's interest in order to gain a high response, stating:

> '...this cannot be the whole story, because 90 per cent of those who receive our Poultry and Pigs enquiry, claim to have no such livestock and yet the group responds quite as well as those who have positive information to give' (ibid. p178)

Ehrenberg criticised this point.

> '…*(Scott's)* argument was that in the poultry and pig enquiry 90 per cent of informants had no such livestock and therefore by implication no interest. It does not follow that these 90 per cent did not find the questionnaire "interesting"' (ibid. p196).

Rather than attempt to make the questionnaires for this research interesting to all possible recipients, it was felt more appropriate to select a sample that was likely to have an interest and awareness of Intelligent Networks. Although this initially appears to bias the responses, many of the options for the questions used technical terms that only people with a knowledge of Intelligent Networks could answer, therefore pre-selection was essential. This approach, by default, tended to fulfil the requirement of making the questionnaire interesting so as to achieve a high response rate.

Bailey et al. (1995) identified the options for boosting response rates to (typically) a postal questionnaire as being to:

- telephone;
- send a polite reminder;
- send a second questionnaire; and
- waiting beyond the deadline for late returns.

They were concerned that sending the questionnaire to a second sample '...may threaten the representativeness of ...*the*...sample, since the replacements may not match the originals' (ibid. p193). Despite this, Bailey et al. also suggested increasing the number of responses by collecting additional data through personal interviews, designed to collect the same data as the postal questionnaire. I was personally concerned with the combination of data collected by these two methods, since personal interviews may have injected a bias not existing with postal questionnaires.

Scott (1961) himself generally used two follow-ups,

> 'The first consisting simply of a very short letter, the second another short letter or slip together with the original letter, a second (serially numbered) copy of the questionnaire and another return envelope' (ibid. p164).

He said that

> '...the follow-up is the only technique which has been consistently found to raise response by a substantial amount - say over 20 per cent' (ibid. p178),

and indicated that the time to send the reminder is when the '...returns have almost stopped' (ibid. p166).

When this should be was indicated by Figure 1 (ibid. p159) in his paper. This showed that following reminders, the vast majority of replies (approx. 95%) were returned within two weeks, with the remainder being returned by week 3. He identified that his findings did not agree with a formula proposed by Mansfield (1948) in which Mansfield identified 90% of returns within 2 weeks.

Another method of reminding respondents is to use a telephone call. Scott cites Waisanen (1954) who

> '...used a telephone call with marked success....and the ultimate response rate was raised from 62 per cent to approximately 70 per cent' (Scott 1961 p166).

Scott (1961) also identified Official Sponsorship as potentially being a means of improving the response rate. Although he summarised his findings, he did not come to any conclusion and hence did not offer any direct advice as to whether to distribute postal questionnaires privately or with a sponsor's support. He did however cite the National Education Association (1930) as indicating that educational sponsorship was more successful than private.

In selecting a sponsor to support the research survey questionnaire, there were three options. It could have been sent personally, have the Open University (OU) support it, or have my company support it. Based upon the National Education Association (1930) findings, the OU was chosen as sponsor, adding greater authenticity than if it were sent under my own name. Sending it out under my employer's (BT) name could have seriously restricted the quality and quantity of replies as discussed in the Ethical Considerations section later.

It was felt appropriate to boost response to the research questionnaire, by providing two reminders to recipients, the first being a telephone call after 2 weeks and then a repeat questionnaire after 3 weeks, allowing a minimum of four weeks before analysis. Those not responding were identified by marking the questionnaire.

Scott (1961) felt that putting a stamp on the return envelope, (which he argued conveyed a feeling of a waste of money if it were not used) would also improve the chance of a postal questionnaire being returned. He additionally justified this by citing Ferriss (1951) who indicated a tremendous difference in responses, 66% for stamped envelopes versus 12% for unstamped. It was felt that since letters would be sent to individuals in companies, individually stamped letters, compared to franked letters, would make no difference, so replied paid envelopes were enclosed with the postal survey (apart from those sent abroad where faxed returns were encouraged).

Other suggestions by Scott, such as hand-written notes to convey a personal element, or special delivery to convey a sense of urgency, were considered, but not implemented. My experience with receiving a large amount of unsolicited material is that both these methods are widely practised and have lost any impact they might have. Admittedly the hand writing is not individually written, but actually printed in a different type and colour and the correspondence is made to appear as though special delivery is used whereas this is not the case.

Although the idea of a reward to encourage questionnaire returns was an attractive one, a monetary award as suggested by Scott (1961) was not thought appropriate. A more appropriate one for those returning the postal questionnaire, was to offer a copy of the analysis to those who were interested. Later in the research, I circulated a second questionnaire at a conference. In this case an entry to a draw for a 'bottle' was offered to participants who completed the questionnaire.

However, having suggested many ideas for improving the number of postal questionnaires returned, Scott (1961) gives the warning that '...experience shows conclusions which hold in one may fail with another' (ibid p144), thus indicating that there is no guarantee that applying the methods he proposes will gain the same degree of success.

Ethical Considerations

Bailey et al. (1995) discussed the importance of research ethics and in particular the '...responsibility of the researcher to make sure that the participants are not harmed by the research' (ibid. p4). They identified that in order to maintain ethical standards in research many bodies have developed professional codes of ethics and suggested the typical contents of a personal code of ethics to help researchers develop a code appropriate to their particular research. The code proposed that researchers seek permission from the participants and let '...the participants know how they will be protected if they agree to take part in the project' (ibid. p5), including their right to privacy, confidentiality and anonymity. It identified how to avoid causing harm to the researcher, colleagues, the college, companies and people, involved in the research and identified that the '...risk to those researched must be balanced against the benefits to be gained from the results of any research' (ibid. p20).

Although Scott (1961) emphasised confidentiality and the need to draw it to the respondents' attention in the covering letter, he did not reach a conclusion as to whether anonymity should be visibly demonstrated or not. He cited several references where experiments visibly preserved anonymity whilst returning the knowledge of who had responded. Rollins (1940) used different room numbers on the return envelope to identify the respondent, whilst Hill (1951), Bradt (1955), Cahalan (1958) and Larson et al. (1959) all used a separate letter or postcard returned by the recipient to indicate that it had been returned[19]. Finney (cited by Scott 1961) criticised the use of methods such as invisible ink to track which surveys had been returned. Scott replied that

> ' The deception here is a deception designed to get people to accept the truth - namely that the response will not be passed on' (Scott 1961 p205).

The right to privacy was considered an essential requirement of this research and was easily implemented for a postal survey. The confidentiality of the information provided and anonymity of the respondent and their company in the analysis of the questionnaires, was promised in an accompanying letter. The letter also provided the means for questionnaires to be coded by respondent and hence a method of following-up unreturned questionnaires. This coding allowed the option of responses from a particular company to be compared with those resulting from other sources such as the ETCO (1990) and DTI (1992) trawls for information. Care had to be taken with such comparisons, since there was a small chance that a company could be identified by comparing survey responses with other published information. Obviously, this would break the promise that the respondents would not be identifiable in the survey analysis.

A second ethical consideration was to ensure that the participants had control over what information they provided. This was considered implicit in the actions they took. For instance, if participants did not want to provide information about their work area, they could simply declined to answer the questionnaire, or certain questions on the questionnaire. Interviewees could act in a similar manner in interviews. Thus no specific actions were considered necessary.

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[19] Interestingly in Rollins's (1940) method, the link between completed questionnaire and respondent had been retained, in contrast to the other methods, but this was not drawn to the readers' attention by Scott.

The Data Protection Act, cited by Bailey et al. (1995), addresses issues associated with the storage, processing and security of data relating to individuals. It was decided that individuals' data could be made secure by storing survey data separately from data relating to named individuals, with the records of the two data sets linked by a single numeric code. The two files were password protected, as was the computer system. With these measures in place it was not necessary to register the data.

Participant Analysis

Several of the references indicated that if research is to produce useful information that can be acted upon, then participant involvement is essential. With Mansell (1993) this took the form of interviews with participants having a common interest (i.e. Public Telephone Operators). The Swedish International Development Agency (SIDA 1995) suggested a wider participatory set taking

> '...the form of an open consultation with and between what it calls the principals (the owners and the sponsors) …, its beneficiaries …and its opponents and supporters' (TU870 1997 p40 citing SIDA 1995).

Similarly, TU870 indicates

> '…tight and neat designs constructed with little or no contact with, or serious support from, the groups targeted by the intervention...make the whole initiative untenable' (TU870 1997 p39).

SIDA (1995), TU870 (1997) and B882 (1991) all suggest that identification of participant involvement can be achieved by using Stakeholder Analysis; stakeholders being groups of people who are linked by a common interest.

TU870 (1997) suggested that if a stakeholder approach is adopted, '…decision-makers can make practical trade-offs with a clear understanding of their likely consequences' (ibid. p15). It

> '...addresses this problem through disaggregation of the costs, benefits and risks of different policies and strategies, as well as projects' (ibid. p45).

The examples cited indicated that Stakeholder Analysis helped achieve the resolution of a problem by identifying all those who were involved in the situation associated with the problem. However, Montgomery (1995a) warned against categorising participants into a particular stakeholder group and assuming that they all conform to the thinking in that category,

> '... within any of these, there are sub-categories of stakeholders with differing interests which may or may not be prepared to subsume in the general collective interest' (ibid. p2).

This warning was reinforced by TU870 (1997)

> 'Where externalities exist and where hidden agendas differ from written ones as in the case of institutions, differences between sets of stakeholder interest, or between stakeholders and society, may be considerable' (ibid. p15).

But TU870 maintained that Stakeholder Analysis is still appropriate '...in situations where there are considerable differences between different sets of stakeholders' (ibid p44).

However, to perform a Stakeholder Analysis the drivers have first to be defined. The Futures Group (1994) proposed the use of a Relevance Tree, such that a broad topic is decomposed in an hierarchical fashion so as to present a clear description of the problem.

Montgomery (1995b) detailed a three-stage process for a comprehensive Stakeholder Analysis contributing to project design:

- 'Stage 1: Understanding a project's various stakeholders';
- 'Stage 2: Drawing out assumptions and identifying opportunities';
- 'Stage 3: Feeding the findings into the project design process' (ibid. p8).

TU870 proposed the following Participation Analysis Matrix (Table 2.1) which could be used in Stage 2 of the above process (TU870 1997 p40). This categorises the stakeholders in order to determine their interest and power.

Active Institution	Active Interest Group
Non-Active Institution	Non-Active Interest Group

Table 2.1 Participation Analysis Matrix

The differing methods of Participant/Stakeholder Analysis are all ultimately directed at conflict resolution. As such they are not always appropriate to areas of research which seeks to gather data and identify conflict, rather than resolve it. However, as part of their problem-resolving process they employ a structured method of identifying participants, data gathering and analysis and it is this aspect of Stakeholder Analysis that appeared useful.

In adopting this approach, care must be exercised regarding the existence of sub-groups, perhaps with hidden agendas, within the larger group. Within this research for instance, members of the group 'Telecommunications Operators' are in fact in competition with each other and therefore unlikely to subscribe to the same set of issues.

Grimble et al. (1994) suggested that such 'Conflict[20] situations could occur at both micro and macro levels and between levels' (ibid. p9) and proposed a tabular technique to classify the trade-offs[21] and conflicts that exist (Table 2.2).

Matrix	Stakeholder 1	Stakeholder 2	Stakeholder 3
Stakeholder 1	±(1)	▨	▨
Stakeholder 2	-(2)	-(2)	▨
Stakeholder 3	+(3)	+(3)	-(4)

+ Complementary Aim
- Conflicting Aim

Table 2.2 Inter-relationship Matrix

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[20] 'Conflicts are situations of competition and/or disagreement between two or more stakeholder groups '.(Grimble et al. 1994, p7)

[21] 'A trade-off is the process of balancing conflicting objectives. A trade-off therefore arises when a stakeholder or stakeholder group faces several objectives ... which cannot simultaneously be achieved.' (Grimble et al. 1994, p7)

This inter-relationship matrix is a two dimensional matrix with the same stakeholders on each axis to plot the interrelationships. 'A (-) is used to indicate a conflict and a (+) to indicate complementary aims (ibid. pps.12-3). The numbers in brackets related to accompanying notes explaining the complementary or conflicting aim. Such an approach is very similar to the Force Field analysis technique proposed by Lewin (1951) and Majaro (1988), in which the balance of a number of opposing forces creates the situation under examination. The priority for this research is the source of these forces, so as to ascertain whether they are conflicting or complementary and for this reason is probably best served by Grimble et al.'s (1994) approach.

The Relevance Tree approach was used for the initial identification of the stakeholders involved in this study. Further refinement of this framework utilised the participation analysis matrix proposed by TU870 (1997) and the Inter-relationship Matrix used by Grimble et al. (1994). Using these in conjunction with (an amended) Montgomery three-stage process created a lead-in to the research.

Selecting a Sample

Bailey et al. (1995) identified a number of techniques for progressively classifying a population and then selecting at different levels until the individual is identified. The first four types of sampling identify the population:

- Quota sampling: 'representing different groups in the proportions in which they occur in the population' (ibid. 1995 p89);
- Cluster Sampling: selecting a group within a population and sampling the group;
- Opportunity Sampling: limiting the sample to those who are accessible;
- Connoisseur Samples: asking others who the sample should be. (An example would be asking who are good managers and using the people identified as the sample.)

The next stage covers three methods of sampling to identify individuals within the chosen population:

- Random Sampling - with every member having an equal chance of being chosen;
- Systematic Sampling - where every nth member is selected;
- Stratified Random Sampling - where the population is subdivided into smaller groups of interest and then a random selection is made from these groups (Bailey et al. 1995).

Stakeholder Analysis was used to identify the key groups to be sampled, the 'Clusters' defined by Bailey et al. (1995) and from within these groups individuals were selected. The method of selecting individuals within these groups reflected the potential number of candidates within a group. For example, since there are very few telecommunications exchange Suppliers world-wide, only one subject was selected from each Supplier. For the larger groups such as Operators, the technique of stratified random sampling was employed.

In the case of candidates for interviews, connoisseur samples were employed, investigating who were the key decision makers and seeking to employ them in the research. Additionally there was a level of Opportunity sampling, taking advantage of those who were accessible at a certain point in time.

Analysis - Response Rate

Scott (1961) reported that response rates for his postal surveys were

> '...between 80 per cent and 90 per cent, up to 1956, however, every such successful survey reported had sampled a special population' (ibid. p144).

He also noted that lower response rates to postal questionnaires (apart from misaddressing/ misdelivery etc.) were obtained from those who had a '...lower mean educational average...*or*...lower status' (ibid p157) (defined by income and certain material possessions) and older women and younger military personnel.

Bailey et al. (1995) indicated that even with chasing, postal questionnaires usually result in low rates of return, often less than 10% and recommend that the only time postal questionnaires should be used is when

> '...you have already gained a firm commitment from the respondents to complete them...*and*...where (usually), you are collecting information from a small number of people and don't have time to interview them' (ibid. p63).

Despite the pessimism, the 10% figure quoted by Bailey et al. (1995) still seemed high compared to the 1% rate of return achieved for many marketing campaigns quoted by Thompson (1990).

Scott's (1961) reported response rates, I suspect, reflected the era in which he lived. The public indifference to questionnaires appears to have increased, as reflected in the lower response rates cited by Bailey et al. (1995) and Thompson (1990).

Drawing from these lessons, the approach adopted for this research was to ensure that the survey had some intrinsic interest to the respondent and to select respondents with an appropriate level of technical competence. Given that the goal of the surveys was to establish the position of organisations rather than individuals, non-respondents could be substituted by another candidate from within the organisation, thereby boosting the response rate.

Analysis - Validity

Consideration was given to the validity of data gained as the result of the questionnaire surveys, since it was important to assess that the data gathered was representative of the industry/industry sector views as a whole. Scott (1961) found that

> '...the mail survey is about as accurate as the interview for obtaining data on occupational class but the mail survey gets a substantially larger proportion of unclassifiable responses and these tend to be biased towards the less skilled occupations' (ibid. p183).

This was not felt to be a problem. By targeting the questionnaire at the technical community, the population did not by default, fall into the 'less skilled' category.

Scott additionally found that '...there is some slight evidence that socially less acceptable responses are more readily elicited by mail questionnaires '(ibid. p183). Although the questionnaires produced for this research did not have a social element, it might have been considered to have had a commercial aspect. The questionnaire therefore was probably more likely to elicit a response to such questions than an interview.

Bailey et al. (1995) said that non-response was a problem in that

> '...people or organisations do not....refuse to co-operate at random,...non response rates of more than 20% usually undermine any generalisations that can be drawn' (ibid. p49).

I do not feel this is applicable here. If the recipient of the postal survey was uncooperative and did not return the survey, the problem was addressed by targeting someone else in the same organisation. However if an organisation has a policy of not answering questionnaires, then this method would not work, but such a situation was considered random within the population group of companies as a whole.

Raimond (1993) and Bailey et al. (1995) cautioned that those who respond to questionnaires are of a different mind-set and could therefore bias results. Whilst a valid concern, it was not felt applicable to this work, since there are numerous reasons for not responding. For example, a respondent may well have other priority work, might lack technical understanding, or simply lose interest, all of which are random events acting upon the population as a whole. Also conflicting with Raimond and Bailey et al.'s (1995) views is Fox's (1990) assertion that provided there is a minimum of 25 in sample, then the results are a good approximation to the whole population.

Interviews

Interviews were felt to be an important means of gathering data, both in the early stages as a means of supplementing the literature in identifying the problems and issues to be researched, and in the latter stages to identify topics of interest to be explored in more detail. The literature offers clear guidelines regarding the types of interview that could be undertaken and the ethical aspects of interviewing.

Bailey et al. (1995) categorised interviews as being Structured and Unstructured. Structured interviews are those for which a schedule is created and all interviewees treated in exactly the same way, with the goal of quantitative analysis to be performed later. Unstructured interviews allow the interview to develop as it progresses, to better meet the different types of respondents and thus '...allows the respondents to express themselves in their own unique way', making '...more authentic responses ... likely' (ibid. p66). The disadvantage with the Unstructured approach is that opportunities for quantitative analysis are limited due to the uniqueness of each interview. Bailey et al. (1995) gave by way of an example, a mix of 'Structured' and 'Unstructured' interviews used by a researcher investigating the knowledge of drugs among young people. A small number of long unstructured interviews allowed the researcher to gather the issues, gain knowledge of the language used and apply this to develop a questionnaire to be used in short structured interviews.

Interviews would therefore seem to offer a number of advantages during the formative stages of a research study such as this one. Furthermore, the method has a proven track record within the field of telecommunications policy, as evidence by noted researchers such as Mansell (1993). There is however, a need to establish clear 'rules of engagement'. Bailey et al. (1995) suggested a Code of Practice for interviews, to ensure that the

> '...interviewees are fully aware of the reasons behind the research and the part they are going to play in it' (ibid. p68),

in essence forming an informal contract with the interviewee. A Code of Practice should detail the reasons for the research, describe how the information is to be used, establish that anonymity will be guaranteed, set the times and location of the interview and define the interviewee's rights regarding the information gathered. In addition Bailey et al. (1995) suggest that consideration also be given to other affected parties, such as the interviewees' employers etc.

It was decided to adapt Bailey et al.'s (1995) code of practice to meet the ethical needs of this research environment and to apprise interviewees of the key points of this code at the commencement of the interview.

In recording interviews, Bailey et al. (1995) identified three methods, with the latter two options being agreed with the interviewee prior to the interview:

- Taking verbatim notes: The disadvantages of this method are that it '...slows down the discussion' leading to the temptation to '...omit parts of the conversation' which will '...lead to inaccuracies'(ibid. p70);
- Using a scribe: using a third person to record the conversation;
- Tape recording: the disadvantages being that interviewees may be worried about being recorded, there can be mechanical problems, leading to background noise, reliability etc. After the interview there may be problems with transcription owing to speech being structured differently to the written word.

For unstructured interviews, a tape recording was considered most appropriate, since the flow of the conversation could be maintained, costs were minimised (no third party) and the tape could be transcribed later.

Triangulation

The preceding discussion has identified two distinct methods of data collection, surveys and interviews. This raises the question as to how the collected data is drawn together.

Cohen et al. (1989) stated that '...the use of contrasting methods considerably reduces the chances that any consistent findings are attributable to similarities of method' (ibid. p270). Bailey et al. (1995) suggest that research can use a variety of methods to collect data, similarly leading to greater confidence in the conclusion; they term the process 'triangulation'.

Denzin (1970) listed 6 types of triangulation:

- Time - Cross Sectional: Researching different groups at the same point in time;
  - Longitudinal: Researching the same group at different points in time;
- Space: Researching groups in different cultures so as to negate any cultural bias in investigations;
- Combined levels: Analysing a situation from individual, group and organisational positions;
- Theoretical: Examining competing theories;

- Investigator: Using more than one observer;
- Methodological - Within Methods: attempting to repeat results using the same methods on a different population;
  - Between Methods: using different methods on the original population.

Theoretical triangulation is explored by Yin (1988) in the form of 'Validity Seeking Research' (ibid. p7), in which one sets out to seek and negate rival hypotheses so as to avoid the danger of developing a blinkered attitude. This approach is also recommended by Smith (1975), 'The investigator should be more active in designing his research so that competing theories can be tested' (ibid. p274) and Cohen (1989)

> 'Exclusive reliance on one method, ... may bias or distort the researcher's picture of the particular slice of reality he is investigating. He needs to be confident that the data generated are not simply artefacts of one specific method of collection' (ibid. p269).

The Validity Seeking Research approach initially appeared useful to the research, since it indicated that if interested parties from different stakeholder groups come to the same conclusion, the subsequent focus can concentrate less on the group members and more on the group's target. However, trying to juxtapose the elements of the hypothesis to produce a rival hypothesis produced nonsense statements, which implied for instance, 'standardised customers'. Unless a direct opposite to the hypothesis was adopted, there was a danger of losing the research focus. Taking a direct opposite to the thesis however, would result in the same research being undertaken as was intended anyway. Thus contradictory evidence to the hypothesis was considered as being revealed as a matter of course during the research.

Triangulation in general is a good way of increasing the confidence of the results. The relevance of the different categories of triangulation was considered as follows:

- Time triangulation: Both types of time triangulation were employed. Cross sectional was used in gathering data from different groups, whilst Longitudinal was used in comparing the gathered data with published information, to indicate if stances had change with time;

- Space triangulation was used to remove an element of cultural bias by focusing on stakeholders in Europe, not just the UK;
- Combined Level triangulation was not considered appropriate since the research was only interested at the organisational level;
- Theoretical triangulation was felt inappropriate, for the reasons discussed previously for not adopting rival hypothesis;
- The use of interviews to discuss findings, produced different observational viewpoints, allowing Investigator triangulation;
- Methodological triangulation was not appropriate owing to the overall small population to be sampled.

Yin (1988) offered yet another set of triangulation methods to ensure evidence is gathered from multiple viewpoints, some of these methods overlapping with Denzin's triangulation types. He suggested that evidence is built from 6 viewpoints, Documentation, Archived Records, Interviews, Direct & Participant Observation[22] and Physical Artefacts.

The first three of these (Documentation, Archived Records and Interviews) were considered appropriate, but the remaining viewpoints were not felt appropriate for the following reasons:

- Direct Observation was impracticable since I work for BT. Trying to gather data while a company is formulating a technical strategy would expose commercially sensitive information to the employee of a competitor. However, direct observation was attempted through attending the BT standardisation meetings to determine what was discussed and why the organisation arrived at the stance it did. This yielded minimal benefit, since most of the discussion was conducted by e-mail[23]. Subsequently I found that conversations with the BT representatives on the standardisation bodies were less time consuming and as valuable. But the usefulness of this data was limited, since no comparison at this strategy setting level could be made with other organisations;
- Participant Observation was not appropriate since I was not in the part of my employer's organisation which influenced such decisions. Should I have been

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[22] Bell (1989 p7) terms Participant Observation research, as 'Ethnographic Style'

[23] It is interesting to note that much of BT's Standards strategy was set by employees fairly low in the organisation with minimal guidance.

able to adopted a Participant Observer role there would assuredly have been a potential reduction in trust, when I (as part of the research) sent a postal survey to attendees of some of the European Standards Setting Meetings. There could have been concerns that I was revealing commercially sensitive information to my employers. However, since I was invited to speak at a number of conferences, a certain amount of unplanned Participant Observation did actually occur;

- The use of Physical Artefacts had no place in this context. Nothing could be gained from looking at the equipment; the connections and signalling could only be gathered effectively from an architectural view.

Interestingly the idea of a survey was not detailed by Yin, although it could be argued to fall within Yin's documentation category (i.e. the collection and examination of current information), or could be considered the equivalent to a structured interview. Yin's viewpoints however, did not draw out and hence give consideration to, the sub-categories within them, to ensure a comprehensive coverage of items. This was addressed by the other aspects of Triangulation which encompass and extends Yin's viewpoints.

Cohen et al. (1989) warns that

> '...where triangulation is used in interpretative research to investigate different actors' viewpoints, the same method...will naturally produce different sets of data.' (ibid p270)

but that the benefit is that '...the more the methods contrast with each other the greater the researcher's confidence' (ibid. p270). It was therefore decided that Triangulation would be of benefit to the research and that generally the approach, scope and period of the research would involve a number of Triangulation options.

Validity of Research

Bailey et al. (1995) detailed criteria for judging the validity or the 'correctness' of the conclusions and hence why they might be invalid. These are:

- Content Validity, where the response from certain parties is at variance owing to differing levels of openness. This could be due to inappropriate questions or a variance in the trust shown to the researcher, leading to differing levels of openness;

- Unreliability, where the questions are unconsciously framed to impact a subset of the population to a greater extent than the others, resulting in a bias from that subset;
- Representativeness, where the researched population is chosen such that they have a greater vested interest in the research.

The validity of the data was an appropriate issue to consider for this study. It was approached by thinking how the conclusions could be invalidated and trying to avoid these situations. An example would be a respondent answering the questionnaire in a biased manner knowing I work for BT (and considering BT as a competitor or potential customer etc.) (Content Validity). Such bias was avoided by not volunteering the information that I work for BT, whilst obviously assuring and maintaining the confidentiality of their responses.

Unreliability and Representativeness were also valid issues, since the postal survey questions were worded and the survey targeted, at those with a technical knowledge of Intelligent Networks. However there was no way to avoid this, since this was the only group of people likely to be aware of the issues associated with this technology.

Gosling et al. (1995) identify a further concern,

> '...the work itself may be bringing about change in the environment around it. Any change will have an effect on the work' (ibid. p11).

Nelson (1990) terms a researcher who changes or influences a situation by their data collection and analysis an Action Researcher. Thus the very act of collecting information may directly, or indirectly, change the situation and invalidate the data. This is another legitimate concern, but not one which was felt likely to cause a problem, owing to the number, variety and magnitude of the different forces acting upon the area being researched, negating any influence introduced by the researcher.

2.4 Summary of Research Methods

Reviewing the literature on research methods and techniques identified the need for a research focus, an understanding of the various methods of data gathering and the actions needed to increase the confidence of the data gathered and subsequent conclusions.

For the research to be of practical use it was decided to treat it as 'Applied' research, resulting in a series of recommendations. Primary data gathering was from practitioners and stakeholders related to Intelligent Networks. Their geographical diversity made interviews impractical, thus questionnaire surveys were adopted and applied with ideas gathered from the Methods Research to encourage a response. Interviews were initially used to gather broad ideas and focus the research, and latterly to explore selected issues in detail. Overall the validity of the research was raised by means of triangulation techniques, a number of which occurred by default from the nature of the situation and the duration of the research.

For instance, Space triangulation was valid since many of the practitioners I needed to gather data from, were in many different European countries; and Time triangulation occurred as the result of the period of time needed to undertake this research part-time.

These areas of choice, why they were adopted and how they were adapted for the research, are discussed in Chapter 3.

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3 Research Design

3.1 Introduction

The literature discussed in the previous chapter defines a broad set of research methods and tools that have been applied to policy research and more specifically to identifying stakeholders and establishing their attitudes to the potential regulation of INs. Which methods and how they were applied, form a key part of the research design. This chapter details the methods which were chosen and how they were adapted and combined to create the research programme.

Developing a research programme of this type is by its very nature an iterative process, whereby early tentative decisions are reviewed and refined as the work proceeds. This narrative however, is inevitably sequential and therefore the rationale for some decisions appears after the initial discussion. For instance, the boundary of information gathering (seemingly set early in the research), was set following discussions with end users (i.e. telecommunications service customers), arising as part of the questionnaire trial discussed later in the chapter.

During the research, the investigation frequently checked back to the ultimate aim of the thesis, which was to produce conclusions concerning the research hypothesis:

> *Tight architecture-based regulation is inappropriate for a rapidly changing telecommunications environment, since that environment is continually challenging and redefining the boundaries of technological change.*

To this end questions were '…designed to produce information on which future decisions can be based' (Bailey et al. 1995 p42). The responses to surveys and interviews for example, allowed the consequences of the standardised IN architecture model[1] and hence potential standardisation changes to be assessed. The thesis therefore has a function regardless of its response to the hypothesis questions, with its findings being applicable beyond IN technology.

The research did not adopt any one 'approach', with several being found appropriate depending upon the situation and data gathering process. By examining the standardisation

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[1] The standardised IN model was introduced in Chapter 2 and discussed and is developed in Chapter 4.

and regulatory processes and in particular the way the Operators, Suppliers, Standardisation Bodies and Regulators interacted and did business, the research adopted a Case Study approach (Section 2.3, Overall Strategy). However, presenting the research findings at Intelligent Network conferences shaped a Participant Observer role for the researcher (Chapter 2.3, Triangulation). The findings presented might have influenced the course of IN technological development and hence subsequently gathered evidence. This is particularly relevant over the longer timescales taken to pursue a part-time research degree. Two examples of the influence the research might have had, are an interviewee (interview Alvestad 1997) and a survey respondent (cba1401), which indicated that material I had presented and questions asked had given them information and made them think of issues, of which they were not previously aware. Overall however, it seems unlikely that the research has impacted the future of INs, since it was heavily influenced by key stakeholders with a commercial interest.

A Participant Observer role was similarly played by the researcher in gathering data by participating in BT standardisation meetings, to discuss BT's stance on issues arising from the standardisation working groups. The danger in this case was that researcher judgement may have been impaired, judging observations as typical of the stakeholder group as a whole (Bell 1989). Adopting a BT bias was a danger of which I, as an employee of BT, was constantly aware, since it was the one to which I would be most likely to succumb.

A key influence of this research is the adoption of Triangulation, discussed in the next section (Section 3.2). Within this, the different technologies considered as the basis for the research are explored and how a Stakeholder Analyses was employed, to categorise those with an interest in Intelligent Networks.

The remainder of the chapter discusses the survey strategy (Section 3.3) addressing the layout of the questionnaires, how the recipients were selected and how data were collected and analysed. Finally Section 3.4 discusses the interviewing technique employed and how the early interviews acted as a trial to develop the strategy adopted for the majority of the interviews.

3.2 Triangulation

The research employed Triangulation in order to examine the data from several angles and determine if there was a consistent message/result. This created a broad overall perspective maximising the value of the research. The Triangulation categories considered for the research (using Cohen et al.'s (1989) categorisation for each, as detailed in Chapter 2.3) were:

- Longitudinal Time - the programme of research exhibits Longitudinal Time Triangulation, with data gathered over an interval of time allowing an assessment of the stance of stakeholders over that period;
- Cross Sectional Time (1) - an analysis of technologies employing centralised intelligence was made in order to determine if it was feasible to gather data relating to more than one technology. Consideration was similarly given to the developing Intelligent Network standards to assess the possibility of world-wide gathering data.
- Cross Sectional Time (2) - more than one view-point was employed, involving not only Value Chain members but other stakeholders, for example regulators and standardisation bodies, to gather data and identify concerns and issues;
- Space - the research involved multiple companies from across the European Union, but drew-in evidence from other regions of the world where appropriate, such as the Pacific Rim and North America, to support, to argue against or to illustrate the probable result from certain courses of action etc.;
- Investigator - the results and the conclusions reached from the analysis of data were examined and discussed with others, to ensure correct interpretation;

These categories were developed and incorporated (via an iterative process), into the research programme depicted in Figure 3.1.

Research Programme (Longitudinal Time)

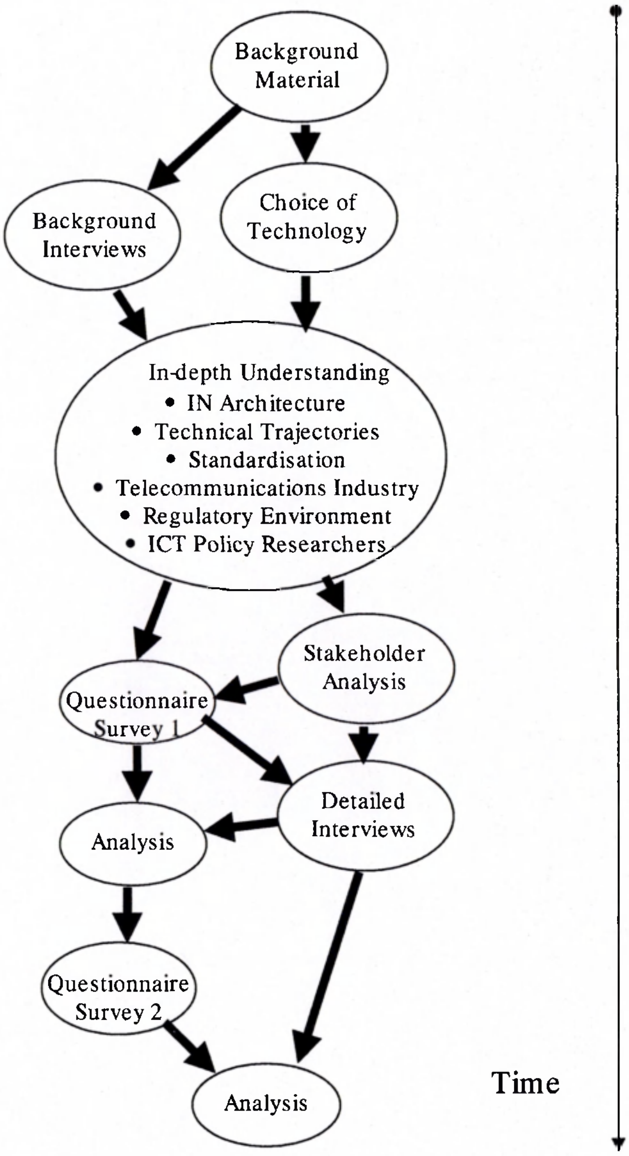

Figure 3.1 A Representation of the Research Process

Gathering and analysing the background material formed the initial step into the research, taking the form of a literary review to help establish the parameters of the research, and define and refine the hypothesis and background interviews to achieve a better understanding of the issues. This led to the development of alternative Intelligent Network architecture models based upon the perceived weaknesses of the standardised architecture. These architectures were tested in Survey 1, to gather data to analyse the implications of implementation and prove their attractiveness and viability. A postal survey was chosen as the main source of primary information-gathering, owing to the number and geographic spread of companies needing to be targeted, in order to get as accurate a view as possible. The survey was supplemented by interviews, undertaken to understand and explore the reasoning behind the issues identified in the responses. The first survey was followed by a second information-gathering process in the form of a second questionnaire survey, to verify, update and develop the information gathered.

This strategy provided a suitable scope and depth of data gathering, without resorting to the process of extensive interviewing. Following the questionnaire survey by interviews, also countered any unconscious tendency for the interviewer to place emphasis on strong views arising from early interviews.

Although the research programme can be considered as a way of applying Longitudinal Time Triangulation, the scope of the technology under study could similarly potentially be developed, to achieve another triangulation, that of Cross Sectional Time.

Technology (Cross Sectional Time)

INs was but one of a number of 'centralised intelligence' technologies under development during the period of this research and therefore the technique of Cross Sectional Time Triangulation as described in Chapter 2.3, Triangulation, might provide a means of highlighting common issues.

To this end, a structured analysis was employed at the commencement of the research (Figure 3.2) to initially identify and subsequently establish the state of other technologies that employed central intelligence. This was to determine if they could provide an analysis comparable with that of INs.

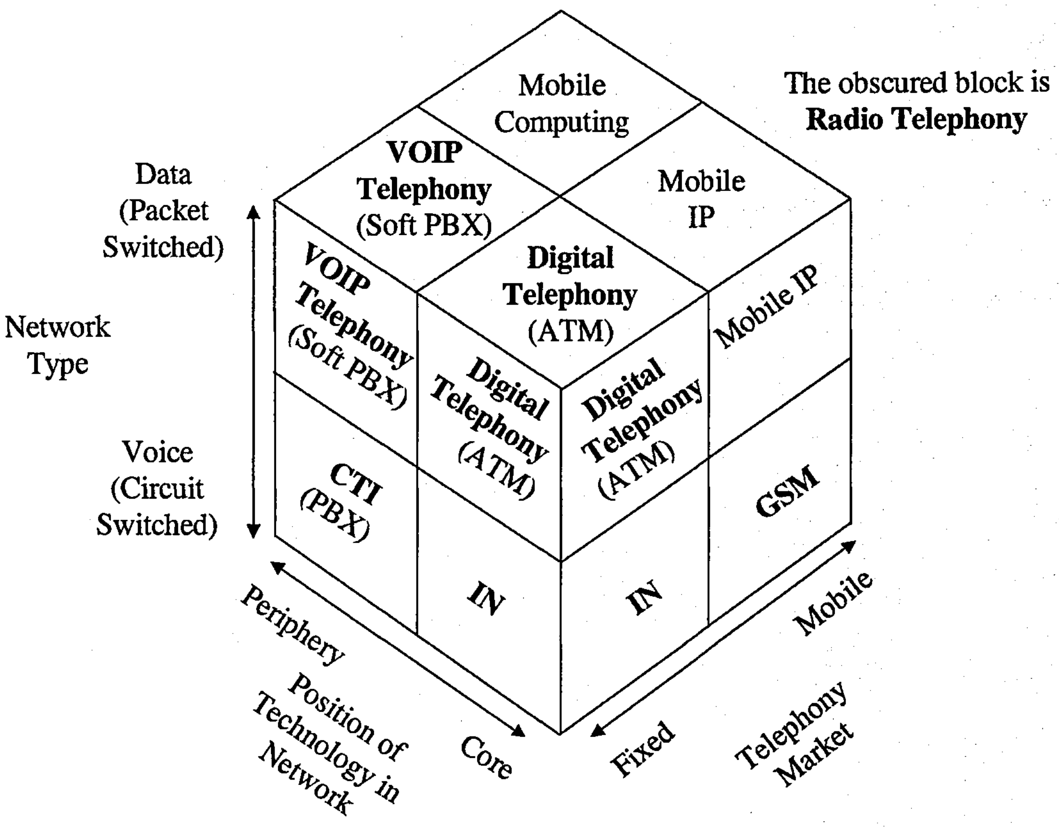
The obscured block is **Radio Telephony**

Figure 3.2 Technologies Employing Centralised Intelligence

These alternative central intelligence technologies are represented on a three dimensional map, using the parameters of Network Type (Packet or Circuit Switched), the Telephony Market (Fixed or Mobile) and the Position of the Technology in the (end-to-end) Network architecture; Core (in the Operator's network) or Periphery (in the customer's network).

The technologies identified at the time were Voice Over Internet Protocol (VOIP) Telephony, Internet Protocol (IP) Telephony, Computer Telephony Integration (CTI), Intelligent Networks (INs), Global System for Mobile (GSM) and Radio Telephony. The technology map indicated that there was a 'technology void' for a 'Core , Mobile, Data Network', which has since been filled by Mobile Internet Protocol. Mobile Computing was another 'technology void', which does not yet appear to have been filled by a Centralised Intelligence technology. (These technologies are explained below.) The prerequisite for a Cross Sectional Time Triangulation based upon INs, was a technology that employed centralised intelligence (closely mirroring that of INs), employing non proprietary standards and not subject to regulation (at the time).

VOIP Telephony employs a single telephony server to process calls. Its benefit is that a company could use its existing data infrastructure (Local Area Network), to not only connect computers, but telephones too. Its key disadvantage, was that at the start of the research the telephony capability was almost wholly proprietary and was limited to private company (not public use).

The term Digital Telephony embraces a number of mechanisms for carrying telephony traffic on a data network. This includes Voice over ATM and VOIP which can also be carried on ATM. Its disadvantage from a research perspective was that it was an immature technology at the commencement of the research.

CTI employs a centralised database to (typically) allow calls arriving at a company's premises to be more efficiently handled. For instance, the 'Calling Line Identity' (originating telephone number) associated with an incoming call, could be used prior to the call being answered, to identify the person who dealt with that caller's account and automatically route the call to their telephone. The disadvantage of this technology, was that again it was highly proprietary (although standardisation was emerging, (Shepherd 1998)) and not appropriate to public Operator use owing to its lack of scalability. (i.e. it was targeted at corporate rather than network Operator markets.)

At the start of the research, Radio Telephony offered a private localised mobile radio service. It generally employed proprietary standards (five-tone, N-tone etc.), although ETSI were in the process of agreeing the 'Binary Interchange of Information and Signalling' (BIIS) standard (Durvaux 1993). The technology serviced a limited niche market and was unlikely to be adopted or develop particularly quickly, thus being considered inappropriate for more detailed study.

Mobile Internet Protocol (IP) was essentially a non-existent technology at the commencement of the research, but one the analysis demonstrated could exist. Initial discussions started in the standards bodies about 1995 and the first service (GSM Packet Radio System (GPRS), launched in the UK in about 1999. The technology was not considered for study, because it was non-existent at the commencement of the research.

The relative merits of INs and GSM have already been discussed in Chapter 1.

Mobile Computing was a similarly non-existent technology at the start of the research and still is, since there is nothing available which meets the criterion of employing centralised intelligence. A combination of Wireless LAN technology (Wireless Fidelity 802.11b) and Internet Protocol version 6's capability to 'roam' however, comes close to meeting this functionality criterion.

It was concluded that undertaking Cross Sectional Triangulation of these other technologies with INs was impractical, owing to their general immaturity and/or lack of recognised open standards. Identifying them however, allowed the research to consider the implications of INs upon other networks such as GSM and CTI (discussed in Chapters 4 and 6) and provided recognition of the value of the research in being applicable to these other technologies.

Although suitable alternative centralised intelligence technologies to IN could not be found in order to apply Cross Sectional Time Triangulation, another area which was assessed for Cross Sectional Time Triangulation, consisted of the standards employed by Intelligent Networks.

Intelligent Network Standards (Cross Sectional Time)

The ITU-T Intelligent Network standards are generally recognised as the international standards applicable to this technology. The initial IN standards ratified by the ITU-T, termed Capability Set 1 (CS1), despite being a collaboration by all parties, proved to be insufficiently detailed to be implementable. The CS1 standards were subsequently influenced by ETSI refining and defining a practical implementation of it. This was termed 'CS1 Refined'. In parallel to the CS1 development, North America (NA) continued to develop their Advanced Intelligent Network (AIN) standard. There were therefore, two regional standards for the use of IN systems developing world-wide, both being associated with the ITU-T standard. These two evolving regionalised standards had potential for achieving Yin's (1988) proposal of expanding the boundaries to gather comparative data, or being used in Cross Sectional Time Triangulation, in this case comparing the situation in North America with Europe. However owing to the difficulty of gathering data from

America, a decision was made to focus on the European specification and standardisation process, drawing comparisons where appropriate with the North America model.

A third area considered as to its suitability to meet the requirements of Cross Sectional Time Triangulation was the gathering of data from different groups.

Stakeholder Analyses (Space/Cross Sectional Time)

Ensuring data was gathered from more than one viewpoint required Cross Sectional Time Triangulation. The viewpoints sought were from employees of Telecommunications Service Value Chain companies or bodies closely related with telecommunications, such as regulators and standardisation organisations. These companies and organisations are termed Stakeholders. The research involved gathering data from stakeholders located across the European Union and addressed the requirements of Space Triangulation by drawing in evidence from the Pacific Rim and North America where appropriate.

The different categories of stakeholder involved with Intelligent Networks, were identified by employing a Stakeholder Analysis as discussed in Chapter 2.3, 'Selecting a Sample'. This was a precursor to identifying companies and key individuals within them, who had knowledge, opinions and an interest in Intelligent Networks and who might be receptive to participating in the research by way of a survey or an interview.

The initial Stakeholder Analysis followed Grimble et al's (1994) format. It gave consideration to the fact that sub-groups often have differing agendas. For instance, different members of the stakeholder group (Telecommunications) Operators, were in competition with each other and therefore did not form a homogenous group.

Using the interrelationship matrix outlined in Chapter 2.3, Table 3.1 was developed to identify those stakeholders with an interest in INs. Their relative importance was assessed using Grimble et al.'s (1994) categorisation of Active or Non-Active. Active in this context refers to whether they were taking an active part in the development of IN standards, operation or their regulation etc. The Telecommunications Managers Association (TMA) is identified as Non-Active, since although they are active in the field of telecommunications products, charges and services etc., their activities are for the most part, independent of any particular technology such as INs.

	INSTITUTIONS	**INTEREST GROUPS**
Active	Exchange Suppliers, Computer Manufacturers, (Network) Operators, Service Providers	European Union (Commission) (Member State) Government (e.g. UK Department of Trade & Industry (DTI)), Regulators (e.g. UK Office of Telecommunications (OFTEL)), Standards Bodies (e.g. International Telecommunication Union - Telecommunications (ITU-T), European Telecommunications Standards Institute (ETSI)), Consultants
Non-Active	Lobby Groups e.g. Telecommunications Managers Association (TMA), Telephone Users Association (TUA) etc.	End User

Table 3.1 Intelligent Network Stakeholder Interrelationship Matrix

The stakeholders identified in Table 3.1, provided the categories used in a ‘Participation Analysis Matrix’ (Chapter 2.3, Participant Analysis), which allowed an initial exploration of the relationships between the stakeholder groups, regarding the introduction of Intelligent Networks and the opening of their interfaces. This analysis proved useful when attempting to explain some of the variations in survey responses by members of the same Stakeholder group.

Matrix	EU	Gvt. Reg.	Exchange Suppliers	Computer Manu.	Operator	Service Providers	Standards Bodies	Consultant	Lobby Gp. /User
Gvt./Reg.	±(1)								
Exchange Suppliers	-(2)	-(2)							
Computer Manu.	++(3)	++(3)	-(4)						
Operator	± (5)	± (5)	-(2)	++(3)	-(5)				
Service Providers	+(7)	+(7)	-(2)	+(3)					
Standards Bodies									
Consultant									
Lobby Gp. /User	++ (6)	++(6)			+(6)	+(6)			

+	Complementary Aim
++	Strong Complementary Aim
-	Conflicting Aim
±	Complementary and Conflicting Aim

Table 3.2 Participant Analysis Matrix

The Participant Analysis Matrix (Table 3.2) summarises the key relationships between the stakeholders, the information being found from preliminary background reading, interviews and my previous experience. A number of cells are grey-filled since they replicate a relationship considered elsewhere in the table. The symbols + & - indicate if the Stakeholders had complementary or conflicting interests and the assessed strength of the relationship. The number in brackets relates to the specific interests as is explained in Table 3.3.

COMMONALITY OF INTEREST (+)		CONFLICTS OF INTEREST (-)
The EU Commission and Member States promotes a competitive telecommunications environment	1	The Member States need to uphold their country's interests in Europe
	2	Moving to open interfaces avoids Operator tie-in to one Supplier.
Moving to open interfaces allows entry to the telecommunications market	3	
	4	The move to open interfaces allow elements of INs to be provided by different Suppliers.
Welcomes open interfaces since it allows equipment to be purchased from a range of Suppliers, knowing it will interwork.	5	Does not welcome opening interfaces to competing Operators, since this improves the functionality of the services they are able to offer.
Welcomes the greater range of services introduced by Intelligent Networks	6	
Welcomes open interfaces since interconnection to other Operators is made easier	7	

Table 3.3 Notes Relating to the Participant Analysis Matrix

In the UK for instance, both the DTI/OFTEL and the computer manufacturers had an interest in opening IN interfaces; the DTI/OFTEL to encourage competition within the telecommunications sector; the computer manufacturers to gain access to the telecommunications market.

The Exchange Suppliers were assessed as (generally) not wanting open interfaces since being able to 'mix and match' Suppliers' equipment would break their close Network Operator relationship of old.

Network Operators liked open interfaces because it increased their range of Suppliers and hence strengthened their negotiating position. However within this group, the legacy/market dominant Operators disliked standardised interfaces, as they provided a possible point of interconnect to their network for Service Providers and new market entrant Operators. The legacy/market dominant Operators therefore had conflicting drivers.

Users (including ‘lobbying’ trade associations such as the Telecommunications Managers Association (TMA) and Telephone Users Association (TUA) in the UK), were not so concerned with the technology, rather than the benefits technology might bring them. Thus INs were supported by users in that they encouraged new services, greater flexibility and reduced prices (due to those services being offered in a more efficient way).

Standardisation Bodies and Consultants are shown as having no complementary or conflicting aims in Table 3.3, since they were neutral. In practice however, they were likely to adopt the stance of their participants and sponsors.

The interrelation matrix and the Stakeholder Analysis were used to perform a Variables Analysis, leading to the identification of the stakeholder paths of influence. This is represented by the ‘branches’ on the Relevance Tree in Figure 3.3.

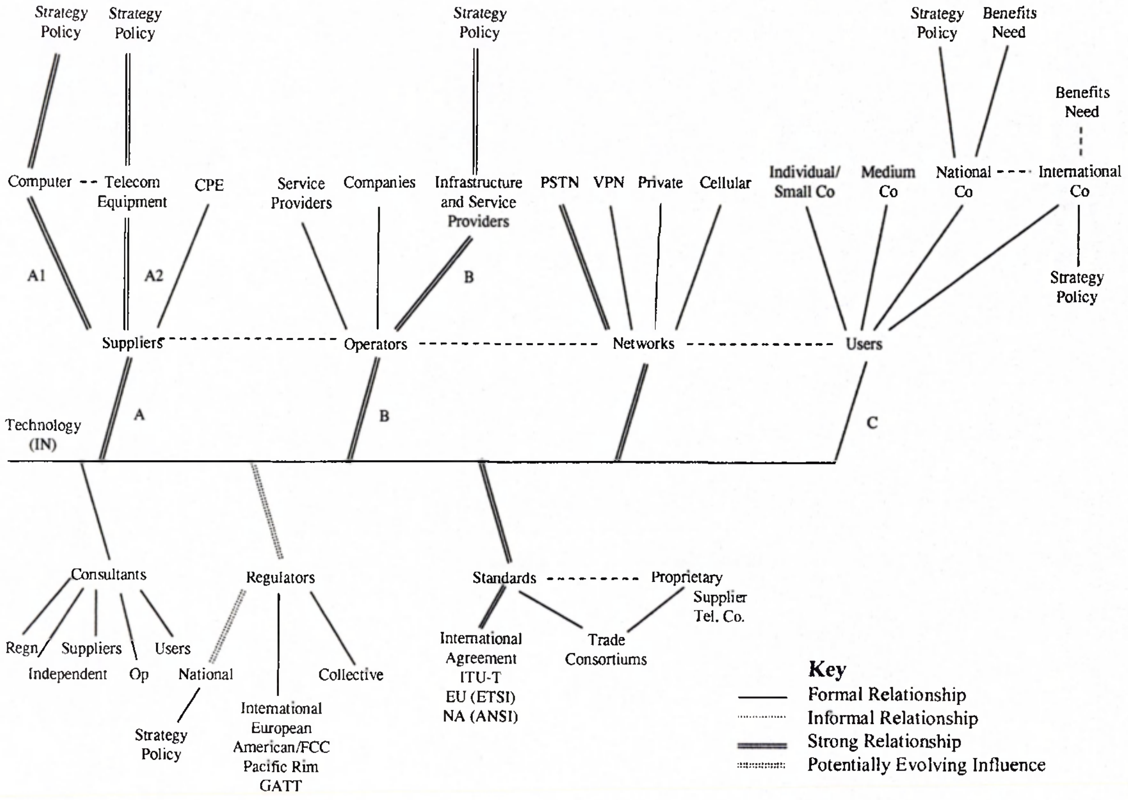

Figure 3.3 The Variables Associated with and Impacting upon, Intelligent Networks

Identifying the variables in the research was key, since they helped define the study areas and acted as a focus for deciding the best method of investigation. For instance, the Independent Variables discussed in Chapter 2.3, could be summarised as the telecommunications services market's main Value Chain elements (marked A-C in Figure 3.3). (i.e. equipment supplier through to product user). Intervening variables included the standardisation and regulatory bodies. The Independent Variables were investigated via questionnaires and interviews and the Intervening Variables by paper research and interviews. i.e. the study involved non-equivalent dependent variables (Bailey et al. 1995).

Figure 3.3 also attempts to identify the relationship between the stakeholders with respect to IN technology. The Participant Analysis Matrix (Tables 3.2 & 3.3) helps catalogue the aim of each Stakeholder, whereas Figure 3.3 differs in attempting to convey their relative influences. The National Regulator is therefore identified as a 'Potentially Evolving Influence', since OFTEL at the start of the research, was considering regulating IN interfaces.

The figure additionally helped identify stakeholder sub-groups and was used to categorise an address list of contacts for the research. These included members of the European Commission and Regulatory Organisations, Suppliers, Telecommunications Network Operators, representatives on Standardisation Bodies and Consultants associated with Intelligent Networks. (A list of the stakeholder categories used, is given in Appendix A.2). The individuals within these groups were compiled from a number of sources ranging from attendees of appropriate ITU, ETSI working groups, respondents to EU, DTI IN consultations, authors of IN articles and IN books, and presenters at IN conferences etc.

The Stakeholder Analysis groupings of interested parties e.g. Supplier, Operator etc, matched Bailey et al.'s (1985) classification of Cluster Sampling. Within a group (cluster), the choice of population was made depending upon the structure and size of the group. For instance the group of telecommunication exchange manufacturers was relatively few in number and it appeared appropriate to seek a response from no more than one representative from each country (in which they had a development presence[2]). For other

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[2] The research questionnaire contained technical terminology and architectures, which tended to be best understood by those developing Intelligent Network systems.

groups such as Operators, a Stratified Random Sampling was employed, sub-dividing the group and randomly selecting from these divisions.

For interviews, Connoisseur Samples were employed, establishing who were the key decision makers and seeking to employ them in the research. Additionally, there was a level of Opportunity Sampling, taking advantage of those who were accessible at a certain point in time, such as at conferences.

Data Gathering (Investigator)

A final triangulation type (Investigator) was employed by examining and discussing the research results and the conclusions reached with others. This ensured the data had been correctly interpreted and a balanced search made for both supportive and disconfirmatory hypothesis evidence.

In summary, Stakeholder Analysis and Variable Analysis identified the stakeholders and sub-categories thereof. Categorising these influences as Independent and Intervening Variables, grouped the stakeholder groups into sub-categories, which were able to be treated similarly in the way data could be gathered from them. Finally, the Participant Analysis matrix and relationship assessment of the Variables Analysis, identified tentative links and associations, which were used to help explain trends emerging from the analysis of the surveys.

With the identification of the structure of the information required and the key actors, the research progressed via a combination of a number of 'standard' techniques associated with data gathering and analysis, including interviews and surveys. The next sections review the strategy adopted for these techniques.

3.3 Surveys

Focussing upon the ETSI IN and in particular its CS1 implementation, identified an ITU-T architecture model which was used as the basis of standards development. In 1992, the DTI in the UK issued a consultation document (DTI 1992), seeking further information on the opening of the interfaces of the standardised ITU-T architecture; implying that they were considering regulation in this area. If this was to happen, it was important that the architecture they used as the basis of regulation was appropriate. This was a key research area. To check the appropriateness of the architecture model, the CS1 architecture was analysed from a number of perspectives (such as technical features, ability to regulate, products offered, harmonisation with company strategies, advantages/disadvantages etc.[3]), and various ways were identified by which it could be altered to better meet differing needs. As a result, two alternative architectures were developed by the researcher[4], which formed the basis of Survey 1 and sought information regarding the appropriateness of opening the interfaces of the standardised and alternative IN architectures from a range of stakeholders perspectives. Thus the research tried to investigate the appropriateness of the standard architecture and the extent to which the DTI should demand the opening of its interfaces.

The danger with prescribing a particular architecture is that as marketing demands change, or the technology moves into parts of the world with different cultural and hence potentially different market requirements, its appropriateness and ability to accommodate different Operators' needs may reduce. Thus it could either restrict development of the architecture (and hence services), or be of limited use in promoting competition; i.e. regulation may not have the desired effect.

The Stakeholder Analysis identified over 250 candidates for inclusion in the data gathering exercise; a combination of individuals, commercial organisations and regulatory authorities. However their geographical spread and variety of languages, precluded interviews as the primary method of data collection and so recourse was made to a combination of surveys. The first of these surveys was undertaken by post, the second was conducted amongst participants at a Europe conference on INs.

The first survey (Survey 1) was designed to test the validity of the 'standard' (centralised processing) and 'alternative' IN architecture models and gathered information relating to

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[3] Discussed in the Chapter 4.

[4] One of the models borrowed the idea of distributed processing from the computing environment and applied it to the telecommunications domain and is now an established way of working with Intelligent Networks requiring centralised intelligence capable of high processing. The other was wholly my own development and introduced the concept of local and central SCPs. BT is currently evaluating an architecture similar to this, although its operation is slightly different to that originally envisaged. (Both of these models were presented at conferences in London, Belgium and Rome (Shepherd 1997a, 1997b, 1997c) and are discussed in detail in Chapter 4.

opening IN interfaces. A postal survey was chosen as an economical method of reaching a large number of relevant people in different countries and speaking different languages. Being a paper survey, questions were presented on a consistent basis, leading to easier response evaluation and negating potential bias introduced by verbal questioning.

An opportunity arose two and a half years later, to undertaken a second survey (Survey 2), in conjunction with the organiser of an Intelligent Networks conference. The survey being targeted at the attendees of the conference, provided a different sample group to Survey 1. It aimed to determine if industry concerns and focus had changed since Survey 1 and provided the opportunity to explore the relationship of INs with new technological developments.

This section discusses the strategy adopted for the survey questionnaires. It addresses their layout, the means used to encourage a response and discusses how the validity of the responses was assessed and the subsequent data analysis.

Postal Survey Strategy

The literary review identified that the EU and DTI had already gathered information regarding the application of Open Network Architecture to Intelligent Networks. The EU obtained this data via a questionnaire (ETCO 1990) and the DTI through an open consultation exercise (DTI 1992). In both these studies there was an implicit assumption that the ITU-T standardised IN architecture was the only option open for discussion. In collecting issues associated with opening the model's points of interconnect, they failed to allow any weighting of the issues.

This research augmented these sources of information. The postal survey offered alternative models and allowed the identification of which of the issues was perceived to be the most important. This allowed an assessment of whether opening any interfaces was dis-proportionally likely to increase regulation. The surveys also provided an in-depth knowledge of how the different Stakeholders viewpoints varied and hence their collaborative or competitive nature. The responses were used to assess the relevance and potential effectiveness of IN regulation, were it to be implemented in the UK and EU, an example of Phillips et al. (1987) 'theory of factors'.

Postal Survey Content & Layout

One of the goals of this research was to scrutinise the 'official' conclusions regarding IN technology. The survey questions were therefore designed to gather data on the appropriateness of opening Intelligent Network interfaces and hence produce information on which future decisions could be based; a conscious check being made as to how the answer to each question would aid the aims of the research (Bailey et al. 1995).

It was felt more important to have a good survey response rate to a number of basic questions, than a small response to a large commercially sensitive survey. The questionnaire was therefore simplified after an initial trial, to avoid asking for detailed or strategic information. This approach addressed Bailey et al.'s (1995) issue of 'Content Validity', where the respondent is wary of providing strategic information by answering the questions in full.

The postal survey gauged stakeholder attitudes to the relative importance of specific IN architectural features, a task best achieved by undertaking a quantitative analysis and hence the use of closed questions. The danger of such a format is that crucial concerns could have been missed. The survey format consequently provided respondents with the opportunity to add their own comments if they felt it was necessary. However such 'free form' answers are not generally amenable to quantitative analysis, therefore the questions were designed so as to lead the respondent to use keywords or technical terms. In this way individual comments using the same keywords could be grouped within a single classification.

In order to improve overseas responses, the questionnaire and covering letter was translated into French, German, Spanish and Finnish, with overseas recipients being sent a questionnaire in both English and the language of their country of residence. Only two of the overseas recipients chose to use the foreign language version.

An English language version of the questionnaire used for Survey 1 is provided in Appendix A1.

Postal Survey Recipients

The list of contacts compiled from the Stakeholder and subsequent analyses formed the survey contact list.

Early interviews and trials of the questionnaire found that there was unlikely to be a response from the UK Government/OFTEL[5], or End Users. For the latter group it was established that End Users were unlikely to have sufficient knowledge at the level required. It was therefore felt appropriate to gather information from governmental and regulatory sources via interviews and only contact End Users should a broader based perspective be required.

The next consideration was to identify who within the remaining groups (Consultants, Operators and Computer & Telecommunications Equipment Suppliers etc.) should receive the questionnaire survey. One concern was that sending multiple questionnaires to a large company could result in multiple returns that would bias the analysis in favour of that company's views, compared to a smaller company returning a much smaller number of questionnaires. Another concern, (which I have experienced first hand in BT with questionnaires arriving from outside the company), is that multiple questionnaires can trigger a company-wide ban in responding to that questionnaire. For these two reasons, the survey was restricted to one representative in each company in each country (keeping the EU as the survey data gathering boundary). Where there was more than one contact in a company in a country, Stratified Random Sampling (Chapter 2.3) was employed, which involved sub-dividing the groups and making a random selection from these.

In summary, the research strategy selected different individuals from within the stakeholder groups by different means and employed the most effective way of gathering information from them. A number of the individuals were sent the questionnaire survey to test the preliminary research and the complementary and conflicting views indicated by the Stakeholder Analysis. These included support for the apparent EU/DTI proposal to open IN interfaces and to test the appropriateness of the alternative architectures developed. The survey attempted to verify these conflicts at a more detailed level.

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[5] The DTI and OFTEL, although willing to talk appeared reluctant to do anything which created a traceable record of their responses to research questions, such as answering a questionnaire or allowing an interview to be taped.

It was felt important that individuals receiving the survey were not only fully aware of the reasons behind the research and the part their information would contribute to it, but that they were assured of their anonymity.

Survey Confidentiality

To address research confidentiality, a check-list (as proposed by Bailey et al. (1995)), was identified and implemented for analysing the questionnaire. Two points from the check-list, the 'Right to Privacy' and 'Control over the Information Provided', are discussed in more detail here.

The confidentiality of the information provided and anonymity of the respondent and their company in all publications arising from this research was explicitly guaranteed in the Survey 1 covering letter. Furthermore, a point of contact was included for any queries that respondents might have. However, in order to provide a follow-up for non-returned questionnaires and to facilitate the comparison of responses with previous published positions (e.g. the DTI or EU survey responses), the questionnaires had to incorporate some form of respondent identification. The method applied was to hide the identifier within a computer filename carried in the footer of the page (Appendix A.2), an example of the strategic approach employed by Scott (1961). As a consequence, particular care has been exercised when comparing survey responses with published data so as to avoid a loss of anonymity. In addition, all company related data was stored in a separate file to that of respondent data; both computer files were password protected and the PC's system password option implemented.

A further consideration was the level at which the respondent had control over what information they provided. Co-operation of the participant was needed at all information gathering stages. If participants did not want to provide information about their work area, they would decline to answer the questionnaire or certain questions on the questionnaire and act similarly for an interview. Control was therefore directly exercisable by the respondents.

In order to assess the validity and comprehension of the questions contained within the survey, a number of staged pilots were employed.

Postal Survey Pilot

Survey 1 was piloted in three stages, with the questionnaire being assessed for revision after each stage. For the first stage, market research experts assessed the questionnaire structure and layout. This was done using three marketing research experts, two from the Open University and a third independent, and resulted in a revised questionnaire layout.

For the second stage, a draft questionnaire was piloted with two people within BT with knowledge of Intelligent Networks who would not form part of the final sample. It was also piloted with an End User, a telecommunications director from a pharmaceutical company (interview Russell 1995), who had no IN knowledge but an excellent knowledge of End User telecommunication systems. This second stage trial checked the clarity (questions suitably worded and understood), validity of content and length of the questionnaire, and allowed changes to be made without invalidating any responses from the eventual sample. It identified minor omissions, but more importantly, text confusion. The questionnaire was also felt to be too long, (the initial survey questionnaire being six pages in length). This resulted in revised wording for some questions and a reduction in the number of questions overall, in order to reduce the length of the questionnaire to two pages. The telecommunication director was totally unable to complete the technical part of the questionnaire since the Intelligent Network terminology meant nothing to him. This identified the need to move the sample boundary, excluding the End Users and focus on IN knowledgeable people only.

The final trial took the form of a pilot survey utilising a small sample of the entire survey population. The development of the questionnaire from the first two trials, created a survey that proved to be sufficiently robust that the pilot did not identify any other errors/problems and there was no need for further changes, thus allowing the answers from the pilot to be considered with the responses from the sample population as a whole.

Encouraging a Response

The Research of Methods (Chapter 2) identified a number of ways to encourage a response to a postal questionnaire. One way identified by Scott (1961) was to make the questionnaire interesting to the respondent. The early trial with the director of the telecommunications department of a pharmaceutical company, (interview Russell 1995) showed that respondents had to have a basic knowledge of INs otherwise they would be unable to answer all but the initial questions. Russell also highlighted that End User companies were more interested in their quality of service, price etc., than any particular method of realising that service. For these reasons the survey did not include End Users in its sample and selected a sample where the respondent was likely to have a knowledge of INs and hence an interest in the questionnaire. This aimed to increase the response rate.

It was thought appropriate to boost responses (as recommended by Scott (1961)), by providing two reminders to questionnaire recipients; the first being a telephone call after 2 weeks and then a repeat questionnaire after 3 weeks, allowing a minimum of four weeks before analysis. Marking the questionnaire identified individuals who had not replied, to be targeted with the follow-up. When a non response to the survey became obvious and another suitable contact (selected at random) in the same company was available, the second contact was sent a questionnaire to encourage at least one response from that company, in that country.

It was felt that since the survey would be sent to individuals in companies, individually stamped (delivery and response) envelopes compared to franked envelopes, would make no difference to the response rate despite the findings discussed in Section 2.3. The argument for this approach, was that the recipients of the postal survey were employees of large companies and that they would not experience the same feelings as the general public who received Scotts's (1961) questionnaires. Thus franked reply envelopes were used (apart from abroad where faxed returns were encouraged).

Other suggestions such as hand-written notes or special delivery was not thought to convey any extra urgency. Personal experience with receiving a large amount of unsolicited material is that both these methods are widely practised and have lost any impact they might once have had.

The idea of offering a reward to improve the number of responses was an attractive one, although a monetary award was not thought appropriate. A more appropriate one was to offer a copy of the analysis to those who were interested.

In practice, Survey 1 received a 9.2% response rate, close to the 10% predicted by Bailey et al. (1995). This was far less than the high response rates reported by Scott (1961), which probably reflected the era in which he lived, the public indifference to questionnaires appearing to have increased since then, resulting in reduced response rates. The 9.2% rate is however exceedingly good given the sub 1% results marketing companies receive using for example, demographic means to target the recipients (Thompson 1990).

Postal Survey Analysis and Validity

The analysis of the questionnaire responses employed both qualitative (stakeholder relationship analysis), as well as quantitative techniques (use of the stakeholder relationship table).

From 250 questionnaires, 23 were returned, a response rate of 9.2%. This relatively high response rate was probably due to the targeted technical audience. This was a representative response, since replies were received from all the major Telephone Operators in the UK and from all the major Suppliers having an interest in INs (and is therefore a good sample of telecommunications equipment Suppliers globally). Areas of weak responses were from consultants and specialist Operators (e.g. Service Providers), restricting the ability to analyse within these sectors.

Raimond (1993) and Bailey et al. (1995) identified a concern that those who reply are of a different mindset to those who don't and are thus biasing the results, since '...people or organisations do not...refuse to co-operate at random' (ibid 1995). Although individual non co-operation was experienced (through the questionnaire not being returned), targeting someone else in the same organisation with another copy of the questionnaire attempted to circumvent this. If an organisation had a policy of not answering questionnaires, this was difficult to overcome, but was random within the sample as a whole and hence was considered not to influence the results. (Only one company, a UK based Supplier, stated they had a policy of not answering questionnaires.)

Conference Survey (Survey 2)

Two and a half years after the first survey, a second survey was used to determine if industry concerns and focus had changed from the first survey and to explore the relationship of INs with new technological developments such as the Internet.

Knowing that I was due to speak at an Intelligent Network Conference in Madrid in 1998, I contacted the organiser to determine whether I could extend elements of my research to a wider EU resident audience. The resulting second survey was therefore arranged to be a collaboration, where the data obtained was used both for the purposes of this research and by the conference organisation to help identify the suitability of topics for the next conference.

The Survey 2 questionnaire was unstructured, comprising of a question followed by a free entry field[6]. This layout was adopted to encourage speed of response and hence encourage a greater number of returns. Since this type of questionnaire does not lead the respondent to answers by asking them to choose or prioritise from a list, there was a greater variety of responses. Given this freedom of responses, quantitative analysis was difficult, but was achieved by grouping similar comments into categories. Then since

> '...the standard deviation of a sample is a good approximation to the standard deviation of the population, providing the number of items in the sample is greater than about 25' (Fox 1990 p24),

this was used to identify which items in the questionnaire were not significant (using the 5% significance level (Fox 1990)). This was only useful across all the stakeholder groups, since within a group, the number within the sample dropped below 25 and became subjective.

With the second survey it was thought a good response rate would be achieved by offering a bottle of whisky as a prize, this being a visible inducement as they completed the form and an immediate reward.

The conference survey had 29 returns, achieving a 22% response rate, better than that achieved for the postal survey. Respondents were mainly from the Telecommunications Operator and Supplier sectors, with the remainder being from a range of other identified stakeholder groups.

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[6] A copy of the second questionnaire is given in Appendix B

The conference organiser originally agreed to provide copies of the responses, provided confidentiality was maintained. This was subsequently amended to copies of the responses with the respondent's name, job title and company blanked, but the categories of the respondent's job and respondent's company identified. In order to differentiate the respondents of this survey from those of the Survey 1, they have been identified by the prefix IN and a number (e.g. IN15).

A copy of the questionnaire used for Survey 2 is provided in Appendix B.

Using survey questionnaires was the principle research technique for gathering data from a wide range of geographically diverse stakeholders. A second principle technique utilised by the research is that of interviewing.

3.4 Interviewing Strategy

The interviews performed fulfilled two purposes. The first set of interviews explored and iteratively focused the scope of the research, developing, assessing and refining the ideas which were eventually tested in Survey 1. The second set of interviews explored selected issues that arose from the survey research.

The first set of interviews questioned academics for their advice on research focus and methodology and also questioned key figures involved with INs for their advice. This provided background information allowing an understanding of IN technology to be developed, tested the understanding of the technology and current regulations, identified key points and issues, and pinpointed potential contacts. Since these interviews were primarily designed to collect qualitative data a semi-structured interviewing approach was adopted (Moore 1987).

The second set of interviews principally focussed on key people involved with particular aspects of INs (standards, operational deployment etc.). They were selected where a certain area needed to be explored in detail or extra information gathered and where the person was unlikely to reply to an (unsolicited) letter/e-mail. Interviews additionally imparted:

> '...discursive information - qualitative as opposed to quantitative ...which usually contains a high degree of opinion or the expression of attitudes' (Moore 1987),

which was also collected. Interviewees were selected by employing Connoisseur Samples (Bailey et al. 1995), i.e. asking who were the key knowledge holders/decision makers and seeking to interview them. Additionally there was a high degree of Opportunity Sampling, taking advantage of those who were accessible at a certain point in time.

Attempts were made to conduct additional structured interviews with some of the second interview set in order to increase the number of completed Survey 1 questionnaires. It was found that interviewees were unwilling to let me complete the questionnaire, with them verbally responding to the questions and didn't return questionnaires left with them (despite reminders). The fact that no questionnaires were completed via structured interviews, avoided the concern that face-to-face methods could have influenced their answers and invalidated a merger of the data with that from the postal questionnaires (Nelson 1990).

The second interview set therefore, made use of unstructured interviews, with a semi-structured element, steering the topic of conversation to areas of interest. In total 40 interviews were performed. A list of interviewees is provided in Appendix F.

Initially the tape recording of interviews was planned as a convenient method of noting information, with later transcription. This would have ensured complete information capture and the uninterrupted flow of the conversation. In practice, with a few exceptions (i.e. academics), interviewees did not want to have the conversation taped. The lack of success with taping the initial interviews, led to abandonment of the attempt to tape later interviews.

Finally, as with the surveys, a Code of Ethics was adopted so that the interviewee knew from the outset what the information was being used for and what action they could take if they had any concerns. Again, Bailey et al.'s (1995) code of ethics was adopted to meet the needs of the research environment and interviewees were appraised of the key points of this at the commencement of the interview.

The adapted code was as follows:

- Interviewees have the right to terminate the interview at any time and/or choose not to answer some or all of the questions;
- During an interview the interviewee may ask for statements to be regarded as 'off the record'. These will not be quoted in the thesis;
- The findings will be included in a thesis submitted to the Open University;
- The identity of individuals and companies will not be disclosed. Analysis will be by stakeholder group.

3.5 Summary

This Methodology chapter has identified how various methods and techniques were chosen, which together have allowed evidence to be collected and analysed and its validity to be established, thus following a Theory Building approach to the research.

The research has adopted the technique of Triangulation to identify what and whom should be considered in the data gathering exercises. Longitudinal and Cross Sectional Time, Space and Investigator Triangulation were considered appropriate for the research.

The research uses Longitudinal triangulation in that it gathers information from the interested parties over a period of time. The data gathering process was iterative, allowing the adoption, adaptation, testing and refining of research techniques within a research block as well as between them, before moving on to the next step. The research structure (Figure 3.1) divides the research into two distinct phases, the first gathering background information to establish and refine the hypothesis, with the second phase gathering data to test the validity of the hypothesis.

The examination of centralised intelligence technologies analogous to Intelligent Networks (Cross Sectional Time Triangulation), confirmed that INs alone appeared to be the best focus for the research owing to its level of development, its adoption by the standards bodies and because preliminary research on opening interfaces had been undertaken by the EU and DTI.

Stakeholder Analysis was undertaken in order to identify interested parties (and their perceived relationship) from whom to gather alternative viewpoints, fulfilling the requirements of Cross Sectional Time Triangulation. The stakeholder groups identified (Regulators, Operators, Suppliers, Standards Bodies, Consultants, Users etc.), were used to categorise the questionnaire recipients and the subsequent analysis of their responses.

Survey 1 was used as the initial primary data gathering tool, testing the validity of the standardised IN model and gathering information relating to the problems of opening IN interfaces. The construction and trial of this questionnaire are discussed together with the need to assure respondent confidentiality, yet be able to provide a follow-up. The findings from the trial were used to remove the stakeholder groups of Regulators and Users from the sample.

A second survey (Survey 2) was used to update the Stakeholder focussed concerns arising from the first survey and provided the opportunity to explore the relationship of INs with new technological developments.

Interviews were identified that could provide information supplementary to the surveys allowing the focussing upon particular topics. These were divided into two categories; initial background interviews to gather information and check the appropriate of the topic of research and subsequent information gathering interviews to expand and investigate specific findings in greater detail.

This chapter has outlined the reasons behind the research design and the strategy adopted. The following chapters detail the findings of the research, with the next two chapters setting the scene by examining the technological aspects of INs and the telecommunications regulatory environment within Europe.

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4 The Evolution of Intelligent Network Technology

4.1 Introduction

Since the inception of Intelligent Networks, the variety of services made available via this technology has rapidly increased, particularly where a network Operator is willing to employ proprietary elements in an implementation. This chapter explains the technology of Intelligent Networks in greater detail, giving a brief explanation of the principle elements and their role in the overall architecture. The chapter also demonstrates how the network could operate in providing a number of services. It continues by describing a framework which I developed for the consideration of Intelligent Network (IN) architecture choice.

The purpose of the chapter therefore, is to provide a historical summary of Intelligent Networks, to define the state of their development prior to the first research survey and to introduce the IN architectural models used in that survey.

It also addresses two of the hypothesis questions posed in Chapter 1, section 1.2. These questions are:

- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'; and
- 'Are INs a service in themselves or simply a means to deliver services?'

The source of the material for this chapter is a combination of primary material such as the ITU, ETSI and ANSI standards that identify the current IN architecture and my own material arising from both the responses to the initial survey and derived from a synthesis of secondary material (including personal knowledge, interview material and general background reading such as detailed in Chapter 2). The architectures presented and described are appropriate up to the year 2000. Although ETSI IN standardisation work has continued beyond this, the introduction of new technology has refocused the IN standardisation bodies' efforts to that of interfacing with the new technologies, rather than further developing the functionality of INs (interview Stretch 2002)[1]. Much of the material

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[1] The exception is China, where the amount of innovative material (conference discussion papers etc.) is still being produced on a regular basis. Similarly the sale of the IN technology manufactured in that country continues to grow and expand into outside markets, as the western markets decline. It is almost as thought there is a time lag in the progression of technology in China compared to the West.

has been presented at conferences (Shepherd 1997a,b,c 1978 & 1999c). The references for this chapter illustrate the wide range of original research conducted for this thesis.

The next section of this chapter gives a brief summary of the history of Intelligent Networks and shows that the services offered were once commonplace, although extremely localised and perhaps not consistent. The section continues by considering the evolution of INs and issues surrounding its development and applications.

Section 3 describes the difference between a traditional telecommunications network architecture and that of an Intelligent Network, giving an example of how a call is routed. It provides a lead-in to Section 4, which gives an overview of the elements of an Intelligent Network, describing its role in the operation of the network.

Sections 5 and 6 of this chapter give worked examples of Intelligent Network Services. In particular, Section 5 shows how interfacing different Operators' networks at different levels in the Intelligent Network architecture hierarchy, can bring operational benefits even though the customers are unable to discern any difference in the connection of their calls. Section 6 introduces services developed for this research to demonstrate what could be achieved by employing proprietary protocols.

Unique to this research is a framework, described in Section 7, which I constructed to identify the factors needing consideration by a Network Operator when implementing an Intelligent Network. The framework of considerations includes technical and commercial influences (such as traffic types and company strategy) and the impact they have upon the choice of IN architecture and the implementation of regulations. The danger to be avoided is that of gearing regulations to one architecture, since it is likely to prevent more appropriate ones developing and thus limit service growth and flexibility. This framework offers a new perspective in which to view IN architectures, leading to the development and implementation of alternative IN architecture models.

One IN service architecture not discussed in this chapter is that of the Pan European GSM cellular network. As discussed earlier in Chapter 1, GSM uses a different set of standards, the centralised application being core to service operation is 'hard coded', leaving little option for offering bespoke services. It therefore offers far less flexibility than the ITU-T standard IN.

4.2 The History of Intelligent Networks

Early Intelligent Networks - Human Switchboard Operators

Intelligence in telephone networks is not new. Public networks were highly intelligent in the very early days, when every subscriber had a local switchboard operator (Figure 4.1) who knew all her customers by name. Advanced services such as ‘calling name delivery’ (identifying the caller before connecting them), ‘call distribution’ (e.g. connecting to the doctor currently on duty), ‘diversion on no-reply’ (connecting to the person's home address when they are not answering at work), ‘call back when free’ etc. were all part of the normally expected service. Thus many of the services offered by Intelligent Network are not new, but a rediscovery of what existed in the past and recreated to accommodate modern telephony usage.

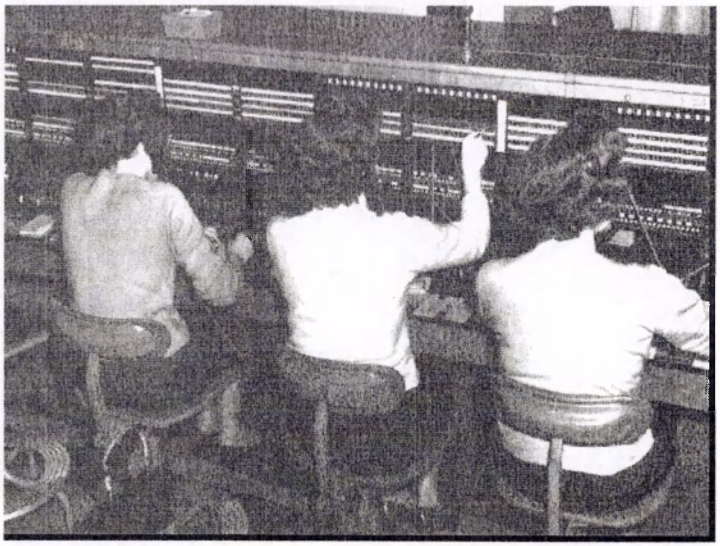

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Figure 4.1 Operators Answering and Connecting Calls

The days of switchboard operator control however were numbered when Strowger invented the first automatic telephony switch in the 1890s[2], reducing the cost of telephone service operation and heralding the advent of automatic switched telephony. The first UK automatic local exchange opened in Epsom in 1912 and the technology was formally adopted to form the basis of the UK telephone network in 1922. Switchboard operators were no longer needed and hence 'intelligence' in the network, in terms of the variety and range of personal services available to customers, diminished over the next 30 years with the demise of switchboard operators.

The First (Non-Human) Intelligent Networks

An Intelligent Network is a telecommunications architecture that shifts some of the telephone call routeing capability held in every switch to a single location. Thus instead of having identical routing information held on every local or transit exchange, an exchange contacts that single location to query routeing parameters.

Such an architecture has a number of advantages over a traditional distributed telecommunications architecture (which will be explored in detail later in this chapter), but the key point is that by holding the telephony call routeing data in a single location, it can be changed far more efficiently than if it were held on individual exchanges. This allows innovative services, requiring the frequent changing of routeing data relating to a call, to be offered to customers.

The concept of Intelligent Networks was introduced by Bellcore in the USA in 1984, when AT&T's monopoly was broken and the telecommunications industry became deregulated (Ungerer 1990). There was an understanding at the time that the Regional Bell Operating Companies (RBOCs) could offer similar 0800 Freephone services to those offered by AT&T as long as they did so using standardised interfaces (interview Anderson 1999). Intelligent Networks generally have centralised information and so present a convenient point for data access and hence a point at which to create a standardised interface between the call control in the Service Switching Point (SSP) and the Service Control Point (SCP). Bellcore therefore led the way with IN standards during the mid to late 1980s, driven by the operating companies' enthusiasm to compete quickly with AT&T for number translation and associated IN services.

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[2] It is generally accepted that Strowger was motivated by the actions of a US local telephone company switchboard Operator, the wife of the owner of a rival business to his own. She was alleged to have connected telephone calls to her husband's funeral parlour business instead of to Strowgers.

In the early days, the Intelligent Network concept had high aspirations. It was sometimes heralded as providing a network re-arrangement capable of providing any telecommunications service need a user could conceivably want. However, factors such as inter-working limitations, financial constraints and commercial priorities constrained the development of the (theoretically) full potential of INs. I discuss later how some of these aspirations proved to be impractical.

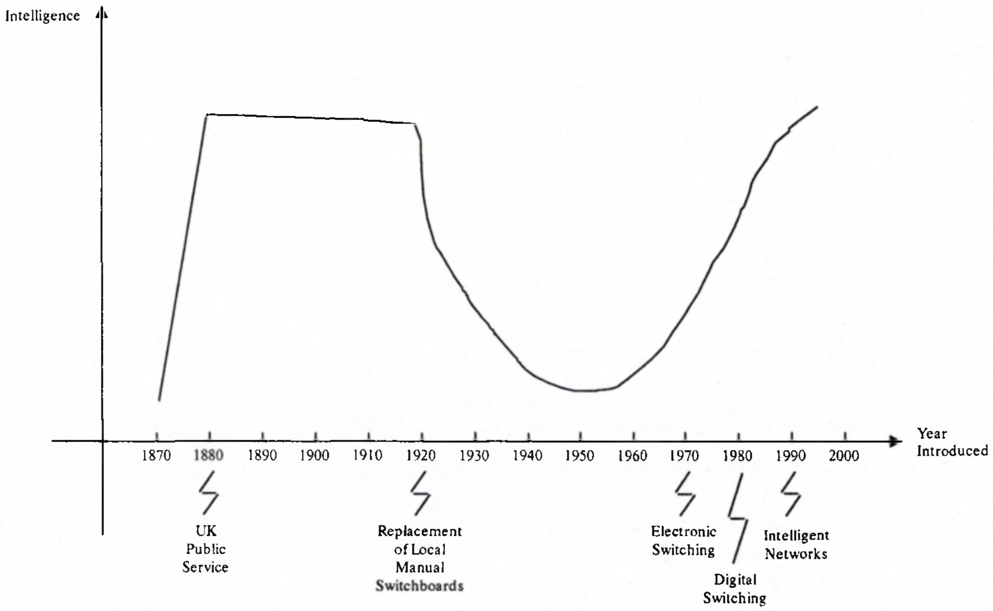

Figure 4.2 The History of Intelligence in the UK Telephone Network

The history of 'intelligence' in the telephone network can be represented as shown in Figure 4.2. Switchboard operators provided the initial intelligence for routing services, but this declined gradually over a period of 30 years as local human-operated switchboards were replaced with automated local exchanges. This led to a decline in the range of services offered, reaching a minimum around the mid-1950s and it was not until the middle of the 1970s that technological developments enabled the re-introduction of some of the services that had gradually been lost with the demise of the local switchboard operator. Services such as 'call forwarding' and 'short code calling' were re-introduced, now totally under the customer's control. It has therefore taken 30 years or more to get back to the level of "intelligence" and "services" reached in the 1880s.

Standards

The early Bellcore development of INs led to the formulation of the Advanced Intelligent Network (AIN) standards, with their emphasis on the North American telecommunications market needs and switching systems. By the early 1990s the International Telecommunication Union - Telecommunications (ITU-T) (formerly CCITT) had established a hierarchy of study groups on INs, leading to the series of ITU-T IN Capability Sets (CSs). CS1 was planned to be the first of several subsequent standards supporting the introduction of INs into existing telephony networks.

The US delegates were generally vociferous in the formulation of the CS1 recommendation. Some US representatives did not want CS1 to include some of the more advanced ideas of independent 'leg-control'[3] (interview Anderson 1999). This resulted in CS1 being a relatively modest set of IN capabilities for voice calls (ITU 1993a,b), since non-US switch Suppliers could not easily adapt to this sort of functionality. (It could be because of this debate, over the appropriateness of CS1, that ITU-T CS1 was detailed only as a recommendation, while CS2 onwards are specified as standards.) Meanwhile in the US, Bellcore was standardising the AIN set of recommendations in parallel to the ITU activities. This resulted in two parallel standard IN specifications, originally targeted by the ITU-T to merge before the ratification of IN CS4 standards. Some authorities (e.g. interview Russo 1997) believed integration would occur. Others, for example Ziemba (interview 1997), disagreed, arguing that North America would not want to be restricted by what the rest of the world would want to do and that a new technology would replace INs before integration occurred. Similarly, Brown (interview 1997) argued that integration would not be achieved before a replacement technology was adopted, because of the time taken to define and implement the standards.

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[3] A telephone conversation consists of a 'send' path from the caller to the destination and a 'receive' path from the destination back to the caller. This allows people having a telephone conversation to speak simultaneously. The 'send' and 'receive' paths are called the legs of a call. Typically, as in a normal telephone conversation, the origination and destination of each of these legs are the same. However, by allowing the network to create the legs of a call independently from each other, thus having a different origin and destination, more flexible services can be created. For instance a receive leg could play an announcement such as a menu of options to choose from, whilst the send leg could terminate on a voice recognition detector. This would allow the announcement to speak the numbers of the menu options, without the detector incorrectly interpreting what is said in the announcement as a customer choice. Currently, many systems avoid this problem by not allowing the detector to operate until the announcement completes – indicated to the caller by a beep. Hence the caller is not allowed to make a selection until the whole of the menu has been played – frustrating for a regular user.

European Operators with INs have in the main implemented IN CS1 or CS1+[4] (interview Anderson 1999). The technological drive towards connectionless Internet Protocol (IP) networks has reduced support within the standardisation bodies for the further development of INs and it is highly unlikely that Operators will upgrade their networks to CS2 and beyond[5]. Thus the ETSI CS4 standard ratified in early 2002, is envisaged to be the last major IN standards development, with any future work restricted to essential items. AIN/CS convergence has therefore been sidelined and is unlikely to be completed because the technology has been superseded, confirming the predictions of Ziemba and Brown.

In the EU, telecommunications liberalisation encouraged the European Technical Standards Institute (ETSI) to be proactive. Thus, although ETSI defined the same Service Independent Building Blocks (SIBs) as the ITU-T did for their implementation of the IN CS1 standard, seven more were added for the ETSI CS1 standard. Therefore the ETSI SIB set was a superset of the ITU-T CS1 standard (Thörner 1994). However, within the ETSI CS1 specification, the Intelligent Network Application Part (INAP) was a subset of the ITU-T CS1 INAP specification (Fayenberg et al. 1997). These pragmatic rationalisations, which also occurred in later ETSI standard releases, helped to influence the ITU-T CS standards, since for instance, the ITU-T adopted the ETSI version and issued it as an update to CS1 called CS1-R (for ‘Refined’) (interview Anderson 1999).

Currently (in 2003), the state of the ITU-T standards compared with the previous CS release, are:

- CS2 - additional services, new functions and peer interconnect;
- CS3 - better leg control of calls (already discussed);
- CS4 - defined management interfaces, including an Internet protocol (IP) interface and API interface (using Parlay);
- CS5 - proposals agreed but work halted due to obsolescence of technology.

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[4] IN CS1+ is the IN CS1 feature set with elements of the IN CS2 standards which provide SCP-SCP and SCP-SDP interaction etc.

In the US several AIN releases have developed and are now being progressed by the US ANSI standards organisation:

- AIN 0 - Ameritech proprietary IN specification;
- AIN 0.1/0.2 - a Bellcore sub-set of CS1 & AIN 1;
- AIN 1 - an ANSI (predominantly) superset of CS1 (including mid-call triggers).

One of the key problems in the US, resulting in the delay in implementation of their equivalent of ITU-T CS1, is that they had to alter their basic C7 signalling system (ANSI SS No. 7, TCAP & ISUP), since it was at too great a variance with the ITU-T C7 standard for CS1 to operate efficiently (Fayenberg et al. 1997).

Elsewhere in the world, the Japanese Telecommunications Technology Committee (TTC) has produced yet another variant of ITU-T CS1 & CS2, JT-Q1218, based on the draft CS2 standards.

The differences between the ITU-T CS Intelligent Network recommendations, ETSI's standards implementation of the ITU-T CS standards, the ANSI AIN recommendations[6] and the TTC JT standards, are generally too detailed to be appropriate for this thesis. Some differences may be referenced in passing, but this thesis uses the ETSI implementation of the ITU-T IN Capability Sets (such as CS1 etc.) to explain the operation of Intelligent Networks. The operation and relationship of the ITU-T, ETSI and ANSI (the US standardisation body) is explored in Chapter 5.

Currently in Europe (2002), the majority of the installed base of Intelligent Networks conforms to ETSI CS1 and part of CS2[7]. Standards, now ratified to CS4, have raced ahead

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[5] There are always exceptions. IN SCPs contain expensive applications and capability. With the move to VOIP technology, network Operators will be looking to a means of using this capability in a VOIP environment, rather than redeveloping all the services. CS4 provides an SCP/IP interface for soft switch capability. Thus there is a likelihood that existing Operators will implement the IP interface part of CS4 to allow this interworking to occur.

[6] For instance, the US AIN standards were less concerned about the SCP - SDP interface than Europe. This was probably because the US had fewer inter-working networks than Europe. Europe had many small network Operators, so there was greater interest in the SCP - SDP interface between networks (as GSM Camel has demonstrated).

[7] Along with many other capabilities (e.g. older signalling types), Suppliers used the need for 'millennium compliance' of their kit, to rationalise previous developments which they needed to continue to support. Several manufacturers took this opportunity to 'upgrade' or 'force' the replacement of Operators' Intelligent Network elements from their original proprietary offerings, to that which adhered to standards (Shepherd 1999 a,b)

of implementation, to the extent that owing to the introduction of new technology (e.g. Internet Protocol networks), the later standards (CS3 and beyond) are unlikely to be implemented. The exception are those aspects of standards related to the interworking of other (especially newer) technologies, owing to the extensive installed base of INs with which they need to interwork.

Similarly, apart from allowing peer interconnect in CS2 and introducing an Internet Protocol interface in CS4, no developments beyond CS1 fundamentally altered the basic architecture model upon which the standards were based. This permits the conclusion that CS releases beyond CS1 are not significant to this thesis.

4.3 Call Routeing in Traditional and Intelligent Networks

Traditional Routeing

When switchboard operators routed a call (prior to the introduction of Strowger 2-motion selectors), a call's destination was determined by verbally passing the number between the switchboard operators at the different exchanges.

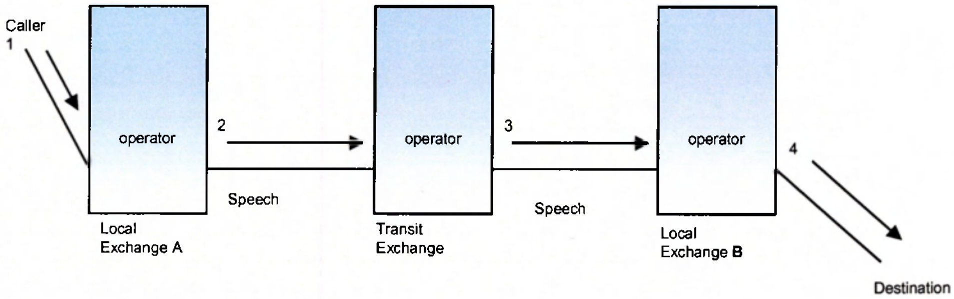

Figure 4.3 Switchboard Operator Connected Calls

The sequence of operations illustrated in Figure 4.3, is:

1. The caller tells the Local Exchange A's operator the number they want to connect to;
2. The operator, selecting an appropriate outgoing route, verbally passes the number required to the operator at the Transit Exchange and connects the caller to the Transit Exchange Operator by means of a plug and cord;
3. The Transit Exchange Operator would perform a similar function with the destination exchange operator (Local Exchange B), who would ring the destination;
4. Upon answer, the destination is connected to the caller by means of a plug and cord at Local Exchange B.

Strowger-based call routeing automation allowed the dialled number to pass from exchange to exchange in the form of a series of electrical pulses; the number of pulses determining the routeing and destination of the call. When the call reached its destination, the same path that was used to convey the dialled number was also used to convey the speech.

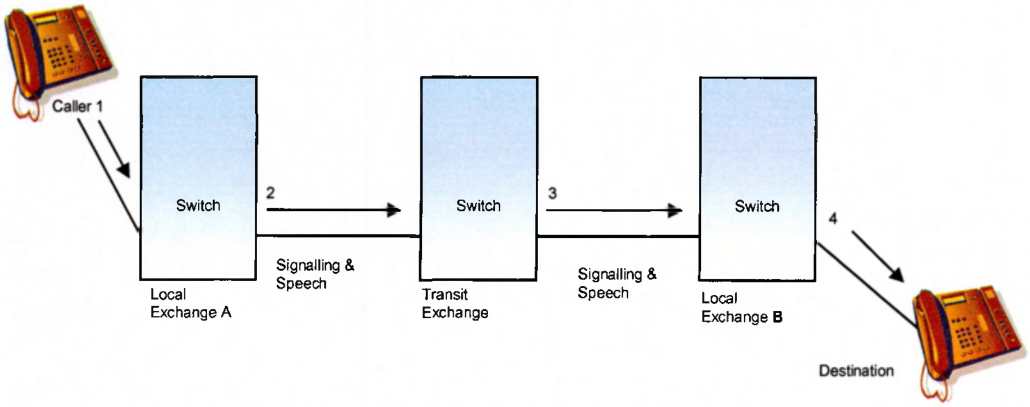

Figure 4.4 Strowger Connected Calls

The stages are illustrated in Figure 4.4 :

1. The number dialled by the Caller is used to select an outgoing route from Local Exchange A;
2. The number is similarly used by the transit exchange to select an outgoing route to the destination Local Exchange B;
3. The dialled number is also used to select the path through Local Exchange B to connect to the Destination, where the telephone is rung;
4. Upon answer, Local Exchange B connects the destination to the Caller using the same physical link that was used to carry the signalling (the dialled number).

A further development in the UK during the 1970s was the introduction of Common Channel Signalling (CCS), in which the routeing signal (which informed the transit exchanges of the dialled number) was carried on a separate path from the speech signal. This allowed more efficient use of the speech circuits. It was this separation of signalling path and speech path that allowed the non-speech-path signalling necessary for communications between remote Intelligent Network elements and hence allowed Intelligent Networks to develop. Just prior to the introduction of Intelligent Networks therefore, most telephony networks employed Common Channel Signalling (typically C7[8] which had separated speech and signalling) and digital exchanges able to operate with such a signalling system. The resulting network architecture is sometimes referred to as a 'Distributed Intelligence' network, because every exchange has sufficient 'intelligence' contained within it to route a call. This is represented diagrammatically by Figure 4.5.

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[8] CCITT Signalling System No. 7 (typically shortened to C7), was a Common Channel Signalling system specified by the CCITT (now ITU-T) for improving the signalling efficiency of telecommunication systems. This was done by carrying all the signalling information on common links freeing some links to carry speech traffic.

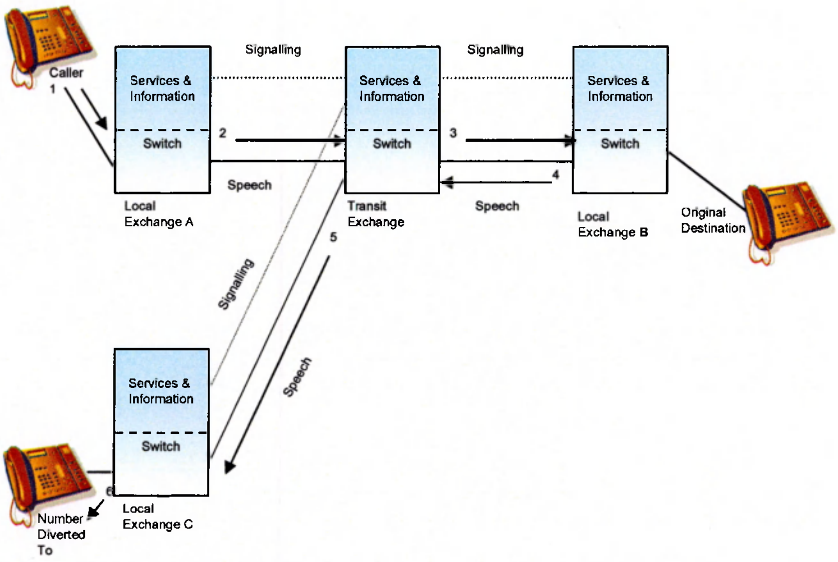

Figure 4.5 'Divert To' on a 'Distributed Intelligence' Network

The 'intelligence' (i.e. information) held at each exchange is replicated on a number of exchanges and can be used to translate a dialled digit string into an address[9] used for routeing the call through the network. Distributed intelligence implies a significant data-management overhead, in that if a piece of data (e.g. a telephone number destination) changes, then it needs to be changed on all the exchanges simultaneously.

Figure 4.5 shows the sequence of a call set-up for a diverted number using the traditional (Distributed Intelligence) telephony architecture:

1. A customer connects to their local exchange A and dials a number;
2. The call is routed to a transit exchange; and
3. onward to the destination local exchange B. The called customer however, has their number diverted to local exchange C; so
4. the call routes to the transit exchange;
5. then to the local exchange C;
6. and then onward to the destination. When the destination customer answers, the speech path created goes from the originating local exchange A, through the

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[9] An address is a digit string (often in the UK containing the dialled number), used to tell tandem exchanges how a call should route. This avoid the need of every exchange to have to look at a dialled number and work out from basics how a call needs to route.

transit to the 'diverted' local exchange B, back through the transit exchange to local exchange C.

The architecture is inefficient, since a 'Divert To' number stored in a customer's local exchange (i.e. one to which they are directly connected), results in calls routeing to that exchange and then onward routeing to the new destination. The new destination may be close to the call origin, thus the call is routed further than necessary. A more direct routeing (as is possible with an Intelligent Network) would better utilise the network and improve performance.

Specifying, developing, testing and deploying new services on a 'Distributed Intelligence' network can take between 2 and 5 years (Shepherd 1999b), owing to the need to thoroughly test upgrades, since once deployed, the service is likely to form part of the Supplier's product portfolio and is unlikely to be changed easily. The periodicity and scope of upgrades are limited by Network Operators to minimise disruption, since the network is more vulnerable to reduced performance and failures during the deployment phase. Conversely, a lengthy period between upgrades results in a reduced ability to react to market demand and competitors' products and a consequence is that bespoke products (to accurately fit the customers' requirements) can become almost non-existent. The introduction of any new service is time-consuming and costly.

Intelligent Network Routeing

Intelligent Networks (INs) differ from traditional telephony networks by tending toward centralised intelligence, allowing centralised routeing control. This centralised control is achieved by separating the services (service logic) and routeing information from the exchange switching actions (call control) and placing the service logic in a single location. An exchange which is required to route a call will ask ('query') the centralised intelligence, which will return the information needed by the exchange to route the call (Figure 4.6).

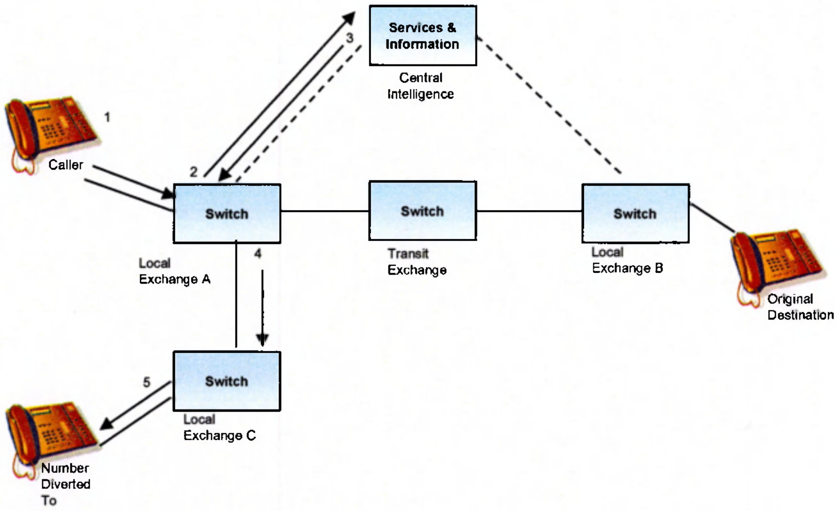

Figure 4.6 'Divert To' on an Intelligent Network

Figure 4.6 shows the sequence of a call set-up for a diverted number using an Intelligent Network and can be compared directly to Figure 4.5. With an IN architecture the 'Divert To' number is stored centrally. When the call is made, a customer:

1. Connects to their local exchange A and dials a number;
2. The local exchange queries the centralised intelligence (containing the services and information) for the routeing of the call;
3. The centralised intelligence has information which identifies that the called number is diverted to another number, so it provides the routeing of this 'divert to' number to the local exchange A;
4. Local exchange A routes the call accordingly, which in this case happens to be to a telephone connected to local exchange C and rings the telephone;
5. When the call is answered the speech path created through the network, is from the originating telephone to the destination telephone via local exchanges A & C.

Using an Intelligent Network architecture the call can route directly to the final destination; avoiding unnecessary routeing that is incurred by a similar call in a traditional architecture.

This example indicates that the function of the Central Intelligence is to enhance an exchange's number translation and routeing capabilities. Whilst number-to-address translation is a normal switch function, it is an expensive and inefficient overhead to load the exchange's real-time call-processing software with the functions and data needed for these extra translations (i.e. 'Divert To' numbers). Some businesses have a widely dispersed and dynamic profile of call reception points, such that during the working day they need immediate changes to their incoming routeing translations, in order to adapt their response to the changing patterns of call (Shepherd 1999c). It would be inefficient to distribute the translation information to hundreds of network exchanges, because of the excessive storage required and because information changes would be slow and processor-intensive; routines would need to be run detracting from the exchange's call carrying capacity. Thus putting the services and information in a central location, creates the need for just a single occurrence of a service and data in a telephony network, allowing quick and easy modifications. With Intelligent Networks therefore, new services and associated information only need be implemented at the central location, this being achievable with (theoretically) no network disruption.

Separating the service logic (from which services are created) from the transport logic, as in INs, created an 'open' architecture. Initially the interfaces of the IN architecture represented in Figure 4.6 were proprietary[10], but the success of Intelligent Networks encouraged '...the desire for service and Supplier independence and gave an impetus to develop new *international* standards for IN*s*' (Pandurangan 1993 p129). This made the technology more attractive to Operators, who were able to choose different Suppliers for the different elements (exchange, central intelligence, etc.) achieving vendor-independence and gaining purchasing power. Standardisation was also attractive to smaller Suppliers, since '...there will be a bigger market for their products and a more stable environment for product development' (Ellis 1992 p1), necessary to have made such developments economically viable. Larger Suppliers offering only proprietary INs were consequently forced to align their products to standards and hence similarly benefited from the potentially larger market. Computer manufacturers were '...interested in IN because it provided them with a means of extending their markets into the telecommunications arena'

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[10] Proprietary IN protocols generally refer to those messages passed between the exchange and the central intelligence. When these messages are proprietary, they are specific to the service, exchange and central intelligence.

(Ellis 1992 p1). However Hawkins (1995) indicated this transition was not likely to be easy, since

> 'Although the technology bases of the telecommunication and computer sectors have converged, it is uncertain that the commercial cultures of the two sectors have converged to the extent that co-operation between them in defining standards will be possible or productive'.

This was similarly recognised by Gilder (1996) who said that '...computers and telecoms are converging like the automobile converged with the horse'.

An Intelligent Network architecture therefore provides a quicker and more responsive mechanism for new service delivery that does not threaten the underlying stability of the network. However, with the service control and supporting information isolated at one location, it creates

> '...a situation where a company's entire incoming communications is based upon a single number *(such as a Freephone number) and* places considerably greater requirements on the reliability of access to that number, since upon failure, all telephone calls to that company are lost.' (Thörner 1994)

4.4 An Overview of Intelligent Network Elements

Intelligent Network Elements

This section uses an example of a geographic routeing service to describe the role of standardised Intelligent Network functions. The physical realisation of an Intelligent Network varies between network Operators; depending upon the services offered and the geographical location of the hardware. Thus although the key functions of an Intelligent Network are discussed in relation to the physical element with which they are normally associated, this relationship may not always be the case. (The relationship of the functional elements to physical elements, is detailed in ITU specifications ITU 1992 and ITU 1995a,b,c).

One example of the type of service provided using an IN would be that for a large windscreen repair company that offers its customers a single, national, Freephone contact number. Calls to this number are always connected to the geographically closest repair depot. Another example is a pizza delivery service, where a chain of pizza restaurants advertise a single Freephone number for a home-delivery pizza service and the call is routed to the restaurant nearest to the caller. Such services are referred to as 'Geographical Routeing' and the call set-up sequence for such a service is illustrated in Figure 4.7.

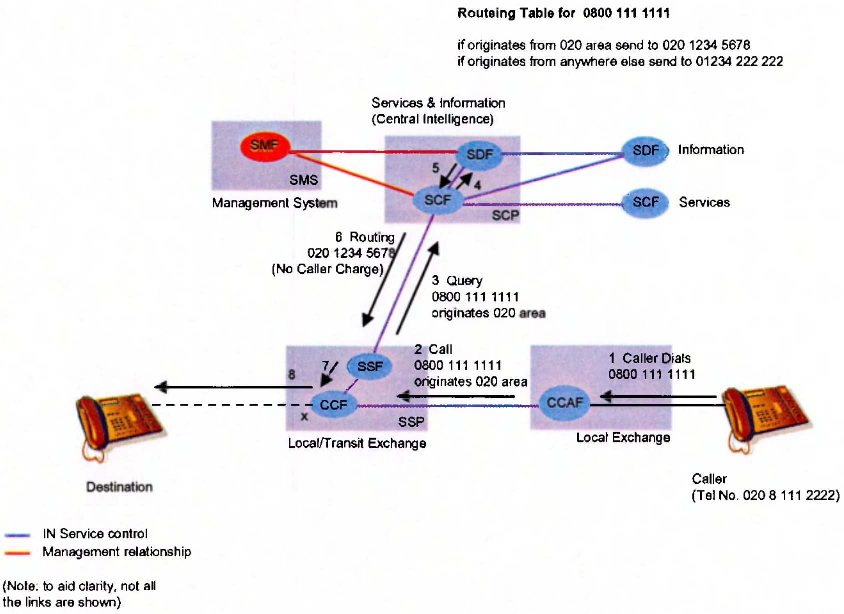

Figure 4.7 The Geographical Routeing of a Freephone Call

The rectangles in Figure 4.7 represent the physical elements, whilst the ovals represent the functionality generally associated with that element.

The Local Exchange

In Figure 4.7, a caller having a telephone number 020 8111 2222,

1. calls a Freephone number 0800 111 1111.
2. The dialled number is recognised by the CCAF as requiring a central database look-up and the call is routed to the SSP.

Non Service Switching Point (SSP) local exchanges can contain 'Call Control Agent Functionality' (CCAF), which when a call originates on that exchange, detects that an Intelligent Network capability is required and routes the call to an SSP exchange which provides service access via the Call Control and Service Switching Functions.

The 'Call Control Function' (CCF) of an SSP exchange can be viewed as containing a 'Call Model' which identifies at which stages in a call a query to the central intelligence (Service Control Point) may be needed. These stages are called trigger points and can arise when a customer lifts the receiver of their telephone or completes the dialling of a number. Different services could utilise different trigger points.

The North American AIN standard utilises a different call model (and hence generates triggers from different points) from the ETSI CS1 standard.

> 'If the database in one country uses an AIN call model and if the node in another country uses CS1, the international service cannot be properly offered' (Pandurangan 1993 p130).

Thus the implementation of a common service across networks comprising the two standards is made difficult since the service may assume the use of a trigger point which does not exist on both networks.

The Service Switching Point (SSP)

The 'Service Switching Point' (SSP) typically hosts the 'Call Control Function' (CCF) and 'Service Switching Function' (SSF). The Service Switching Function ensures that all the information appropriate to a trigger point is gathered into a message, such as step 3 in Figure 4.7:

3. The SSF constructs a query, such as 'the caller has dialled number 0800 111 1111 and is calling from location 020[11]' and sends this message to the centralised service application located at the Service Control Point (SCP).
6. The SSP translates the instruction 'connect the call to destination 020 1234 5678' received back from the SCP into a set of switch actions to be performed by the Call Control Function (CCF), such as

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[11] The Caller's telephone number (020 8111 222) is geographically based, i.e. numbers beginning 020 only occur in London. The caller's telephone number when used in conjunction with a call they are making is called the Calling Line Identity (CLI). With an entirely digital network, the CLI will always be available, however if the CLI is not available, possibly because the call originated from an analogue exchange or other network where the CLI is 'withheld' by the Operator, an approximation of the caller's location can be used based on the incoming trunk. This is known as 'partial CLI', or 'trunk identifier' where the identity of the route into the first digital exchange in the network is provided. Similarly if only part of the caller's number is used (e.g. 020), this is also known as a partial CLI.

7. ‘connect the call to outgoing route x from the exchange and disable caller charging’ - since a Freephone number is being dialled.

The Service Control Point (SCP)

The Service Control Point is a centralised computer (or a number of computers) that contains the ‘Service Control Function’ (SCF) that executes the IN services and the ‘Service Data Function’ (SDF), which stores the data needed for a service.

For instance, the query (3) from the SSP in Figure 4.7, indicates that the caller is dialling the Freephone telephone number of a car windscreen repair company (0800 111 1111). The SSF invokes the operation of the service applicable to that number which may be a ‘connect to the closest branch’ service. The service uses additional information from the query received from the SSP (i.e. call originates from the 020 area), to identify the location of the customer in the country.

4. It will then ask the Service Data Function (SDF) for the destination telephone number of the closest branch.
5. The SDF responds with the telephone number of that branch (020 1234 5678). The SSF constructs this into a message to be sent to the SSP. This has already been discussed above for step 6 of the call flow.

In some cases (such as credit card validation for credit card calls), the information would not be under the Operator’s control and the SCF could use the SDF capability on a remote database to obtain the information.

The Service Management System (SMS)

The Service Management System (SMS) comprises the Service Management Function (SMF) which manages the provisioning, maintenance and operation of IN services (e.g. data updates), therefore acting as the IN system interface for customers (Thörner 1994). (The customer in the example of Figure 4.7 is the one owning the Freephone number and related service application i.e. the windscreen repair company). Needless to say security must be extremely high to prevent hackers from accessing the system and the ITU-T standards Q.1221 and Q.1224 have addressed this with respect to IN security (ITU 1996).

Thus if the windscreen company wished to change the branch to which they routed calls originating from the 020 area, the SMF would convey the new number to the SDF which would then change the appropriate entry in the information table.

4.5 The Progressive Development of Intelligent Network Services

Intelligent Networks currently offer a very wide range of services. Because these services are essentially constructed from the same basic building blocks their functionality overlaps. For example, services could include a Freephone service, a Freephone service with geographical routeing, or Freephone service with geographical and time of day routeing, or call redirection service having geographical and time of day routeing etc. The full functionality available and exactly how such services are implemented will vary between Network Operators.

This section takes the concept of a simple Freephone service introduced earlier and develops it to demonstrate how, using different standardised points of interconnect in the Intelligent Network architecture hierarchy, a progressively more advantageous International Freephone service could be offered between network Operators.

The Freephone Service

The simplest use of an Intelligent Network is to provide a number translation service, as described previously and was the first service offered on INs. The key advantage of the IN over the traditional telephony network, where intelligence is effectively distributed amongst the exchanges, is that the service logic information is held in one place and so it is easy to change.

The world-wide success of the Freephone service, which combines these number translations with the ability for a caller to make a 'free' call - at the recipient's expense - is well-known. Freephone dialling codes (e.g. '1800' in the US, '0800' in the UK) bear no relation to the geographic location of the recipient. Countries which had the foresight to keep letters as well as numbers on their telephone instruments found this factor to be a catalyst in the growth of their Freephone services[12]. Ingenuity encouraged the invention of

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[12] It is interesting to reflect that the near-instant success of the Freephone service appears to have resulted from technology stimulation rather than carefully laid marketing plans (interview Anderson 1999).

easy-to-remember 'numbers', such as 1800-AIRWAYS, or 1800-CARPETS[13], which aided the use of the service.

The Freephone service was initially implemented in North America and the UK using proprietary protocols between the Service Switching Point (SSP) and Service Control Point (SCP). Unless Telephony Network Operators were using exactly the same Supplier's equipment, interaction was not possible and interconnect could only be achieved at the basic (transport) level, i.e. where one Operator presents a call and the number dialled to a second Operator for further processing. Once international standards had been established, then 'intelligent' interconnection was possible.

The following examples demonstrate how different Network Operators' standardised Intelligent Networks, could be made to operate by using different IN interfaces. In each case the example is an 'International Freephone' call where the destination of the Freephone number is in a different country from the originator. In each case the caller discerns no difference in the handling of their call by the networks. (In the figures the Freephone prefix has been omitted and the lengths of the number strings have been truncated to aid clarity).

When these examples were initially constructed (1996), interconnection was only possible at the transport level. Connection at SCP/SDP level was just being ratified in the standards, thus the later examples in this section illustrate what could be offered using these interfaces. There are now (in 2003) examples of networks interconnecting at the SCP/SDP level.

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[13] Unfortunately the relationship between letters and numbers on telephone dials vary between countries. The liberalisation of telephone equipment in the UK in the early 1980s allowed telephone imports with a different letters to numbers relationship to the rotary dial telephones already existing in the UK. Although the number/letter relationship has now been standardised, there are still enough older telephones in use for this form of Freephone number dialling not to have received official sanction in the UK.

International Freephone (Connection at Transport Level)

This first example is still generally an illustration of what happens today, connection between Operators' networks at the basic (C7) transport level.

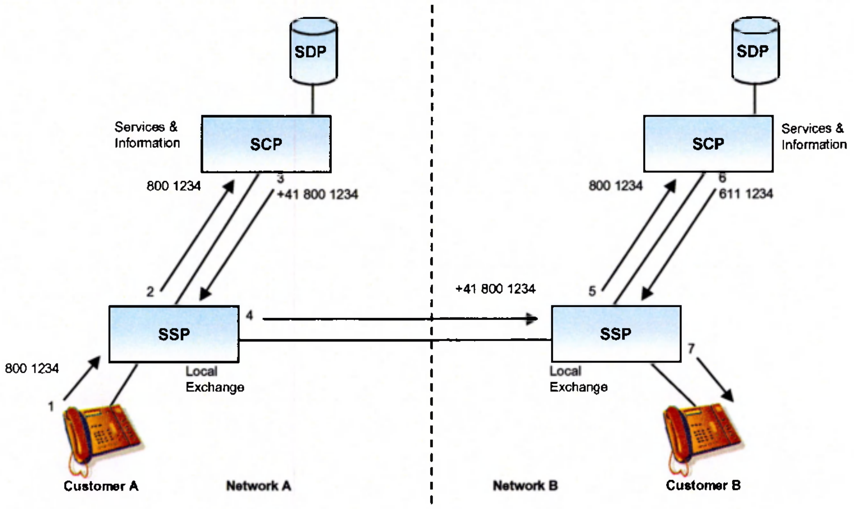

Figure 4.8 Inter-Operator Freephone Service (Interconnect at transport Level)

Referring to Figure 4.8:

1. A customer on Network A dials a Freephone number (800 1234).
2. SCP A receives the query from SSP A and identifies the call as being destined to a Freephone location in Network B. If necessary it translates the dialled number into a number recognised by network B and inserts a Country (or routeing) code (+41) and
3. instructs SSP A to route the call to Network B.
4. Network A routes the call based upon the country code to Network B (establishing a speech path in the process), where SSP B recognising the country code as its own, removes it and
5. queries its own SCP (SCP B) for the destination.
6. SCP B recognises the destination corresponding to the Freephone number 800 1234 as being telephone number 611 1234 and instructs SSP B to route the call.
7. SSP B connects the call to the customer and when the call is answered a speech path is established to connect to that already set-up from network A.

The call uses the SCPs in both the originating network (SCP A) to route the call through to Network B and then again in Network B (SCP B) to connect the call. A voice path is established in Network A as soon as the call is passed to Network B, thus Network A is using voice capacity on its network for a call which might ultimately fail (i.e. the destination number might be busy).

International Freephone (SCP-SDP Interconnect)

In this second example, there is connectivity between Network A's SCP and Network B's Service Data Point (SDP), thus SCP A is able to perform a remote database query of Networks B's database.

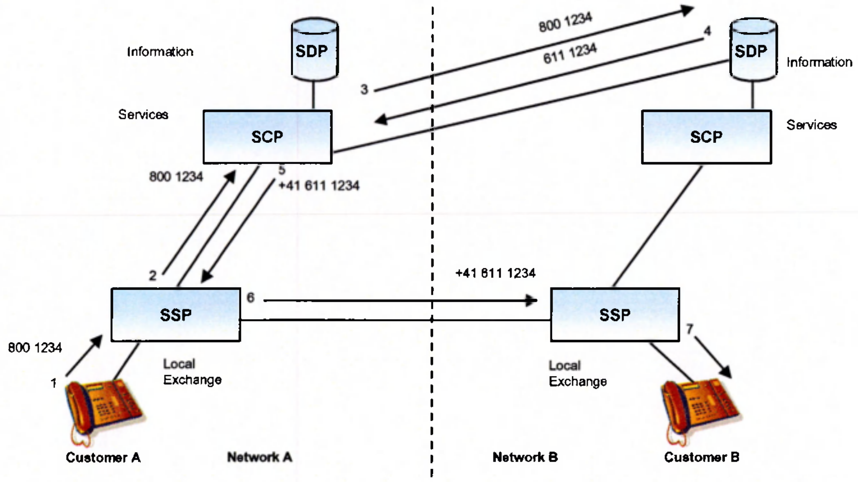

Figure 4.9 Inter-Operator Freephone Service (SCP-SDP Interconnect)

Referring to Figure 4.9:

1. A customer on Network A dials a Freephone number (800 1234).
2. SCP A receives the query from SSP A and
3. recognising the dialled number as belonging to Network B, asks Network B's database for a translation of the number.
4. Network B's database recognises the destination corresponding to the Freephone number 800 1234 as being telephone number 611 1234 and returns this translation to SCP A.

5. SCP A translates the dialled number into a number recognised by network B by inserting a Country (or routeing) code (+41) and instructs SSP A to route the call to Network B.
6. SSP A routes the call based upon the country code to Network B,
7. where SSP B recognising the country code as its own, removes it and connects the call to the customer (without the call requiring a further SCP query). When the call is answered a speech path is established to connect Customers A and B.

In this example, the call only uses SCP processing in Network A, but although SCP A has to do slightly more processing than in the first example, the call processing used overall is less, since SCP B is not used. Call connection time for customer A will be marginally improved (not noticeable to the caller, but helpful to the network owing to reduced reservation time of network resource[14]). A voice path is only established when the destination answers, avoiding the need to establish a path as in the previous example prior to this state being established.

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[14] When a call is made in a telephone network, the dialled number is carried on a separate link to the voice. This allows the destination to be checked to make sure it is free and available to take a call before the speech circuits are connected. However, before the destination is checked the network needs to identify that there is speech circuit capacity available to the destination. Once this is done, the network resource identified to construct that speech circuit is 'reserved' for that call should the destination be free. If the destination is not free, the reserved resource is freed to be used for other calls. This method of working is quicker than establishing speech circuits for every call (successful or unsuccessful) and uses less network processing and requires fewer circuits.

International Freephone (Interconnect at SCP Level)

In this third example, there is connectivity between Network A's SCP and Network B's SCP, thus SCP A is able to ask SCP B for instructions on how to handle the call.

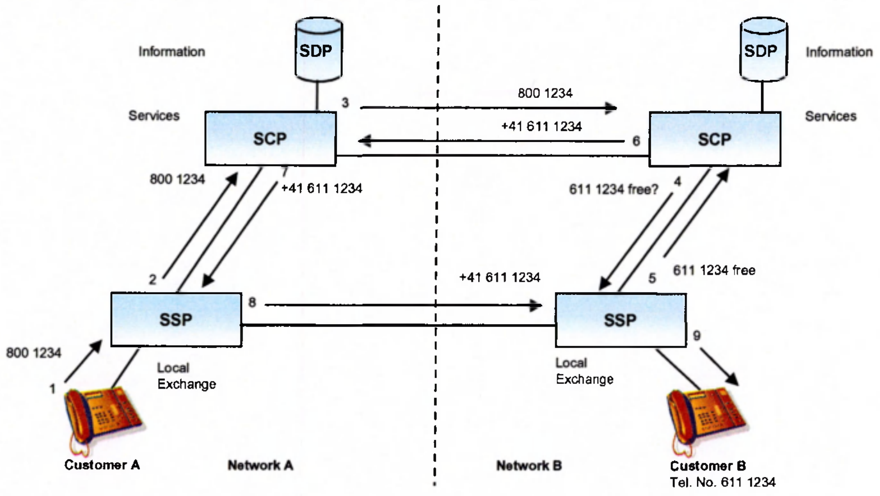

Figure 4.10 Inter-Operator Freephone Service (Interconnect at SCP level)

Referring to Figure 4.10:

1. A customer on Network A dials a Freephone number (800 1234).
2. SCP A receives the query from SSP A and
3. recognising the dialled number as belonging to Network B, asks Network B's SCP for instructions on how to handle the call.
4. Network B's SCP recognises the destination corresponding to the Freephone number 800 1234 as being telephone number 611 1234 (by querying the SDP) and can ask the SSP to check if the destination 611 1234 is free.
5. If the destination is available to receive a call,
6. SCP B returns the telephone number the call needs to route to, to SCP A prefixing the appropriate country codes at the front (+41 611 1234).
7. SCP A forwards the translated number to and instructs SSP A, to route the call to Network B.
8. SSP A routes the call based upon the country code to Network B,

9. where SSP B recognising the country code as its own, removes it and connects the call to the customer (without the call requiring a further SCP query). When the call is answered a speech path is established to connect Customers A and B.

In this example both SCP A and SCP B are involved in establishing the call, but the overall processing load is reduced. Network Operator B knows from the query to SCP B what telecommunications traffic is expected to enter its network, the traffic's origin and its destination, fractionally in advance of it happening[15]. Call connection time for customer A is marginally improved (not noticeable to the caller, but helpful to the network owing to reduced reservation time of network resource[16]). A voice path is only established when the destination answers, avoiding the need to establish a path prior to this state, as in the first example .

Interconnecting SCPs introduces a level of trust between the two parties since inappropriate messages could cause operating problems for the other Operator's network.

> '...the protocols to connect between the different entities have not been designed to be secure (in the sense that wrong messages from one entity might upset the functioning of the network)' (Yeoman 1993 p2).

This concern is echoed by Woollard, 'Let INAP get into the wrong hands and you can take down the whole UK network' (interview Woollard 2002). The ITU-T documentation covering IN CS-2 includes the provision of security-assisting functions at the SCF-SDF and SDF-SDF interfaces; however these functions, of themselves, are not sufficient to assure the security of IN structured networks (interview Anderson 1999).

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[15] Advanced information on network loading is important since it allows an Operator to be proactive in managing their network resources, particularly in overload conditions. In this particular case, if Operator B's network is in congestion (attempting to carry more traffic than it can handle), the SCP B can send a congestion message to Network A and have the call blocked in Operator A's network. Normally a call would route into Operator B's network through several transit exchanges before it was blocked, using both Operators' switching resources for what will be a failed call attempt and preventing that resource from being used for other callers in the Operators' networks who might other wise have made a successful call.

[16] As footnote 10

In practice,

> 'Separate implementations by carriers have created a situation in which service applications cannot be provided across carrier networks, or at least not in their entirety' (Langner 1993 p864);

thus even today connections between Operators in different countries do not occur at anything other than the basic transport level.

4.6 More Advanced Services

The following examples (similarly of my own construction) are services which could be implemented by Intelligent Networks, but would need non-standardised capabilities. These examples appeared quite radical when conceived and were constructed to illustrate the potential of open interfaces, with respect to integrating INs with Customer Premise Equipment (CPE). The aim was to explore Isenberg's (1998) (and others') thoughts of intelligence moving out to the edge of the network, in conjunction with INs.

> 'The simple telephone will not be capable of maximising all the potential of intelligence in the network. New types of terminal equipment should represent an opportunity for service providers by making more complex and data-rich services practical' (Jordon 1993 p4).

These examples employ capability being discussed and observed to exist at the time (1998), with elements of these designs now (2002) realised.

Computer Telephony Integration

Computer Telephony Integration (CTI) is the integration of computer (or server) technology with (voice) telephony. A typical application is that employed in 'call centres' where the callers telephone number (termed Calling Line Identity - CLI) is used to retrieve customer information from a database and present it on the attendant's screen at the same time as the call is presented to them through their headset.

In the example below, a simple 'Call Pick-up' function (where any agent can answer a ringing line) is being employed.

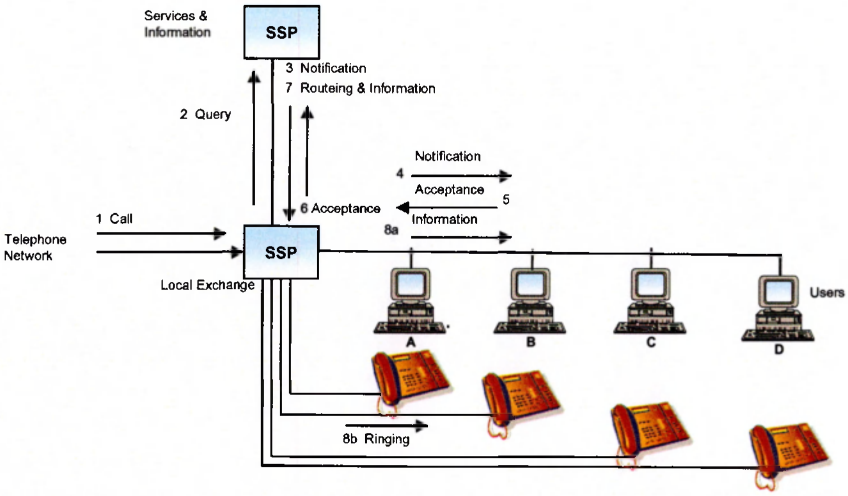

Figure 4.11 Call Pick-up

The terminals in Figure 4.11 represent the four users of a call pick-up group, each having a telephone and a computer terminal.

1. A call is routed through the network destined for telephone D.
2. The call is referred to an IN SCP for an address translation and the call connected to telephone D based upon the CLI. After a pre-set time, the timer in the SSP activates a trigger to the SCP. The subsequent query contains the dialled number, the CLI and a Service Key value indicating the reason for the query (i.e. that the call was not answered). From the dialled number, or the Service Key value, the SCP front-end invokes the SCP application logic that handles the call pick-up service. This identifies which other destinations could be offered the call.

3. It then instructs the switch to send the CLI to the terminals belonging to users in the pick-up group (using perhaps the ISDN[17] data channel),
4. invoking a pop-up screen from which other members of the pick-up group could accept or reject the call, via their terminal.
5. Supposing user B accepts the call, the acceptance is passed back to the switch in the form of a (ISDN) CLI and
6. this is passed to the IN (via the SSP), which
7. subsequently instructs the switch to connect the call to the telephone of user B.
8. a. Information relating to the customer is displayed on user B's terminal as,
8. b. the call is connected to their telephone

The key benefit of the IN in this case, is not so much the call pick-up capability, which many companies' internal telephone systems already possess, but that the pick-up group members could be geographically remote from each other. A secondary benefit is the computer terminal integration, which could be enhanced by the inclusion of a server and corporate directory so that not just the telephone number of the caller is displayed on the user screen, but also the caller's name and other relevant details.

At present there are no examples of CTI using a wholly network based SSP & SCP; instead such services utilise hardware performing the same functionality on the customer's premises, for example a Private Switch (PBX) & CTI Server. As Jabbari et al. indicated in 1992, most customers prefer this arrangement as it gives them greater control over the introduction of new applications.

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[17] Although it is not applicable in this example, it is worth emphasising that ISDN and IN did not (until more recently) function together. This is because once an ISDN call was established, the traffic was 'enveloped' through the telecommunications network (analogous to 'tunnelling' in an Internet Protocol network), preventing the network from identifying and acting upon relevant information sent by the caller. For instance, should a person make a Charge Card call (with an ISDN origin and destination), then once they had finished that call they would normally indicate to the network (by means of a sequence of key presses), that the current call could be terminated and that they would like to make a 'follow-on' call. With an ISDN connection, the information would be 'enveloped', the network would be unable to see it and act upon it. The customer would have to clear their call (replace their handset) and then redial the Charge Card bureau and re-authenticate themselves, before continuing with the second call. Similarly, Call Models are unable to act upon end to end supplementary information messages carried over ISDN. This problem is not an issue in this example since the caller would be using a PSTN line and the ISDN functionality would only exist on the company's premises. (Batten et al. 1991, interview Paterson 1994, Buck 1995, interview Guram 1995).

More recently however, customers have taken the first step towards a fully integrated network solution, with dedicated interfaces on the CTI server providing information to the SCP on the local loading and average call holding time of their call centres, allowing the SCP to work out the appropriate call distribution.

This example of a 'call pick-up' service uses the customer's home number (their CLI) to route the call to the appropriate user group. There are several types of CLI available in a telephony network, broadly falling into the categories of 'Presentation' and 'Network' CLI. 'Presentation' CLI is that which the user wants to be displayed to users, whilst the 'Network' CLI is that used by the network to uniquely identify a location. 'Presentation' CLI can be 'withheld' by the customer if they don't want others to know their telephone number. 'Network' CLI cannot be 'withheld'. In the last example, the Call Pick-up service used 'Presentation' CLI and if the caller chose to withhold their CLI then the application would typically have used some kind of default routeing, perhaps connecting the caller to an attendant handling general enquires, rather than the group dealing with their account.

There are however, applications (such as Geographical Routeing) which need the CLI to ensure correct operation. In this latter case, the network uses the 'Network' CLI for routeing purposes even though the CLI may have been withheld by the customer. This ability of certain services to 'see' the 'Network' CLIs, potentially allows other services and their administrations (who may be independent from the underlying Network Operator) to discover the number and hence the identity of a caller - something the caller may not want known. This gaining of information from other services, as well as services detrimentally interacting is called 'Service Interaction'. If a customer wishes that their CLI remains hidden, the obligation is upon the Operator to ensure that this is done. This is supported in law in the USA and at present in licensing conditions in the UK.[18]

Another aspect to Service Interaction is the interaction of call-processing features. This is particularly an issue with the development of third party applications running on an Operators platform. Since the Operator is given minimum visibility of their operation, there is the possibility of two applications interpreting the same information in different ways, leading to operational problems. For instance Cain (1992) indicates that for a large business customer, a flashing of the switchhooks (equivalent to quickly placing a telephone receiver on its rest and picking it up again) can mean any of the following:

- 'Initiate the second leg of a three-party call;
- Bridge the second leg of a three-party call onto the call;
- Initiate call waiting, putting a current call on hold and answering a second incoming call;
- Toggle a pair of call-waiting calls, putting the current call on hold and retrieving the held call;
- Attendant take-back of a call originally transferred by the attendant;
- Initiate any of several other features such as call transfer.'
  (ibid p44)

Although these examples are not particularly pertinent to Intelligent Networks, they do give an indication of the multitude of features which may rely upon the same trigger to activate them. Products created by different parties and used by a single customer may find they have a common trigger for some functions. It is this aspect which needs to be addressed when allowing third party access to an Intelligent Network Service Creation environment or Service Logic Execution Environment.

The conclusion to draw from this detail is that for the introduction of a new service, it is not only the security of the operation of that service that needs to be examined, but also the security and operation of all the other services that may be required to work with it. The impact of service and feature interaction, both from security and network integrity perspectives is therefore perhaps the greatest ongoing challenge to be resolved. This significant conclusion was recognised by Thörner (1994),

> 'Service interaction and the inherent risk of undesired effects when two or more services are used together become a major problem unless we develop tools to handle this problem very quickly' (ibid p92).

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[18] Interestingly in the UK, this licence condition could be argued to be breached by mobile telephone Operators, both in their Short Messaging Service (SMS) (where CLI cannot be withheld) and in their Directory Enquiries Service (where telephone numbers can be SMS'd to the callers telephone even with their CLI withheld)

Integrating CTI, IN and the Internet

This example of an advanced Intelligent Network service, takes a topic arising from Survey 2, that of integrating INs with the Internet and identifies how an IN can be used to offer a service in conjunction with a web page.

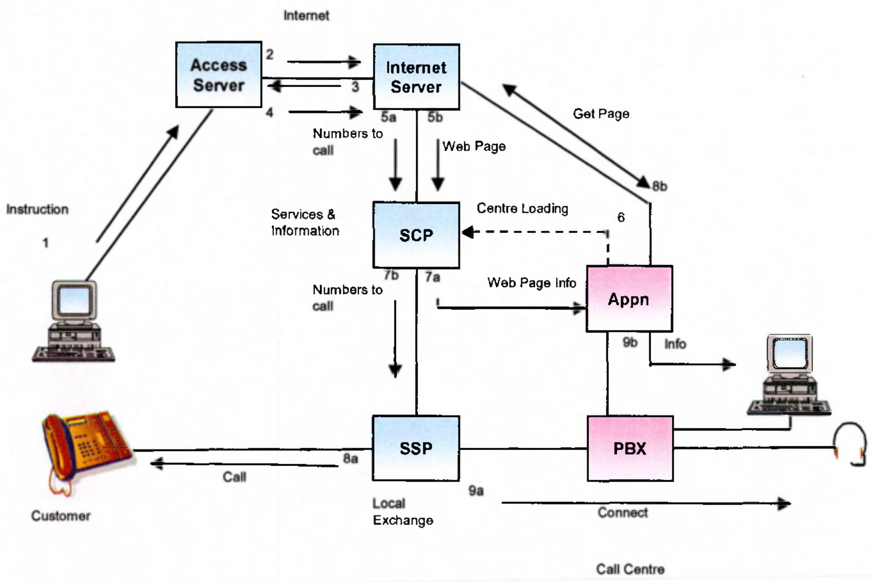

Figure 4.12 Internet 'Call Me' Instruction

In this scenario, the customer is browsing a page on the Internet and wishes to talk to a representative of the company to which the page belongs, perhaps to obtain further information. An icon on the page indicates a 'call me' capability.

1. & 2. When the user selects the icon, this is detected by the Internet Server which
3. sends a request to the Access Server owned by the Internet Services Provider.
4. The Access Server provides the customer's telephone number to the Internet Server. The Internet Service Provider (owning the Access Server) knows this from their own user account information and the logon identifier of the user.
5. (a) The Internet Server invokes a call-me instruction in the telecommunication network Operator's SCP. The SCP application, having a geographical routeing capability, is able to identify the most appropriate company call centre to which the call is to be connected. (Geographical routeing is important given that the

Internet Server could be accessed from anywhere in the world). (b) Along with the call-me instruction, the Internet Server provides details of the Internet page the customer was looking at when they selected the 'call-me' icon.

6. The SCP can check the loading and call queuing capacities of this centre by means of a back-end link to Call Centre's server and thus if necessary, select an alternative centre.
7. Having identified an appropriate Call Centre to handle the call, the SCP (a) sends details of the web page to the Call Centre and (b) instructs the SSP to
8. (a) generate a call to the customer while (b) the Call Centre application is retrieving a copy of the Internet page the customer was looking at.
9. (a) Upon the customer answering, the SSP can connect the call to the call centre (using call queue jumping[19]) and the attendant answering the call will have (b) the appropriate Internet page displayed on the screen of their terminal. The call and Internet Page information could use the channels of an ISDN link, providing integrated access to the attendant's position.

Although this service was developed for the purposes of the research and required new protocols, all the information and much of the capability already resided in telephony networks at the time of the design (1998). Despite this, such services have not been implemented, probably because the increased use of Voice Over IP from the p.c. would appear to make such a proposal redundant, although one Operator is currently (2002) considering it (Shepherd 2002).

4.7 Factors to Consider when Choosing an Architecture

In researching Intelligent Networks, it became apparent that there was little thought being given to the appropriateness of Intelligent Networks in meeting a telecommunication Operator's needs. It appeared to be considered a 'must have' or 'flavour of the month', in much the same way as the Internet is currently. Intelligent Networks were developed and integrated with other technologies; global partnerships and joint ventures were established and new services were implemented as fast as possible. Operators were perpetually

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[19] Queue jumping can be achieved by a variety of means. The most widely practised method of queue jumping used by Call Centres is to use the CLI of the caller to identify if they are an existing or valued customer, the Call Centre CTI application then moving them to the front of the queue. In this particular example, queue jumping could be achieved by using a different telephone number to access the centre compared to other users, to establish priority.

ensuring there was capacity in the right place at the right time, with little thought being given to where their evolving architecture was taking them.

This section sets out a framework, comprising a number of factors which should be analysed and assessed against an Operator's existing network and proposed IN architectures. The goal is to determine whether the proposed development is the best course of action in helping the company achieve its strategic goals. The next stage identifies the role of INs in an Operator's network. Drawing on the findings of this research, it has been possible to identify a common sequence in which Operators implement INs; an Operator reappraising the role and hence structure of their network as time progresses, thereby unconsciously moving INs through a number of discernible stages. This section also identifies different traffic types, these being discussed in association with a number of different implementations of IN architecture, with consideration being given as to how some IN architectures may be better suited to meeting an Operator's company strategy compared to others. Finally, with the research taking a number of years, it has been possible to compare some promised aspects of IN technology with what has been realised, to perhaps temper the vision with reality. This is included again as a consideration point for an Operator implementing an IN.

The Impact of INs on Operators' Legacy Networks

Assuming the decision to implement an Intelligent Network has already been made, that decision-making process should have considered the benefits, that an IN implementation of services offers over similar services implemented on an Operator's legacy network (assuming there is one). The benefits of supporting services on an IN architecture have already been discussed, but many of those services can be offered (albeit less efficiently) on a traditional distributed processing network. The primary reason for using an IN arose when the Services were frequently modified, or if there was a high churn in customer information, such that the volume, or frequency, of updates caused the management and network systems problems in achieving acceptable update times and accuracy.

Having chosen to implement an IN, there were periods when Network Equipment Suppliers were introducing a standardised IN product into their portfolios (about 1994 onwards), or developing 'open management' interfaces (about 1999), when there appeared to be a benefit to Network Operators to delay the introduction or upgrades of INs, in that they would get these new features. This would have aided the integration of the new equipment with the existing equipment and provided a level of future-proofing. Obviously such a delay would have been strategic and only really achievable if they could have maintained the revenue stream from their existing network, without losing market share. However it is fair to say that by 1998, all large network Operators were looking either to implement their first IN (e.g. Cable & Wireless in the UK) or upgrade their existing IN (e.g. BT in the UK). Intelligent Networks had therefore established themselves as an essential part of any large Operator's network.

The key problem with existing (non IN) switches were that they were not developed with the modular IN approach in mind and thus were not easily upgraded to IN working[20]. Furthermore, those elements that were upgradeable would not conform to IN standards. The option of an upgrade path depended largely on Suppliers developing existing products (rather than producing new products) to construct their IN product portfolio. As can be imagined, Suppliers typically followed the 'distributed intelligence' path, then developed a 'proprietary' IN product, followed by an IN product adhering to international standards. Consequently, Operators that did not progressively upgrade (or update) their original switches found that they could not be upgraded to an IN model, since the upgrade from a 'distributed intelligence exchange' to an IN exchange required too many changes to be cost effective.

Upgrading older 'distributed intelligence' networks carried with it the requirement for a signalling protocol, such as C7, capable of handling non circuit-related messages. This was necessary in order that messages relating to SCP queries could be conveyed to an SCP located remotely from the exchange[21] (Ellis 1992).

Operators with a substantial investment in an existing network adopted the strategy of 'overlaying' the existing network with an IN, where only calls requiring IN services were routed to the overlay. This strategy also minimised the disturbance to the existing network, the operation of which would be compromised by upgrades.

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[20] Upgrading a non IN requires additional digit discrimination and triggering intelligence in the switch in order to query the central database. This is the 'intelligence' which upgrades a telephone exchange to SSP (Service Switching Point) status and represents a major network enhancement.

In addition to the real-time network enhancements, large changes to the support systems for management and billing were essential for these new INs.

> 'The greatest challenge to the introduction of the Intelligent Network is the administration of billing, call tracking and call identification information' (Harrington 1993 p13).

New elements obviously had their own management capabilities, but the real challenge was to converge these with the existing alarms, faults, network statistics and other network management and control systems already operating. IN services introduced major new revenue streams for network Operators and so appropriate billing arrangements were crucial to the success of the service. Whilst building a bespoke billing system just for a new IN might have appeared to be an attractive option, most customers purchased a range of services (offered on both IN and non IN equipment) and wanted a single bill addressing them all, not an individual bill for each service. Thus billing systems needed to be rationalised and converged in the same way as the other operational areas, to combat the onset of unmanageable complexity (Shepherd 1997c, Shepherd 1998).

Other exchanges in Operators' networks may have been early IN implementations. These were proprietary, their applications hard-coded and the modules (SSP, SCP etc.) closely integrated with one another. The problem the Operator faced was the alternatives of being tied to one supplier until their network is upgraded to international standards or much of the network equipment having to be scrapped to upgrade to an architecture adhering to international standards (Shepherd 1999a,b).

As will be shown later in this chapter, the dilemmas discussed have resulted in Operators' networks developing into hybrids, where elements of legacy network, proprietary IN and standardised IN operated in parallel with each other.

This section has alluded to proprietary and standardised implementations of INs and 'overlay' implementations. The next section develops these points by discussing the

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[21] Within C7, the (Open Systems Interconnect) application layer (layer 7) uses TCAP protocol to provide the signalling and allows INAP to be carried in the component layer, which is used for communication between the SSP and SCPs.

reasons hindering the uptake of Intelligent Networks and reveals that the implementation of INs have followed well defined stages as the technology has matured.

The Development of Intelligent Networks

In implementing an Intelligent Network, the implications for existing exchanges of the new functions specified in the ITU-T IN Capability Sets, were major. The changes necessary to introduce the triggering functions were fundamental to the structure of the call control software in the exchanges. This was the reason for the initial slowness of the emerging ITU-T Intelligent Network standards. Equipment Suppliers had significant vested interests in the achievement of a standard which they could implement with least effort given their existing product range[22]. Furthermore, the 'knock-on' effects, in terms of the impact on the extra processing needed for the triggering (of queries to the SCP), were considerable and led to performance degradation, loss of software structure and software maintenance problems, as well as the difficulty of inter-working the new IN service with existing switch-based features.

Because the emergence of a standardised IN was a slowly evolving process, the aim that it should become a platform for the fast launch of new service opportunities didn't materialise. Customers required new services immediately, not when the standardisation organisations got round to it and those new services were provided in ways which continually under-mined the standardised IN cause[23] and potential business-case arguments, adding to the difficulties of introducing the IN.

Therefore the implementation of ITU-T based INs was a slow and expensive process and was only achieved by established Operators in a piecemeal way. There was obviously a need for each stage of IN growth to justify its cost and so staged business cases were built, based on the expected revenues of the service functionality introduced. In this manner, a 'business-as-usual' approach to INs gradually took root, with Operators 'edging forward' and adding functions within the ITU-T framework, as each service was justified on its predicted revenue stream.

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[22] It has already been mentioned how North American Suppliers resisted 'leg control' in the ITU-T standardisation forum, since it did not align with the existing proprietary Bellcore IN specification and hence proprietary implementations of INs in North America.

[23] i.e. the services could have been provided on an Operator's legacy non IN network, or on a proprietary IN - not easily ported to a standards based IN.

Thus doubts were raised over the wisdom of the course of the development of IN specifications, with some Operators wondering if the unquestioning pursuit of the standards through CS1, CS2 .... CSn, was the most cost effective route (interview Anderson 1999). The fact that much of the installed base of INs has not progressed beyond CS1 or CS1+[24], tends to confirm this.

The research has identified that Operators implementing an IN tended to develop through any number of four stages, illustrated by Figure 4.13.

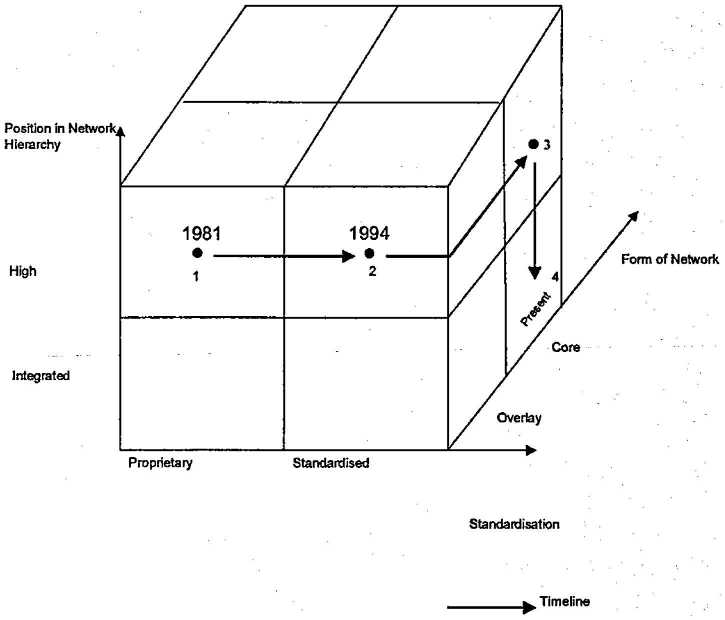

Figure 4.13 The Stages of Intelligent Network Development and Integration

The figure consists of three axes. The first indicates the position of the Intelligent Network in the routeing hierarchy of a telecommunications network. 'High' means only Tandem Exchanges had the ability to make SCP queries, while 'Integrated' means local exchanges had that ability. The second axis of 'Standardisation' has the options of 'Proprietary' and 'Standardised'. 'Proprietary' means that the Intelligent Network deployed was developed using a Supplier's proprietary standards (making it difficult to connect to other INs at anything other than the transport level), whilst 'Standardised' means the Intelligent Network adhered to international open standards (allowing easier interconnection and a

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[24] CS1+ is CS1 with parts of the CS2 standards (such as SCP-SCP and SCP-SDP interaction)

degree of vendor independence). The last axis 'Form of Network' indicates how the Intelligent Network was implemented in an Operator's telecommunications network. 'Overlay' indicates that special dedicated tandem exchanges were used, calls being routed specially to these exchanges for the functionality they offered. 'Core' indicates the Intelligent Network elements were integrated in the Operator's main network and performed ordinary routeing as well as IN functions.

Many of the IN's in Europe were implemented by monopoly Operators with an established distributed legacy network, which employed a high level of capital and was not easily upgradeable to an IN (CI 1996). Owing to the hierarchical nature of these distributed networks, the tendency was to employ an overlay IN (point 1, Figure 4.13). An overlay IN employed a single specialist node, or sub-network of nodes, which were capable of triggering to an SCP. It was therefore small and self-contained, provided by one supplier, with access and egress of calls to a suitable point in the legacy network switch hierarchy. It was a means by which new services, made commercially viable by IN functionality, could be quickly made available to an existing customer base. It was however, a tactical rather than a strategic approach and had the tendency to lock the Operator into an expensive and proprietary upgrade route.

Prior to 1994 overlay networks were constructed from proprietary elements. After this date overlays, if proprietary, would have standardised elements and almost certainly include the facility to migrate to standards-based protocols and interfaces (point 2, Figure 4.13).

At some point, as demand for services grew, implementation in the core network became attractive and a combination of demand, cost and time, typically dictated that it reside high in the hierarchical structure (at tandem exchange level), rather than at the majority of local exchanges (point 3, Figure 4.13). Eventually demand and the need to upgrade local exchanges, has encouraged the IN architecture to migrate to local switch level, such that the local exchange is the SSP (point 4, Figure 4.13), this typically beginning to occur about 1999.

Examining Operators' networks revealed that they aligned to varying and indeed multiple, points on the above path (i.e. they had different INs in different parts of the network to provide different services). Thus when considering the implementation of an Intelligent

Network, one of the primary considerations should be to identify how the new architecture will integrate with what exists in the telecommunications network; not how the existing architecture should change to accommodate it, as this would be expensive and not always technically feasible.

Types of Telephony Traffic

A consideration when implementing an Intelligent Network is the types of services to be offered and hence which telephony traffic it may be expected to carry and matching this to the network architecture. A step towards identifying what traffic types are expected, is to identify the market segments in which an Operator might function; be it resale[25], carrying basic telephony traffic, a televoting call-centre service provider, an Internet Service Provider, an International Service Provider with Card Access[26] or a network Operator handling a combination of all traffic types. Table 4.1 identifies the typical types of traffic that might have been found on an Operators network.

Traffic Type	Busy Period	Duration	Number of INAP Queries	SCP Processing	Network Impact
Basic Telephony (POTS)	1000 - 1200	3 min	1	Min	Low
Televoting	1800 - 2100	15 sec	1	Min	Very High
Internet	0000 - 0300	1 Hour	1	Min	High
Calling Card	1200 - 1400	6 min	3	Med	Low
Free Phone	1000 - 1200	3 min	1	Min	Med

Table 4.1 Traffic Types (Shepherd 1997c)

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[25] Resale is where an Operator acts as a carrier.

Telecommunications networks have traditionally been dimensioned utilising the characteristics of basic telephony and this has continued to be the most significant traffic type for most Operators. It had a low SCP processing impact and typically a low data churn (i.e. the management systems did not have to accommodate a large number of data changes). A danger for Operators expanding their market by launching new IN services, was to continue dimensioning their networks based on figures derived from this type of traffic. The following examples illustrate the potential impact of 'new' service options, with the next section discussing which IN architectures are best suited to the different traffic types.

> **Televoting** is one IN service application that requires special consideration. The characteristics of this service are a very high calling rate, but short call hold time. The traffic volumes generated have a tremendous impact on the whole of the network, potentially swamping all the other traffic types. With no management of the calls generated, 95% of the total calls of an hour long televote would occur within the first two minutes and with 98% within the first five minutes of the event (Shepherd 1997c). Although individual calls have little impact on SCP processing, collectively (at thousands of calls per second) they require an extremely large amount of processing in a very short period. Any architecture chosen to carry televoting traffic should have the ability to process televoting calls, while continuing to offer a suitable quality of service to other customers using IN services.
>
> **Internet** calls on the other hand, have little processing impact upon the SCP, but they have an extremely long busy period, because they are generally long duration calls. Many Internet Service Providers (ISPs) minimise the number of modems at their network access points to maximise resource use. This can result in a high level of call connection failures when all the modems are busy, resulting in a similarly high level of repeat-call attempts to the local exchange providing the ISP access, impacting other traffic on the network and the local exchange.

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[26] Card Access allows secure authenticated voice access to the Service Provider's network from the networks of different Operators.

Calling Card calls have a higher than average impact on SCP processing because the application has to remain active in the SCP; for example, maintaining the call count for follow-on calls thus avoiding the need to re-authenticate the customer. Some IN architectures have the potential for the SCP application to return the call context information with the initial routeing to the SSP for resubmission, should a follow-on call be initiated. This reduces the overall SCP processing requirements, but increases the SSP processing requirements.

Freephone calls have minimal impact on an IN for a basic number routeing, but the SCP processing required, incrementally increases if additional features such as Time Dependent or Geographical routeing are used.

The type of traffic carried heavily influences the architecture of a network. One possibility is to choose an architecture that is the best compromise between all the types of traffic carried based upon traffic volumes, or revenues, or the profit the different types of traffic attract.

An alternative approach is to implement several IN platforms to meet the different service needs, allowing the different types of traffic to be handled by the most efficient platform. Although this provides flexibility and purchasing power, the downside to this strategy is the increased costs of multiple installations, particularly those associated with operation and maintenance contracts.

Finally, the mix of call traffic on a network will change with time, possibly as the result of new market products, thus any IN architecture will need to be sufficiently flexible to accommodate future needs, including new regulations, such as re-numbering and number mobility. It is important to get the architecture right at the outset, since downstream change is not always easy and of course involves expense.

Intelligent Network Architecture

Having discussed some of the considerations which need to be applied in selecting and developing an IN, it is appropriate to determine what architectures could be used to meet those needs. This section therefore discusses a number of architectures.

The first two architectures relate to a traditional (non IN) network and the ITU-T IN model and provide a baseline of features against which other IN architectures, such as those constructed as part of the research, can be compared. Each of the architectures is evaluated in terms of its ability to 'provide a fast response' to routeing queries, having a 'high level of processing', necessary to cope with high volumes of calls or complex services and its 'ease in modifying services and information' to provide a measure of its ability to quickly and easily alter customer data.

Traditional Network Architecture (Distributed)

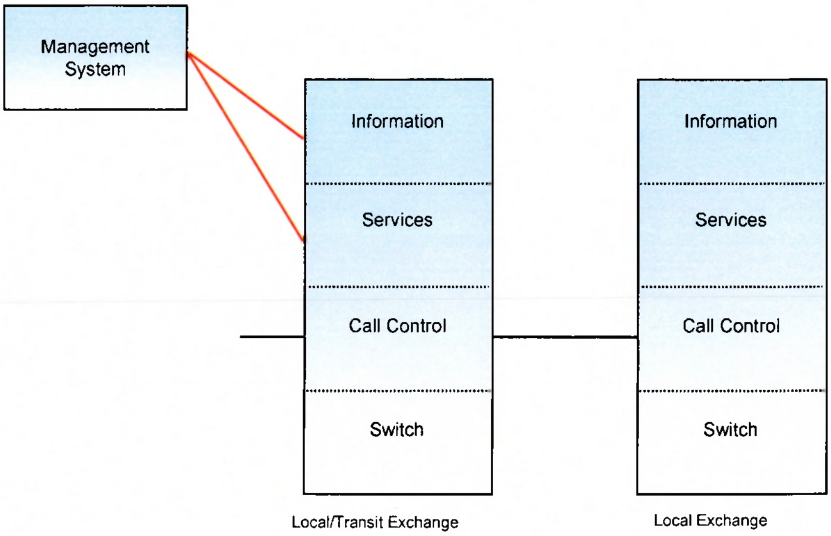

Figure 4.14 Traditional Network Architecture (Distributed Intelligence)

The traditional (pre-IN) exchange architecture, from which all voice telecommunications networks have developed, is illustrated in Figure 4.14. Its operation has already been discussed in detail in Section 4.3. The service applications and information are replicated in each of the switches. The importance of this traditional architecture lies in the fact that it needs to be considered when identifying how an IN is to be introduced and where the various services are to reside. The problem with traditional exchanges is that changes to applications, data, or architecture, affect all exchanges and thus it is difficult to implement changes quickly or easily, especially if there are more than a few exchanges (Table 4.3).

	Fast Response	High Processing Available	Ease of modifying Services/Information
Traditional	**Good**	**Good**	**Poor**

Table 4.2 Summary of Traditional Network Architecture's Benefits

The traditional network architecture is ideal for basic telephony traffic where data does not often change and numbers are geographically based. Suppliers' investment in IN technology to form the basis of their telecommunications equipment portfolio however, meant that future growth of a non-IN circuit-switched network was limited, as it was in the Supplier's interest to sell an Operator an exchange capable of SSP functionality, whether that functionality was wanted or not. An advantage however, lay in an easier IN implementation in the future should it be needed.

The ITU-T, Capability Set 2 Intelligent Network Architecture

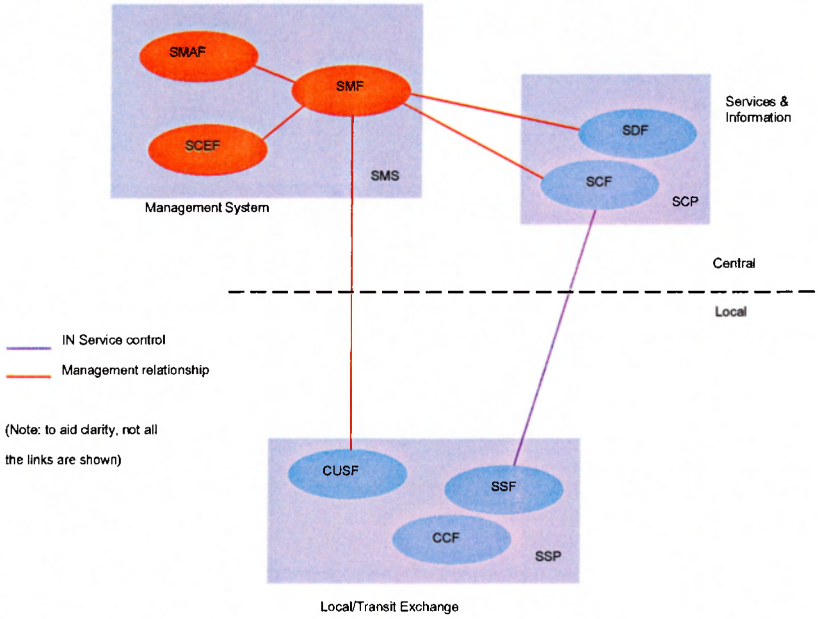

Figure 4.15 IN-CS2 Architecture

The ITU-T IN physical architecture formed the basis of all the Suppliers' IN offerings and hence the basis of Operators' INs. Two new capabilities shown in Figure 4.15 not explained earlier are the operation of the management system and the Call Unrelated Service Function (CUSF).

The management element within an IN is termed the Service Management System (SMS) and provides three essential functions, the Service Management Access Function (SMAF), the Service Creation Environment Function (SCEF) and the Service Management Function (SMF).

The Service Management Access Function acts as an interface to customers wishing to update stored information (such as the telephone number to which they want their calls to be diverted).

The Service Creation Environment Function is the means by which services are constructed. In theory services could be created by the customer, but they are normally constructed by the Operator. The main reason for barring direct customer access, is the potential damage that could be done to the network from incorrectly constructed applications[27].

The Service Management Function acts as an interface to the network elements for the implementation of service applications and the changing of information (data). It essentially checks and ensures that all the equipment is at a common application/data build level.

The Call Unrelated Service Function (CUSF) is a capability in the SSP that allows information to be passed to the management system without an associated telephony call. For example, it would permit customers to update their data/information held in the SCP by using the data channel of an ISDN line.

The key point with the IN CS architecture is that the service applications and information are held centrally and any changes are made to this single copy. This architecture is

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[27] IN CS2 supports security through the provision of a number of security assisting functions, which are intended to permit secure service applications, both intra-network and inter-network, when one application communicates with another. Thus the security assisting functions support both internal network operations and interworking between two or more networks. However these security features do not guarantee network integrity, rather than help it, by allowing secured systems to be built.

therefore ideal for traffic models requiring frequent data changes, such as Calling Card services (Table 4.3).

	Fast Response	High Processing Available	Ease of modifying Services/Information
Standardised (ITU-T) IN	Average	Average	Good

Table 4.3 Summary of IN-CS2 Architecture's Benefits

There are many variations on the classical CS2 IN architecture, such as using local SCPs (adjuncts), local caches, or operating in a distributed environment using IN protocols and distributed processing. Suppliers offer a small number of IN architecture variations and others have been constructed for the purposes of the research. The merits of these alternative architectures are considered in the following sections and seek to demonstrate how each is able to meet one or a combination of the demands made upon them (such as handling different traffic types).

Centralised & Distributed SCPs (& Adjunct Processor)

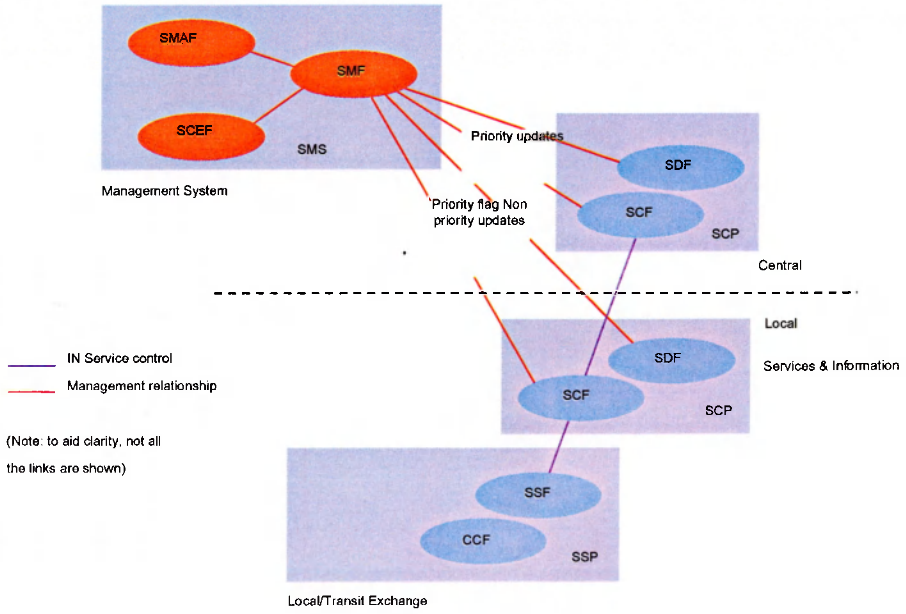

Figure 4.16 Centralised & Distributed SCPs

The architectural model illustrated in Figure 4.16 is one that was developed in early 1996, as part of this research, using the basic principles of Intelligent Network operation. It also formed a key part of Survey 1. I subsequently learned of work by Shelly (1996) relating to distributed architectures, although I have been unable to gauge the precise IN architecture to which his description refers and hence the similarity to those presented here.

> 'When a large IN call capacity is required, the downsized IN systems are distributed over the network, while maintaining central control for service operations and the corresponding operations support systems.' (ibid p21)

In this architecture, applications are held both in the Central SCP and Local SCPs. Not all central applications have to be replicated locally, but all applications held locally must be replicates of those held centrally. Local SCPs are often referred to as adjunct processors, however the key difference between the operation of adjuncts and the SCPs of this architecture is that adjuncts do not normally have copies of centralised applications, just those localised to their area of operation.

Local SCPs are not necessarily located at every exchange, since this would make the architecture almost indistinguishable from the Traditional (non-IN) architecture. Rather a single SCP serves several exchanges in a particular area. An example would be in the Caribbean, where the telecommunication systems of some islands are connected by slow and not particularly reliable, Satellite links. In this case each Local SCP could serve all the exchanges on an island or closely grouped set of islands.

With this architecture, central applications are invoked from the SSP in the same manner as for the traditional ITU-T IN architecture (Section 4.3), thus what deviates from the standardised IN model are those applications replicated in both the Central and Local SCPs.

An application held locally allows a speedy response from the SSP to a query, but requires more time to update across all the Local SCPs. There would be an extended period during which some Local SCPs would be using out-of-date applications or information, whilst others are using newer versions. This is precisely the situation where a centralised application (as per the ITU-T architecture) is more advantageous, since it is relatively easy to update a single central copy of an application. However, a centralised response to each query is slower, significantly so at times of peak loading[28]. In order to prevent 'race' conditions, a 'validity' flag is introduced to carry the current status of the application within a Local SCP. Should the SMF update an application centrally, an instruction would be sent to each of the Local SCPs setting the validity flag to the 'invalid' state.

A call originating at a Local SSP requiring IN service, will first query the local instance of the SCP and examine the validity flag associated with that particular application. The flag will indicate if the stored version of the application is still valid and if it is, it will be used to process the call. If the flag indicates that the application is invalid the query is forwarded to the Central SCP to process the call, returning instructions to the SSP.

This process is summarised in the following flowchart (Figure 4.17).

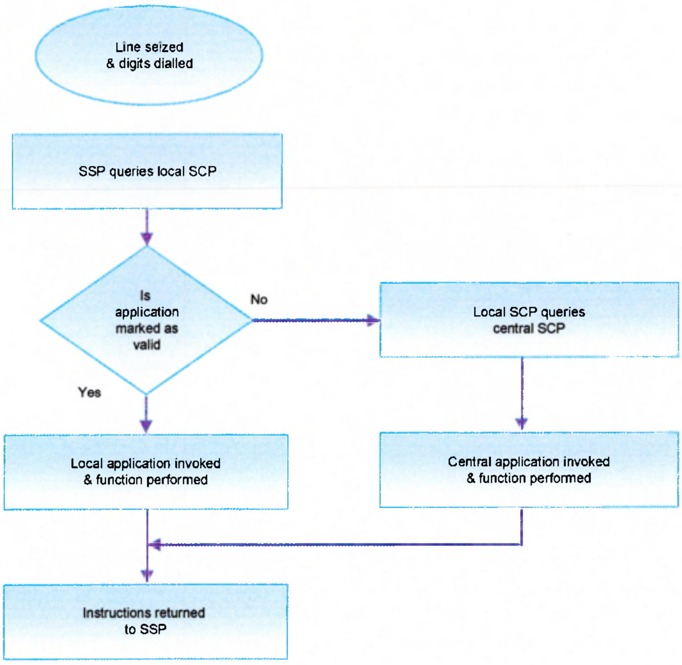

Figure 4.17 Query/Response Flowchart for Centralised & Distributed SCFs & SDFs

To complete the process, once a central application has changed and the local applications marked as invalid, the SMF will (as a low priority task) update each of the local applications and set the local flag back to the 'valid' state.

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[28] If the centralised SCP utilised a distributed processing environment with end-to-end application fragmentation the response would be slower still, when the SCP is heavily loaded.

What this architecture achieves, is the retention of the key benefits of the centralised architecture, whilst introducing additional benefits as follows:

- The speed of a query/response is increased, since an application is normally processed locally;
- There are network integrity benefits since there is a reduced chance of congestion owing to fewer SSP - SCP (INAP[29]) messages querying the central application and a subsequent transmission cost-benefit; and
- The potential for a major network failure will be reduced[30].

The Centralised and Distributed architecture is ideal where the SCP and SSPs are geographically remote, if there are a number of local oriented services which do not need to be replicated centrally, or there are heavily used services (such as for televotes requiring much processing) or infrequently changed services.

This assessment is summarised in Table 4.4.

	Fast Response	High Processing Available	Ease of modifying Services/Information
Centralised & Distributed SCPs	**Good**	**Good**	**Good**

Table 4.4 Summary of Centralised & Distributed SCPs Architecture's Benefits

There are of course disadvantages with this architecture. It employs a more complex, non-standardised operation, both in call processing where flags are employed and for the management functions where the application version at different local SCPs have to be tracked. A second disadvantage is the cost of replicating services centrally and locally, necessitating additional local storage and processing. For some situations, such as if the SSP and SCP are separated by continents, a local SCP may be the only means of guaranteeing an acceptable service. The concept of a local SCP is not so radical, since

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[29] Intelligent Network Application Part (INAP) messages are those passed between the SSP & SCP when asking and replying to instruction on how to route a call. The INAP messages are defined by the various IN CS releases.

[30] A well designed network with a centralised architecture should be designed not to have any major failure points. Nevertheless, keeping the majority of the processing and signalling local with the option to query the central SCP does increase operational reliability.

some Suppliers' exchanges were constructed with elements of an inherent SCP, such as Ericsson's AXE10 exchange, which was used for exchange housekeeping purposes and could have been developed into a full SCP.

Another disadvantage stems from the lack of management standards. Since there are no internationally recognised standards to which the Suppliers have developed their products, they will each employ their own implementation of a Service Creation Environment and Service Management Function. This makes mixing SCPs from different Suppliers extremely difficult, effectively tying the Operator to the one Supplier. Although this problem also exists with the standardised ITU-T IN architecture and would limit an Operator's flexibility in upgrading, the Centralised & Distributed SCPs architecture exacerbates the problem since multiple SCPs are employed.

The description of the operation of the Centralised and Distributed SCFs & SDFs architecture above, has just referred to a service application being held both locally and centrally. Exactly the same method of working is applicable to the Data/Information held in the SCPs. In practice it is more often the data (announcement, destination, etc.) relating to a service that changes rather than the service application itself, thus use of a data flag and local storage of data is in some ways more useful. Similarly there are variations in the exact method of working. The example uses a Local SCP to Central SCP query, the inference being that that a Local SCP forward the query to the Central SCP. An alternative would be to hold the flag in the SSP and then generate a Global Title address in the INAP message, using a Signalling Point Relay to direct the query to the correct SCP[31].

When this architecture was presented at a conference (Shepherd 1997a), an attendee mentioned that a distributed processing environment (discussed later) solved all the processing problems. He felt the use of one SCP to forward queries to a second SCP totally inappropriate. Interestingly, one large Operator is currently (2002) considering migrating their network to an architecture very similar to that proposed.

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[31] Thus the SSP determines (from an internal flag table) which SCP hold the valid application, constructs the query to the SCP, identifying by means of the global title in the message the SCP the message is destined for. The message is then sent to a Signalling Point Relay (effectively a means of connecting several SSPs to several SCPs) whereupon it determine the destination SCP from the global title and forwards the message accordingly.

In discussing this architecture, reference has also been made to an IN architecture proposed by several Suppliers, which employs an adjunct processor. The physical architecture is identical to that shown in Figure 4.16, but the Local SCP (or adjunct as it is known), only employs services and information pertinent to its locality of operation. All the advantages of the Centralised & Distributed SCPs IN architecture remain, except that they only apply to localised applications. A significant proportion of calls will still need to query the Central SCP, hence its overall response has been graded as average. Its benefits can therefore be summarised in Table 4.5.

	Fast Response	High Processing Available	Ease of modifying Services/Information
Adjunct (Service Node)	Average	**Good**	**Good**

Table 4.5 Summary of an Adjunct Processor's Benefits

Local Caching

A further important variation on the Centralised & Distributed SCPs architecture, is not to employ a Local SCP, but to use a local cache capability. A local cache provides the means of storing data/instructions provided in response to SCP queries, local to the SSP. This avoids the need for the SSP to query the SCP, when another call requiring the same call handling is detected.

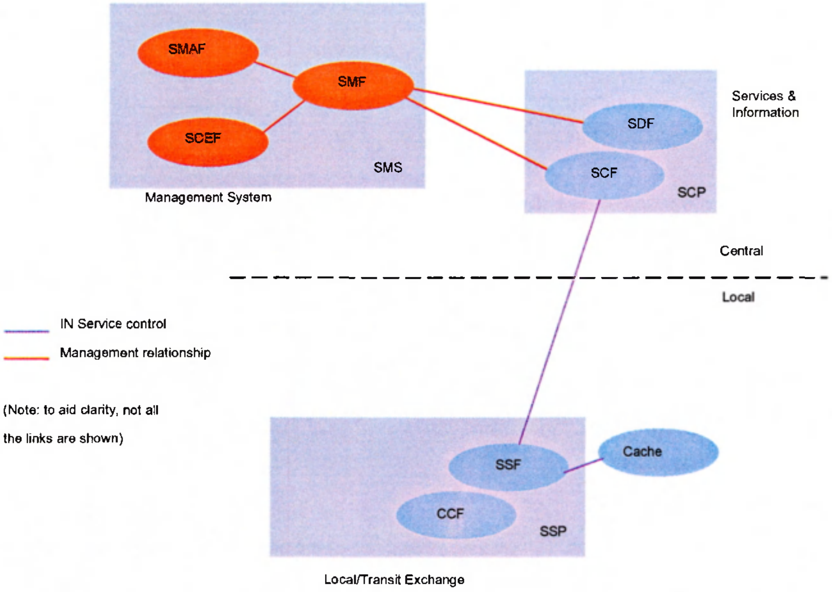

Figure 4.18 Local Caching

In the local caching scenario shown in Figure 4.18, responses from the central SCP to queries generated by calls, are marked as being suitable for storing in a cache, as if they were a straightforward number translation. (Applications such as geographical routeing would obviously be unsuitable[32]). Further calls at the local exchange to the same dialled number would query the cache and obtain the appropriate call routeing etc. (call action[33]) from the stored data.

Cache entries would normally time-out based upon some default duration, or the SCP response might contain a 'valid until' flag (such as would be needed for Time of Day routeing applications) that would override the default duration. But therein lies the inherent disadvantage; information could change rapidly and there would be a time-lag during which calls would be incorrectly routed. Such a state would continue to exist until the cached data times-out and the SCP was re-queried.

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[32] With geographical routeing, the number translation depends upon the origin of the caller. A local exchange may serve customers in two different geographical areas, thus the call routing for one may not be suitable for the other.

[33] The cache would contain other relevant information such as used for call charging, thus strictly speaking the cache provides call action information - which includes the call routeing)

A benefit of this architecture is that by not querying the SCP for every call, SCP load control[34] has occurred. This is ideal for Televoting applications, ensuring SCP processing is not overwhelmed and therefore available for processing other calls. The benefits of using local caching are presented in Table 4.6.

	Fast Response	High Processing Available	Ease of modifying Services/Information
Local Caching	Good	Good	Average

Table 4.6 Summary of Local Caching Architecture's Benefits

Distributed SCPs

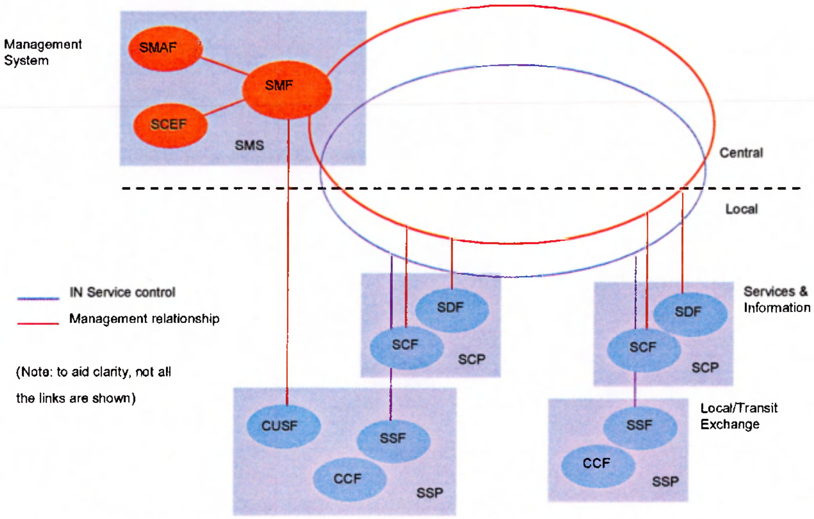

Figure 4.19 Distributed SCPs

The architecture in Figure 4.19 was developed following Survey 1 and aimed to demonstrate how applying legislation to open, standardised, IN interfaces could have the benefits circumvented by the choice of IN architecture. It comprises a number of SSPs and

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[34] Load Control is the selective blocking of calls to certain numbers to ensure that the telephone network is able to continue to offer a suitable level of service to other customers. For instance a Televote with no blocking would generate sufficient calls to use all the network's processing resource, preventing for instance, the ability to make (999) emergency calls.

co-located SCPs (containing a SCF and SDF) which may be geographically diverse from each other, each possibly serving a number of local exchanges. The SCPs communicate by a signalling ring labelled ‘service control’ and the network elements are linked back to the Service Management System (SMS) by a management ring. The architecture initially appears identical with that of a traditional (non IN) distributed processing telecommunications network, the main difference being that a local SCP would in practice service a number of local exchanges. Additionally, only services receiving high calling rates are replicated on every SCP, the remaining services being located on only one or two of them. Service operation using this architecture however, is totally different from that of a traditional (non IN) distributed processing network as follows.

If the customer’s service changes, then the SMF will update the service application on a particular SCP and mark it as the ‘master’. Messages are sent from the Management System to all of the other local SCPs marking their version of the service application as ‘Invalid’ and, more importantly, identifying which SCP holds the master. If a call arrives at an SSP and querying the local SCP finds the local application marked as invalid, would use the additional information supplied by the SCP to forward the query (around the ring) to the local SCP flagged as containing the updated application. This would return the appropriate response to the originating SSP, which would then process the call.

Having updated one local SCP with the latest service application and marked the other applications as invalid, the SMF will (as a low priority task), update those service applications on each of the other SSPs and revalidate their flags for this application.

Although this example has only referred to service applications changing, the same method of working can be applied to the information held in the SCP, with the use of flags to indicate validity.

This architecture processes the majority of the calls close to their point of origin and is thus ideal for Televotes or those services (or applications), such as Calling Card, that require greater than normal processing (Table 4.7).

	Fast Response	High Processing Available	Ease of modifying Services/Information
Distributed SCPs	Average	**Good**	Average

Table 4.7 Summary of Distributed SCPs Architecture's Benefits

The disadvantages are the same as for the Centralised & Distributed SCFs & SDFs architecture, in that there is duplication of resources due to the existence of multiple local SCPs.

Interestingly, this architecture would allow an Operator to adhere to ITU-T standards, but make it very difficult for other Operators to connect effectively to the network at anything other than basic transport level. For instance, connecting at a particular SSP/SCP interface would only allow access to that SCP's applications which, following an update at another SCP, will be invalidated. The second Operator would be unable to gain access to that application until it had been updated on the SCP to which they were connected. Thus here is an example, where an Operator could abide by the potential ruling of a regulator to open appropriate standard IN interfaces to other Operator's network, yet make it ineffective.

Centralised Distributed Processing

A centralised distributed processing architecture, such as that commonly employed in computing environments, offers an alternative way of increasing the central SCP processing capability. This section examines two Centralised Processing Architectures; one where the services are fully distributed and one where the common services are replicated on front end processors.

i. Fully Distributed

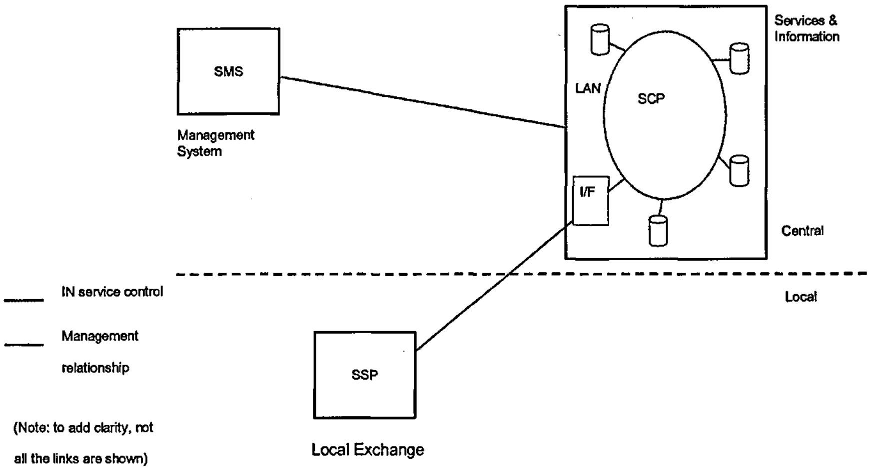

Figure 4.20 Centralised Distributed Processing - Fully Distributed

Figure 4.20 indicates one method of employing centralised distributed processing, with all the services and information fully distributed on servers around a Local Area Network (LAN). An SSP INAP message querying the SCP arrives at the interface[35] (I/F) gateway from where it is forwarded around the LAN to a free processor . The Service application's response to this query is to pass back the routeing information via the same interface gateway.

The key advantage of this architecture is that single points of failure are reduced, although there is potential for LAN congestion (Table 4.8). The processors connected to the LAN can either operate in paired load-sharing mode or operate in parallel.

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[35] The C7 gateway acts as an interface between the signalling protocols uses in the telephony environment and those used on the LAN in the distributed processing computer environment.

	Fast Response	High Processing Available	Ease of modifying Services/Information
Distributed Processing (Fully Distributed)	Average	**Good**	**Good**

Table 4.8 Summary of Centralised Distributed Processing - Fully Distributed Architecture's Benefits

This architecture is ideal for all traffic types, although there is the potential that Televote traffic could cause LAN congestion. (i.e. Televoting traffic queries should be restricted at the local exchange or such queries be restricted to a certain number of INAP messages in a defined period and the restriction deployed at the SCP interface.)

When this architecture was originally conceived (1996) and presented at a number of conferences (Shepherd 1997 a,b,c) there appeared to be no Intelligent Network SCPs operating in this fashion. Currently in 2002, it is quite common to have the SCPs using distributed processing in this manner (Perdikeas et al. 2001).

ii. Replicated Front End Processing

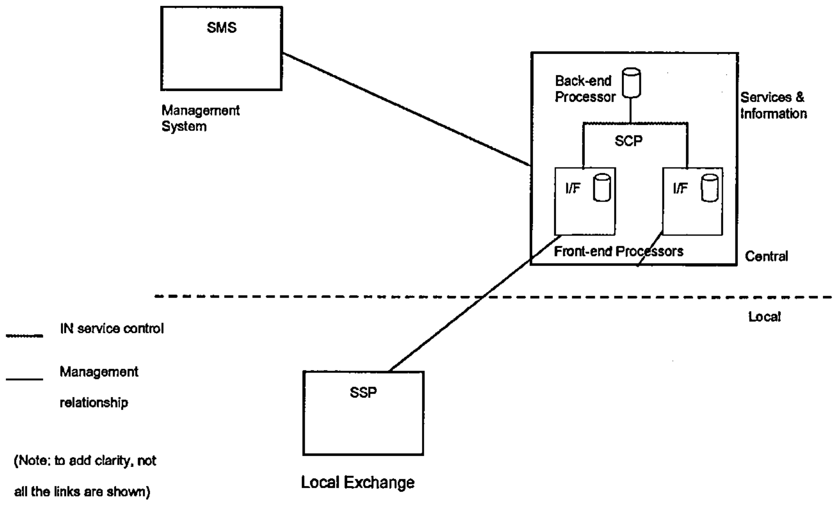


Figure 4.21 Centralised Distributed Processing - Replicated, Front-End Processor (with Back-End Application)

An alternative centralised distributed processing architecture developed for this research, which addresses some of the disadvantages of the standard ITU-T IN architecture comprises front-end application processors, holding their own applications and data. Call queries from the SSP arrive at the front-end processor. If the processor has the ability to process the query, it will do so. If the application does not reside on the processor, the query can be referred to a back-end processor. Thus the front-end processors can have replicated service applications and data for services which infrequently change or have high calling rates. The back-end processor would contain the service applications and data for services which changed frequently. This is summarised in Table 4.9.

	Fast Response	High Processing Available	Ease of modifying Services/Information
Distributed Processing (Replicated Front-end)	Average	**Good**	**Good**

Table 4.9 Summary of Distributed Processing - Replicated, Front-End Processor (with Back-End Application) Architecture's Benefits

This architecture again is ideal for all traffic types, although the front-end application processor would also be ideal for processing televote calls.

With such an architecture, care would need to be taken in balancing the load on the front-end processors. An exchange could have its load spread across a number of front-end processor ports or it could establish a primary front-end processor and have a secondary (back-up) front end processor, to handle emergency traffic under failure conditions. Alternatively, the load can be spread by processor loading which can be planned or real-time. A further way is to spread processor load by application usage, this being a good way of limiting network congestion to a certain application (such as televoting), whilst minimising the impact on other traffic being serviced.

The problem with distributed processing is the lack of a standardised architecture.

> 'The computer sector does not have a particularly strong record of producing and implementing non-proprietary networking standards. Indeed, many of the interconnection and interoperation problems that for years have bedevilled the private computer networking environment may well migrate to the public network arena.' (Hawkins 1995)

Proprietary SCP implementations make it difficult for an Operator to purchase additional SCP capacity from another Supplier.

This problem however, is likely to reduce, since as is frequently demonstrated with other technologies (e.g. mobile telephony), there will be a reduction in technical choices with time.

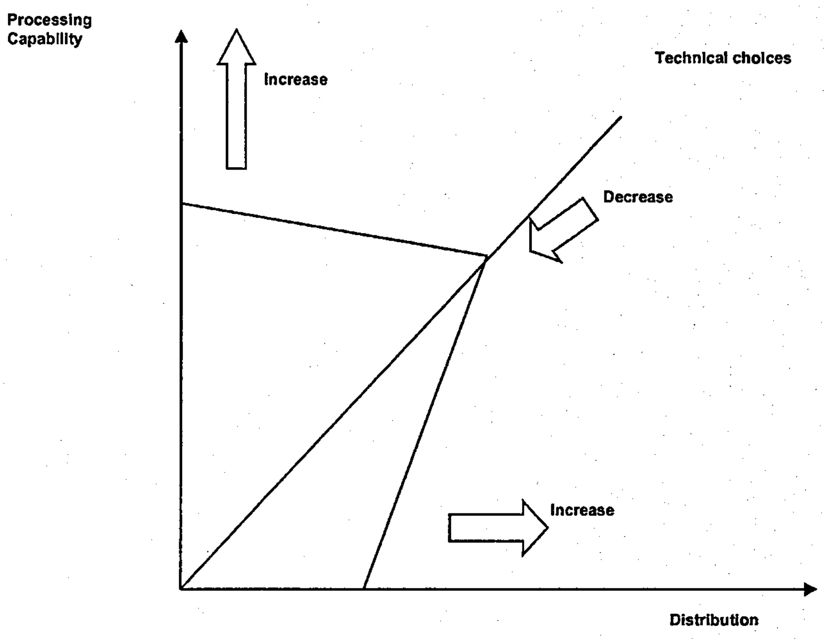


Figure 4.22 The Impact of Time on the Deployment of Distributed Processing Options

Figure 4.22 suggests that during the same period of time that the range of technical distributed processing choices decreases, Processing capabilities will increase. ('Moore's Law...states that the processing power of computers will double approximately every 18 months' (Brown 1998)). Similarly technology will allow the distribution (geographic separation) of the servers to increase. These changing factors would improve the attractiveness of employing a distributed processing architecture.

Currently (2002) there are Operators using Distributed Processing architectures similar to both the models presented in this section. The implementation of that shown in Figure 4.21 (Replicated Front-end Processor) is slightly different to that originally envisaged, where the front-end processors offer simple (e.g. number translation) services, whilst those on the back-end processor offer more complex and processor intensive applications.

Televoting Architecture

A final Intelligent Network architecture is one appropriate for very high calling rates, such as Televoting. A number of Suppliers have developed their own way of dealing with Televotes, typically in conjunction with the standardised ITU-T IN architecture.

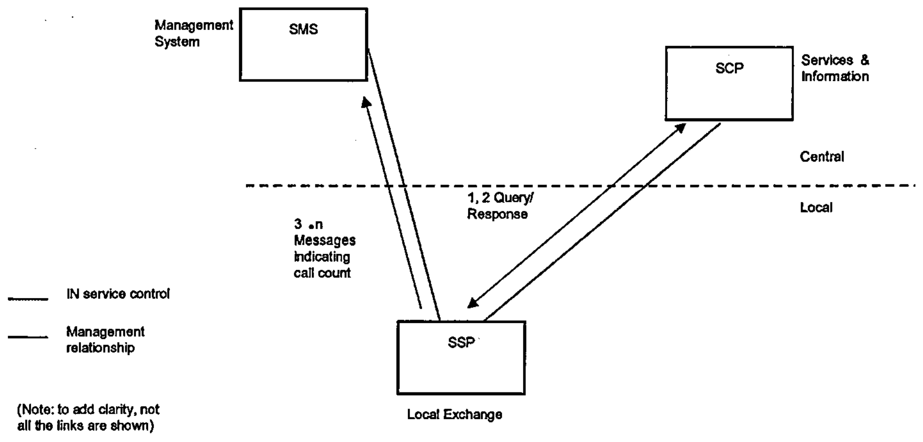


Figure 4.23 Televoting Architecture

The implementation shown in figure 4.23 is a variation, developed for this research, of a Televoting architecture offered by GPT. The first call to the televoting number causes the SSP to generate a query to the SCP. The SCP's response is to instruct the SSP to route this and subsequent calls to the same telephone number, a televoting application on a switch integrated peripheral. The caller receives a courtesy announcement indicating, for example, that their vote has registered. Subsequent calls to the same number use a cache in the SSP to determine the routeing of calls, without further queries being made to the SCP.

The SSP maintains a count of the number of calls to a particular number, which can be forwarded to (or polled by) the SMF at regular intervals. A suitable management application can then be used to collate and manipulate the total votes cast.

In the commercial variant, the SSP generates an INAP message every 10 calls received, allowing a separate SCP based application to undertake the collation. I believe using the SMS to process the call is an improvement compared to the GPT offering, since it reduces the number of INAP messages and hence SCP processing, whilst using an existing infrastructure (the SMF to SSP link used for management) to convey information. The net effect is to reduce the load on both the signalling network and the SCP. The characteristics of this Televoting architecture are summarised in Table 4.10.

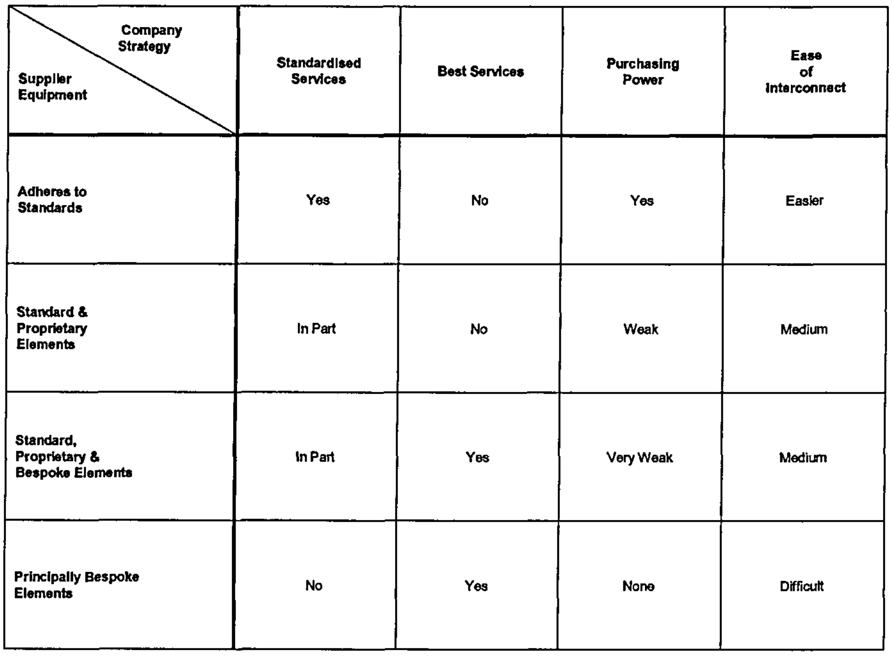
	Fast Response	High Processing Available	Ease of modifying Services/Information
Televoting	**Good**	**Good**	Average

Table 4.10 Summary of Televoting Architecture's Benefits

This section has looked at a number of IN architectures for addressing the operational requirements (traffic types, geographical spread) of an Operator's network. Another consideration when selecting the IN offerings available, or which could be developed, is the operational strategy of the Operator.

Operator Strategy

Table 4.11 identifies four offerings of Supplier's IN equipment that may be possible and four considerations that may feature in an Operator's strategy.



Company Strategy / Supplier Equipment	Standardised Services	Best Services	Purchasing Power	Ease of Interconnect
Adheres to Standards	Yes	No	Yes	Easier
Standard & Proprietary Elements	In Part	No	Weak	Medium
Standard, Proprietary & Bespoke Elements	In Part	Yes	Very Weak	Medium
Principally Bespoke Elements	No	Yes	None	Difficult

Table 4.11 Operational Strategy

Considering the Supplier Equipment categories first, the 'Adheres to Standards' category includes those IN offerings that fully adhere to international IN standards with no superset of functionality. It is probably theoretically the least expensive of the four and is ideal for a company adopting a market-follower approach, where the basic features of a competitor's popular service is replicated and undercut on price. Services offered on such a platform can be easily replicated, since they are constructed from capabilities which wholly conform to standards.

The 'Standard and Proprietary Elements' category, conforms to international IN standards, but is supplemented by the Suppliers own proprietary elements. Again, it is ideally suited to a market-follower strategy, since any Operator with the same Supplier's equipment can replicate the services. The Operator however, risks being tied to a single Supplier's product, since it will become increasingly difficult to replicate services that use the proprietary elements, should the Operator want to move to using another Supplier's equipment.

The 'Standard, Proprietary and Bespoke Elements' offering, requires Operator use of an Application Programming Interface (API) allowing them to develop their own applications. This is ideally suited to a market leader strategy where the company wants to stimulate and capture initial market share. It is expensive and thus better suited to overlay networks, but with the drawback that the Operator is tied to one supplier. This is an area fraught with difficulty, since the Operator has to define the areas, level and scope of the API that is required in order to maintain future flexibility and service operation transparency with their other switches.

The 'Principally Bespoke Elements' offering is one that is heavily proprietary in nature, aiming not only to allow the development of services not easily replicated by competitors, but within a competitive environment, reduces the options for competitors to offer a seamless service across the two networks. Needless to say, adopting such a technical strategy is expensive owing to the bespoke development required. Currently (2002), the EU will not permit this, since regulation compels Operators to implement standardised equipment with a well-defined interface and operation. Even without the EU limitations, Suppliers would not now consider developing and maintaining bespoke developments for one Operator, although this was certainly possible up to about 1990.

Looking at the second dimension of Table 4.11, the Operator's strategy could be to offer only services developed from standardised capabilities or to be a market leader offering the 'Best Services'. They could additionally consider 'Purchasing Power' a priority with the ability to mix and match suppliers' equipment. Finally, they might consider interconnect. If they are a carrier or a new Operator, they would perhaps consider 'Ease of Interconnect'[36] a priority. Conversely if they are an established (legacy) monopoly Operator, they may wish to make interconnect at anything other than (the C7) transport level, difficult.

The pressure to conform to standards has, in practice, forced Suppliers to restrict their offerings to those based upon a standardised implementation. However, an element of proprietary functions remains essential to ensure that their product remains more attractive against the competition. Bespoke elements, if requested by an Operator and developed by the Supplier, are normally integrated into the Supplier's existing proprietary elements and hence made available to other customers (Shepherd 1993). Operators need these proprietary elements to give their products some degree of 'value added' - which their competitors cannot easily replicate (unless they use the same Supplier). This was recognised by Pekka Peltola, president of Teligent, 'It is not possible to invent something truly new...The INAP protocols are typically associated with pre-defined services' (Shelly 1996 p21) and has resulted in some Operators (e.g. BT) developing their own standards-based SCP.

The point at which a Supplier's product is optimised for both standardisation and service differentiation is when the non-standard, proprietary elements employed are standardised in later versions of the relevant international standard by the standardisation body. The Supplier benefits since they have no retrospective engineering to do, as the product will now have no non-standard elements (Aiken 1997) and the Operator is happy because he has a future proofed (to future standards) system from the outset. Clearly this vision is unrealistic. No one can predict the future with such clarity and accuracy, but it does explain why Suppliers and Operators lobby so hard in the standards forum for architectures and ways of working that map to their existing products rather than those produced by other Suppliers (interview Anderson 1999).

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[36] 'Ease of Interconnect' in this case being high in the in architecture hierarchy.

Telecommunications Operators therefore face the dilemma of do they wait for standardisation before implementing services, or do they supplement the standard elements with proprietary ones to create a service. The former strategy will lose them market share, whilst the latter ties them to one Supplier and they risk the standardisation of these elements being implemented differently to their own in the future.

The Constraints Associated with an Intelligent Network

Rarely in discussions of the benefits of an IN architecture, is mention made of the constraints and limitations associated with the use of an Intelligent Network. This section therefore draws together observations gathered during the research concerning the deficiencies of Intelligent Networks as a topic of consideration by an Operator contemplating implementing an IN. It discusses the misconceptions associated with the cost of deployment of the initial network and of subsequent services, the problem of IN services being used to replace existing services and the ease with which IN services can be offered seamlessly across other Operators' networks.

i. Cost of Deployment

Putting the services and information in one location, the SCP, is less expensive than putting it in a large number of exchanges as was traditionally the case. However some services still require exchange development such as the need to upgrade the Call Model. Thus the overall saving of using an IN, compared to a traditional distributed processing architecture, is significantly less than originally envisaged.

> '...if we could have performed our service offering without investing in IN, we would have done so...It is a very expensive way of delivering solutions for what are relatively small markets.' (Hudson 1996)

Similarly, although the IN architecture may be standardised, the management system used for its control is proprietary. Thus if an Operator doesn't want to develop its own management system and it is purchasing the SCP and SSP from different Suppliers, then it will also have to purchase each Suppliers' management system. This results in greater purchasing and operational costs. The issue of being unable to integrate management systems has been recently addressed with the specification and application of Telephone Management Network (TMN) Q3 standards. If adopted by Suppliers, these standards will aid the ability to manage different Suppliers' equipment from a common management system (interview Stretch 2002).

ii. Ability to Introduce New Services

An argument promoted in the early days of Intelligent Networks is that customers '...demand customised services that suit their specific situation' (Pandurangan 1993 p128) and that they could 'be offered what amounts to a constructor's kit option to build their own services' (Achar 1998), creating services from Service Independent building Blocks[37] (SIBs) in the management environment and downloading them to the SCP. This would have allowed products to be brought quickly to market, with the idea that quick to market means capturing the initial market share.

Experience has shown that the flexibility originally promoted did not materialise and that what little flexibility did exist, was limited by the Service Independent Building Blocks[38] (SIBs) available (Shepherd 1997b,c). Operators often found that the available SIBs did not permit the realisation of a newly envisaged product (Collet et al. 1992). The SIBs were decided upon by the Supplier based upon a number of considerations. These included their marketability; a Supplier not being willing to develop a SIB for which they could not make a profit; and switch limitations; a SIB not being able to be built for a function a switch is unable to perform. Time was therefore taken liasing with the Supplier in the production of new SIBs and upgrading the network (Jefferies 1993, Swale 1997), increasing the overall time to market. The standards bodies also had an indirect influence in what SIBs were produced, by standardising basic services capabilities. This compelled the Suppliers to provide them in order to demonstrate their products were standardised and as has been indicated by Herian (interview 1996), these were not necessarily appropriate to the market needs. The restriction imposed by the limitation of SIBs encouraged 'edge of the network' services (such as CTI), which were not directly dependent upon network control.

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[37] SIBs are typically groups of network actions bundled together. Examples of SIBs are to 'collect dialled digits' or 'connect to announcement'. SIBs are represented graphically on the screen of a Service Creation Environment. By stringing a series of SIBs together on the screen an service is created which can then be downloaded to the SCP.

[38] Services are developed and customised up by linking numbers of Service Independent Building Blocks (SIBS) together. Each of these performs a number of different switch actions, such as 'connect customer to dial tone', 'capture dialled number and interrogate database', 'route call' etc. Together these constitute a service and by using different SIBs, customers can have services developed to better match their needs.

iii. Network Exhaustion

Even the best-designed networks eventually reach a point of saturation, when it is not possible to add 'more of the same' to overcome a problem. This is typically due to a physical constraint such as designed capacity, or a consequential constraint such as processing speed, or obsolescence. The impact is that an affected IN is constrained in its development, preventing for instance, an overlay network from developing into a network based IN.

Such problems rarely result just from customer growth, but more generally as a result of adding new features and capabilities in order to offer new products to existing customers (interview Hall 2000). This creates a 'Processing Cycle' (Figure 4.24).

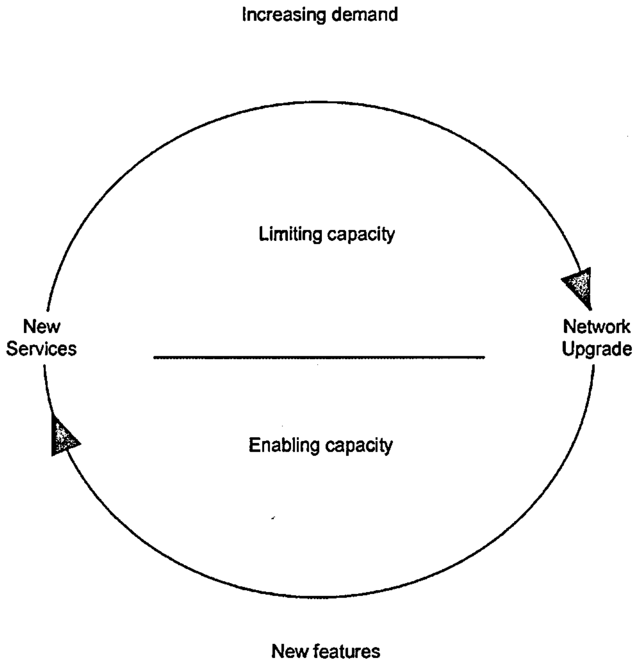


Figure 4.24 The 'Processing Cycle'

New features necessitate new equipment and hence network upgrades. The new features are used to create new services, which aim to stimulate the market and become profitable. Success brings the need to increase network capacity. The subsequent network upgrades include new network resources, hence further new network features and so the cycle continues until the equipment/architecture limitations are reached (Figure 4.24).

Consideration of the factors affecting design, such as consciously employing an architecture directly linked with an Operator's strategic needs, will delay the network exhaustion point.

iv. Maintaining the Appearance of Services

When an Operator introduces an IN, they may wish to replace existing services and perhaps employ some of the basic range of services supplied with the product. The challenge they face is how best to match these services with their retained offerings whilst maintaining a consistent 'look & feel' of the set of products from a customer's perspective. This difficulty is magnified where a service is classified as a 'universal service' obligation, owing to EU regulations limiting the extent of the changes possible.

v. Offering Services across Networks

The interworking of non-standard services between Operators could be a problem, especially if they use different Suppliers' equipment, since each Supplier will implement a particular service in a slightly different way. Market forces will see Suppliers offering proprietary interfaces (Jordon 1993) and 'Network *(Operators)* and service providers will continue to offer services using proprietary protocols ahead of standards' (Pandurangan 1993 p130). Thus the ability to retain a common look and feel to a product (from a customer's perspective) across networks is reduced.

vi. Speed of Response

A disadvantage of INs is the speed at which the SCP is able to respond to a switch query as a result of increasing demand on the SCPs processing capability. This should obviously not be a problem when the network is commissioned, but upgrades and new services that demand more SCP processing, affect the speed of response. An example of this are the IN CS2 interfaces that allow external database queries and SCP-SCP interaction. Overloading an SCP will affect the operation of the whole IN, whereas overloading a traditional network would produce localised processing problems.

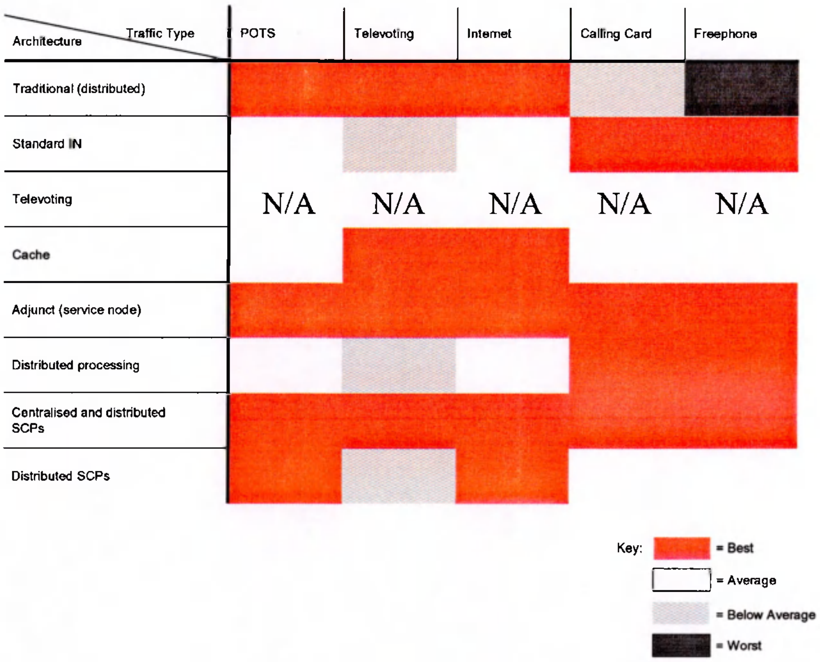
Summary of Considerations

This section has addressed a number of the factors that influence the choice of an Intelligent Network architecture. It has also identified a range of questions which should be addressed in selecting and implementing an Intelligent Network architecture. These not only help ensure that an appropriate IN architecture is chosen, but also create an awareness of the practicalities of implementing and operating such a network. The questions can be summarised as follows:

- Strategy - how does the architecture match the operating company's business strategy of where they want to be in the future?
- Geography - is the network of a cost-effective size, or is an excessive amount spent on hierarchical infrastructure compared with revenue generation?
- Size - is the network sufficiently large, or geographically dispersed, such that centralised processing or a single SCP could cause speed of response or reliability problems?
- Processing - does the architecture have a mechanism for handling SCP overloads?
- Response Time- is the size of the network so large that bandwidth or query response delay is significant?
- Migration - how would migration from an existing architecture to the new one be effected? What is the impact on the services offered and SCP applications and SCP (data); will it need replicating elsewhere? Can currently offered services and billing capabilities be replicated, matching their look and feel exactly? Can the same product name continue to be used? (Some product names are supplier copyright, allowing use of their names when the services are offered on their equipment.)
- Interworking - how conducive is the architecture to interfacing with other networks and offering a seamless service between them?
- Scalability - what are the limitations of the chosen design; to what extent can it grow and evolve; how scaleable is it?
- Upgrades - can upgrades be implemented in an acceptable time, without service interruption and an acceptable recovery time should something fail when the upgrade is taking place?
- Future - what possible interconnect regulations might affect the network in the future? Where will the 'intelligence' (applications and data) be located? Options here include in the Operator's network, in the network of other Operators or Service Providers, or on the customer's premises (e.g. CTI, but perhaps also in the home of the residential customer). What interfaces would be

used for this? Options here include the IN standard SCP-SCP interface, the CTI de facto or propriety standard, or some other.

- Architecture - which architecture is most appropriate for the mix of traffic envisaged by the Operator?



Architecture \ Traffic Type	POTS	Televoting	Internet	Calling Card	Freephone
Traditional (distributed)	🟥	🟥	🟥	▒	⬛
Standard IN	⬜	▒	⬜	🟥	🟥
Televoting	N/A	N/A	N/A	N/A	N/A
Cache	⬜	🟥	🟥	⬜	⬜
Adjunct (service node)	🟥	🟥	🟥	🟥	🟥
Distributed processing	⬜	▒	⬜	🟥	🟥
Centralised and distributed SCPs	🟥	🟥	🟥	🟥	🟥
Distributed SCPs	🟥	▒	🟥	⬜	⬜

Key: 🟥 = Best
⬜ = Average
▒ = Below Average
⬛ = Worst

Table 4.12 Architecture Comparisons for Different Traffic Types (Shepherd 1997c)

Table 4.12 rates the ability of the different architectures discussed in this chapter, to handle particular types of traffic. The traditional distributed architecture is less suited to a calling card service and Freephone. These are services where customer data is continually changing, with a customer's credit limit decrementing for card services and Freephone Service Providers frequently altering their service routeing.

The standardised ITU-T IN architecture is not so good at Televoting, where the large number of calls can swamp the SCP

The other architectures developed for the purposes of this research vary in their efficiency in handling different types of traffic. The Televoting architecture is really an addition to whatever architecture it is applied, thus its appropriateness to other traffic types is marked as Not Applicable (N/A) in the table.

As can be seen in the example of a Telecommunication Operator's network in the next section, architectures can be mixed as the needs dictate.

A Typical Operator's Architecture

The previous section has identified a range of different architectures and factors influencing the design of an Operator's Intelligent Network. It is therefore interesting to observe the network of a large Operator, to determine how varying influences, demands and constraints have evolved their network.

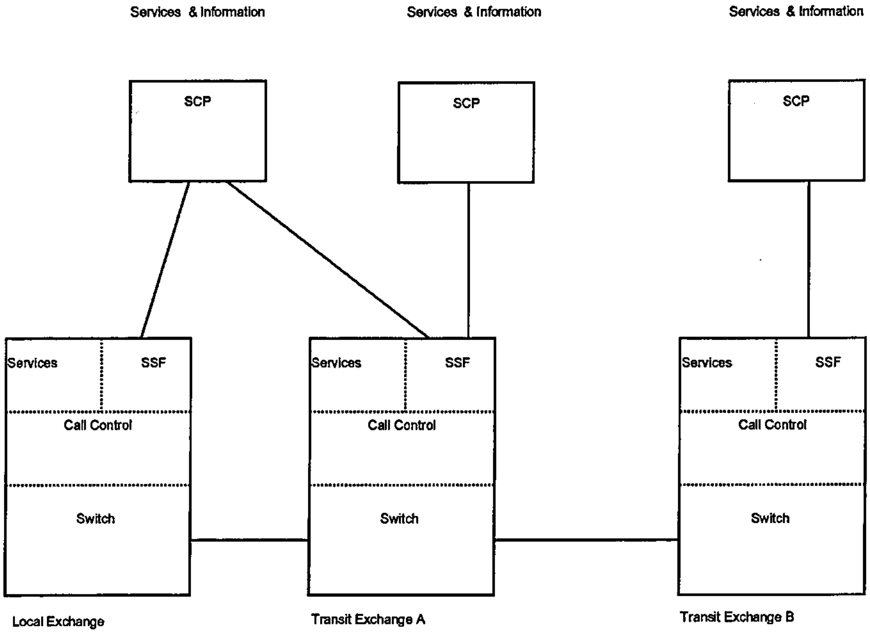


Figure 4.25 An Operator's Network Architecture (2000)

Figure 4.25 shows the structure of an Operator's voice telecommunications network in 2000[39]. The Local Exchanges and Transit A Exchanges form the core network (carrying all types of traffic), while Transit B exchanges form an overlay, only carrying traffic requiring specialist SCP services.

It can be seen that all of the exchanges have some level of embedded services, but in addition there are three Intelligent Networks offering a variety of services, accessed from the different exchanges in the local/transit network hierarchy. These comprise a proprietary IN, a commercial standardised IN and an IN developed to BT's specific requirements, but

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[39] Personal observations whilst working as a consultant.

also adhering to standards. Thus maximum use is made of local legacy exchanges by continuing to use their inherent capability to offer basic services without recourse to the IN, but upgrading them to SSPs to enable access to SCP services. The exchange hierarchy, is used as a tool to reconcile the customer usage of a particular type of service with the IN location of the service and hence offer an optimum implementation of that service.

4.8 Summary

This chapter has provided an overview of the history of Intelligent Networks from the concept developed by Bellcore through the standardisation by ANSI, ETSI and the ITU-T. It has argued that 'intelligence' in the network is not new and drew a parallel with the services originally provided by a human switchboard operator and those typically provided by an Intelligent Network.

The components of an Intelligent Network have been introduced, including the key IN functions of SSF, SCF and SDF, together with their typical implementation by the physical elements SSP (i.e. SSF) and SCP (i.e. SCF & SDF).

The research has found that Intelligent Network technology has a large established base, but almost all of it operates to the first ITU-T standards release of CS1 or its derivatives. It is unclear whether conformity to later standards has been avoided due to the inappropriateness of the detailed regional variants of these standards (as this chapter has proposed), or whether the evolution of newer technologies, such as IP, has caused Operators to refocus away from IN's. It is likely that the only potential for developments of Operator's INs are those necessary to meet local needs. There is therefore unlikely to be further major developments to IN standards in the future.

A comparison has been drawn between a traditional distributed (non-IN) architecture, where the services and associated information are held at multiple exchanges and an IN architecture which has the services and information held in a single location. This showed that INs facilitate rapid updates to services and information, encouraging a range of new services where quick changes to the data are needed. Examples were constructed for an international Freephone service using existing standardised capability, indicating how

Operators could gain increasing operational benefits by interconnecting at progressively higher levels in an Intelligent Network's architectural hierarchy.

Further examples developed for this research showed how Intelligent Network functionality could be moved to the periphery of telephony networks. One example demonstrated how an SCP could be used to replicate and add value to CTI applications, removing the need for localised intelligence at the customer's premises. A second example, indicating potential linkages between INs and the Internet, presented a method of using an IN to connect a customer by telephone to a Customer Service Centre, by means of a hyperlink on a web page.

Finally, the chapter developed a framework for assessing the value of implementing an Intelligent Network. The research has established that Operators have progressively implemented INs in a series of distinct stages, depending upon the maturity of the technology and the role the Operator wants an IN to perform in their telephony network.

A number of IN architecture models were original and specifically developed for this research and analysed to assess their appropriateness for helping to achieve an Operator's telecommunications product strategy and their ability to carry different traffic types. Their characteristics are summarised in Table 4.13.

	Fast Response	High Processing Available	Ease of modifying Services/Information
Traditional	**Good**	**Good**	**Poor**
Standardised (ITU-T) IN	**Average**	**Average**	**Good**
Televoting	**Good**	**Good**	**Average**
Local Caching	**Good**	**Good**	**Average**
Adjunct (Service Node)	**Average**	**Good**	**Good**
Distributed Processing	**Average**	**Good**	**Good**
Centralised & Distributed SCPs	**Good**	**Good**	**Good**
Distributed SCPs	**Average**	**Good**	**Average**

Table 4.13 Summary of Different Intelligent Network Architecture's Benefits

The optimum choice of architecture for an Operator's IN implementation depends upon a very large number of variables identified by the framework, which will differ from Operator to Operator. It has been shown that an Operator's network may comprise a number of INs at different stages of their life cycle, needed to achieve the company's required product strategy. Thus there is no one ideal architecture for all Operators. This leads to two considerations:

1. The standardised IN architecture model is unlikely to be appropriate for all Operators, thus the ITU-T (and related) IN standards developed to this architecture may similarly be inappropriate and sub-optimal for alternative IN architecture models.
2. The application of regulations that force Operators to:
    a) adopt an inappropriate IN architecture model;
    b) open IN interfaces to allow access by other Operators, could be ineffective if the Operator has adopted an inappropriate IN architecture model.

The appropriateness of Intelligent Network architectures and opening IN interfaces to interconnect by other Operators, therefore framed the basis of Survey 1 of this research.

This chapter has also addressed two of the research questions arising from the hypothesis put forward in Chapter 1. It has shown that there are alternative IN architecture models which have sufficient, but differing benefits, that Operators may have been encouraged to adopt one of these in preference to the standardised ITU-T IN architecture model. Applying standardised interfaces to one of these alternative architectures may not encourage optimum performance of the architecture and indeed may have proved impossible. As has been shown from the alternative architectures discussed, Suppliers did not move away much from the ITU-T IN architecture. Thus developing standards to one particular architecture tended to limit the potential benefits to be achieved by other IN architectures. Therefore in partial answer to the Chapter 1 (section 1.2) hypothesis question

> 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'

in the context of INs, the chapter suggests that detailed standardisation can indeed constrain technical innovation and service delivery.

It has been shown that the introduction of INs has made it possible to offer services which were previously uneconomic, with some arguing that the technology created a new market. For instance, it can be argued that INs have introduced a flexibility which allowed the breaking of the paradigm of the caller always being charged for a call. The analysis of IN architectures has shown that some architectures are better at offering specific services than others. In addressing the Chapter 1 (Section 1.2) question

> 'Are INs a service in themselves or simply a means to deliver services?'

this chapter has shown that INs are not a service but a means to deliver a service.

Chapter 2 identified that there are two key strands to this research; that associated with the technical aspects of IN technology and that associated with the standardisation and regulatory processes associated with IN technology. This chapter has addressed the technical aspect; the next chapter addresses the standardisation and regulatory processes. It will also consider the research questions:

- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?' and
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'

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5 The Evolution of Regulation and Standardisation Policies in Regulation

5.1 Introduction

The literature review, Chapter 2, established the two key strands to this research into INs; that associated with the technological aspects and that related to the regulatory and standardisation processes. The key technological issues have been addressed in Chapter 4, so the focus of this chapter turns to regulation and standardisation. The scene is set by reviewing some of the widely perceived conflicts arising from the liberalisation of the telecommunications sector, particularly that in the European Union (EU).

The regulatory sections provide a brief history of the regulation of UK telephony services, followed by an examination of the current regulatory mechanisms developed within the UK and subsequently within the EU. Where appropriate, comparisons are drawn with alternative structures, such as that of federal regulation within the USA.

The standardisation section examines the use of standardisation as a tool for supporting the implementation and application of regulation. A standardisation model for the EU is developed and discussed, based around the European Technical Standards Institute (ETSI), indicating how the regulatory needs for standards are realised.

Taken together, these sections contribute to the development of answers to two of the questions posed in Chapter 1:

- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?' and
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'

In order to provide a backdrop to the regulatory and standardisation discussion, the next section identifies some of the key tensions arising from the liberalisation of the EU Telecommunications Services market.

5.2 Industry Tensions

The 1998 European Telecommunications Open Market directive[1] was the primary driver for the majority of the EU Member State liberalisation programmes and came at a time when most countries still had state-owned monopoly telecommunications Operators. The liberalisation of this sector can be traced back to studies undertaken by the EU in the 1980s, which suggested that to develop and prosper economically, the EU needed a cost effective, well established, telecommunications infrastructure, supporting both internal and external services. To achieve this, Europe had to ensure it was part of the developing global telecommunications scene (Ungerer 1990). This forced the EU to consider the impact of a regulated telephony environment, both to achieve its aim of systematically removing the trade barriers between Member States, and to aid the economic growth of the EU with respect to the rest of the world. Further justification for change came in the form of the Uruguay Round of the World Trade Organisation talks (General Agreement on Tariffs and Trade (GATT) at the time), that added telecommunication services to the agenda (PNE 1997a). The strength of evidence and global pressures pushed the EU to the conclusion that liberalisation was the way to proceed.

The state of play by 1980 was that each EU Member State had a basic, geographically diverse, telephony service, albeit nationally fragmented and employing a basic level of inter-working. Operators had often collaborated with in-country Suppliers; thereby gaining complete control over equipment specifications and proprietary standards and technologies, and making international interconnection complex[2].

The EU Commission recognised that a pan-European network required Operators to employ common standards. A review of the European standardisation organisations resulted in the creation of the European Telecommunications Standards Institute (ETSI). As standards were ratified, Member States undertook to implement them so as to ensure a universal service and commonality of services across Europe. The net effect of these pan-European standards was a break-up of the close Supplier/Operator relationships. Network

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[1] The directive liberalised all Member State telecommunications services (including Voice Telephony), opening network infrastructure to competition.

[2] Hawkins (interview 1997) termed this traditional relationship a hierarchical type of architecture. Each element in the architecture was tied to the commercial interests of that particular Supplier and that the whole structure worked to sustain itself; the equipment Suppliers would do well if the network Operators did well and the close relationship effectively minimised competition and enhanced profits.

elements could be purchased from different Suppliers, and in the case of Intelligent Networks, a Service Control Point (SCP) could be purchased from either a traditional telecommunications equipment Supplier, or a computer manufacturer. Suppliers could no longer rely upon an Operator for a sustained level of business. Thus consciously, or sub-consciously, Operators developed a more flexible strategy that could cultivate or drop relationships as required.

Globally, other pressures were similarly forcing a path towards greater standardisation. In North America, telecommunications equipment Suppliers were faced with an increasingly competitive market and looked to growth opportunities in the rest of the world. To exploit this market their equipment had to work to standards that were more generic and less focused on the North American market. As a consequence, exchange Suppliers became another driver for global standardisation.

The target date set for liberalisation proved challenging for many EU Member States. Some members were unwilling to pass the necessary legislation, whilst others required changes to a constitution that enshrined the rights and obligations of the monopoly service provider[3]. As a consequence, some state-owned Operators had little more than 2 years in which to prepare for the commercial environment. Their operating paradigm, developed over many years, was no longer appropriate and new relationships had to evolve. Liberalisation and competition meant reducing costs, often through the deployment of new technologies and staff redundancies. This frequently induced Trade Union action that further slowed implementation.

A consequence of liberalisation was a proliferation of joint ventures between the Operators of the EU Member States (e.g. Telenordia, Vebacom). The benefit of these joint ventures to Operators was the reduction of competition in their home markets and a stronger position from which to seek a presence in new markets.

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[3] The French and German constitutions guaranteed the provision of telecommunication services, hence constitutional amendments were required prior to the privatisation of France Telecom and Deutsche Telecom (Reuters 1996, interview Hawkins 1997).

The development of the UK cable-TV market, from primarily US investors, showed that predation could also come from outside the EU. A number of the joint ventures therefore, were with US companies (e.g. Concert, Global One, Unisource) (CI 1996a).

The EU Commission used its power of approval of the joint ventures as a tool to promote liberalisation. For example, approvals involving the German and Spanish monopoly Operators were withheld until such time as their home markets were liberalised, which effectively meant liberalising well in advance of the 1998 deadline (Telecommunications 1996). This resulted in the unusual situation of Operators bringing pressure upon their own governments to force the pace of change (Porter 1995).

In establishing the liberalisation programme, the EU provided Member States with few ground rules and what was provided typically identified desired outcomes, not an approved course of action. It was left to the individual Member States to implement the liberalisation process in the way they thought best, which Le Goueff (1998) felt left '...plenty of scope for abuse'. Consequently, different Member States imposed different conditions within the awarding and operation of Operator licences. In the Netherlands for instance, Operators did not require a licence. Some countries continued to favour their legacy national Operator, by imposing onerous licensing conditions and fees on the new Operators (PNE 1996f, Sandler 1996). Other countries positively discriminated against the legacy national Operator, for example by banning them from offering new services (EIU 1995). The mismatch of conditions by Member States gave some Operators an advantage in both their home market and the markets of other countries.

For an Operator building a pan-European network, the cumulative bureaucracy and varying licence conditions acted as a barrier to competition (PNE 1998b). The result of this has been new EU legislation, to be implemented by Member States by the second half of 2003 (discussed later), that will provide consistence guidance to Member State Regulators.

5.3 What is Regulation ?

Dictionaries generally interpret regulation as being a means to control or direct via rules or restrictions. The literature review in Chapter 2 has already reviewed some elements of the telecommunications regulatory environment including:

- the UK regulatory Framework;
- the role of licensing; and
- the evolving position of the EU Commission as a pan-European overseer.

These areas are developed further in this chapter, but for the present the focus is upon the role and implementation of regulation.

Whilst the UK telecommunication industry was nationalised (effectively 1913 – 1984), regulation comprised rules that were designed primarily to achieve the aims of the provision of a universal service and guaranteed communications for national security. There were also restrictions in the form of a budgetary allowance from the treasury and an indication that it should (in the main) be spent with UK industries. From the government's perspective this achieved the aims of building the UK telecommunications infrastructure, making the country self-sufficient in the supply of telecommunications equipment, and promoted investment in the UK economy.

As time progressed the defence needs of a telecommunications system was perceived to have reduced and that (of a national) universal service sufficiently achieved to be replaced by the perceived economic benefits of an extensive modern network. It was decided this could best be achieved by investment from the private sector and the introduction of competition, leading to a need to privatise (Baumol 1995). In the current telecommunications environment, the rules and restrictions are therefore the result of legislation.

Such legislation could have been enacted in one of two ways. The first option would make use of a regulator, who applies regulation within the guidelines laid down within the legislation. The second option would be for the legislation to directly identify the framework and boundaries, within which a particular Telecommunications Operator could function.

Hawkins (interview 1997) favours the first model for the telecommunications service sector. This is the one that has been adopted by the UK and by other EU Member States. In the UK the legislation was enacted by the 1984 Telecommunications Act. This Act provided a general set of guidelines and established a regulator, the Office of Telecommunications (OFTEL). Its Director was delegated suitable powers and allowed a degree of latitude in which to regulate the Industry according to the Act's guidelines. These powers included the right to allocate licences and the ability to impose specific conditions upon each licence holder.

With the 1984 legislation, regulation moved from being implicit in the actions of government, to being explicit in the multiplicity of actions of the country's regulator; the focus '...shifting from administrative and operational matters to commercial practices and market structures' (Reuters 1997).

The second legislative model is one in which legislation attempts to regulate directly. This would typically be achieved by incorporating the framework and boundaries within which a particular Operator etc. could operate, in law. However, such a model lacks flexibility. Whereas a regulator is able to adapt to changing circumstances, whilst still adhering to legislative guidelines, changes to a framework laid down in law would need to be argued directly within the legislative body (in the UK, the House of Commons Select Committee for Telecommunications). This would result in an interminable process for even minor amendments. It was this situation that arose in Germany, delaying their liberalisation process; their communication system being enshrined in the constitution, required a constitutional amendment to privatise Deutsche Telecom (interview Hawkins 1997, Reuters 1996)).

This shows that effective regulation requires a broad legislative framework. The precise nature of regulation should not be enshrined within the legislation, since legislation cannot effectively regulate an evolving environment. The 1984 Telecommunications Act was therefore not a set of detailed regulations but a framework on which to base regulation (interview Hawkins1997).

The UK 1991 White paper on Telecommunications (DTI 1991) recognised that for competition to be successful in a deregulated environment[4], standardisation was required to achieve interconnection and hence any-to-any services. OFTEL therefore took on the role of creating, developing and latterly facilitating, the Network Interfaces Consultative Committee (NICC), the body that evolves UK telecommunications standards. By sponsoring the creation of these standards and compelling their use via generic licensing conditions[5], OFTEL was additionally regulating the behaviour of Operators via standardisation.

This need for standardisation to achieve interconnection has been recognised for many years. In the very early years (1900s) the standards used in telecommunications systems were proprietary, needing a bespoke interface for each interconnection between different Supplier's equipment. As time progressed (1930s in the UK), Operators saw benefits in purchasing equipment utilising their own standards, thereby removing the Supplier's proprietary interfaces and facilitating inter-working. Controlling the standards also allowed Operators to introduce competition amongst Suppliers. Some of these Operator standards (e.g. Digital Access Signalling System) became de-facto standards and were eventually adopted by standardisation organisations, such as the ITU-T.

The ITU-T was created to provide a worldwide reference for telecommunications standards and these were necessarily high level and lacked minutiae, in order to be adaptable by the different regions of the world; with such regional implementations being heavily influenced by their legacy systems. Hence when the US moved to Common Channel Signalling and 64k circuits to improve international inter-working, they continued to use their 24-channel PCM technology, rather than the more globally used standardised 30-channel systems. Such regionalisation is decreasing, as Suppliers find it increasingly inefficient to develop regional variants within a global market.

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[4] Hawkins (1995a) pointed-out that as the telecommunications sector was liberalised and competition allowed, the use of the term 'de-regulation' to describe the process was inaccurate. De-regulation, he said implied 'that the role of regulation is diminishing and that the quantity of regulations is lessening - implications that are contrary to fact in most instances'.

[5] An Operator's licence requires them to utilise standardised interfaces (where possible). For example, although a UK Operator is not compelled to use C7 ISUP, if they do so, they have to use the NICC developed, OFTEL approved standard, termed 'UK ISUP'. This is the UK variant of 'ETSI ISUP' which is in turn the European variant of the 'ITU-T ISUP'.

5.4 The History of Telecommunications Regulatory Development

The UK has a long history of telecommunications regulation and licensing policy and as one of the first Member States to undertake deregulation it has proved influential in the transformation of the EU telecommunications sector (Beesley et al. 1995, Ungerer 1990, interview Hawkins 1997). Understanding how current UK regulation policy is applied (through OFTEL and the DTI) provides invaluable insights into EU regulation and the formulation of global policies under the WTO.

The question 'Is legislative regulation the appropriate means to shape a technology in rapid change?', posed in Chapter 1, is addressed with respect to the UK and EU telecommunications regulation. Examples of other regulatory regimes are introduced as appropriate.

Telegraphy in the UK

The regulation of Telegraphy in the UK is summarised in Figure 5.1.

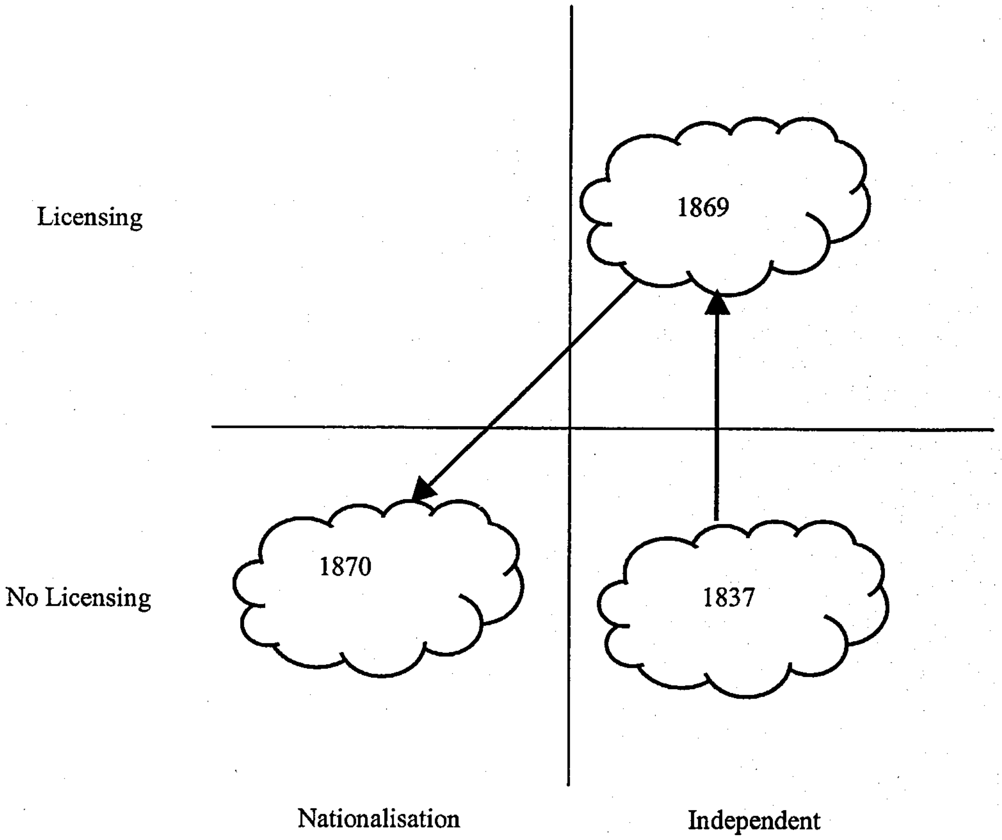

Figure 5.1 The Regulation of Telegraphy in the UK

The first commercial telecommunication services in the UK evolved from about 1837, with the start of short distance (60 km) telegraphy services (BT 1993a). As technologies developed, increasing both the distance and speed, signals could be carried, so the number of telegraphy companies grew. By 1870 there were a number of regional companies offering telegraphy services, most utilising different proprietary standardised equipment.

In 1868 the Postmaster-General gained responsibility for administrating the telegraph networks in the UK. He initially nationalised a number of telegraph companies to form a UK nation-wide network and licensed the remainder. This state was short lived as full nationalisation followed in 1870 (Telegraph Act 1868, Telegraph Act 1869).

Nationalisation[6] allowed migration toward a common telegraphy equipment standard, gaining economies of scale. It also brought a potentially strong national tool of governance under governmental control (BT 2002a).

The telegraphy service was never denationalised, closing instead in 1962 (BT 1993a).

Telephony in the UK

By 1880 the first telephony operating companies (Operators) had appeared. Their service was deemed to be telegraphic apparatus under the 1869 act and subject to a licence from the Postmaster-General. (The common association between telegraphy and telephony continued until the 1951 Telephony Act.) The Postmaster-General licences were valid for a period of 31 years, restricted an Operator's area of operation (and hence development), and placed a levy on the income (i.e. licence fee) from the company's operation. The decision that Operators should be regulated by the 1869 act also meant that conditions of nationalisation within that act were applicable. This allowed the government the option to nationalise Operators after a set number of years, reducing the Operator's incentive to invest and expand.

In 1882 the Postmaster-General (Henry Fawcett) decided that an area monopoly[7] in the supply of telephone telecommunications was not in the public interest and adopted a policy

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[6] The Post Office was a government department, thus bringing the telegraphy service under Post Office control was not strictly nationalisation. However, Nationalisation is used in this thesis to denote a monopoly under government control.

of granting licences to all 'responsible subjects' applying for them. This competitive stance continued until 1884, when to encourage more of a universal service[8], national licences were granted, allowing Operators to combine their local telephony networks to create national networks.

This position continued until 1892 when the Postmaster-General nationalised the largest Operator's (National Telephone's) trunk network and allocated new licences to the remaining Operators, restricting their operation once again to local geographical areas (as per the 1892 Telegraph Act). The justification for this change in strategy was the poor quality of service experienced by customers and the unsightly proliferation of overhead wires (BT 1993b). It is difficult to see how removing the trunk network from private control significantly reduced the number of overhead wires. A photograph from about 1900 (Figure 5.2) shows that overhead wires continued to be an issue after trunk nationalisation. A more appropriate reason might have been the competition and loss of revenue they caused the Post Office's own network, which was by then derived predominantly from telephony (rather than telegraphy).

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[7] Area monopolies were formed by Operators being licensed to operate in a particular area with no competition.

[8] 'Universal service' in this context, was the provision of telecommunication services at a reasonable price, to all (including rural) communities within the British Isles. Providing service in rural communities was not favoured by telephone companies owing to the low number of users, the need for long line lengths causing a high cost of provision and a higher than average fault rate. Such installations therefore generated a low profit.

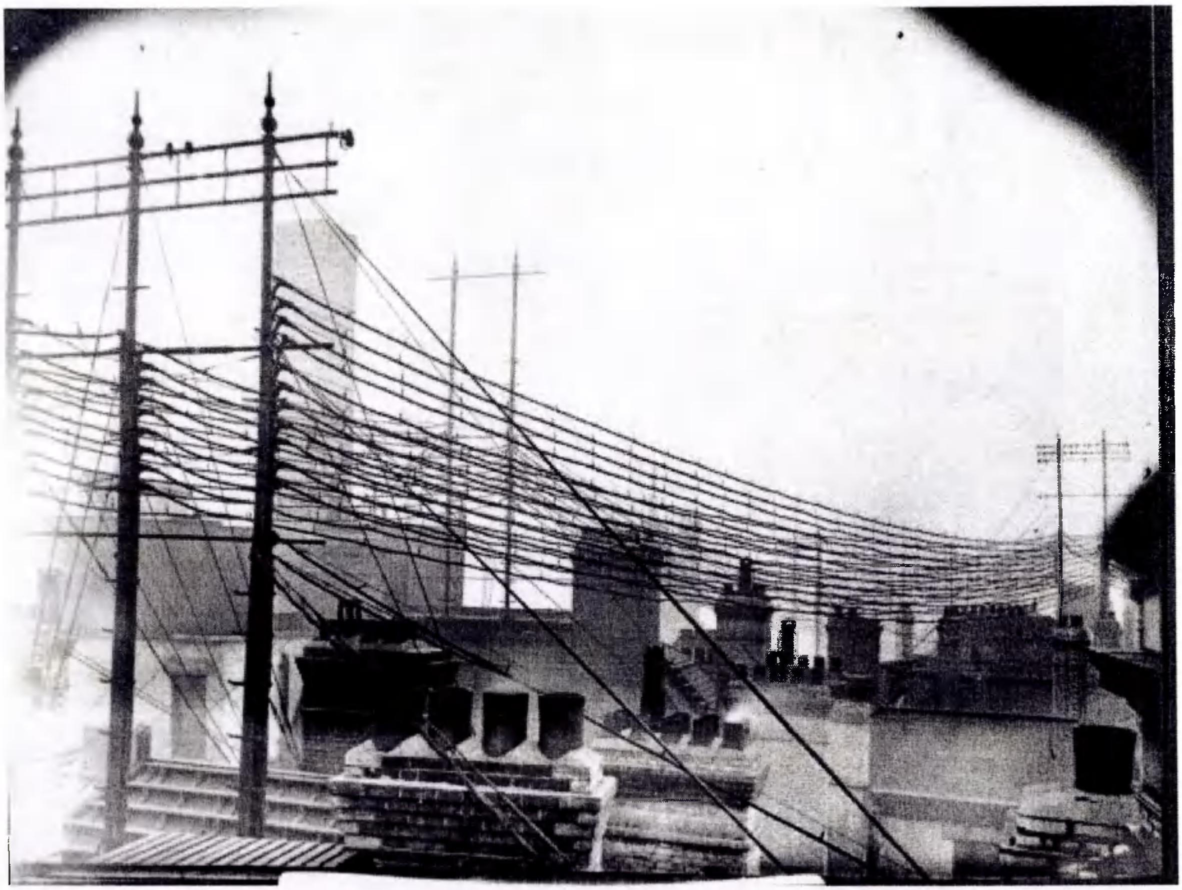

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Figure 5.2 Overhead Telephony Wires, Holborn Exchange, London, about 1900

Along with nationalisation of the trunk network came interconnection agreements allowing local telephone Operators to use the Post Office Trunk Network. This was essential to provide a Universal (any-to-any) Service.

Further operating licences were granted to local authorities in 1899, allowing them to develop and operate local telephone systems, to encourage competition with the National Telephone Company (Telegraph Act 1899). Of these local authority systems, that set up by Kingston upon Hull still exists today as the telecommunications Operator 'Kingston Communications'.

In 1901 further interconnection[9] agreements allowed the Post Office and the National Telephone Company to share line plant (cables) in London and achieve local interconnection (other than via a trunk network). In 1912 (upon expiry of the original

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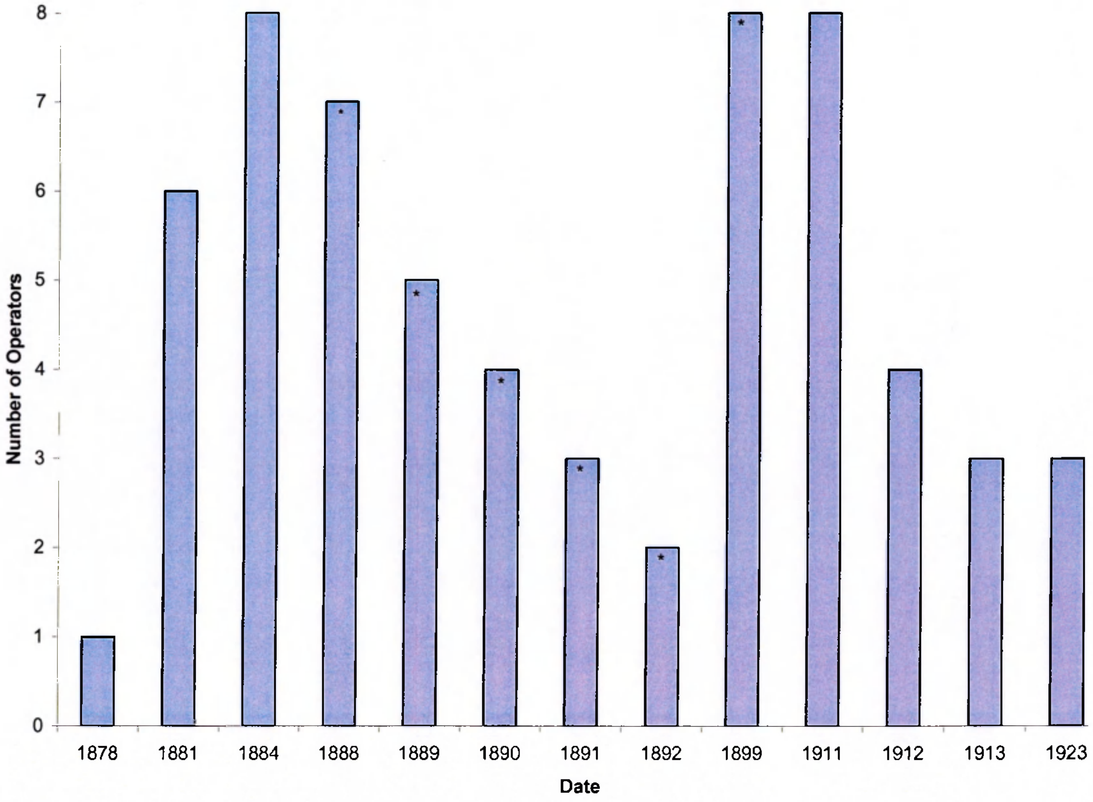
[9] Interconnection is the action of connecting the networks of two Operators in order to allow the customers of each to contact each other.

licences and to a 1905 agreement) the Postmaster-General nationalised the National Telephone Company and (by 1913) additionally took over the control of almost all the local authority networks[10].

The impact of licensing and nationalisation upon the number of UK telecommunications Operators is illustrated in Figure 5.3



* figure based on statements relating to mergers, acquisitions etc.

Figure 5.3 Impact of Regulation upon the number UK Telecommunication Companies

In 1929 the British government created 'Cable and Wireless' to operate all overseas telecommunications. This was prompted by the strategic consideration to keep all overseas cable service interests within British control. Cable and Wireless therefore took control of the private-sector cable services and the Post Office's overseas cable and wireless

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[10] It is not clear why nationalisation was justified, but it is likely that arguments used for the justification of earlier licensing actions, (i.e. offering a universal service, defence of the realm and governing purposes) still held.

service[11]. The unusual governmental backing of this company allowed it to gain international maritime rights unequalled by other international companies and still enjoyed today (interview Hawkins 1997).

The 1969 Post Office Act (promoted by the Postmaster-General, Anthony Wedgewood-Benn) established the General Post Office as a public monopoly corporation, removing its status as a government department and split the organisation into Posts and Telecommunications divisions. Although not envisaged at the time, this split aided the 1977 Carter committee report, which recommended the creation of a separate corporation for the telecommunications part of the Post Office. Separation was implemented as part of the 1981 British Telecommunications Act, creating a new company, British Telecommunications plc (BT) (Beesley et al. 1995). The 1969 act also allowed the Secretary of State to issue licences to other companies (subsequently known as Service Providers) to operate in direct competition with BT in the area of Value Added Network Services (as per the 1981 Beesley report recommendations issued earlier in the year).

About this time, the Governor to the Bank of England stated that the UK was going to lose its markets (particularly financial) to the rest of the world, unless its telecommunications infrastructure was improved. However the money to achieve this was severely restricted by the treasury[12] (Baker 1997). The alternative was external investment and competition (to remove the opportunity to take advantage of a monopoly situation) (Beesley et al. 1995). In 1982 the Conservative government proposed a bill to sell a majority stake in British Telecom (against DTI advice (Ellison 1997)) in order to provide the freedom from ministerial control needed to make commercial decisions and grow in a developing market. The bill was finally passed as the 1984 Telecommunications Act and was followed by the government selling a majority stake in the company, effectively relinquishing their control. The removal of BT from direct governmental control created a private company holding a monopoly position in the market. To prevent BT from exploiting this position competition was introduced (Gist 1990) and to regulate the telecommunications market more generally, the 1984 legislation also created the Office of Telecommunications (OFTEL) (as per the

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[11] In 1950 all Cable and Wireless services operating from the UK, were returned to Post Office control (which included those originally leased to Cable and Wireless by the Post Office), leaving the company controlling only an overseas network.

1983 Littlechild report) and licences, which OFTEL granted on behalf of the Secretary of State. The effect of the Act therefore, was telecommunication service liberalisation and regulation through licensing and licence conditions.

It is interesting to speculate on the alternatives to liberalisation. If a Labour government had been in power, their traditional stance against denationalisation would probably have meant increased government investment in the telecommunications monopoly provider, BT. Such a policy would have speeded modernisation of the UK telecommunications network and would have been likely to have led to different outcomes. For example, greater investment could have seen full implementation of Prestel (the electronic information/mail service), or hastened the development of BT's non-standard 80kbit/s ISDN service to introduce digital communications. BT's close relationship[13] with the UK Suppliers (principally GEC and Plessey) would have remained for longer[14]. However, the long-term benefits are not clear. Prestel might have become a commercial success, as was France's Mintel service, or could have failed because of incompatibilities with the evolving worldwide e-mail standards. Similarly, the 80kbit/s ISDN service might have led early developments of digital communications, but ultimately failed given the incompatibility with worldwide standards. In either case substantial upgrades would have been essential.

Overall however, it is fairly certain that the UK would have found itself in a position closer to the other EU Member States as the 1998 liberalisation deadline approached. Legislation would have been rushed through and BT would have been looking for significant joint-venture partners to develop a strong defensive (anti-poaching) stance. As it was, a deregulated BT was regarded as a significant predator at the time. If a Labour government had invested in a nationalised service, it is unlikely that any subsequent Conservative governments would have denationalised it. Although BT's denationalisation turned out to be very successful, leading to the denationalisation of other industries, evidence indicates

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[12] The government found the telephone network developed a useful income, which the treasury considered part of the UK treasury budget and thus tended to limit the finance available for development of the telephone network.

[13] Hawkins (interview 1997) termed this traditional relationship a hierarchical type of architecture. Each element in the architecture was tied to the commercial interests of that particular Supplier or service provider and that the whole structure worked to sustain itself; the equipment Suppliers would do well if the network Operators did well and the close relationship effectively minimised competition and enhanced profits.

[14] The scenario maintains the existing Operator/Supplier relationships. In practice it was found that the introduction of a third party significantly reduced purchasing costs (Shepherd 1987).

that prior to BT denationalisation, the government was sceptical and support marginal (Blakeway 1997).

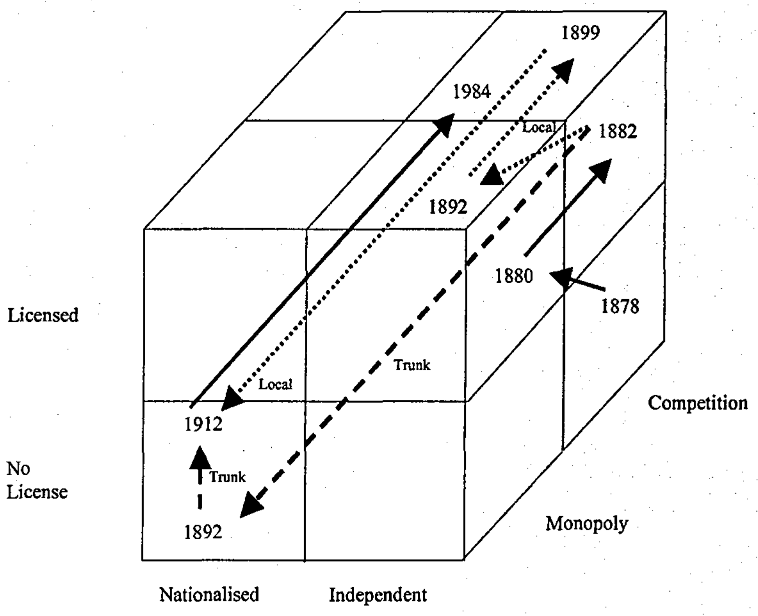

Figure 5.4 The Regulation of Telephony in the UK

When the history of UK telecommunications regulation[15] is presented diagrammatically (Figure 5.4), it can be seen that regulation prior to 1912 (almost all introduced by Liberal Governments under Gladstone) struggled to find a satisfactory formula; mixing monopoly licensing with competitive licensing, before partial nationalisation and then complete nationalisation of the network in 1912. By this date, the regulatory environment had already alternated between monopoly and competition twice (in 1882 and 1899). A third cycle was completed in 1984 when the telecommunications network was denationalised.

Telephony in the USA

By way of a comparison, it is useful to review the development of the regulatory framework in the USA, since this was another regulatory regime examined by the European Commission when it considered options for the 1998 liberalisation. The USA was similarly driven by the desire for universal service, but it did not consider a national telephone network as important for defence purposes as did the UK, leading to the evolution of a different solution.

The American Telephone and Telegraph Company (AT&T) was conceived in 1885 as a means to interconnect its regional parent Bell operating companies so as to offer inter-regional services for its customers. In 1899 the companies were reorganised such that AT&T became the parent company. By the early 1900s AT&T was in competition with other Operators offering telecommunication services in the USA. As had occurred in the early days in the UK, these companies had set up unconnected networks in the same geographic areas, the customers of one Operator being unable to communicate with those of another Operator. AT&T refused to interconnect with other Operators' networks, except in areas where AT&T did not have a presence and then only under the condition that the local Operator did not itself connect to any other network. This refusal to universally interconnect and the conditions imposed on those that did, encouraged criticism from the utility regulators. AT&T however, stemmed the argument against compulsory interconnection on the grounds that its approach actually encouraged universal service and as a trade-off unofficially accepted the regulatory commission control of telecommunication rates as an '...appropriate and acceptable substitute for the competitive marketplace' (AT&T 1998, similarly Muller 1993).

The policy of monopoly interconnect resulted in anti-trust suits and the 1913 'Kingsbury Commitment' which prevented AT&T companies from taking over competitors. The anti-trust judgements (which found against AT&T) and the 1913 Commitment, were overturned by the Willis Graham Act of 1921. This Act argued that a universal telecommunications system was more important than a fragmented, competitive one (Mueller 1993). Thus AT&T began a period of consolidating its monopoly through take-overs.

As the Century progressed, AT&T was periodically accused of having abused its monopoly power in a number of areas, resulting in key anti-trust suits in 1949 and 1974. The 1949 anti-trust suit resulted in a formal declaration by AT&T of the scope of their business as being only '...the regulated business of the national telephone system and

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[15] Hawkins (interview 1997) argued that the European Telecommunications market has never been regulated. He does not see public ownership (i.e. control by a government) as regulation. 'Such action has the effect of

government work' (AT&T 1998). The 1974 anti trust suit resulted in the 1984 break up of AT&T into a long distance carrier and seven local Operators (termed 'Baby Bells'). In return it was agreed that the statement made by AT&T in response to the 1949 anti-trust suit would be nullified, again potentially opening up the scope of their operations (Armstrong et al. 1995, AT&T 1998). The break-up allowed the introduction of competition into the long distance market and more recently the local market (Margasak 1996, Times 1996).

The Federal Communications Commission (FCC) was established as part of a 1934 Communications Act, to ensure that AT&T did not abuse its monopoly position. The FCC regulates inter-state and international telephony communications via its Common Carrier Bureau (one of several bureaux that regulate all communications services, including television, radio, etc.) (Darlington 1981).

Intra-state communications are overseen by individual regulatory agencies. As is normal, some of the boundaries between the FCC areas of responsibility and an individual state's regulatory authority are open to definition[16], sometimes leading to the curious position of a state's regulatory agency joining with Operators to take the FCC to court[17] over their actions, whilst they themselves are perhaps being taken to court by the same Operators, for the decisions they have made in a different area (CWI 1996, Perrin 1998, PNE 1996). Such litigation tends to slow the pace of change.

The two-tier system found in the USA (i.e. having both national and regional (state) regulators) provides an interesting contrast to the relationship and operation of the EU Commission and the UK regulator OFTEL, examined in the next section.

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regulating the market by preventing competitors and establishing a monopoly, but because there are no competitors, the market is not regulated'.

[16] An example of FCC/State Regulator conflict is where the FCC removed regulatory pricing controls on new services (to create incentives for the development of new services) and also had to gain the right to override any state regulation which might reintroduce it, in order to ensure its effectiveness (Tele.com 1997).

[17] Regulatory agency decisions can be appealed against in the state courts, while the FCC decisions can be appealed against to the US Circuit Court of Appeals and then to the Supreme Court.

5.5 How Telecommunication Service Regulation is Applied in the UK - OFTEL

The Office of Telecommunications (OFTEL) was created by the 1984 Telecommunications Act as an independent regulatory body for the telecommunications (but not broadcasting) industry. The role was originally intended to be undertaken by the Office of Fair Trading (OFT), but a decision was made that a dedicated regulatory agency was required and the concept of OFTEL developed. OFTEL was modelled on the Office of Fair Trading (OFT) and was designed to merge with the OFT at a later date (Beesley et al. 1995).

Prior to OFTEL's creation the Department of Trade and Industry (DTI) looked after the interests and needs of UK telecommunications, both within and outside the UK. After the creation of OFTEL the DTI focused more upon international telecommunication affairs, using OFTEL as an interface to the UK telecommunications industry.

OFTEL has sole responsibility for the granting, monitoring and enforcement of telecommunication licences. However the Department of Trade (DTI) (headed by the Secretary of State) remains politically responsible for telecommunications policy in the UK.

For OFTEL to be successful it needed to be independent of political control and Operator influence, a stance subsequently receiving formal recognition by the EU Commission and incorporated into their 1998 liberalisation guidelines. Without such impartiality the regulator's decisions could be questioned and prospective new competitors could perceive an increased risk of entry to the UK market (EIU 1995).

David Edmonds is the current head of OFTEL and holds the title of 'Director General of Telecommunications'. This post purports to be independent of government ministerial control. OFTEL's expenditure is set and underwritten by Parliament (subject to annual Treasury approval), but the income is almost entirely derived from licence fees[18] (OFTEL 2001a). This method of funding makes OFTEL financially independent of government and

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[18] In the case of the larger Operators, the licence fee is approximately related to the size of the turnover of the business.

arguably independent of political influence. However it is still a government department and at the end of each (calendar) year, the Director General has to compile a report to the Secretary of State, who presents the report to Parliament. This indicates that OFTEL has an indirect responsibility to the government and hence parliament[19] (Walker 2001).

The role of OFTEL is described by Peter Walker, OFTEL's director of technology, as being:

> '...to achieve those desirable and justified outcomes for consumers and the community as a whole that do not arise naturally from the market' (Walker 2001 p258).

To achieve this OFTEL has developed a number of objectives including:

- the protection of consumer interests;
- the promotion of competition;
- the issue, amendment and enforcement of licences;
- advising the UK government upon telecommunication related matters;
- overseeing telecommunication activities in the UK
  (OFTEL 1997).

OFTEL achieves these objectives by issuing and overseeing the operation of licences (i.e. ensuring the terms and conditions are met), using its statutory powers to collect and analyse appropriate information from licence holders.

From Mid 2003, the telecommunications regulatory framework will change when the five UK communication regulators (OFTEL, Independent Televisions Commission (ITC), Radio Authority, Radio Communications Agency, and Broadcasting Standards Commission) are subsumed into a single Office of Communications[20] (OFCOM) (OFCOM 2001). A common Communications Regulator should better address such areas as 'Pay as you View TV', which has historically fallen within both OFTEL's and the Independent Television Commission's (ITC) remits.

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[19] OFTEL supports the stance that has been adopted, that National Regulatory Authorities should be independent of government (OFTEL 1996d).

[20] This will create a body with a similar scope to the US regulatory authority, the FCC (POEU 1981).

Responsibilities

OFTEL is responsible for enforcing the Competition Act 1980 for the UK telecommunications industry, through the allocation, amendment and hence enforcement of licence conditions. Telecommunication licences are allocated by the Secretary of State following a recommendation from the Director General (OFTEL 2001b).

OFTEL also continuously monitors telecommunications activities in the UK and overseas, so as to advise government departments (the DTI and the Secretary of State) on, for example, what telecommunication issues should be discussed at the EU Commission level, problems with implementing EU directives, and so on.

In fulfilling its responsibilities, OFTEL endeavours to achieve a balance such that:

- all reasonable UK telecommunications service demands are met;
- Service Providers operate efficiently and their services are self financing (i.e. not subsidised);
- effective competition is maintained in the UK;
- the ability of the UK telecommunications industry to compete overseas is encouraged
  (Long 1988).

Gillick (1991) recognised this last point in a written response to the government's duopoly review (DTI 1991). He suggested that the government needed to improve the orientation of the UK telecommunications industry in the global market and to recognise the need for, and the regulation of, network interconnection arrangements (Gillick 1991). This would not only address terms and conditions, but the standards employed.

Licensing

The UK Telecommunications Act 1984 (DTI 1984) made it an offence to operate a telecommunications system without a licence granted by the Secretary of State; the Act together with a subsequent amendment (DTI 1991), detailing the categories of telecommunications licence available[21]. The Secretary of State has devolved the

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[21] The telecommunication licences available are described in detail in Appendix C.

responsibility of the granting of licences to the Chairman of OFTEL, the Director General of Telecommunications (DGT).

OFTEL uses licensing as a method of restricting access to a market segment as well as controlling the actions of Operators within that segment. For example, a number of restrictions become operative when a company is deemed (by OFTEL) to have 25% market share[22]. In the case of fixed networks such restrictions appeared to apply mainly to the incumbent Operator (BT). BT has in turn expressed concern about the 'significant market share' clause being used to restrict its access to other market segments, such as Personal Communications Networks (now obsolete) and Broadcast Services.

A new EU directive to be implemented in July 2003, will abolish licences, replacing them with 'authorisations'. The directive therefore frees Operators from applying for licences, but imposes upon them the conditions in the directive and thereby creates a common set of regulatory requirements applicable to all European Operators (OFTEL 2002, Walker 2001).

Powers

OFTEL and the Director General have no direct power derived from the 1984 Telecommunications Act to determine the issuing or modification of a licence, or to enforce the adherence to licence conditions. This is done by the Secretary of State, but on the Director General's recommendation.

OFTEL however, has considerable indirect power through conditions written into the licence, making the licence holder answerable to them for certain information and permitting OFTEL the power to revoke licences under certain circumstances. For example, breaches of licensing conditions could require the Director General to take remedial action by issuing a provisional order, followed by a final order. These can be enforced by civil action.

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[22] A 'Framework Directive' ratified in 2002 and due to be implemented in 2003, provides a new EU definition of 'Significant Market Power', which OFTEL must use in considering the actions of UK Operators (OFTEL 2002).

OFTEL's decisions can be challenged in a variety of ways depending on the type of decision made. If the decision is related to price controls, this can be referred to the Competition Commission[23] (who principally take their advice from OFTEL). In 1996 one observer thought the number of referrals excessive and that OFTEL themselves should be investigated to determine the cause (Bennett 1996). If the decision relates to licence conditions this could be challenged by a judicial review based upon the decision's relevance to the Competition Act. However,

> 'BT argues that the system is unfair because it has no realistic means of appeal; it can ask for a judicial review, but that takes 18 months and the onus is on BT to prove that OFTEL's action is 'not reasonable'. In contrast, if an MMC recommendation goes against OFTEL, it is not obliged to act on it' (EIU 1995 p41).

Alternative approaches to resolving Operator disputes with a National Regulatory Authority have been proposed by the European Commission (for example in 1996), but these did not develop further, possibly owing to their perceived encroachment on National Sovereignty (Read 1996). They have however, simplified the basis of the right of appeal by Operators from those given above, to one based on 'grounds of merit'[24] with the implementation of the Communications Bill in mid 2003 (interview Clark 2002).

The UK Telecommunications Business Model

When the UK telecommunications service industry was liberalised, OFTEL adopted a business/operational model on which its telecommunications regulation is based. The main constituent of the model is voice telephony although it also encompasses data. Telecommunication products and services are grouped into an ascending hierarchy, with Network Business providing the basic transport and forming the foundation upon which the other services are offered. The groups are categorised as shown in Figure 5.5.

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[23] Formerly the Monopolies and Mergers commission (MMC).

[24] An example of 'Grounds of Merit' may be a decision which is likely to have a disproportionate impact compared to what it is trying to achieve.

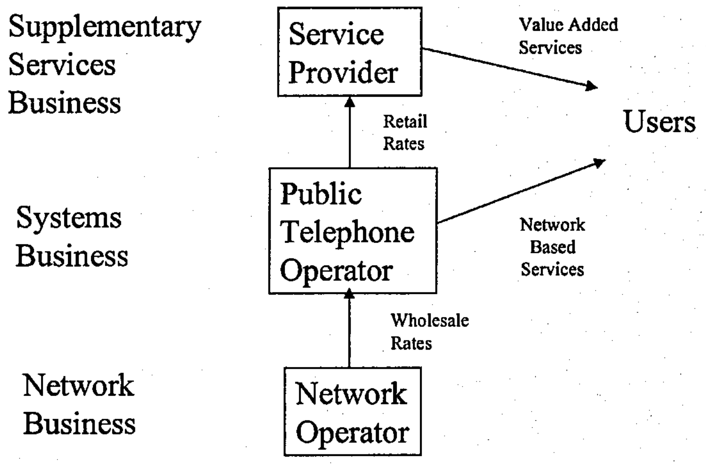

Figure 5.5 The UK Telecommunications Business Model

Public Telephone Operators purchase network capability at wholesale (or Network Operator) rates as per BT licence Condition 13 (C13), whilst Service Providers[25] have to buy such capability from Systems Business at retail rates (Figure 5.5). Operators however, typically offer a range of services falling within Systems Business (SB) and Supplementary Services Business (SSB) categories, but are not subject to the rules of the model unless they are deemed to have significant market share. For fixed network telephony, BT was the only Operator deemed to be within this category. The situation was further complicated by OFTEL having historically granted some Service Providers 'Relevant Connectable System' status (a particular class of UK telecommunications licence), which allowed network capability to be purchased at wholesale rates, whilst other Service Providers did not have this benefit (OFTEL 1995). What this means is that Operators (other than BT) and some Service Providers were able to offer Value Added Services with the underlying network capability being subject to wholesale rates, whilst most Service Providers and BT's supplementary services division products were subject to retail rates (DTI 1993). This anomaly was frequently drawn to OFTEL's attention:

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[25] The concept of Service Providers appears to have originated in the USA. The services they offered were termed Value Added Services, that is to say something in addition to the Network Operator's service, such a 'Golden Numbers'. (Golden Numbers are typically those which are memorable such as '1-800 1111111' or '1-800 call now'.)

> '...the Service Providers present were unhappy that they could only get retail prices from BT, but because Network Operators had access to C13 prices they could, without adding any value, resell BT services at cheaper than BT retail tariff - an option not available to BT itself. For this reason Service Providers felt they had as much right to C13 tariffs as Network Operators' (Sutton 1995).

Further potential anomalies have been blocked by OFTEL. This includes some large organisations operating private telecommunications networks that tried to follow the example of US companies by attempting to gain Network Operator licences (Savarnejad 1996). This would have allowed them to purchase their telecommunication capability from Operators at wholesale rates and reduce their overall operating costs (Molony 1996b).

Of particular relevance to this research is the impact of the business model upon the opening of Intelligent Network interfaces to third parties. A situation could arise whereby a customer may use a service offered by the monopoly Operator that comprises a variety of capabilities provided by different organisations and subject to different regulatory constraints (Bicknell 1993). It would be very difficult to categorise the service as SB or SSB, since it may combine a third party capability (normally SSB) that can only operate in conjunction with a particular Suppliers equipment (normally SB).

Using a model as the basis to regulate a business highlighted the need for a clear, unambiguous, definition of the terms used by the model. The definition of 'Supplementary Services Business' or 'Value Added Services', 'Systems Business' or 'Network Services', varied between EU Member States. In the USA, the definition of 'Value Added' was forced to develop and change with time and new technology. Its interpretation has been challenged and reviewed in the law courts. Presumably to avoid such confusion, the EU 1987 Green paper did not use terms such as 'Value Added', but rather 'Reserved Services' and 'Competitive Services' and concentrated on defining 'Reserved Services' only. What constitutes the remainder was left for the individual Member States to decide (Ungerer 1990).

The goal of creating a business model[26] was to split the products of the incumbent Operator (BT) into market segments, 'virtually' separating them as trading entities, thereby negating any advantage the entities might gain from operating collectively (such as cross-subsidisation and knowledge transfer). The aim was to encourage market segment competition (Armstrong et al. 1995). Almost all of BT's competitors supported the model and product split (OFTEL 1996a); hardly surprising since they were not subject to the same operating and accounting separation conditions, because they fell outside the rule of 'significant market share' (DTI 1993). However such action potentially restricted BT's economies of scale[27] and arguably reduced its growth overseas[28].

There were however, other business models that could be considered. One approach seemingly missed in OFTEL's discussions (OFTEL 1996b), was the option of Operators having to contract-out new services to Service Providers (Figure 5.6). Many of the issues associated with Network Operator pricing and open interfaces would have been avoided, since all new products could be offered only by Service Providers. Such a model would also promote market competition whilst avoiding the danger of Operators diluting market share beyond a critical limit and making it uneconomic.

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[26] The telecommunications business model is very similar to that proposed by KPMG (1993) in its report to the EU. This is discussed in Chapter 2.

[27] Similar equipment owned by Supplementary Services Business and Network Business cannot be purchased under the same contract.

[28] Concert's Audio Conferencing Product comprised of subcontracted MCI and BT Audio Conferencing services. BT's service was higher priced than MCI, disadvantaging its use elsewhere in the world. This higher price was attributed to the need to purchase network capability from BT at retail rather than wholesale rates (Shepherd 1996).

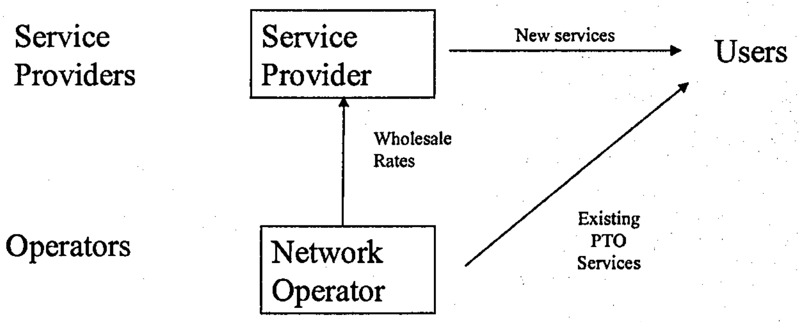

Figure 5.6 New Services Offered via Service Providers

Another approach proposed by some respondents to the OFTEL document (OFTEL 1996b), is shown in Figure 5.7. This proposes a structure similar to that initially imposed upon the UK Mobile Network Operators, whereby they could only sell network capability to the Service Providers and the Service Providers sold the service to the public (OFTEL 1996b, YG 1996). The approach indicated by this model is sometimes referred to as the maximalist view.

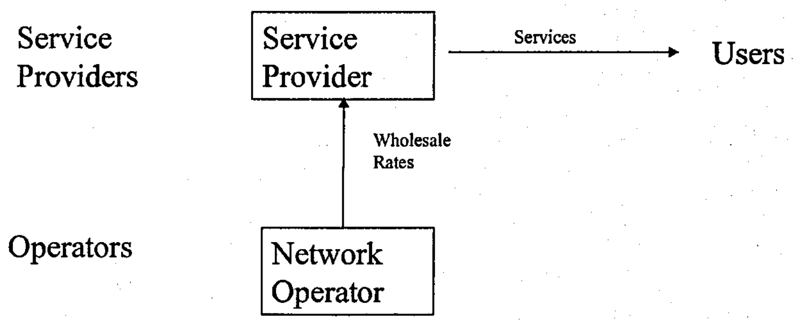

Figure 5.7 The Physical Separation of Operators and Service Providers

The problem with a model separating Operators from Users is how to handle the existing Network Operator's customers. This model is therefore perhaps best for totally new market segments, as indeed it was with the launch of UK mobile communications.

The growth of data services and the migration of traditional real-time (i.e. time-dependent) transmission products to non real-time products on a data network[29] (e.g. Facsimile, Voice Mail etc.) indicate that the categorisation of products is changing and that any business model should correspondingly have the capability to evolve. The current move to 'connectionless' (Internet Protocol) networks suggest that the base capability of the model should be a data network supporting supplementary services (including voice), since products are increasingly independent of the network on which they are carried (Figure 5.8).

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[29] Data packets carried on Data network are give a Class of Service Rating. Real time products (such as voice telephony) are given the best rating which endeavours to transmit them with minimum delay. Non real-time products (such as computer data or Facsimile) are given a best effort marking, implying they can suffer a fair amount of delay with no end-user problem. In this way, the data network is able to manage its traffic more efficiently during periods of high usage.

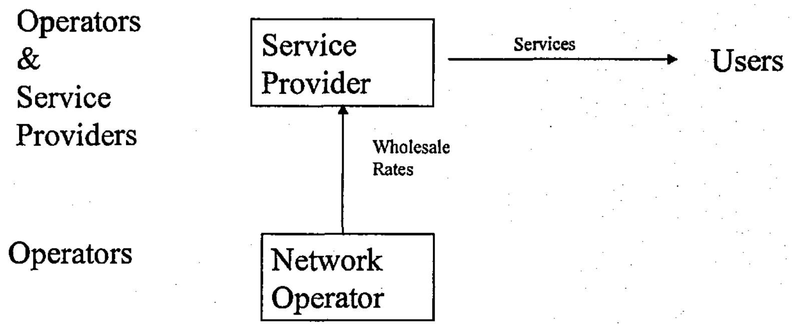

Figure 5.8 The Financial Separation of Operators and Service Providers

In such a model no services are considered 'Network Dependent' and an Operator's retail division operates on a similar basis to Service Providers, using the same interfaces and negotiating similar wholesale rates. However

> 'Once you distinguish the service from the infrastructure, allowing competition on one but not the other, then you need complicated rules of access to the part that remains a monopoly so as to ensure that the monopoly does not discriminate in favour of its own services arm.' (YG 1996 p7)

Hence the relationship between the Network Operator and the Operator's retail division needs to be independently monitored to ensure fairness.

Over-regulation of the Network Operator/Service Provider relationship in Figure 5.8 could have a negative impact. For example, in the US the FCC regulations allowed Service Providers

> '...to buy new services at deep discounts...*making*...it very difficult if not impossible for Telcos to recoup the development costs of these services... Competitors can use that price difference to undercut incumbent offerings, hampering Telco efforts to use service prices to recover their costs.' (Tele.Com 1997)

As a consequence the FCC was obliged to remove the regulatory pricing controls on new services.

All the alternative business models presented in this section have a simpler structure than that adopted by OFTEL (Figure 5.5). The simpler structure is better able to accommodate future technology development (since this will always occur at Network Operator level) and will tend to avoid inequalities at the Service Provider level. For example, if the business model in Figure 5.6 had been employed by OFTEL, the implementation of new technology and consequential independence of services from the network, would have allowed a non-interventionist evolution to the model in Figure 5.8. Thus the impact the regulated business model has upon service delivery would be minimised, despite any change to the underlying technology.

5.6 UK Interconnection Regulation

A major contributor to the success of liberalisation is the mutual provision and operation of services over competing Operators' networks. This raises the issue of inter-working (Figure 5.9).

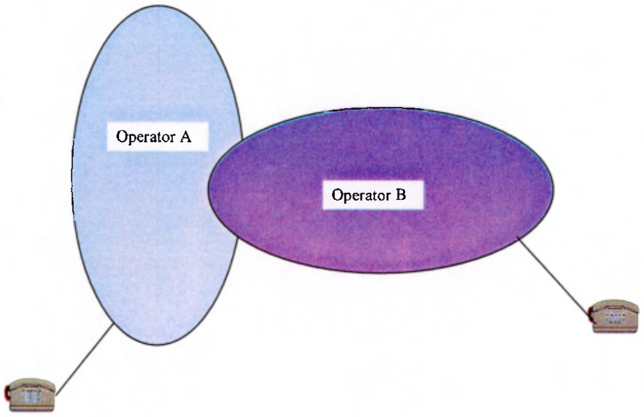

Figure 5.9 The Interconnection of Networks to Offer Universal Service

OFTEL's approach is to refer technical interconnection issues to the Network Interoperability Consultative Committee (NICC)[30]. Such referrals fall into two categories; those associated with general interconnection to encourage the operation of services (i.e. upgrading networks to ISUP), and those services which are deemed Supplementary Services Business in the UK business model (e.g. BT's Call Minder product) and hence capable of cross network provisioning and operation.

General network signalling upgrades result from the realisation that existing services could be offered more efficiently, or better services would be encouraged, by the implementation of a new or enhanced standard. The NICC would normally take the relevant ETSI variant of the ITU-T standard and discuss the benefits its adoption would bring UK telecommunications[31]. This is effectively a benefit analysis that weighs the advantages and disadvantages of new and existing, or competing standards[32]. Assuming the benefits are sufficient, discussion continues as to what messages will be supported and the action/responses needed[33]. Without this mutual understanding of what a message means and its appropriate response, serious network problems could result. An example of what could happen should this agreement process fail to take place, is found where data has been incorrectly built on exchanges, such that it deviates from the agreed message/response format. In the worst case, this could cause interconnecting exchanges to go into congestion and eventually cease to convey any calls.

The second area of NICC discussion, is the specification of standards interconnection for services deemed as Supplementary Services Business (SSB). In this case (as has previously been discussed) the service is not considered integral to a network and thus should be able to be offered by any Service Provider. An example of this is a message service, allowing callers to leave a message when the person they are calling is unavailable. Initially this capability was offered by an answer-phone, a piece of Customer Premise Equipment (CPE)

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[30] The NICC is the body charged by OFTEL to consider issues of interconnect. It takes its guidance from ETSI or ITU-T standards, where they exist, or else defines specifications to fulfil local needs.

[31] Such discussions also cover the use of the standard in the interconnect of UK Operators with European and Overseas Operators.

[32] New standards do not necessarily offer unqualified advantages over those they replace. For instance, 'ISUP' offers a greater 'payload'(more information in a single message) reducing the number of network messages needed for an application. However some existing services using 'TUP NEED', messages not supported by ISUP, would need to be redesigned if ISUP were employed.

that plugged into a telephone socket. As CPE it was deemed network independent. BT developed a network-based call answering service (Call Minder), which by competing with answer-phone CPE was deemed to be SSB. Thus BT was obliged to provide an interface that allowed BT's competitors to purchase the service and offer their customers the same facilities[34]. The NICC examines the interface standards of such SSB products to ensure the specification is understood and that it is not specified in such a way as to disadvantage competitors from purchasing and reselling the service to their own customers. Often such interfaces (although based upon international standards) are heavily UK focussed, the NICC developing the interface standard without formally considering the European view. However participants who contribute to both NICC and ETSI standardisation discussions provide an unofficial link between both bodies. There is a strong case to be made that network inter-working should be considered at a European level to create a useful pan-European network, rather than the independent arrangements currently evolving as a result of the global communications companies (MCI WorldCom etc.) and their alliances (PNE 1996d).

The role of the NICC is therefore to discuss and reach agreement upon the specification of interconnection standards. Such agreements are recommended to OFTEL for formal ratification. In the case of general interconnection standards they are adopted as the UK variant, which should be used if UK Operators adopt that standard (e.g. UK ISUP). In the case of the interfaces used for an SSB product, OFTEL (through powers identified in the 1991 White Paper (DTI 1991)) could ask the telecommunications Operator proposing the product, to implement that interface, the alternative being that OFTEL would not sanction the product. The actions of OFTEL, by referring standardisation discussions to the NICC, have acknowledged that a Regulator is not an appropriate body to handle technical interconnection issues; rather it is a process requiring specialist knowledge and skills. However, it does highlight the value of a standardisation process in support of regulations.

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[33] For instance, the response to a congestion message may be any of the following three options: stop sending a particular type of traffic to an OLO network; stop all traffic to the OLOs network; or take the interconnecting route the message was received on 'out of service'.

[34] Australia has a similar approach to allowing interconnection at certain interfaces. However the criteria for allowing interconnection is not if a service is classified as equivalent to the UK SSB categorisation, but if the interface is declared uneconomic to duplicate. This 'Declaration' of interfaces was introduced by the Australian 1997 Telecommunications law and allows Service Providers to purchase and resell Operator network capability.

The Service Providers in the UK usually operate by having their own equipment and if appropriate to the product, will tandem calls. They are typically restricted (initially by regulation and latterly by the Operator) to a 'customer type interface' (e.g. ISDN). Customer type interfaces have reduced capability, but are regarded as 'safer' by Operators in that inappropriate messages are not likely to cause network problems as is possible with C7. OFTEL has not made the availability of C7 or IN interconnection compulsory for Service Provider interconnection, except where they are used for SSB products and then only for that product's use[35]. Products are designed very carefully so that they use such interfaces minimally, since the extra cost, policing messages on the interfaces, could make a new product uneconomic (Shepherd 2002).

Service Providers in the USA often own their own exchanges for terminating and routeing calls, which allows them to develop and offer their own services. Since it is easy to route a call to separate equipment, act upon the information accompanying the call (e.g. dialled number, CLI etc.), then route the call onwards using standard network interconnection at the transport level (e.g. SS7), the need for open Intelligent Network interfaces was reduced. However, operating in such a manner was less efficient than the same service where no link-through was required (OFTEL 1996b sect.2.1). Thus the FCC later revised its position and under the US 1996 Telecommunications Act Operators were required to open different Intelligent Network interfaces via a Mediated Access Function (FCC 1996). One of the roles of the Mediated Access Function is to protect network integrity, a key concern discussed in Chapter 6.

A new EU 'Access and Interconnection Directive' passed in 2002 (to be implemented mid 2003), formally identifies the role and scope that a regulator may play in achieving interconnection between two parties. It restricts the regulator from imposing interconnection (and hence the need to specify interfaces and functionality), to only those Operators deemed to have 'Significant Market Share', this term itself being defined in the 'Frameworks Directive' approved at the same time (OFTEL 2002). This is not expected to significantly change the way technical interface regulation is currently approached or implemented.

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[35] A C7 interface has never been used for an SSB product.

An alternative approach to the regulation of interconnect is that which is applied in Australia, arguably the first country to complete the transition from privatisation and liberalisation (using a regulator), through to a self-regulated market (using general competition laws). The Australian 1997 Telecommunications Act scrapped the regulatory authority (Austel) and added telecommunications responsibility to the remits of the Australian Communications Authority (ACA), responsible for technical standards, and the Australian Consumer and Competition Commission (ACCC), which oversees competition. The result was that the Operators themselves formed a body called the Australian Carrier Industry Forum (ACIF) in an attempt to apply internal industry controls, particularly in the area of interconnection standards. The ACA only get involved when the industry is unable to reach internal agreement. This experience questions the need for a state sponsored standardisation body, indicating that industry can be self-regulating in the production of standards.

An unusual consequence of Australia's approach of using a general competition authority to oversee fair competition, was that the Australian Telecommunications Users Group (ATUG) industry association took a leading role in spotlighting industry issues. They particularly focussed attention on Service Provider issues and those of new entrants competing with the incumbent Operator (Telstra) (Dimasi 1998).

A third approach to the regulation of interconnection is that which is applied in New Zealand from when it liberalised the telecommunications service industry in 1991. Here there is negligible regulation of the interconnection of networks and transparent inter-working of services across networks and is arrived at by joint agreement between the parties. This strategy is sometimes referred to as the minimalist approach to regulation (EIU 1995). The disadvantage is that any major disagreements that arise must be referred to the courts. 'Getting entangled in court is one of the main brakes to liberalisation' (Cockborne 1995), resulting in costly and lengthy disputes (EIU 1995, Williamson 1996). Thus a body with no expertise in the telecommunications area, the judiciary, shapes the direction of telecommunications through the judgements it makes, or as one industry player mused 'In New Zealand the courts take four years to get the wrong answers' (EIU 1996 p40).

Whatever the attributed shortcomings of the UK regulatory system and whatever criticism is levelled at OFTEL, it appears to have introduced competition into the UK service segments quicker and more efficiently than in New Zealand, thus helping to justify the need for regulators (albeit in the initial stages). This is further evidenced by the actions of Sweden, which introduced a regulator 10 years after the introduction of competition (EIU 1995). However having a regulator does not automatically mean that a successful competitive environment will automatically follow:

> 'The art of the regulator is knowing not only when to intervene in the market, but also when to leave it to its own devices' (PNE 1997b).

5.7 Telecommunication Regulation from the European Union Perspective

Telecommunications policy and regulation is now a European issue. The Articles of the Treaty of Rome (1957) identified and agreed the key aims of the founding Member States of the European Economic Community (now known as the European Union (EU)). Although the Articles did not specifically identify objectives for the Telecommunications Sector, a number of Articles have proved applicable. For example:

- Article 86 addressed fair competition and formed the basis for allowing competition between Member States in the telecommunications environment.
- Article 90 applied the competition rules (article 86) to companies or organisations having a dominant market share or enjoying a monopoly. This was a key consideration in how incumbent Operators were treated in the lead-up to the 1998 liberalised telecommunications market.
- Article 100 allowed free trade in products and services between Member States.

Supporting the above were Articles 30 and 59, which outlined the action that could be taken against Member States that did not adhere to the EU legislation.

Other articles, such as Articles 128 and 130, allowed community funding for technical research and development, since '...technical progress makes new services possible' (Ungerer 1990 p198). The results of such research have often provided the basis for developing technical specifications that encouraged European standardisation. An example was the Research and Development in Advanced Communications Technologies in Europe

(RACE) programme, which developed a pan-European specification for Broadband ISDN (B-ISDN) and was also involved in the agreement of air frequencies used for the Universal Mobile Telephony System (UMTS), the third generation mobile technology.

This section discusses how the European Union Commission, based upon the remit of the Articles of the Treaty of Rome, has developed and implemented legislation within the telecommunications sector.

The Role of EU Regulation in Telecommunications

By the end of the 1970s basic telephony services in the EU Member States were nearing saturation and growth was reaching a plateau. Operators looking for new growth opportunities introduced mobile and Value Added Services. The EU for its part was looking to encourage growth in this area and was encouraged by the introduction of computer intelligence within telecommunications as a means of introducing new services, thereby enhancing growth opportunities for the industry (Ungerer 1990). The importance of the development of this sector was increased, when the 1987 Telecommunications Green Paper (EU 1987) suggested that, not regulating the EU telecommunications services market would severely damage the long term economic strength of the Community. Conversely, a strong comprehensive telecommunications sector would contribute significantly to the development of European economic activity and a more effective European free market (Cranston 1991). Furthermore, a comprehensive, liberalised telecommunications infrastructure was essential preparation for the EU's role in developing future trading relationships with the rest of the world and in particular with the World Trade Organisation signatories. To achieve this, Europe needed to ensure it was part of the developing global telecommunications scene, forcing the EU to consider the impact of a regulated telephony environment, both in the context of achieving its aim of systematically removing the trade barriers between Member States and of aiding the economic growth of the EU with respect to the rest of the world (Ungerer 1990). The underlying argument was that successful free-trade required a good telecommunications infrastructure and that a good infrastructure encouraged regional growth (Ungerer 1990). However, for the telecommunication sector services to be optimally priced, so that both the customer and the Operator would benefit, competition was necessary; hence the drive to liberalise (Ungerer 1990). The larger European market might also make services viable that a single national market could not sustain.

In analysing how to achieve this, the European Parliament felt:

> '...that the traditional system of telecom administration regulation which has served well in the past, lacked the flexibility to allow the development of new products and services necessary to keep pace with innovation in this sector' (EU 1984).

The EU Commission considered that re-regulation was needed, which would permit more rapid development of the sector, whilst still providing the necessary consumer safeguards (such as the maintenance of universal service etc.). They had seen how the American and the Pacific Rim markets were developing, following the US (1984) and Japanese (1985) de-regulation of telecommunication. Within Europe there was evidence from the UK, Finland and Sweden of how economies could benefit from a competitive market. However, the Commission discounted the USA model of deregulation, comprising competing long distance and local Operators, suggesting it could not be applied within the EU because of the number of Operators involved.

Thus the Commission authored the 1987 Green Paper (EU 1987), which with hindsight can be identified as the first significant step contributing to the 1998 liberalised telecommunications environment. The paper identified the key requirements for the development of telecommunication sectors:

- an obligation on Operators to interconnect (applying the principles of ONP[36]);
- ceasing cross subsidisation;
- taxing Operators rather than transferring excess budget to government;
- providing telecommunication networks to standards that create and maintain community-wide operability
  (Ungerer 1990).

In considering how to implement these requirements for a liberalised market, the Commission recognised that telecommunication regulatory harmonisation in the EU needed to occur simultaneously for all Member States. Any alternative would result in the

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[36] ONP is the EU's regulatory regime defining that standardised interfaces and charging should be applied on an equal basis to the service arm of a monopoly provider and its competitors (YG 1995 pES7).

development of a multi-stage system[37], that would create an information gap, resulting in economic and hence social disparity. However, most Member States still had a state owned dominant Operator, associated with which were a number of issues that needed to be addressed, before any liberalisation legislation would be effective (Ungerer 1990). These issues included:

- the political attitude of the Member State government;
- the degree of control exercised over the existing telecommunications Operators (particularly where the incumbent was government supported) (PNE 1996a);
- the pressure applied to the government for change by the telecommunications Operators, users and the EU/other Member States;
- the support of the trades-unions towards the changing position of government employed employees (as was demonstrated in Eire, France and Germany) (EIU 1995);
- the quality of service provision by the new telecommunications Operators (Cranston 1991).

Recognising these issues the EU adopted the approach of applying legislation at the European level, thereby forcing the Member States to take appropriate action at the national level (ET 1994).

> 'National systems are locked by rigidities which have evolved from different cultures, public beliefs and ideological positions born out of a variety of historical influences. National politicians obviously have to answer these local pressures... The EU then has a clear cut responsibility to introduce new ideas to meet the wider goals, sometimes even imposing decisions which would not be possible in national circumstances' (Bangemann 1995 pps. 6-7)

During the lead-up to liberalisation, the EU faced the fundamental problem of how to alter the mindset of Member States to reflect a European position in a global market, rather than a nationalist view in a European market (Bangemann 1995). A number of large companies held similar views (EIU 1995). For example:

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[37] Multi-stage in that different Member States liberalising at different points in time, would embrace telecommunication sector development at different times. Those developing later would always be struggling to catch-up and by never catching-up would minimally benefit from the economic betterment such action was calculated to bring.

> 'Government can and must, take a global view of regulation and standards...I know this carries the hard and unpopular message that national and regional interests must be subordinate to a global view. But telecommunications is not a respecter of national boundaries' (Vallance 1995 p17)

These conflicts of multi-national companies and EU commission views, versus the nationalist views of an EU Member State, occasionally led to open disagreement. An example of such a conflict in another sector occurred with a 1995 German decision not to allow the merger between the Lufthansa and Interflug airlines. This was overruled by the EU Commission on the basis that:

> 'If Germany is treated as a relevant market, then the *(German)* decision was logical as Lufthansa is number one in Germany. However, if you use the global market as the relevant unit, which is the correct one for airlines, then you would come to other conclusions' (Bangemann 1995 p9)

Another area where the EU Commission stepped in was where it passed legislation that made users subject to Member State Value Added Tax (VAT) on the telecommunication services they used, wherever they were sourced in the world. Prior to this, EU-sourced services were subject to VAT, whilst those sourced outside were VAT exempt, encouraging multi-national companies to employ non-EU telecommunication services (Skeldon 1997).

As EU telecommunications services liberalisation approached, Member States that had experienced restructuring delays owing to Trade Union action and legislative processes, sought to extend their 1998 liberalisation deadline[38]. In some cases (e.g. Eire) the EU Commission withheld joint-venture approvals involving that Member State's Operator, unless the liberalisation date was brought forward once again (PNE 1996e). Regional administrations in some Member States similarly put pressure upon their governments to liberalise early. The Flemish region of Belgium, Catalonia in Spain, Frankfurt in Germany and areas of France, all encouraged telecommunications competition in their regions, well before their national governments had established a suitable structure for such changes (EIU 1995). Subjected to internal and external pressure for change, some governments were compelled to retract their requests for exemptions to the 1998 liberalisation deadline (PNE 1996b, PNE 1996c, Maloney 1996).

Whilst managing this situation, the EU had begun to adopt an international regulatory role by way of seeking reciprocal agreements for the granting of telecommunication licences. For example, the Unisource consortium (which includes the Swiss PTT) was cleared only after Switzerland[39] (a non-EU member) agreed to open up their Telecommunications infrastructure to competition and the Member States of the other consortium members (Italy, Spain and the Netherlands) committed to introducing network infrastructure competition early[40] (PNE 1996i). Similar agreements were sought from Norway (re. the TelNor consortium), Germany (re. the Global 1 consortium), Spain (re. the UniSource consortium) and the USA (re. the UniWorld consortium) to open infrastructure (ET 1996, Communicate 1996, PNE 1996a, PNE 1996b, Cromer 1996). i.e.

> '...national operators joining global alliances as full partners or as distributors will find themselves having to think more globally' (PNE 1996d).

The FCC in the USA took an identical approach by withholding approval of EU Operators' joint ventures with US Operators, unless the appropriate Member States opened their network infrastructure to other (competing) US Operators[41] (EIU 1995).

In this way the EU has been using commercial alliances as a mechanism for formally opening non-EU geographical areas to competition. One consequence of this approach is that negotiations between EU and non-EU countries are changing to being between the EU Commission and the non-EU country. For instance, it may become inappropriate for the UK to negotiate certain levels/types of telecommunications interconnect to the USA; rather such agreements become the province of the EU Commission and are applicable to all EU

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[38] Originally (November 1994), Belgium & Luxembourg were allowed to extend their liberalisation date to 2000 and Greece, Eire, Portugal & Spain to 2003 (EIU 1995)

[39] Some Non-EU countries (e.g. Norway, Switzerland etc.), have an agreement with the European Free Trade Association, covering one or more trading sectors such as telecommunications. These countries are allowed to trade with the EU in that sector as though they were a member, provided they adhere to that sector's EU regulations and hence allow reciprocal competition from EU members. Although they are allowed to observe, they do not have the right to participate in EU policy discussions (CI 1996b). It is unclear if the EU has a right to intervene in an interconnect agreement between one of these countries and a non EU Member State.

[40] An EIU (1995) survey reported that more than half of the telecommunications industry professionals responding felt the 1998 liberalisation date should be advanced.

Member States, or not at all. Examples of this approach, such as the Commission's guidance to Belgium, Spain, Italy, Greece and Portugal at the 1996 WTO talks, not to improve their offers on opening their countries to foreign Operators, until the offers made by other non-EU Member States were improved, have already been observed for some time (AFR 1996).

Liberalisation saw a new set of problems arise, especially those associated with licensing. Member States imposed different conditions in the awarding and operation of a Telecommunications Operator's licence. In the Netherlands for instance, Operators did not require a licence. Interconnection similarly brought about its own set of inconsistencies. For example, in the early days of liberalisation France, Germany, Italy and Spain supported their monopoly Operator's stance of insisting that interconnection only be permitted if a large number of interconnect points were available, effectively preventing small companies from getting established (Nye 1998). Charges for interconnected calls also raised concern, with the European Commission investigating a number of Member State Operators who appeared to be making excessive charges for forwarding calls to other European Telecommunications Operators (PNE 1998a).

Peter Sadler of the European Commission recognised these potential problems in 1996, highlighting licensing and interconnection as the key areas requiring consistent implementation and consideration/consultation for 1998 deregulation and beyond. Furthermore, he argued that common implementation should consider and allow for those Member States who were at different stages in the liberalisation process (Stephen 1996). As a result, DG X111 was asked in 1998

> '...to explore the value-added effect of a European regulatory authority and ... to evaluate the effectiveness of such a proposal' (Cockborne 1998),

The work was undertaken as part of the EC's review of the effectiveness of telecommunications regulation in 1999.

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[41] A reciprocity clause in the 1996 US telecommunications law indicates that other countries should provide similar access to US companies as is provided to those countrys' Operators in America (Shankar 1996, Hellerstein 1996).

It was this non-uniformity of liberalisation among EU Member States that resulted in some Operators lobbying the EU commission, to try to secure a commitment from the Member State governments to a pan-European regulator or arbitrator (Molony 1996a, PNE 1996, PNE 1996f, Warwick1996). Such a regulator was supported by both Martin Bangemann (then EU Commissioner for Industry) and Edith Cresson (then European commissioner responsible for science and research, training and competitiveness) (EIU 1995). In Bangemann's case he felt an EU regulator was essential to deal with the convergence of communications and computing technologies (ET 1997).

However despite the need to co-ordinate the implementation of regulation across Member States, the remit of any European regulatory body would have had to be balanced against the role Member States considered subject to national sovereignty. Schier (1998), in highlighting that the role of an EU regulator would be similar to the FCC in the USA, also indicated that the Member States were opposed to such a body. Cockborne (1998) similarly reported that there was reluctance on the part of Member States to recognise the need for such an EU body and Doyle et al. (1998) believed that politics should be kept out of telecommunications regulation. Doyle proposed instead that regulatory enforcement should remain at the Member State level, but that the relationship between the National Regulatory Authorities (NRAs) and the European Commission's competition (DG XIII) and telecommunications directorates (DG-IV), should be strengthened. The argument being that the key functions of an EU regulatory authority already existed in that:

a) the commission by now represented EU telecommunications interests on an international scale;
b) they looked for unfair trading practices between Operators, as in interconnect pricing investigations; and
c) the EU Court of Justice was able to apply competition law.

The EU achieved a liberalised EU telecommunications environment in 1998, by adopting and producing European-wide standards and policies in mutual support of legislation, which progressively forced the Member States to adopt those policies and standards. This resulted in:

- Member State Regulators comprising a separate body to the dominant Member State Operator (a 1987 Green paper recommendation (EU 1987))[42];
- The sale of legacy telecommunications companies in government ownership;
- The necessity for Government owned Operators to be treated in the same way as independently owned competitors. Thus governments were no longer able to add money or take profits from them (a traditional source of income), being restricted to general taxation. There was therefore no advantage for the legacy Operator to remain in state ownership. An additional factor was that government responsibility for the regulator and government ownership of the legacy Operator could be argued not to fulfil the liberalisation obligation to separate the two functions[43];
- The prohibition of bespoke standards unless exempted by the regulator. (In the UK this is achieved through the operation of the NICC, sponsored by OFTEL);
- The monitoring of value added services to ensure that income covers operation.

This was a significant achievement, given the general resistance to change by the EU Member States and the fact that many companies felt the EU regulations would have a marginal effect on their ability to make better use of telecommunications (EIU 1995).

The interpretation and implementation of European telecommunications policy however, rested almost entirely on individual Member State regulators. The consequence was a maze of national interpretation and implementations that complicated and slowed the liberalisation process.

EU Telecommunications Law/Policy Process

EU legislation takes the form of ‘directives’, ‘decisions’ or ‘recommendations’. A ‘directive’ is mandatory for all Member States and the Member States typically amend their national legislation to align with the directive. A ‘decision’ deals with administrative

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[42] With both the telecommunications operations and regulation frequently being part of a country’s civil service, this goal could only be achieved through the privatisation of the monopoly telecommunications Operator.

[43] Although the European Commission is prevented from interfering in matters of Member Sate ownership of companies (EIU 1995 p81), its actions in the 1998 liberalisation of the telecommunications service sector appears to have had a common affect of relinquishment of total Member State ownership of telecommunications Operators.

matters and is similarly binding on Member States. A 'recommendation' is a proposal that Member States can adopt, or not, as they see fit (Ungerer 1990).

The Processes for producing EU telecommunications legislation are illustrated in Figure 5.10.

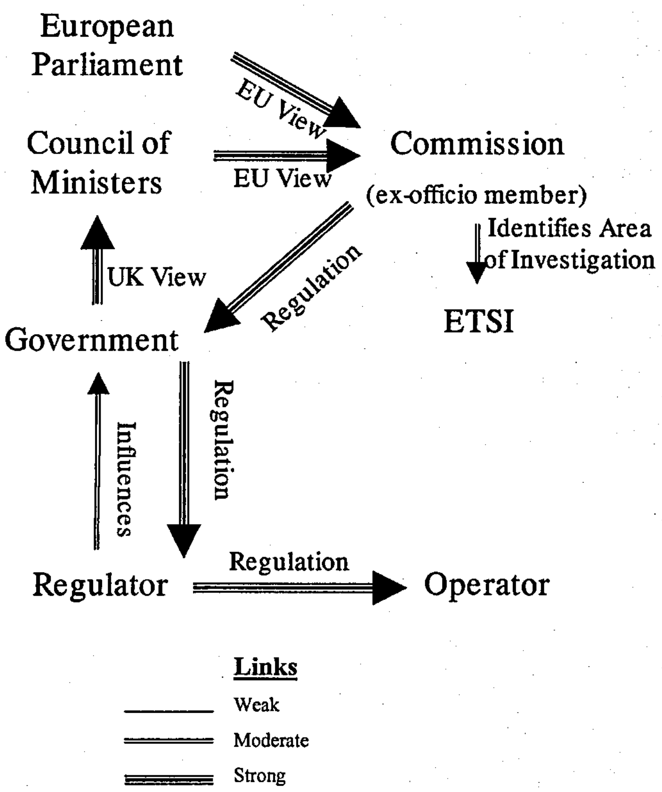

Figure 5.10 The European Telecommunications Regulatory System

The legislative process is an iterative one with information passing back and forth between the interested groups at each stage, although the following description implies a principally uni-directional flow. Legislation can be passed in one of two ways.

The first is the 'co-decision' procedure introduced by the 1991 Maastricht Treaty. Typically (but not always) this would be initiated and agreed in outline by the Member State governments at the Council of Ministers or by the European Parliament. It is then passed to the Commission and investigated. Evidence is drawn from Member State regulators and if necessary the ETSI standardisation body, allowing refinement of the proposed legislation. The Commission draws up the detailed legislation and submits the proposal to the European Parliament. The Parliament may ask for alterations, but once it has approved it, it is submitted to the Council for its approval, which may go through a similar refinement process. When both the Parliament and Council are in agreement, the legislation is passed. Parliament however, has a power of veto. This veto was used in July 1994 by the Parliament to block the adoption of a proposed directive applying the rules of Open Network Provision to voice telephony services (EIU 1995).

The second way of introducing legislation is by the Commission and although undesirable, can be done without the need to consult the Council of Ministers or the European Parliament. An example of this in the telecommunications sector is the 1990 directive that introduced competition to the telecommunications services market. This was the first legislative step by the EU of its liberalisation programme and was adopted by the Commission on the basis of aligning the operation of this market with Article 90 of the Treaty of Rome. This unilateral decision by the Commission was legally binding on the Member States.

Once the legislation is passed and enshrined in EU law, it is implemented by the national governments, applied to the Operators, and policed/enforced by the national regulators.

A directive becoming law does not oblige Member States to enshrine it in their legislation. However, if Member States do not adhere to the directive, the EU Commission has authority in the form of the European Court (Braun 1990). Competition commissioner Karel van Miert made threats in the early days of EU liberalisation, to invoke Article 90, when Member States could not agree on a date for telecommunications liberalisation (eventually set as 1998) (ET 1994). Similarly the European Commission threatened fines if liberalisation was not enacted on time (PNE 1996h). Come November 1998 the EU were still threatening proceedings. In fact history has shown that prosecutions only occur many years after legislative enactment, such as for the EU clean water directive (Cromer 1998). Thus the EU Commission appears reluctant to take immediate action, particularly if a number of Member States are slow in adopting a directive;

> 'Even within Europe, we have seen the ability of national governments to frustrate the intentions of the very directives to which they subscribed in Brussels. For instance three years into the regime defined by the Telecommunications Services Directive, only four countries out of twelve had implemented the prescribed

> rules...we do need the Commission's Competition Directorate (DGIV), to be given teeth' (Vallance 1995 p18).

Since Regulation of the liberalised telecommunications sector resided with Member States, the EU commission tried to remove bias from the regulatory process by separating the operational and regulatory functions of telecommunications within Member States. This reduced the chance of a legacy Operator (traditionally under state control) manipulating local telecommunication market terms and conditions, or influence EU policy via their government.

The EU legislative framework operates a two-stage acceptance process (the European Parliament and Council of Ministers) to pass legislation. A third body is the European Commission, arguably the least connected with individual Member States which is also able to pass legislation. This legislative structure can be assessed in two opposing ways. Firstly, the Commission is the least associated/answerable to Member States[44] and thus is likely to be the most impartial of the three bodies when independently drawing-up legislation. Secondly, by being the least answerable of the three bodies, Commission legislation is less likely to consider the reality of its impact upon individual Member States. The research has identified examples of both viewpoints, although it was not always possible to identify which legislation was drawn-up solely by the Commission and that which had detailed input from the Council of Ministers and European Parliament.

5.8 A Global Perspective - The World Trade Organisation

The arguments made in favour of national (e.g. Member State) and supra-national (e.g. EU) telecommunications liberalisation, apply equally at the global level. The World Trade Organisation (WTO)[45] had as its primary objective the provision of a framework and agreements for unimpeded trade between member nations (over a hundred countries). These agreements included market access (i.e. open markets), national treatment (alien and indigenous companies having the same legal rights) and non-discrimination (indigenous companies not being given preference). The WTO recognised that such free trade applied to, as well as required, a global telecommunications infrastructure for it to be successful.

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[44] The Council of Ministers and European Parliament both comprise of members voted into office by the electorate of their Member States.

Therefore its general agreements of non-discrimination of the previous decade (regarding import/export duties etc.) were applied to the telecommunications sector, to encourage competition, innovation and development.

> 'Even five years ago, a typical ITU person would not have agreed there was a role for the WTO in telecoms...*but*...the new regime has recognised the WTO will have a tremendous impact on ITU members in terms of underlying competition, allowing foreign participation, breaking down barriers and encouraging investment' (Isenberg 1998).

WTO discussions in 1996 centred on a 'General Agreement on Trade in Services', including in the telecommunications arena, value added services and data interchange/processing. Later discussions led to agreements that included basic voice telephony. The implications were that a nation should not favour its indigenous companies over those of another member nation. For example, countries with an Operator having a telecommunications monopoly, should not erect a barrier to prevent companies from other (WTO) member nations from entering the market.

A number of countries and organisations (i.e. the EU, US, Japan, Canada and the ITU) joined forces to push the WTO proposals forward (Stephen 1996, Molony 1998). Some of these (i.e. Japan and the USA) had to revise their existing legislation restricting foreign ownership of companies within their countries, in order to meet the WTO requirements they were promoting (PNE 1997a).

Such agreements have furthered the adoption of international standards[46] for interconnect and potentially the adoption of the European/USA model of demonopolisation of the telecommunications industry to enhance competition. However, an EIU survey of commercial organisations indicated that they did not feel they would benefit from regulations occurring outside their immediate sphere of operation, thus the potential benefit of the WTO agreement was not necessarily perceived by customers (EIU 1995).

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[45] The WTO arose from the General Agreement on Tariffs and Trade (GATT), a dominant post Second World War international trade regime.

[46] Actually upgrading to international standards

To leverage an open telecommunications environment, the WTO threatened/restricted the free trade of goods in other market segments, until acceptable progress was made. This sanction similarly applied to member nations not keeping to the word of the agreement; however detection of such non-agreement appears to be challenging (ET 1997).

Regulation Summary

Regulation exists at a number of levels; internationally through the WTO; at the supra-national level through bodies such as the EU Commission passing legislation and negotiating on behalf of all the Member States; and at the national level through typically National Regulatory Authorities.

This thesis has argued that an effective liberalised telecommunications environment is best achieved through regulation supported by legislative guidelines and that such regulation be the responsibility of a regulator who can provide the flexible interpretation of guidelines necessary for a rapidly changing environment. However, in the EU there are many regulators and thus differing interpretations of the operational framework associated with the EU legislation. This has given rise to new legislation and a revised operational framework to be implemented in mid 2003, which will address a number of these Member State interpretative inconsistencies and normalise them throughout the EU.

A common regulatory tool is the standardisation of interfaces. Regulators at all levels, particularly at the supra-national and national levels, sponsor standardisation bodies to encourage the discussion of standards. Standardisation leads to interoperability of services on different networks, achieving the common regulatory goal of universality of service. However, the application of inappropriate, or overly restrictive, standards could inhibit innovation of products and services and reduce competition.

5.9 The Role of Standardisation in the Delivery of Telecommunication Services?

Standardisation can be defined as 'complying to a recognised form' and is used in all areas of telecommunications technology design. The literature review in Chapter 2 identified that telecommunications standardisation has multiple foci. These included:

- encouraging inter-working and universality of service;
- extending the life of investment through standardisation updates;
- increasing the market available to manufacturers of standardised telecommunications equipment.

This research is particularly interested in the action of standardisation with respect to telecommunication's technological interfaces, especially quotas, timeliness, and co-ordination between standards bodies. This chapter therefore considers these areas, whilst discussing the role and operation of the ITU-T and proprietary standardisation groups and developing standardisation models for the EU and UK.

The definition of standardisation indicates that its role is that of a harmonising tool, comprising the technical process necessary to provide a universal service through the inter-working of products from different manufacturers. In the UK, the importance of standards really developed during the 19th Century Industrial Revolution, particularly with the development of railways. Standards were used to specify the composition of steel used for rail tracks and later to define a common gauge to encourage an inter-connected public railway network.

In telecommunications, standards were similarly used to encourage a fully connected public telephone network. Initially, telephony used different technologies, and the bespoke developments needed to achieve interconnection introduced unnecessary complexity. Telecommunications standards were revised when the telephones division of the British Post Office settled on Strowger technology[47] as the basis of a new automated telephone network. Suppliers were made to pool their Strowger related patents in order to allow them to manufacture a common 'switch' (BT 1993b). A new role for standards was therefore to

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[47] The last operational Strowger Exchanges were removed in 1995, the technology having lasted some 100 years from its invention (BT 2002b)

give Operators purchasing power, since they no longer depended on one Supplier for a particular type of equipment, but had flexibility of choice. New equipment designed to such a standard could be purchased by competitive tender, minimising the price paid.

Non UK Operators saw the benefits of standards, and set their own standards, or adopted existing standards such as those established by the British Post Office Telecommunications Division. It was still common, up until the late 1980s, to see overseas Operators specify that their network equipment should have BT DASS2 interfaces or adhere to BT C7 NUP (Shepherd 1987)[48]. Historically then, it has been monopoly Operators who have set the pace of change and innovation, their standards becoming de facto standards for the industry.

Telecommunication services were provided by monopolies. There was no urgency to modernise or develop systems, and benefits could be gained by waiting for standards to mature before implementation. Suppliers saw the standardised development of their equipment as a benefit to help sell their products and benefit from a larger market (Pandurangan 1993). Indeed, it became a commercial necessity for less influential Suppliers to ensure their equipment adhered to standards and that it could work with that of the market leaders.

The benefits of standardisation have encouraged the formation of special interest groups, typically comprising a mixture of Operators and Suppliers[49] and it is within these groups that standards are currently created,[50] either within standardisation organisations or by small, self-developing technological interest groups. Standards are therefore continually arising and developing, the more significant ones evolving to improve their content with a view to making the associated technology more efficient and versatile. Hawkins (1995b) and Tassey (1991) view this role of standards as acting to define

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[48] Such action unconsciously increased the potential for the global interconnection of telecommunication networks and equipment, thus further encouraging the global adoption of these defacto standards.

[49] Suppliers knew that to develop standards and equipment in isolation might not gain sufficient market interest to be successful. This was demonstrated by IBM in the early 1980s where their personal computer architecture was available to be copied and 'clones' encouraged market development. In the late 1980s they introduced their Systems Network Architecture (SNA) which being initially closed and despite being later opened by EU action did not attract 'clones' and the concept died (Ungerer 1990 p170).

[50] An exception is perhaps the Internet Engineering Task Force (IETF) group, where standards development can comprise an individual's suggestions which after appropriate public critique may be accepted. This less regulatory regime has led to the development and formal acceptance of some 'joke' specifications.

> '...the benchmark below which the parallel development of technology is perceived to be inefficient and/or technology-based competition is perceived to be redundant' (Hawkins 1995a).

There are a number of key standardisation organisations that form a hierarchical structure embracing national, regional and global standards. At the bottom of the hierarchy sit the national and technological bodies such as the NICC in the UK or the Parlay Consortium, whose members typically contribute to supra-national regional bodies such as ETSI in the EU. The supra-national regional bodies in turn, contribute to the International Telecommunications Union - Telecommunications (ITU-T), which sits at the top of the hierarchy and specifies world-wide standards. Typically, subscription to the standardisation process is upwards from the special interest groups and national bodies into ETSI and from ETSI into the ITU-T. Standards adoption is downward, with the ITU-T standards being adapted by ETSI for the EU region and hence adapted by the NICC for the UK.

The EU has recognised the importance of harmonised standards in providing end-to-end network and service connectivity. Without harmonisation a barrier exists in the provision of international telecommunications, limiting the growth of international trade and business and/or increasing the cost of operations in international markets (Pandurangan 1993).

This importance of standards makes standardisation a potential tool for regulation. The following sections examine the operation, role, and interrelationship of the standardisation bodies with respect to the standardisation process, and as a consequence identify how the established framework of operation can aid or hinder the application of regulation.

The UK Standardisation Model

UK governments have consistently strived for universal telecommunications service, employing tools such as nationalisation and licensing to achieve it. These actions allowed the provision of telephony links to costly rural customers, thereby achieving one aim of universal service. Standardisation was seen as a way of encouraging the second aim of universal service, that is, the ability of any user to connect to any other user.

The pattern of UK Telecommunications Regulation has been explained earlier in this chapter. UK Telecommunications standardisation follows a similar pattern, influenced by the regulatory environment. In 1884, licences to allow the development of national networks, encouraged interconnect between competing Operators and standardisation of that interconnect to offer an any-to-any service. Nationalisation of the trunk network in 1892 took this a stage further. Full nationalisation in 1913 led to greater purchasing power and by the late 1920s the Post Office (who operated the telephony system) had made its Suppliers pool their patents in order to produce a common specification. Equipment could be procured from any of them[51]. This strategy was perhaps last repeated on a large scale with the introduction of System X exchanges in the UK, where the three Suppliers (GEC, STC and Plessey) were each tasked with developing a different part of the design to produce a common standard, which could then could be manufactured by all of them. In the UK's liberalised environment the role of standardisation has now been taken over by the Network Interoperability Consultative Committee (NICC), developing UK specific standards applicable to the UK telecommunications market.

With time the original notions of universal service (any-to-any voice communications) was achieved. However, deregulation of the telecommunications sector has seen the scope of the definition of universal service expand to include feature transparency between networks (e.g. ensuring a 'call back when free' service will operate when the two end points of a telephone call are on different Operators' networks). Standardisation therefore continues to play a role in a deregulated market.

The UK Network Interoperability Consultative Committee (NICC)

The UK government's 1991 White Paper (DTI 1991 Paras. 7-32) identified the need to establish a UK consultative forum. In this forum Operators, Suppliers, and users could address interconnection standards and the related technical issues needed to ensure end-to-end services in a competitive environment, beyond basic telephony. The resulting forum, the Network Interfaces Co-ordination Committee (subsequently renamed the Network Interoperability Consultative Committee), was created and sponsored by OFTEL's Regulatory Policy Directorate, which influenced and specified the standards used in the UK. The NICC recognised that

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[51] Competitive supply reduced costs, making services to remote users more cost effective, thereby aiding the

> 'Public systems must inter-work coherently to provide network services,...*that such inter-working*...requires the use of well defined interfaces...*and that*...such interfaces cannot be defined by any one party in isolation from others' (OFTEL 1993).

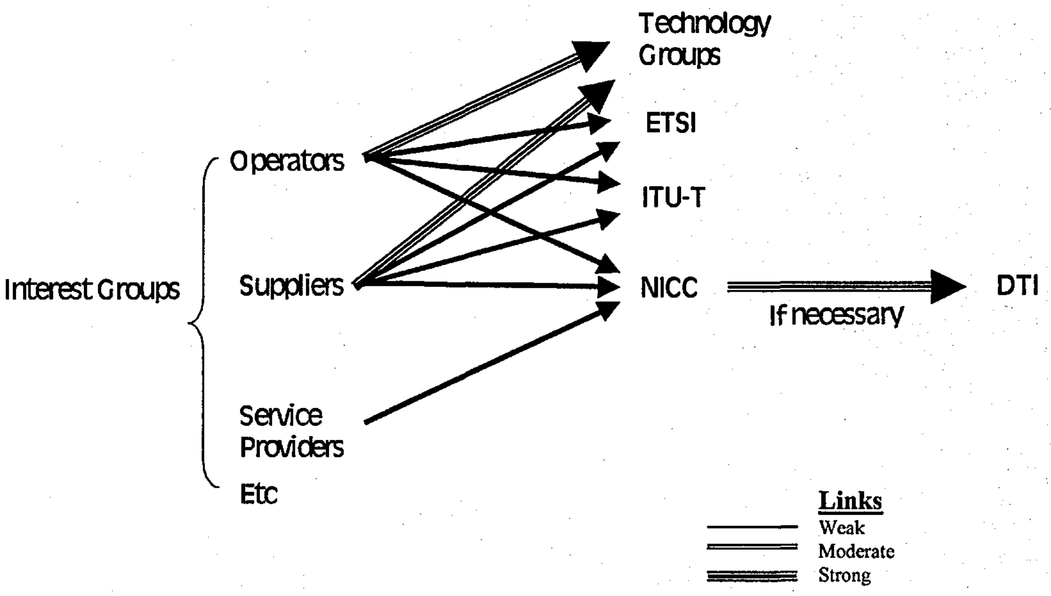

Figure 5.11 The NICC Standardisation Process

The contributors to the NICC standardisation process (Figure 5.11) comprise Operators, Suppliers, representatives of interest groups, and official body liaison members (such as from BSI, BABT, DTI and OFTEL). Many of the NICC members are individually involved in standards definition work in other organisations, including the ITU-T and ETSI, aiding consistency between the standards of different bodies. Although OFTEL does not drive the output of the group, it directs and facilitates its operation, mediating between the different parties and aiming

> '...to reduce technical barriers to the interconnection of different networks and to the interoperability of services on different networks'(OFTEL 1996).

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universal service objective.

The NICC maintains a public register of generally available, established and emerging network interfaces. New standards (such as those needed for SSB products) or variants on international standards (e.g. UK ISUP) are discussed, agreed and formally accepted within NICC task groups. Implementation of NICC agreed standards is voluntary, but OFTEL will take action if a standard they feel should be implemented (such as for an SSB product) is ignored (interview Bowman 2003). Ungerer (1990) referred to EEC directive 83/189 (now superseded by EU directive 98/34) addressing Technical standards and indicating that Members States must inform the EU Commission of the technical specifications they intend to introduce. This allowed the Commission the opportunity to block standards not considered to be in the best interests of the EU. However this only applied to

> '...technical regulations and standards called up by such regulations. NICC outputs are not in themselves regulations, neither are they mandated by regulations...the procedures set out in 98/34 therefore do not apply'[52] (interview Bowman 2003).

This indicates a lack of formal co-ordination among the Member States for such standards. If each State develops its own detailed standards in isolation, this hinders the goal of inter-operation among Operators and Service Providers in different Member States.

Of particular relevance to this research has been the work of one NICC task group, which since 1993 has been responsible for discussing:

> 'Intelligent networking interfaces for connection of service switching, service control and data base interrogation functions' (OFTEL 1993 standards p5).

However, nothing of significance appears to have emerged from this task group regarding the development of IN standards (interview Newman 1997).

The EU Standardisation Model

National Operators have always tended to focus on their own individual needs, considering interoperability only if it appears in their interests. Standardisation not only encourages the interoperability of telecommunication services between networks, but also reduces fixed costs owing to the minimal level of customisation needed (Ungerer 1990).

From an EU perspective, standardisation encourages the interoperability of intra-state telecommunication services. Operators in different Member States are then better able to interconnect their networks, potentially allowing more complex end-to-end services between and across the different networks. This helps the telecommunications sector play its part in the economic growth of the EU. The EU's aim therefore has been to try and ensure that technology has an EU sanctioned standard, facilitating the development and adoption of those standards where it thinks appropriate. Examples of its work are GSM and Broadband ISDN. However, total harmonisation of networks to new standards is generally slow, since Operators are reluctant to upgrade networks without incentives, financial or otherwise (Ungerer 1990).

A related consideration recognised by the EU (EEC 1983) was that standards could be inflexible and stifle innovation:

> 'Politicians should not seek to impose standards on technological developments. Instead we should aim to promote an undertaking about standards among all key players' (Bangemann 1995 p8).

Standards should therefore strive for a compromise between providing sufficient structure to facilitate interoperability, whilst avoiding the rigidity of overly detailed technical implementation, that might hinder the development of an Operator's network.

Notwithstanding these concerns, there are benefits from a standard being under the control of a recognised standardisation body with well-defined links to other standardisation bodies and stakeholders. These benefits include standards being 'open', internationally recognised, and having a structured change control mechanism. Another concern is that industry might not deliver the appropriate standards in a timely fashion to support the developing regulatory objectives. In recognising these points, the EU reviewed and revised the number of standardisation organisations and in 1988 created the European Telecommunication Standards Institute (ETSI). Prior to this date all European telecommunication standardisation was undertaken by the Conférence Européenne des Administrations des Postes et des Télécommunications (CEPT) (Ungerer 1990).

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[52] Standards in the UK which would apply are those designated a 'British Standard'; these needing to be

The telecommunications standardisation system in Europe is therefore centred on ETSI. The EU Commission has attempted, through ETSI, to bring co-ordination to the activities of the many standardisation organisations existing at national, regional, and international levels, and within the telecommunications industry. It has now established a well-defined association (ETSI) and is hence able to interact with and influence its focus.

ETSI is funded by the EU under the Treaty of Rome Articles 128 and 130, which allows community funding for technical research and development. ETSI defines the common technical standards necessary for the free trade of telecommunications between Member States. In doing this, ETSI not only considers the European prospective, but considers the appropriateness of EU originated services internationally, so as to encourage the competitiveness of the EU Member State Operators in the world market. Input to ETSI discussions can be made directly by any individual who has an interest, the standards being approved by a majority vote, weighted by Member State (Pandurangan 1993)

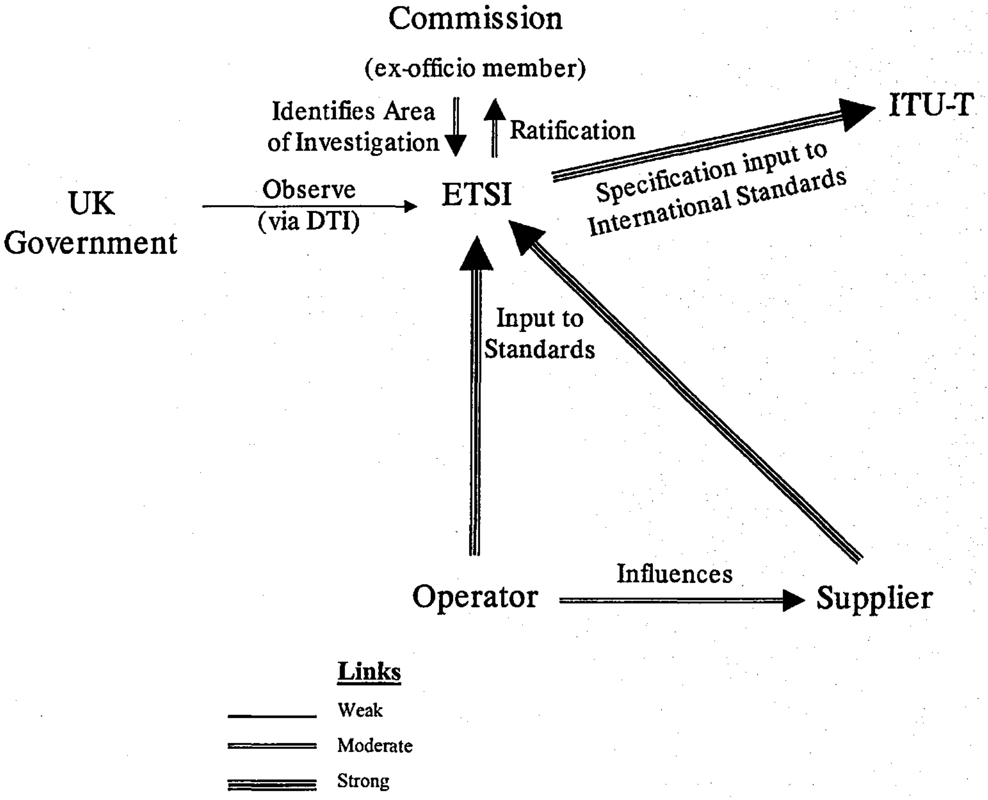

Figure 5.12 The European Telecommunications Standardisation System

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submitted to the EU Commission for their approval.

Figure 5.12 outlines the European Telecommunications Standardisation System. Although ETSI obtains its steer from the EU Commission, it is also influenced by decisions in the ITU-T and the industry in general (in terms of what the Operators and Suppliers are doing). Once topics for discussion, or development, are agreed, they are developed by the members of the appropriate ETSI forums. The members of the forums are drawn principally from European Suppliers and Operators. The resulting standards are passed to the EU Commission for formal ratification and adoption by the standardisation bodies in the EU Member States. If appropriate, the EU 'developed' standards are fed back into the appropriate international standardisation organisation (typically the ITU-T), as the European position and considered for amendment/adoption at this higher level. An example of this in the area of Intelligent Networks (INs) was the definition of a minimum set of IN features for ITU-T Capability Set 1 (CS1).

The standards created by ETSI are taken by the Comité Europêen de coordination des Normes (CEN)[53], which publishes them throughout Europe via European Standards (European Norms (EN)) and harmonisation documents, drawn up in conjunction with the standardisation bodies of the EU Member States (Ungerer 1990).

ETSI thus fulfils an important role as the EU develops the concept of a pan-European Telecommunications network, a role recognised and supported by the Commission.

> 'As interconnection and interoperability rely to a certain extent on the development of the technology and standardisation, we are putting money into that' (Bangemann 1995 p8)

However, the influence of the EU Commission on the standardisation process can be detrimental. Hawkins (1993) reports on the imposition of quotas and resultant unwanted standards. This research has similarly identified an area of standards definition produced with little 'market requirement analysis' in order to meet a deadline (interview Herian 1996). This indicates that not all standards are 'fit for purpose' and although their use has been shown to improve the deployment and inter-working of technology (e.g. GSM), the imposition of flawed standards could have a detrimental effect. This perhaps leads to the OECD (1995) view that the production of specifications is of lesser importance than the

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[53] CEN is effectively the European body covering the subject areas of ISO.

standardisation process itself, comprising '...information exchange between competing firms'.

ETSI does not limit its membership to the Operators, as was the case with its predecessor CEPT, but includes administrations, standardisation bodies, Suppliers and manufacturers, users, etc. (Ungerer 1990). Australia is another member of ETSI, a memorandum of understanding allowing the mutual recognition of standards between the two continents. A key representative is the European Computer Manufacturers Association (ECMA).

The European Computer Manufacturers Association (ECMA) have ITU and ETSI members acting as liaison between the organisations, feeding standards ratified elsewhere (typically de facto), which they feel are sufficiently important for the industry, into the Commission/ETSI for discussion/approval (e.g. the 3GPP specifications). The strength of ECMA lies in the number of members, who through their European subsidiaries are representing global companies and the fact that a linkage is provided between computing and telecommunications standards.

From a telephony service perspective, there is increased blurring of the telecommunications and computer sectors. Initially computers were incorporated into telecommunications equipment (leading to new commercially viable value added features). Now that trend is reversing, as telecommunications are increasingly being offered on computer networks, challenging the whole way telephony is offered to the public (e.g. Microsoft Internet telephony).

A concern for the EU is that standards for computer telephony are a mixture of competing international, de facto and peer (e.g. IETF) standards. If a standard does not appear to do what is wanted, it is changed or an alternative developed. For instance, the ITU-T H323 VoIP standard is being superseded within the industry by SIP, a private collaborative standard that is considered to offer greater flexibility than H323. Thus from an EU standardisation perspective, it is difficult to prescribe which standard should be used for VoIP telephony. The industry is deciding for itself, resulting in various network standards being implemented and consequential reduced inter-working.

The International Telecommunications Union - Telecommunications (ITU-T)

The International Telecommunications Union (ITU) (formally CCITT) tops the standardisation organisation pyramid, addressing global standardisation. One part of the ITU is the ITU-T (the telecommunications part of the ITU). Its role is to encourage international co-operation in order to promote standardisation and arrive at an efficient international telecommunications infrastructure. It produces functional standards, (based upon recommendations produced by the International Standards Organisation (ISO)) which provide a framework for operation, typically indicating how certain (established) applications should be made to work and providing recommendations for others (Ungerer 1990).

The development of ITU-T standards is undertaken by input from the three major regional bodies; the American National Standards Institute (ANSI) covering North America, the Telecommunications Technology Committee (TTC) covering the Pacific Rim and the European Telecommunications Standards Institute (ETSI), all feeding co-ordinated regional positions into the ITU process. Operators, Suppliers and other standardisation organisations also send representatives to contribute to the ITU-T process. These representatives have the opportunity to influence the international standards along the route best suited to their company/organisation. However, they are limited by the stance of the regional organisations and the ultimate sanction by their country's government representative. This national representative is often one of their colleagues, historically and frequently still, drawn from the company of the monopoly Operator.

There is theoretically no direct political impact upon the organisation's standardisation process, with non-technical participants having only observer status. However there has been major criticism of the slow speed of the ITU-T standardisation process and its domination by government (CWI 1998), presumably through a government representative's ability to reject contributions from other nationals.

Standardisation has also taken on a social element, with the role, implementation and impact of standardisation being considered within the ITU. This is the remit of the relatively new ITU-Development (ITU-D) group. The group offers technical and implementation assistance (particularly to developing countries) in the field of telecommunications. It aims to highlight the importance of telecommunications in supporting national economic and social development programmes (reinforcing the capabilities for human resources development) and to provide advice on possible telecommunications structural and policy options that will achieve this. The implications of this new consideration to the ITU remit may be that in future, ITU specifications could be written with a view to actively aiding in some way, the accelerated development of telecommunication services in less advanced countries.

Proprietary Standards

Although standardisation organisations fulfil an important role, they are by no means the only standards generators. Organisations can also get together to develop common standards (e.g. Parlay, SIP etc.) in order to '…ensure that the equipment to be supplied could work together with that of the most influential suppliers' (Durven et al. 1992), gaining Operators purchasing power and Suppliers a larger market. The ultimate hope is that a standard's usefulness and openness will lead to it being generally utilised (known as *de facto*) and eventually adopted by a standardisation organisation.

A similar strategy applies where individual Suppliers produce their own standards. By making the standards open they hope others will adopt them, resulting in greater market penetration of their products. An example of this is Microsoft Windows. By allowing software developers to develop their programs to operate with Windows, Microsoft have little worry of emerging competition, since the same range of applications would not exist for the competitors.

However, where companies have a monopoly in areas of popular, yet closed proprietary (de facto) standards, the EU have demonstrated they will act, as for example when they compelled IBM to open its Systems Network Architecture (SNA) to other manufacturers. (Ungerer 1990)

Standardisation Summary

The process of standardisation is a complex one, with many external pressures influencing the content of particular standards. With some bodies, for example the NICC and ETSI, individuals with proven interests (but not necessarily being commercially connected) are able to contribute. This all leads to unpredictable outcomes that may not be easy to change, but which are beyond the control of regulatory bodies. Thus implementing a regulatory policy that relies on standards as a means to achieve a desired outcome is a questionable strategy.

However, the process of standardisation has been shown to have merit. There are clear benefits for both Operators and Suppliers in terms of competition and market size. There are also benefits from the service perspective (and hence arguably the regulative perspective), since standardisation leads to interoperability of services on different networks. However, the larger the standardisation body the slower the progress made, indicating the need for a flexible structure that provides the ability to progressively adapt to regional, national and thence specific working limitations at the Operator level. Overly detailed standards created by the higher-level standardisation bodies are unlikely to be adopted.

Standards at each level in the standardisation hierarchy (for example, ITU-T, ETSI, NICC) therefore, need to achieve a compromise between providing sufficient structure to facilitate interoperability, whilst avoiding the rigidity of overly detailed descriptions that might hinder technological, and hence Operator product, development.

In conclusion therefore, standardisation appears a most appropriate tool for ensuring the delivery of services using Intelligent Networks; the imposition of standards is not.

5.10 Summary - The Implications for Telecommunications

History has shown that attitudes to, and hence the regulation of, the telecommunications market in the UK have been cyclical as the technology developed. Both Telegraphy and Telephony (which originated from prior applications of theatre transmissions) have followed similar regulatory trajectories (Figures 5.1 & 5.4). As the technology is developed to offer a public service, a free market is created, which is subsequently licensed by the government (arguably to encourage efficiency, quality of service, and universal service). This in turn led to the nationalisation of the companies in support of governance, defence of the country, and again for universal service. In the case of telephony, a retreat occurred when telephony was de-nationalised and reverted to licensing in 1984. Such cycling of regulatory strategies reveals a restrictive set of tools with which to implement telecommunications regulation, these being licensing and nationalisation.

The pattern of innovation, licensing, and nationalisation could perhaps be used to predict the future regulative position for the newer communications technologies. Consider the Internet for example, where numerous court cases in the US against Service Providers (for typically defamatory content) may lead to licensing (in order to improve the quality of service). Terrorist web sites and those inciting civil unrest may be perceived as a national security threat and result in regulations being taken a step further, leading to direct government control in the defence interests of the country.

By contrast, the USA telecommunications market, arguing a case similar to the UK for universal service, evolved into a regulated monopoly. The break-up of this monopoly occurred with the re-introduction of competition in the 1980s. Of particular interest in the USA model is the relationship between the FCC and State regulators, since it provides an insight into the possible future relationship between an EU regulator, should it be developed, and the regulators of the EU Member States.

The EU liberalised the telecommunications sector in 1998, profoundly changing the paradigm of working for Member State's monopoly Operators. Traditional Supplier/Operator relationships were broken. Fearing competition, Operators formed themselves into alliances to strengthen their position, paradoxically hastening the liberalisation process against which they were reacting[54]. Regulation in support of liberalisation was implemented in a variety of ways by the different Member States, leading to benefits for some and disadvantages for others. Although such biases have been reduced since 1998, regulation in the form of new EU directives due to be implemented around the middle of 2003, is designed to further ease and equalise regulation by Member States.

It is also appropriate to consider the role of universal service in the current environment. Historically it was one of the principal arguments for regulation and the EU made explicit reference to it when drawing up its liberalisation legislation. However the scope of its interpretation is expanding. It no longer just aims at a fully interconnected national telecommunications network. It includes supra-national networks, (regions such as Europe) and a world-wide network (through the WTO). It is no longer concerned solely with voice interconnect, but with efficient service and data interworking. Regulation has therefore developed from the national to the regional level and is evolving at the global level.

Regulation

In theory, general (e.g. competition) legislation is applicable to the telecommunications sector, but the resulting litigation tends to slow the development of the sector. More dangerously, it allows parties who may not fully understand the technical considerations (like the judiciary) to determine appropriate action (Williamson 1996). The experience of Sweden and New Zealand, contrast with many other countries who have a specific telecommunications regulator. However Australia and to a lesser extent the EU (from mid 2003), are now tending to follow a less directly regulated regime. The appropriateness of this will be shown in time. Although within the EU there will be an easing of specific regulation and a greater reliance upon general legislation, the Member State regulators will still have a specific role in ensuring that new directives are adhered to.

In the EU, regulation operates at both the competitive (regulatory) level and, arguably, the technical (standards) level, with the two being integrated through DGXIII. The regulatory system (Figure 5.13) links the EU commission with Member State regulators.

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[54] The EU Commission generally withheld approval for joint ventures until the members' countries were liberalised.

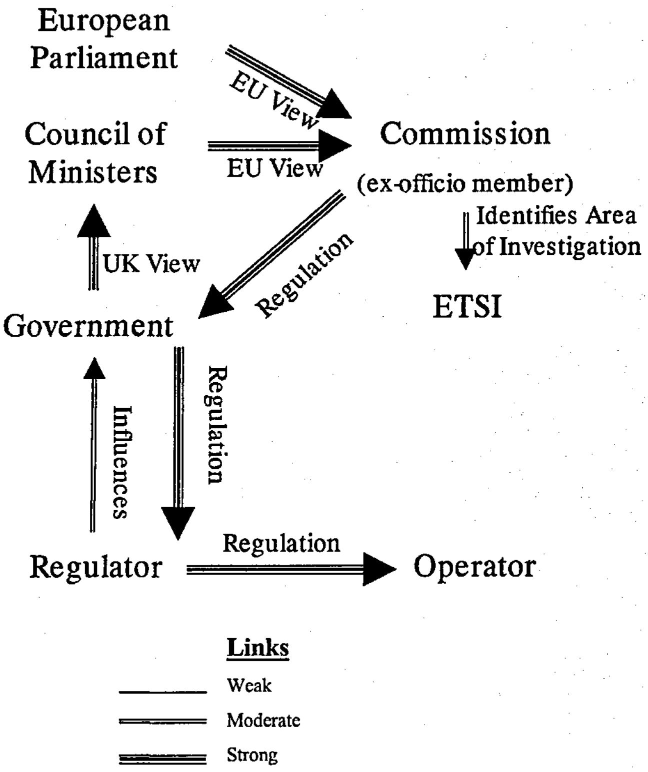

Figure 5.13 The European Telecommunications Regulatory System

One problem experienced by the regulatory system is that the Commission can take unilateral action, independent of the Council of Ministers or European Parliament. An example was that the Commission set the timescale for EU wide implementation of geographical number portability. The UK Operators persuaded OFTEL and the DTI that the timescales proposed were not achievable and suitable DTI representations were made to the EU Commission to extend the timescale. These were turned down. The result was that when the deadline passed for implementation of the service, the DTI (and OFTEL) should have taken action against the UK Operators for a non-compliance with which they sympathised. By not taking action, they were themselves liable to EU penalties. In practice, the delay in implementation was short and no repercussions at EU or national level seem to have occurred.

The application of regulation can be supported by appropriate standards. The danger with this is that the standardisation process can be relatively slow, especially when the technology reaches maturity. In this latter stage the standardisation process attracts many more contributors, increasing the amount of discussion and slowing the decision-making process. Operators that are obliged to adhere to the standards through regulation, could get frustrated by the slow process, which limits the speed at which they can introduce new services.

Standardisation

The Standardisation regulatory system in Europe (Figure 5.14) is centred around ETSI. The EU recognised that a European integrated telecommunications infrastructure was necessary for economic growth. ETSI aided the regulations put in place to achieve that growth, by producing pan-European standards that would be used for telecommunications interconnect by the different Operators, enabling seamless services across Europe.

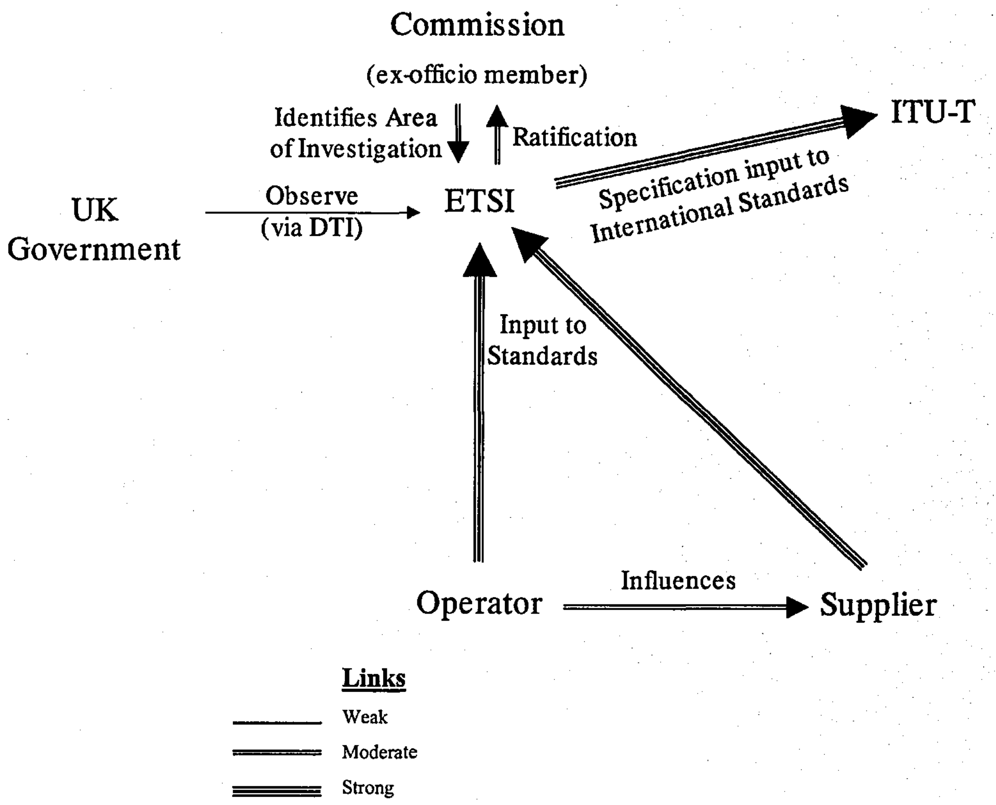

Figure 5.14 The European Telecommunications Standardisation System

The EU Commission therefore directs ETSI to focus on the development of standards in areas that are envisaged as essential to encourage technological development (e.g. GSM), or in support of legislation (such as ONP in support of liberalisation) and for these standards to be produced in a timely manner.

The research for this thesis has shown that the process of standardisation generates discussion among competitors. This process generally achieves a compromise for the standard specification, maximising usefulness, technological benefit and potential adoption. However it has also found that external influences (e.g. time constraints and quotas) can have a detrimental impact upon the content of standards. The impracticality of such 'compromised' standards are not immediately obvious, this only becoming apparent with time, by their lack of adoption. Similarly the usefulness of standards varies with the state of economic development. It is no use developing a network to the latest standard if the economy is such that Operators are unable to recoup their investment. Competing technology will also render the most excellent of standards obsolete, such as has been demonstrated with the IN standards beyond CS2.

Interconnect (and influencing the standards to achieve it) is also a political process and shapes the form of the technology policy and regulation to encourage service interworking and prevent interconnection barriers from arising. The production of Standards requires people with specialist knowledge and skills. The standardisation model has shown that these specialists are drawn principally from the telecommunications Operators and from the Suppliers (whose equipment the Operators will use to offer their services), with the Operators arguably having influence over the Suppliers in the form of purchasing power. Thus the standardisation process can be influenced by the very group of stakeholders (the Operators) to which the legislation is directed.

In summary, standards have been shown to encourage technological evolution and product development, but any forced application of standards, such as in the support of legislation, is fraught with difficulties. Standards compromised by external influences and contributor input, the state of the economy, or supersedence by alternative emerging technologies, would all make standards imposition inappropriate.

This chapter has also addressed two of the questions arising from the Hypothesis stated in Chapter 1.

- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?' and
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'

The answer to the first question is that technical and architectural models, together with the standards into which they are incorporated, are a compromise; they will not be ideal for all stakeholders. Technical architectures will therefore never receive unanimous agreement and owing to rapid changes of the environment, will progressively become less ideal with time. This reveals the necessity to constantly revise and update standards to optimise their appropriateness, ensure their longevity and discourage their supersedence.

Answers to the second question revolve around the necessity of flexibility. Standards need to provide a framework that eases the process of interconnection and interworking, whilst retaining the flexibility required by the individual stakeholders to develop their networks. But standards are a compromise; they are not ideal for everyone. Thus there is a danger that either regulating standards or the enforced implementation of a standard will affect the framework of standards generation (necessary to facilitate regulation) and the role standards take in the interplay of technology. Both of these actions are likely to lead to a sub-optimal outcome. Regulation and detailed standardisation could therefore constrain technical innovation.

This chapter has looked at the evolution of regulation and standardisation policies in regulation. It has discussed how and why the EU encourage standardisation in order to aid the implementation of its regulatory polices. The surveys and interviews have gathered data from the viewpoints of various stakeholders, to assess the perceived impact of imposing Intelligent Network standards as part of interconnect regulation. The original IN architecture models developed for this research (discussed in Chapter 4) are addressed in the next chapter, Chapter 6, which analyses data obtained from the surveys and interviews.

5.11 Chapter 5 References

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6 Stakeholder Attitudes and Concerns

6.1 Introduction

This chapter addresses in particular, four of the questions arising from the hypothesis stated in Chapter 1. It principally uses primary data gathered from the two surveys and interviews undertaken during the course of this research. The specific questions addressed are:

- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'
- 'Is legislative regulation the appropriate means to shape a technology in rapid change?'
- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?'
- 'Do the members of the standardisation bodies (often the employees of the incumbent monopolies) subvert the goals of the regulators?'

These questions are addressed in sections 6.4 to 6.9 of this chapter, but prior to any analysis it is worthwhile summarising the perceived stakeholder positions in order to understand some of the survey trends.

6.2 Stakeholder Viewpoints

The Participant Analysis Matrix discussed and developed in Chapter 3 as part of the research design, revealed a relationship between the stakeholders which has been considered in analysing the survey responses. This is summarised in Table 6.1, which has been reproduced (in part) from Chapter 3, where the relationships are explained in greater detail.

Matrix	EU	DTI OFTEL	Switch Suppliers	Computer Suppliers	Operator	Service Providers	Standards Bodies	Consultant
DTI/OFTEL	+-							
Switch Suppliers	-	-						
Computer Suppliers	++	++	-					
Operator	+-	+-	-	++				
Service Providers	+	+	-	+				
Standards Bodies								
Consultant								
TMA/TUA/ User	++	++			+	+		

+ Complementary aim between stakeholders
- Conflicting aim between stakeholders

Table 6.1 Participant Analysis Matrix

The table identifies perceived complementary and conflicting aims between the different stakeholder groups and was used in conjunction with the data analysis to confirm the preliminary findings or explore variances.

This section therefore considers the perceived position of the surveyed stakeholders (Suppliers, Operators and Service Providers), along with others not surveyed (UK & EU regulators and the WTO), in order to set the scene for data analysis. Three of the stakeholder groups in Table 6.1 (the Standards Bodies, Consultants and Users) have not been discussed, since their position was not directly affected by the analysis.

Supplier Perspective

Switch Suppliers originally did not want open standards, since closed proprietary standards were more likely to constrain an Operator to using its own equipment (Shepherd 1999a). Once the equipment was purchased and operational, the 'entry threshold cost' for an Operator changing its Supplier was much higher (owing to evaluation and inter-working development). It was generally more economic for the Operator to purchase more of the same, than diversify to other Suppliers.

However as technology has progressed, the cost of developing new technology has become increasingly prohibitive, resulting in joint developments and joint standardisation evolution groups. The new technology, being more efficient than that previously deployed, results in a shrinking market (Brown 1998). Hence Suppliers have to be involved in joint ventures, concentrate on targeting niche markets, or run the risk of failing, as in the case of GPT in the UK.

An alternative Supplier strategy would be to attempt to capture global market share by developing products to established international standards, with a view to giving their product worldwide marketability.

In practice, Suppliers appear to be pursuing a variety of strategies depending upon the technology and maturity of their existing products.

Operator Perspective

Traditionally, Public Network Operators developed a symbiotic relationship with a small number of Suppliers, often encouraged by a national government. Typically, the Suppliers resided in the same country as the Operator and ensured that the Operator's investment (sanctioned by government) was retained in that country. Such a relationship allowed an Operator's precise needs to be met, but resulted in the Operator being tied to that Supplier, often paying a premium as a result. Liberalisation saw the removal of Operators from governmental control and a consequential weakening of the links between Operator and Supplier. Sector liberalisation encouraged standardisation to aid interconnect and hence promote competition. An Operator looking for a reduction in costs, welcomed standardisation, owing to the ease of interconnect and operation with other Suppliers' equipment, giving them flexibility and purchasing power through competitive procurement.

However Operators were also mindful of the competitive advantage that could be achieved from the proprietary elements of a particular Supplier's equipment. They found that to offer services differentiated from their competitors, they needed to use these proprietary elements. If, due to competitive procurement, their network comprised a variety of equipment, then it was likely that services using non-standardised elements would operate in a slightly different way, according to each Suppliers' equipment. This might have presented their customers with a slightly different 'look and feel' to the service, depending upon to whose equipment their telephone line was connected[1]. Should such a product have been designated as a Supplementary Service Business in the UK, the problem would be exacerbated. This is because an interworking interface would have had to be approved for the product by the NICC, in order to allow other Operators/Service Providers the option to adopt the service and allow inter-working between the different Operators' networks. With different Suppliers' equipment working in different ways, a common interface was difficult to achieve. If the product were classed as Services Business, which does not require a third party interface, the problem would not arise.

Operators generally do not like opening interfaces to other competitors for interconnection, since it could set a precedent for allowing competitors access to other services offered over that interface, which had not previously been available to them.

Service Provider

Service Providers (SPs) in the UK focussed upon niche markets, providing information or specialised services to their customers. Although they were in competition with the Operators, their specialism, their ability to purchase capability at the most competitive rates and lower overheads, should have made them competitive with Operators offering similar services. This was perhaps true in competition with the incumbent Operator BT, since BT was dominant and forced by its licence conditions to treat such business as Supplementary Services Business. This meant that BT retail had to purchase network capacity at the same rate as the Service Provider, making the competition fair. However other Operators not being classified as dominant, did not have the same conditions and were able to charge at lower rates. Some Service Providers were similarly advantaged, since they were historically given the same rights as Operators to interconnect rates (known as Licence Condition 13 rates or C13 for short[2]) and were able to purchase network capacity at wholesale rates.

The position was therefore that SPs were generally unhappy, because they did not in the main have access to the same tariff structure (C13) as the other Operators. This meant all the other Operators (apart from BT) could, without adding any value, resell BT services at

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[1] Should only one Suppliers equipment be able to offer a service, then only a subset of the Operators customers would be able to use it. In the UK, the regulator OFTEL, would prevent such a service being launched because it could not be universally offered.

cheaper than BT retail tariff, whilst the prices SPs were forced to pay meant they had to sell their services at potentially greater than retail. For this reason Service Providers felt they had as much right to C13 tariffs as Operators (OFTEL 1995).

Service Providers were also pressing for a more open Operator architecture, suggesting that services should not be 'bundled' and that a toolkit approach could be employed. This would allow them '...to construct their own services from the service functions available from the Network Operator' (Sutton 1995).

OFTEL Perspective

The UK national regulator (OFTEL) had a series of objectives, discussed in detail in Chapter 5. These included a single virtual UK telephony network, the protection of consumer interests and effective competition. Competition, leading to competitive pricing and minimised service charges, was used to ensure the consumer received value for money. Standardisation was used to expedite basic interconnect and the interconnection of BT's Supplementary Services Business products, thereby seeking to ensure an 'any to any' service.

EU Perspective

The EU perspective was similar to that of a national regulator, but at the supra-national level. It identified that a sound economic European telecommunications infrastructure was important for the continued economic growth of the EU and hence positioning and influence of the EU in the world market. In order to develop such an infrastructure it adopted the approach that competition would lead to investment, which in turn would lead to development of the infrastructure. This approach fitted quite nicely with its ongoing objectives of breaking-down the trade barriers between Member States, thus telecommunications became another area for its market liberalisation programme.

The EU Commission's initial (1998 liberalisation) approach was to open the Member States' telecommunications markets to service competition. Latterly (2002), it has sought to bring the application of Members States' regulations on a more common footing, by generating a number of lower level directives. These (in mid 2003) replace key judgement

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[2] More recently these have become known as Condition 69 or Annex 2 rates.

criteria of individual Member States with a common interpretation and application to regulation.

The EU, like OFTEL, recognised the importance of standardisation in ensuring a pan-European telecommunications network. The EU created the ETSI standardisation body and the Commission provided direction as to the areas of standardisation to be generated, both in support of new technology initiatives and regulatory directives[3].

Global (i.e. WTO) Perspective

The World Trade Organisation had an objective, to help encourage the development of impoverished countries through trade with better developed countries. The WTO sees that a strong telecommunications infrastructure aids trade with other countries and encourages such economic growth. Better lines of communications allow production to be sited in poorer countries with reduced labour costs, whilst retaining the ability to react quickly to market demands and changes to the product, as demanded by the developed countries' markets in which the goods are sold[4].

To encourage such trade, the WTO aims to reduce the barriers between countries (such as the taxation of imported goods or services to protect home produced items), allowing goods produced in other countries to be imported without hindrance.

These stakeholder positions provide a reference with which to compare and possibly correlate with the responses arising from the survey data analysis. Prior to the analysis, the next section provides details of what surveys were undertaken, their recipients and what they had as their objectives.

6.3 Survey Overview

The theoretical development underpinning the framing of the questions used in the construction of the surveys, has already been discussed in Chapters 3, 4 & 5. Survey 1 (The Regulation of Intelligent Networks) focused on stakeholder attitudes towards the

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[3] ETSI also decide for themselves areas which should be discussed for standardisation.

[4] Some say such an approach encourages the exploitation of workers of poorer countries, through the production of goods by workers working long hours for low pay. These groups frequently disrupt the international WTO meetings. Others argue that such workers enjoy a higher rate of pay compared to others living locally and that it brings income to the country.

validity of three IN architectures (the standard ITU-T architecture model and two alternative IN architectures) and gathered and prioritised information related to opening IN interfaces. Additionally, it aimed to determine concerns that could arise with the development of regulation and standardisation of interconnection interfaces. Survey 2 (Intelligent Networks '98') was undertaken to assess if industry focus and concerns had shifted since Survey 1 and to explore the relationship of INs with new technological developments, such as connection-less transport and routing.

This section provides details of what surveys were undertaken, their objectives, their recipients and the response rate achieved.

Regulation of Intelligent Networks (Survey 1)

For the first survey (Appendix A) 250 questionnaires were distributed and 23 were returned (a 9.2% response rate). The majority of respondents were based in the United Kingdom (UK). Responses were sought from named individuals of the key institutions within each of the stakeholder groups identified in Chapter 3. In those cases where the respondent failed to reply, another representative from the same organisation was approached[5]. The benefit of targeting named individuals with a known interest in, or responsibility for, INs is evidenced by the relatively high response rate achieved (Thomson 1990).

The survey allowed confirmation, development and prioritisation of the findings from the background research. It also investigated the problems and issues with interconnect within INs at different points in the architecture. More importantly, other IN architecture models could be considered just as architecturally appropriate as the standardised one, illustrating that standards might be more important than regulation as a means of encouraging IN innovation. Additionally it was hoped to identify areas that would aid or hinder the interconnection of Intelligent Networks, in order to determine whether the regulators or standardisation bodies had recognised and addressed them.

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[5] See Chapter 3 for details of how the Stakeholders were selected.

The survey fulfilled a number of key functions for the research:

- confirmation of the preliminary questions derived from the background research;
- development of these questions through an exploration of user issues related to the interconnection of INs;
- exploration of alternative IN architectures;
- establishment of the relative importance of the standardisation and regulation processes as a means of promoting innovation in INs;
- prioritisation of research activity.

Respondents were, in the main, from Operators (9) (referred to as Public Telephone Operators (PTOs) in the survey[6]) and Suppliers (9). Service Providers (2) and Consultants (3) made up the remainder. The number of responses from the Operators and Suppliers were representative, since they provided insight into the views of all the major Telecommunications Operators in the UK and all the main Suppliers in Europe. The data used to draw the conclusions is therefore dominated by the Operators and Suppliers. Where the other categories of respondent are significantly different, the text indicates who and what these are.

An attempt was made to determine whether there was a correlation between 'job function' and response patterns. A review of the job titles suggested that all the respondents could be grouped within five categories, namely Network Strategy (8), Design (7), Implementation (3), with a minority in Sales (2) and Marketing (3). There were no discernible trends in the answers from respondents working in the different areas, perhaps confirming that company strategy is stronger than any thinking that different roles within a sector may have.

The analysis of the data identified a number of weaknesses within the survey, where tighter wording of question options, or a larger number of options, would have produced more discriminating data. 'Private Branch Exchange' Suppliers are a case in point, as their responses differed significantly from the other Suppliers. The most probable cause is that these Suppliers were not intent on developing their products as an integral part of a public telephone network, but rather saw their market as the Service Provider/User end of the market that would not wish to integrate with the Operator's network to which they were connected. Greater benefit may therefore have been gained by sub-categorising the types of Supplier. This and other potential improvements, are discussed further in the analysis.

Intelligent Networks '98' (Survey 2)

Survey 2 (Appendix B) provided the opportunity to reaffirm the goals and concerns identified in Survey 1. More importantly it allowed new questions relating to emerging technologies, specifically the Internet.

The survey was undertaken in conjunction with the organisers of an IN conference the researcher was addressing (Shepherd 1998). The recipients of the survey questionnaire were the attendees of the conference with a known interest in INs, employed within a wide variety of European telecommunications related organisations.

The survey achieved a response of 29 questionnaires from a total of 132 distributed forms (a 22% response rate). Respondents were mainly from Operators (19, including 4 Mobile Operators) and Suppliers (6, including one exchange/switch Supplier) and the remainder from Computer Suppliers and Information Technology companies[7].

The survey asked respondents for their Job Titles. Although some direct mapping from this to the first survey's categorisations can be made (Sales, Network Operations etc.), a large number of job titles were nondescript, e.g. 'Business Analysis' (IN16), 'Business Development' (IN42), and the categorisation which best suited that individual was unclear. It was therefore considered inappropriate to try and identify response trends by job segment (rather than by stakeholder segment) owing to the inability to confidently categorise the respondent.

The survey format employed was that of individual questions followed by a text box. This approach was taken to speed completion of the form and hence promote the greatest number of returns. However such a format led users to employ a much wider set of terms within their responses, making analysis more subjective. The analysis approach adopted

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[6] The term 'Public Telephone Operator' (PTO) was common at the time of the survey, but now appears dated. This thesis therefore uses the shortened form 'Operator' in its discussions.

[7] Information Technology in this context is that associated with software and computer coding.

was to equate and categorise responses through the use of key words or phrases. These categorisations were based upon personal experience and expertise, but have been checked with other experts in the field of Intelligent Networks, Network Operations etc., to ensure they have been correctly interpreted. Since respondents were not being forced to select from a prescribed list, the equated responses had potentially greater significance than comparable questions within Survey 1.

With this background in mind, the remainder of the chapter examines the analysis of the survey data and interview information, with a view to addressing a number of the questions arising from the thesis hypothesis given in Chapter 1.

6.4 Intelligent Network Architecture Models

Information gathered in the early 1990s, by the European Union (EU) (ETCO 1990) and the UK Department of Trade and Industry (DTI 1992), indicated a high probability that any regulation of Intelligent Networks would be based upon an implementation of the International Telecommunication Union - Telecommunications (ITU-T) IN architecture model. The implicit assumption that the ITU-T model was the most appropriate, is one of the major questions raised by this study, that is:

- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?'

Should the model used be found to be inappropriate, then the standards based upon it may be sub-optimal and use of the resulting standards in support of regulatory policy may be inappropriate.

Survey 1 investigated this issue by asking respondents to select one of three possible IN architecture models as the most appropriate from the perspectives of technical features, regulation and product strategies for the identified stakeholder groups. The first architecture was the standard IN model, referred to as the 'Centralised Processing Environment' and labelled A in Figure 6.1. The researcher developed the other two models as an original contribution to architecture diversification. The first of these, referred to as the 'Centralised Distributed Processing' model and labelled B in Figure 6.1, borrowed the idea of distributed processing from the computing environment and applied it to the telecommunications domain. This is now an established model for Intelligent Networks requiring centralised intelligence and is capable of high levels of processing, enabling high volumes of calls to be quickly serviced. The third model, referred to as the 'Centralised Distributed Processing' model and labelled C in Figure 6.1, was wholly the resercher's own development and introduced the concept of local and central Service Control Point (SCPs). These models have been discussed in detail in Chapter 4.

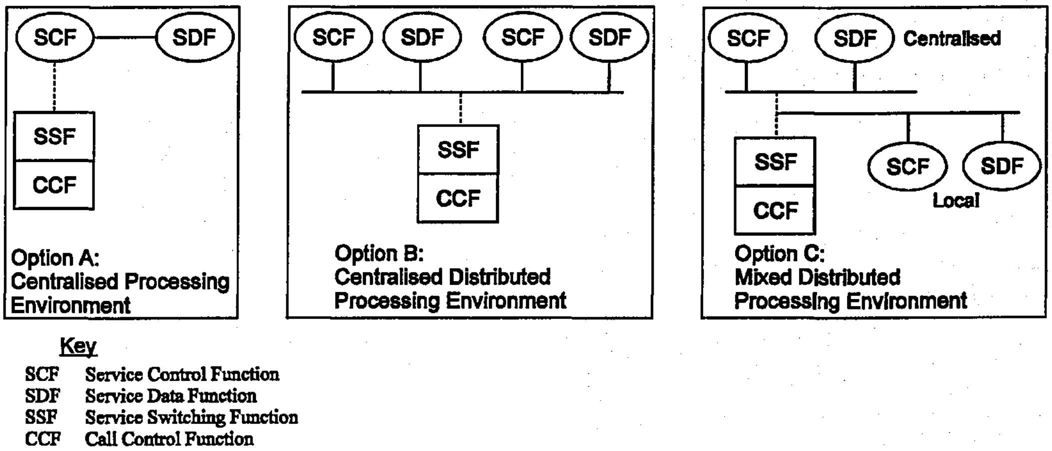


Figure 6.1 Network Architectures

20 respondents answered this question in Survey 1, with four Supplier respondents identifying more than one model as being an appropriate IN architecture. The related survey results are charted in Figure 6.2 and discussed in the following subsections.

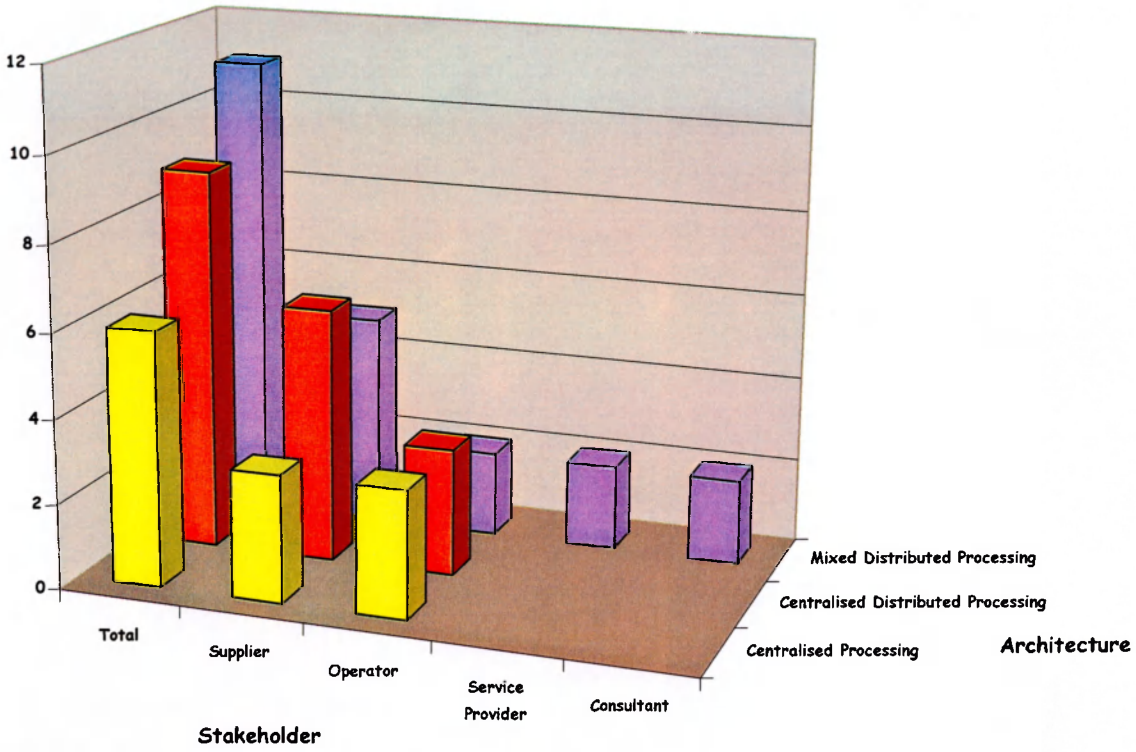


Figure 6.2 Respondents' IN Architecture Preferences

Centralised Processing

Stakeholder Architecture	Operator	Supplier	Service Provider	Consultant	Total
Centralised Processing	3	3			6

Table 6.2 Respondents preference for the Centralised Processing Architecture

Table 6.2 shows the categories of respondent preferring the Centralised Processing architecture model. Six of the respondents selected it, giving the reasons as lower cost, simplicity, or that it matched the CS1 IN architecture (e.g. cbc09). In arguing this latter case, the respondents asserted that the system limitations which would render it inappropriate were unlikely to be reached, either through low growth of the services, or because advances in processing development, would ensure that upgrades always stayed in advance of service growth.

Centralised Distributed Processing

Stakeholder Architecture	Operator	Supplier	Service Provider	Consultant	Total
Centralised Distributed Processing	3	6			9

Table 6.3 Respondents preference for the Centralised Distributed Processing Architecture

Table 6.3 shows that nine out of 20 respondents (predominantly Suppliers) preferred the Centralised Distributed Processing model, recognising the cost benefits of centralisation (cbb14) and the benefits of a distributed processing architecture to ensure adequate speed of response and resilience (bby44, cbb25). The model was also said to provide flexibility, by providing the option to migrate to the mixed distributed architecture should it be needed (cbb14).

At the time of the survey, there were no internationally ratified standards for computer distributed processing. Such standards were generally produced by computer manufacturers and were specific to their equipment. The favourable reception of the model in the survey, perhaps indicated that further consideration should have been given to introducing a Centralised Distributed Processing model into the IN standardisation fora, allowing Operators to expand from single to multi-processing INs, whilst remaining vendor independent and allowing reuse of processing hardware.

A number of respondents identified that different architectures would be better for different situations, depending upon the geography, traffic and services offered. For instance, one Supplier stated 'Mixed distributed allows office based services. (Centralised) Distributed *is* best for GSM etc. where centralisation *is* key' (bay40). Other respondents, reflecting on the potential geographic coverage of the model, gave opposing viewpoints. One indicated that Centralised Distributed Processing was appropriate for a small network (and for reuse of equipment) (bay05), while a second argued that it was appropriate for a large country-wide network (with its greater processing requirements) (cba18).

Mixed Distributed Processing

Stakeholder Architecture	Operator	Supplier	Service Provider	Consultant	Total
Mixed Distributed Processing	2	6	2	2	12

Table 6.4 Respondents preference for the Mixed Distributed Processing Architecture

The Mixed Distributed Processing Architecture was the researcher's own development as an attempt to compromise between the speed of the traditional distributed processing architecture and that of the standardised IN. In this architecture, the service and data are located both centrally and locally.

As is summarised in Table 6.4, 12 of the 20 respondents replying to this section in Survey 1, selected the Mixed Distributed Processing (MDP) architecure. However, it is interesting to note that this includes the selections of the two Service Providers (SPs) and two Consultants who responded to this question in the survey. Examining the model in terms of its attractiveness to Suppliers and Consultants, it was selected by 8 of the 20 respondents (predominantly Suppliers), making it about as attractive to them as the other architectures. The two SPs and two Consultants preferred the model owing to its more open architecture, the SPs opting for the greater flexibility in the way they could interconnect to Operators networks compared to the other architectures. With an Operator's network able to cope with multiple SCPs, the benefit of an SP owning and interconnecting an SCP to the Operators network increases, particularly if the SPs are regional or offer primarily regional services. Analysis of the responses indicated that the architecture was interpreted as operating in one of two ways.

The first is where applications are running both centrally and locally. Those having frequent data changes, would run centrally, whilst those where the data changes are infrequent could run locally (increasing the query/response speed). This is how it was originally envisaged to operate when first constructed (see Chapter 4).

The second interpretation is that unless an Operator is willing to be tied to one Supplier's equipment, the design constraints of different Suppliers' systems forces the Operator to accept the mixed distributed processing environment architecture (day22). A number of respondents adopted this second interpretation because (at the time), applications from different Suppliers could only run on their own SCPs. Standardisation fora therefore needed to concentrate on expanding their scope in the arena of Intelligent Network applications and the service execution environment, to truly mix and match both hardware and software. This would have been of greater benefit than concentrating on expanding feature sets.

Another respondent favoured the Mixed Distributed Processing (MDP) model because they felt that the services would inevitably be a '...mix of ... standardised ... and those creating competitive advantage' (day14). This respondent perhaps recognised that a market leader would not be constrained to offering services within the limitations of the IN standards prevailing at the time, or to only one Supplier's offering. Another view, from a Consultant, was that 'The multiplicity of service networks and service providers means no one can dictate a single uniform solution' (day07). Here the respondent seemed to be taking the view that the large variation in types of services and the demand for flexibility, would create an ever evolving capability set and thus never be sufficiently firm for standardisation and hardware/software matching. In both these cases the inference is that an Operator has to adopt the MDP architecture if it wishes to maintain a competitive advantage in the services it offers.

One unfavourable response to the MDP architecture came from the respondent who didn't '...want multiple service agreements/accounts' for customers (cbb25), preferring the centralised distributed architecture. A possible interpretation of this response could be an unwillingness to pay for an integrated support and billing system (see the later section on 'Other Interconnection Issues'). The fact the respondent was employed by a relatively new telecommunications company lent support to this interpretation. Such responses add weight to the argument that standardisation bodies should perhaps have given greater priority to considering and developing management interfaces (including billing) for IN equipment.

The Operator respondents, in not choosing this model, gave the reasons as complexity, cost and not conforming to the CS1 model (cbb14, cba18, cbc13, cbc09).

Summary

Examining the combined responses of the Suppliers and Operators, there was little preference for any one of the three architecture models with four of the Suppliers indicating that different models would be appropriate for different situations. There was a slight preference for the two alternative IN architectures (Centralised Distributed Processing and Mixed Distributed Processing) compared to the standardised Centralised Processing architecture. However, considering the choices of the Service Providers and Consultants, with their preference for a more open architecture and perhaps lack of awareness of the issues associated with such an architecture, the Mixed Distributed Processing model becomes the favourite. The principle reasons were its operational flexibility and/or speed of response.

Survey 1 has demonstrated two key points. First, that the standardised IN architecture is not necessarily the favoured architecture and secondly that no single architecture can be described as being the favourite, since different circumstances will favour different architectures. Thus in answering the question raised in Chapter 1:

- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?';

it is unlikely that complete technical architecture models will ever exist prior to standardisation, owing to differing and changing circumstances that make alternative architectures attractive to different stakeholders at different points in time. This indicates that standards need to be sufficiently flexible to accommodate different architectures, including those not envisaged when the standards were initially ratified. It also indicates that using the IN standardised architecture as the basis of regulation to open IN interfaces and interconnect could be inappropriate, since this will not be the optimum architecture for some Operators.

This section has sought to test the appropriateness of the standard IN architecture. However, since the IN architecture can be regulated through the opening of interfaces, the next section discusses the issues identified with the points of interconnection relating to the standard architecture.

6.5 Points of Interconnect in a CS1 Environment

Inter-operation across networks owned by different Operators requires a point of connection, or interconnect, between the networks, the precise location of which determines the level of sophistication and functionality available to each of them.

As has been discussed in the previous section, actions by the DTI in 1992 indicated a high probability that any regulation of Intelligent Networks would be based upon the standardised ITU-T CS1 architecture and its associated interfaces. This architecture, shown in Figure 6.3, was used as the baseline model by both the DTI (DTI 1992) and in this research.

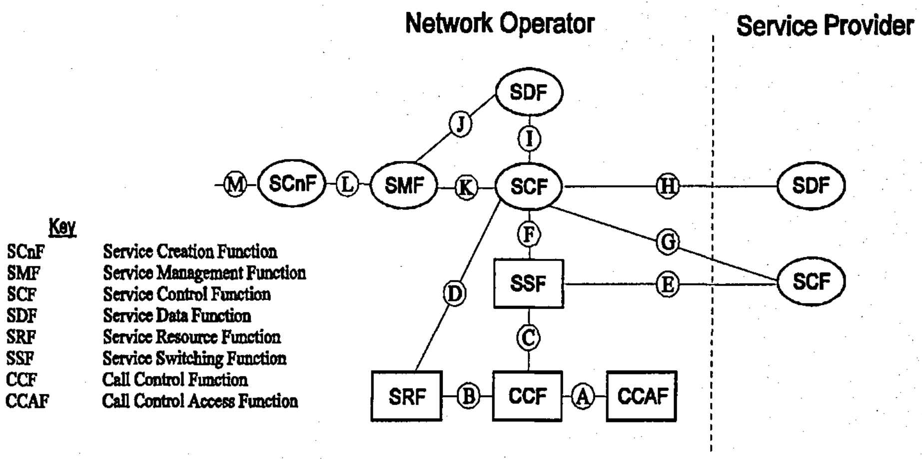


Figure 6.3 Points of IN Interconnect

The operation of the architecture shown in Figure 6.3 has been explained in Chapter 4. Respondents were asked to identify the most suitable interfaces for the different groups of stakeholders and to identify the problems associated with using these interfaces (similar to the KPMG (1993) model). It addresses the research question:

- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'

The findings are summarised in Figures 6.4 and 6.5.

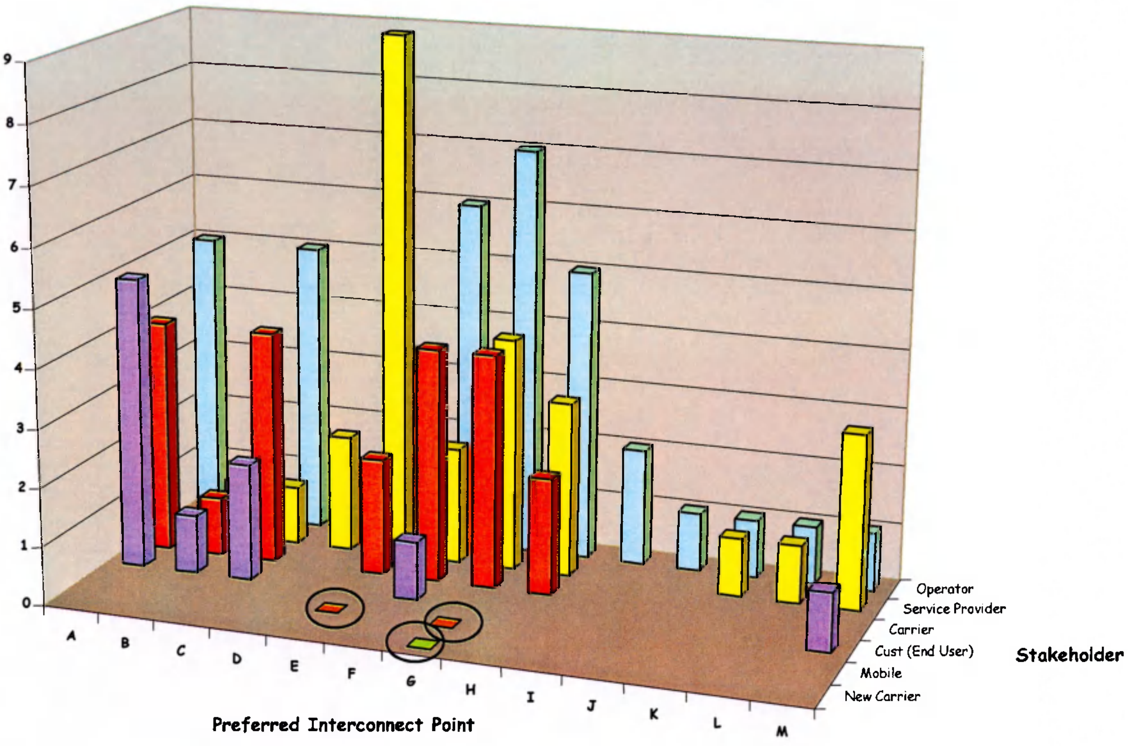
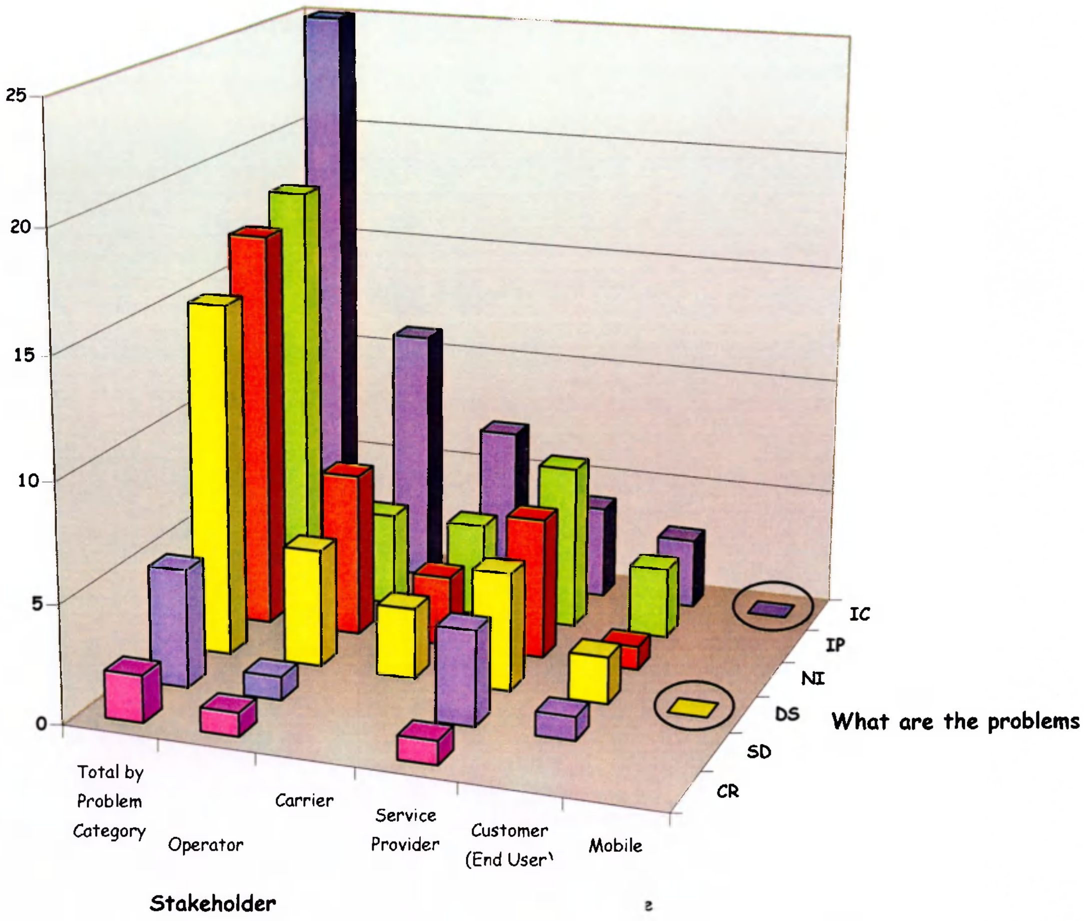


Figure 6.4 Preferred Interconnect Point for Different Classes of Stakeholder

Figure 6.4 shows the totals for the choices made for each interface by each stakeholder. The three zero values (ringed), represent interconnect points for two classes of stakeholder (Mobile and New Carrier), which were identified by respondents but were not given in the list of prescribed response options. As such, they cannot be compared quantitatively with the data for the other groups of stakeholders, but are considered qualitatively.



Key

Interconnect Compliance testing	*IC*
Data Security	*DS*
Interface highly Proprietary	*IP*
Network Integrity	*NI*
Conflict with current Regulations	*CR*
Service Differentiation	*SD*

The two zero values represent alternative interconnects proposed by respondents.

Figure 6.5 The Problems Associated with the Interconnection of Different Classes of Stakeholder to an Operator's Network

Figure 6.5 quantifies the responses relating to the perceived importance of problems associated with each stakeholder group interconnecting with a standardised Intelligent Network.

An unexpected finding from the Survey 1 question concerning the most appropriate interface to interconnect to an Operator's IN, is that six of the respondents replied with a multiple answer. In such cases it has not been possible to associate the specific problems they identified in Question 3.5 of Survey 1 with the interface point they selected in response to Question 3.4. However these respondents did not give multiple interface responses for every stakeholder group, thus there were a large number of cases where problems could be directly associated with individual interfaces and these, together with the remaining respondents who did not give multiple answers, allowed trends to be established. It was these trends that were used as the basis in deciding where the issues are discussed in this section.

The following subsections consider the survey data relating to points of interconnect from four different service aspects, the choices being summarised by applicable interface at the beginning of each subsection.

Service Development and Provisioning

Stakeholder	**Preferred Interconnect Point** (by number of respondents considering it appropriate)	
	L	*M*
Operator	1	1
Carrier		
Service Provider	1	3
Cust. (End User)		1
Mobile		
New Carrier		
Total	2	5

Key
Service Creation Interface (M),
Service Creation – Service Management Interface (L)

Table 6.5 Preferred Interconnect Points for Service Development and Provisioning

Seven respondents to Survey 1 felt that the Service Creation interfaces were appropriate for interconnection. These responses implied that Service Providers would want to create their own services and use the Operator's SCP to run them. This could be achieved either by the Service Provider downloading their application to the Operator's SCP (interface L) or by the SP using the Operator's own Service Creation Environment (interface M). Service Creation for network services was an issue for 12 out of the 29 respondents to Survey 2. Their main concern was that service creation was not as flexible as they desired. Comments relating to 'customisation to local requirements', (IN12) and 'service differentiation from competition' (IN18), suggested that the 'SIBs *were* too few to make real new service*s*' (IN38).

The Operators found themselves in a dilemma in that whilst welcoming standardisation to minimise costs (purchasing off-the-shelf with minimal bespoke development) and gaining themselves purchasing power (by being able to mix different Suppliers' equipment), they found they were getting a similar service building capability to that of any other Operator with standardised equipment (Shepherd 1997). In order to create unique services, Operators would have to compromise the ideals of standardisation and Supplier competition, in order to develop a bespoke SIB set, resulting in 'Fast service Creation...*allowing the Operator to be* the... leading edge' (IN30) in the provision of Intelligent Network provided services.

A related problem is that applications are often created with the control of one particular Supplier's SSP in mind. These applications will employ SIBs which may not interact and operate with another Supplier's SSP, owing to the different ways switch actions have been implemented by the different Suppliers. This creates the situation whereby either duplicate applications are written for the same service (to service the different SSPs of different Suppliers), or (what often happens in practice) the call is routed to an SSP of a type which communicates with the SCP containing the application. Woollard (interview 2002) indicated that this limitation has meant the flexibility of SIBs has never been realised. Various intermediate Application Programming Interface (API) initiatives such as Sun Microsystem's Java API for Integrated Network (JAIN) and Microsoft's Object Request Broker (ORB) have been developed to help avoid this situation, but have not been implemented to any great degree (Blau 1998, Korzeniowski 1998).

One respondent (Survey 1) felt that the 'SCEF *(SCnF interface)*... should be made open so as not to compromise the integrity of the network' (day22). They considered that this would be an appropriate interconnect point for Service Providers, writing their own applications and running them on an Operator's platform; however Bohacek et al. (1993) felt that international standards for this interface were unlikely to be developed.

The respondent also recognised that the integrity of the network must be maintained in so far as the third-party application must not be allowed to damage the operational capability of the Operator's network. A similar observation was made by Leber:

> '...increased activity, much of it linked with third party service providers, brings the potential risk of large-scale network disturbance if actions are not taken.' (ibid 1998)

The potential damage that could be caused would be on a par with major network outages arising from software upgrades. For instance, in 1991 a signalling software problem resulted in millions of customers in the USA losing service for several hours (Tele.com 1998). Pandurangan (1993) suggests employing gateways to screen messages, but many of the hazardous messages would, under normal circumstances, be considered valid. It is the quantity and context in which they are used that are the issue.

Another respondent (to Survey 2) highlighted issues relating to 'Total Service Creation' (IN8), with a further three respondents regarding Service Creation as the key Intelligent Network challenge. These respondents were concerned with the bespoke provisioning of services for customers (i.e. adapting a product to a customer's individual requirements), inter-working with the customer's equipment in order to provide these services (IN16, IN26, IN34), (see 'Other Interconnect Issues' section) and provisioning in conjunction with existing (non IN) services.

Since IN and non IN services would not operate on the same platform, they would not be built using the same service creation environment, therefore integration would only be at the operational level. For example, suppose that an Operator sells a messaging service comprising the ability to implement a diversion application at the IN Level and a mailbox application at the exchange level; a non-integrated Service Creation environment would mean that the application associating the customer telephone number with a mailbox would need to be initiated at the exchange level and, using a totally different order entry system, a diversion application would be created on the IN associated with the customer's telephone number. That is, the one service requires two service applications to be invoked and similar details entered on two different systems. An integrated service creation environment would allow a messaging product to be developed which would encompass both the mailbox and diversion applications from the same provisioning system, thereby requiring a single service invocation to supply the customer with the messaging product. Separate Service Creation is a significant problem for any Operator offering IN services in conjunction with existing services on its legacy systems.

All the problems identified with Service Creation could be symptomatic of such provisioning difficulties. Thus the restrictions of service development (e.g. the inflexibility of Service Independent building Blocks resulting in a limited ability to adapt to customer requirements), service inter-working, throughput of management systems (to implement applications and alter customer data), as well as providing customers with the ability to build, invoke and change services/service data themselves, could all be caused or exacerbated by a poor service creation capability.

Interconnect at the Intelligence Level

Stakeholder	**Preferred Interconnect Point** (by number of respondents considering it appropriate)				
	G	*H*	*I*	*J*	*K*
Operator	7	5	2	1	1
Carrier	4	2			
Service Provider	4	3			1
Cust. (End User)					
Mobile	*				
New Carrier	*				
Total	15	10	2	1	2

* Not marked on survey questionnaire, but raised by respondent in free format field

Key
Service Management – Service Data Interface (J),
Service Management – Service Control Interface (K),
Service Control to Service Data Interface (Intra-Network) (I),
Service Control to Service Data Interface (Inter-Network) (H),
Service Control to Service Control Interface (Inter-Network) (G)

Table 6.6 Preferred Interconnect Points for the Intelligence Level

The inter-network Service Control to Service Control Interface (G), was preferred by seven respondents as a suitable point for Operator interconnect, by four respondents as suitable for Carrier interconnect and by four respondents as suitable for Service Provider interconnect. The principle problems identified with Operator and Carrier interconnect were the Interconnect Compliance Testing of this interface and Maintaining Network Integrity. Interestingly, given a Carrier's technical similarity to an Operator, network integrity did not feature as significantly for the Operator respondents. It could be that Carriers typically have fewer services than Operators and thus there is less chance of accidentally compromising other services. Despite interface G being standardised in CS2 (ratified after Survey 1 was returned) and there being a standardised set of IN services, the construction of those services on individual SCPs would almost certainly be different, so inter-networking is not as simple as commonly envisaged.

The next most popular interface (10 respondents) was the inter-network Service Control to Service Data Interface (H). This is a fairly simple interface and one that has been standardised in CS2. It requires SCF knowledge of the third party's SDF's data structure. As before, the key issue identified was that the 'SCF/SDF should be made open so as not to compromise the integrity of the network' (day22).

Two respondents chose the intra-network Service Control to Service Data Interface (I) as a suitable interconnection point. This is a bit meaningless, since for a third party to interconnect at this interface would effectively mean an inter-network Service Control to Service Data Interface (H) had been created. It is therefore perhaps more appropriate to sum these choices to those of interface H.

The Service Management – Service Data Interface (J) and Service Management – Service Control Interface (K), were only chosen by a few as appropriate interconnection points. This is unsurprising since these interfaces principally relate to the management of the equipment. The small number of respondents identifying these interfaces, may have been considering their suitability for remote monitoring the state of the network and in particular, third parties' applications which may be running on the SCP.

Interconnect at the Switch Level

Stakeholder	Preferred Interconnect Point (by number of respondents considering it appropriate)					
	A	*B*	*C*	*D*	*E*	*F*
Operator	5	1	5	1	3	6
Carrier	4	1	4		2	4
Service Provider		1	1	2	9	2
Cust. (End User)	5	1	2			1
Mobile					*	
New Carrier						
Total	14	4	12	3	14	12

* Not marked on survey questionnaire, but raised by respondent in free format field

Key
Service Switching – Service Control Interface (Intra-Network) (F)
Service Switching – Service Control Interface (Inter-Network) (E)
Service Resource – Service Control Interface (D)
Call Control - Service Switching Interface (C)
Service Resource - Call Control Interface (B)
Call Control Access – Call Control Interface (A)

Table 6.7 Preferred Interconnect Points for the Switch Level

There was some confusion shown in the responses in Survey 1, between the preference for the intra-network and inter-network Service Switching – Service Control Interfaces (E & F). A third party interconnecting at this point should always choose interface F, since they must always have their application operating on their own platform. If they wished to have their application operating on the Operator's platform, then they should choose the Service Management – Service Control (K) or Service Creation – Service Management (L) interfaces, in order to load their own applications on the Operator's platform. Under such circumstances the inter-network Service Switching – Service Control Interface (F), is wholly internal to the Operator and opening it to third parties is meaningless. For this reason, those responses indicating interfaces E or F for a particular question have been combined and regarded as meaning the same.

The Service Switching - Service Control Interface (E/F) was the most popular for Operator, Carrier and Service Provider interconnect. Interconnect Compliance Testing to ensure network integrity is maintained, was identified as a key problem. This reaffirms the traditional view within the industry that this interface is an appropriate interface for SP interconnection to Operators and acknowledges the problems of operating across this interface (i.e. sending potentially damaging commands to the switch, causing congestion etc.) and compromising the integrity of the underlying network.

Interface F is also the one Operators would ideally like to use when implementing an IN, potentially allowing re-use of their existing switches. Interconnection with the legacy network was seen as a critical challenge for seven of the respondents to Survey 2, in implementing their organisation's IN network design. The specific reasons given included '...implementing SSP functionality in all switches' (IN46) and 'Integration of new INs with existing IN components (SSP)' (IN10). Many of the deployed switches were designed without considering INs (INs did not exist when the switches were being designed) and those switches which were able to evolve to incorporate an SCP interface, almost certainly implemented INs in a proprietary manor, thereby restricting the ability of the hardware to be upgraded to incorporate standardised functionality.

The Call Control Access - Call Control Interface (A) and Call Control - Service Switching Interface (C) were equally popular for Operator and Carrier interconnect, with the Call Control - Service Switching Interface (C) being predominantly chosen by Operators. Interconnect Compliance Testing was once again identified as a key problem. The traditional problems with the provision of these interfaces have been seen as:

- for A, the call models had proprietary elements, therefore the easiest way to connect via a CCAF would be to pass the call to an exchange having a SSF; and
- for C, the SSF/CCF interface was highly proprietary having been developed in an evolutionary fashion rather than planned
  (Shepherd 1993).

The implementation of these interfaces therefore tended to vary between Suppliers' equipment and would be costly and time consuming to standardise[8], for what could arguably have been minimal benefit. Only recently (2001) have some Suppliers released the Application Programming Interface (API) for these areas and hence allowed access to these interfaces (interview Jenkins 2001).

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[8] i.e. Upgrade to a standard, should a standard ever be developed.

Integration with Customer Premise Equipment

Stakeholder	Preferred Interconnect Point (by number of respondents considering it appropriate)	
	A	*G*
Operator	5	7
Carrier	4	4
Service Provider		4
Cust. (End User)	5	
Mobile		*
New Carrier		*
Total	14	15

* Not marked on survey questionnaire, but raised by respondent in free format field

Key
Service Control to Service Control Interface (Inter-Network) (G)
Call Control Access – Call Control Interface (A)

Table 6.8 Preferred Interconnect Point to Customer Premise Equipment

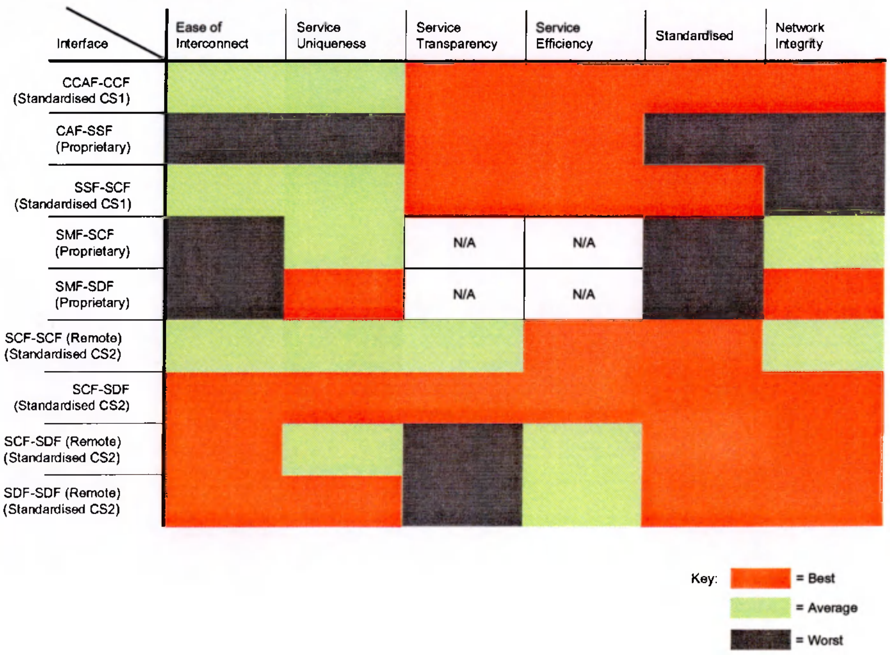
The most appropriate interconnect point for a customer was thought to be the Call Control Access – Call Control Interface (A) (Survey 1). This is typically a C7 Call Control interconnect[9], as referred to by one respondent (day22) and represents the way Operators and Carriers currently interconnect in the UK. Service Providers and Users are currently not allowed to connect in this way; thus the respondents could either be inferring that such an interconnect be made more freely available or that the CCAF functionality could be made inherent in Customer Premise Equipment. Weight is given to this latter argument by identification of the problem of a proprietary interface.

Some respondents to Survey 2 highlighted potential problems when offering an end-to-end (routeing) service over networks incorporating non-integrated management systems. For example, '...relationship with PABX vendors' (IN16) and '...provision of CTI in IN' (IN44). Such comments highlighted the need for interaction between IN and Computer Telephone Integration (CTI) applications. There are clearly benefits to be gained from an IN application interacting with a CTI application before routeing a call, so as to ensure efficient call handling (Shepherd 1998, Shepherd 1999c). Although the researcher is not aware of any complex interactions currently taking place in a public network, there are simple interactions which have recently (2000) been implemented. For instance, based upon information from a CTI application on the customer premises, (such as one monitoring queuing and call handling times at a call centre), an IN application in the public network can dynamically alter the routeing and hence the spread of calls across a number of geographically remote call centres.

Points of Interconnect Summary

In order to provide a telephony connection to customers on networks provided by different Operators, the networks need to be connected. With Intelligent Networks, the point of interconnection can be made at several points in the network, depending upon the level of sophistication and functionality the Operator wants to provide. These were shown in Figure 6.3.

The responses to Survey 1, identifying the problems associated with the different interfaces, together with additional information from interviews, publications and personal experience, were presented at the 1997 Brussels 'Intelligent Network' conference (Shepherd 1997). This information has been summarised in Table 6.9.



Interface	Ease of Interconnect	Service Uniqueness	Service Transparency	Service Efficiency	Standardised	Network Integrity
CCAF-CCF (Standardised CS1)	🟩	🟩	🟧	🟧	🟧	🟧
CAF-SSF (Proprietary)	⬛	⬛	🟧	🟧	⬛	⬛
SSF-SCF (Standardised CS1)	🟩	🟩	🟧	🟧	🟧	⬛
SMF-SCF (Proprietary)	⬛	🟩	N/A	N/A	⬛	🟩
SMF-SDF (Proprietary)	⬛	🟧	N/A	N/A	⬛	🟧
SCF-SCF (Remote) (Standardised CS2)	🟩	🟩	🟩	🟧	🟧	🟩
SCF-SDF (Standardised CS2)	🟧	🟧	🟧	🟧	🟧	🟧
SCF-SDF (Remote) (Standardised CS2)	🟧	🟩	⬛	🟩	🟧	🟧
SDF-SDF (Remote) (Standardised CS2)	🟧	🟧	⬛	🟩	🟧	🟧

Key:
🟧 = Best
🟩 = Average
⬛ = Worst

Table 6.9 Points of Interconnect - Ease and Value of Implementation

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[9] The Call Control connection between telecommunications exchanges is at what is termed the transport level (ISO term). The protocol used to convey information, both signalling and voice over this link is CCITT No. 7 Signalling System, often abbreviated to C7.

The columns of the table categorise the characteristics exhibited by each of the interfaces shown in the table rows. The colour of each cell indicates the ability of the interface to meet that feature requirement.

The features are:

- Ease of Interconnect - the ease by which a third party (e.g. competitor) can implement a suitable interface to enable interworking;
- Service Transparency - the continuity of the 'look and feel' of services offered across interconnected Operators' networks;
- Service Uniqueness - the flexibility an Operator has in developing unique or complex services, not easily replicated by competitors;
- Service Efficiency - the level of processing required to offer and manage services;
- Standardisation - whether a particular interface is proprietary or to internationally recognised standards;
- Network Integrity - the ability of an interface to avoid being used to convey potentially damaging commands from a third party.

The table indicates that overall, remote database look-ups are the easiest to implement owing to their simplicity and standardisation in CS2. It also reveals that interconnect at the management interfaces is likely to be difficult, due to the proprietary nature of the messaging involved. Subsequent to Survey 1, open management interfaces were gradually addressed in the standards arena, but with the advent of competing technology slowly replacing INs, a standardised IN management interface will never be implemented.

To some extent, regulation in the UK has forced the opening of IN interfaces through the regulation of products falling within the Supplementary Services Business[10] (SSB) category. Such products have to have interfaces for third parties to interconnect to, in order that another Operator can offer the same service on their network. This was discussed in detail in Chapter 5.

A number of the problems associated with stakeholder interconnection have consistently arisen regardless of the interface under discussion. This demonstrates them to be generally applicable to interconnect and not necessary attributable to a single interface. Respondents to Survey 1 felt 'Interconnect Compliance Testing' of the interfaces was the greatest problem, followed by the use of 'Proprietary Interfaces', 'Network Integrity' and 'Data Security'. For example, 'Regulators ... should impose that network integrity and data security is ensured' (bay05). Other respondents highlighted that 'the problem "Service Interaction" is unsolved.' (cbc13, supported by bay05 & day22).

All these problems are interrelated. The use of proprietary interfaces generally means that the interface specification has not been released by the Supplier and interconnection is not possible, except to more of the same Supplier's equipment. If the interface is open, then Interconnect Compliance Testing is needed to ensure that rogue commands from one network to another do not compromise Network Integrity (i.e. causing it to fail in some way) and that customer-specific data held on the network cannot be retrieved by commands from a third party's network, except on a 'need to know' basis. This latter point highlights a grey area of what information should be considered essential for the efficient (intelligent) routeing of a call and could be released, and what should be withheld. The requirements will vary from network to network and service to service, depending upon their implementation.

OFTEL's view was that they

> '...will not necessarily accept particular arguments that secure interconnection is not achievable and encourages those involved in the development of standards to build in appropriate means of access control. OFTEL would, of course, also expect network Operators to design their internal network configurations to limit the extent of damage that might be done' (interview Newman 1997),

placing the onus of ensuring Network Integrity on the Operator.

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[10] SSB is deemed by OFTEL to be all dominant Operator services utilising capabilities which are not dependent upon any particular telecommunications network e.g. Conference Calls.

The issue of Service Interaction also implies the need for compliance testing, but at the application level, to ensure new applications do not have a detrimental affect on existing applications and possibly the network. For instance, certain sequences of key presses for voice mail retrieval might already be in use for transferring the charging responsibility for a call. Service Interaction is therefore a major problem, since through third party differentiation, not all services would be known in advance.

Despite any regulation or testing, a level of co-operation, openness and trust must exist between two inter-connecting Operators that share information for the interconnection to be said to be successful. The easiest method of implementing more complex services (by allowing connection at SCP level), also increases the potential for damaging acts. A practical example of a 'liberty' was given by Gottleib (interview 1995). An Operator, who having tried to deliver a call to another Operator's network and had it fail, would attempt to connect the call twice more before failing it themselves and conveying that failure back to the originating customer (usually in the form of a tone, such as the 'busy' signal). The reason they would try twice more (which would take less than a couple of seconds), was that there was a chance that the cause of failure in the second Operator's network (e.g. network congestion, terminating customer busy etc.) would clear during the period of the next two attempts. However, if the problem resulted from the second Operator's SCP being in congestion, the repeat attempts would only exacerbate the problem, potentially further reducing the operational capability of that second Operator's network. This indicates that regulatory agreements will not, and cannot, cover every eventuality and trust has to exist between the parties to instil confidence that a particular interface will be used in a sensible manner.

This section has indicated that interconnection at various points of the IN model may be desirable, but is not always possible owing to the proprietary nature of the interface. It has also identified that although standardisation helps interconnection, it tends to allow successful services to be easily replicated by competitors. Thus in addressing the question raised in Chapter 1:

- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?';

it is clear that although detailed standardisation will help regulation by easing the process of interconnection, there are a number of interconnection issues which need to be addressed, to ensure satisfactory operation of that interface by both parties. It is particularly important to ensure that each party's network operation is not compromised by the other's. Additionally this section has indicated that regulation geared to standardisation could inhibit innovative new services, which might make use of proprietary elements not yet standardised.

This section has sought to identify the implications of enshrining standards in regulations by investigating the issues associated with opening the interfaces of the standardised IN model. There are however, other interfaces outside the scope of the architecture model, which need to be considered when integrating Intelligent Networks. This is discussed in the next section.

6.6 Other Interconnect Issues

The focus of Survey 1 on the use of the standardised architecture interconnection points to interconnect stakeholders, omitted consideration of the interfaces used for support systems such as billing. This was addressed in Survey 2, as was interconnection to emerging network technologies such as the Internet. This section considers and discusses the data gathered from (principally) Survey 2, relating to non-standardised interfaces, in the context of the following questions raised in Chapter 1:

- 'Is legislative regulation the appropriate means to shape a technology in rapid change?';
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'

The interconnections considered are those to the Internet, Billing and Management Systems.

Interconnecting with the Internet

Seven respondents to Survey 2 identified that there was no 'unified view' (IN32) of interfacing with the Internet. Furthermore, three of these respondents identified it as their biggest IN challenge and through their comments, emphasised the need for interconnection standards. Some of these respondents indicated that interconnection to the Internet was potentially applicable to all telecommunication technologies, not just INs, whilst others were more specific, indicating Service Creation, Data Amendment, Service Operation and Support Services, as their reason for wanting to interconnect. The implications of these areas are as follows:

- Service Creation
  The concept here is that the customer buying a service would be able to customise it from within an Operator's 'Service Creation Environment' ,which they would typically access via the Internet. This requires secure access to the Operator's domain with the ability either to re-create the Service Creation Environment locally (off-line) and upload the application with an acceptable delay, or to develop the application on-line with minimal delay of the implementation (IN30, IN44).

- Data Amendment
  In this scenario, respondents are given greater flexibility in the way they could alter their personal profile[11], by having the ability to alter their data via the Internet. For instance, they could change the destination of a 'Time of Day Routeing' application (IN30, IN44).

- Support Services
  The goal of this option would be the provision of a customer interface to the Operational Support Systems (OSSs) for administration purposes (service ordering, fault reporting, profile changes etc.), or billing purposes (notification or break-back of call statistics and on-line receipt of itemised bills) (IN20, IN28, IN50).

- Service Operation
  This scenario covers those situations where the Internet or (more appropriately) an extranet is used to access third party applications or data. The challenge is to

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[11] A customer's personal profile contains the data relating to their service. For example for a time of day routeing service, it would contain the telephone numbers that they would want their calls routed to, together with the hours of the day those routeings would be applicable.

> convey IN commands over IP networks[12] rather than C7 or IEEE 802.3 (IN4, IN8, IN52), or to carry calls over IP (VOIP)[13], which requires some means to query the SCP service for information (IN20, IN28).

Use of the Internet in both these 'Service Operation' cases, would normally be considered inappropriate owing to the Quality of Service requirement that messages are transported and responses returned in a timely fashion. What was probably meant by the respondents, and explicitly identified by seven respondents to Survey 2, is the use of 'IP telephony'. IP telephony implied a new generation of control structures that offered a competing technology with Intelligent Networks, since IP telephony and INs were not initially dependent upon each other (IN38). Initial implementations were interconnected only at the transport and call-signalling level, therefore the respondents were most likely referring to some kind of integrated access. Such applications might employ an Intranet to convey integrated data and (IP) telephony from a customer's premises, with separation into two streams at the Operator's local point of presence.

Thus the issue raised by these respondents was one of identifying an elegant way of passing telephony signalling information from the terminal equipment (in this case a customer's intranet) to an IN application so as to mimic the SSP Call Model trigger points (off-hook, time-out etc.)[14]. This would allow calls originating in an IP network to be routed to a traditional telephony network, without the need for an IN look-up on its ingress to the traditional network. However, without an elegant mapping of telephone numbers to the Internet system of addresses, such inter-working will be extremely limited (Korzeniowski 1998).

By the time of Survey 2, Operators and Suppliers saw the meteoric rise of the Internet and viewed it as a technology with which they would have to integrate. This view was not shared by the Information and Communication Technology sector as a whole at the time of the survey. Discussions with Internet Protocol experts in BT (not formally recorded) indicated the view that IP could do everything that an Intelligent Network could do, thus

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[12] Sigtrans allows INAP to be carried over IP.

[13] H323 or SIP allows voice to be carried over IP.

[14] Passing telephony signalling information from terminal equipment to an IN application might be possible using an SCP interfaced to a Radius or DNS server. Alternatively, the IN CS4 standard specifies a capability to interface an SCP to a Soft Switch, allowing an SCP service to be invoked in the routeing of an VOIP call.

Intelligent Networks were not needed. However INs are an established technology, with an enormous investment; they cannot be instantly scrapped and replaced by IP. Even at the time of writing in 2003, IP voice networks do not possess the same level of functionality that can be utilised for a public telephony service, as are provided by INs; thus a degree of intelligent inter-working between IP and INs would be beneficial.

The literature in this area considers Internet access primarily as a means of providing new Service Management capabilities that enhance existing services, allowing the customer greater control over their services, adding value to the existing products and potentially increasing revenue as a result. This aligns with the categories of 'Data Amendment', 'Support Services' and to a lesser extent 'Service Creation', in the situations given above. In addressing these needs, each of the different areas has its own specific requirements, so there is no simple solution with one interface solving all problems. All the categories apart from 'Support Services' could conceivably be brought within the IN model by creating suitable interface points to the SCnF and SMF.

These issues (being in response to a specific question addressing problems associated with IN and Internet convergence) were only weakly supported by responses to other questions in the survey. For instance, responses to a question on Service Management, which was likely to have produced corroborative data, did not emphasise interfacing to the Internet to the same extent, perhaps indicating that the Internet interface was an important, but minority need.

Integration of Billing Systems

Eight of the respondents to Survey 2 identified billing and integrated billing as a problem, due to the lack of a standardised interface. This aligns with past research (Shepherd 1993) which indicated that customers prefer integrated bills (not one for each of the services to which they subscribe) and similarly bulk discounting. In order to achieve integrated billing, a single system is required to handle all the billing information, for all the services, for all the different platforms. Intelligent Network services will therefore need to do the same. However the more platforms this central billing system integrates with, the larger the system becomes and the more complex, difficult and slower it is to link to and accommodate the products needs. The flexibility introduced by an Intelligent Network could be restricted by the billing system's inability to differentially price that flexibility.

The inability to integrate billing capability was exacerbated by a lack of standards. In North America a standard Call Detail Record, Automated Message Accounting (AMA), was developed for capturing information used in pricing a basic PSTN call. Although it was not universal, it was adopted by the majority of exchange Suppliers, developing a virtual de-facto standard. This allowed Operators to use a common billing system to handle call records from different exchange Suppliers; although link protocols still remained an issue. Concerns about protocol adaptation is evidenced by IN58 and Kidd (1998) who identified it as a key problem for integrating OSSs. There is no equivalent to the AMA standard for IN call detail records.

The very nature of IN services requires that date, time, destination and duration information be captured, but they must be captured for each service invoked within a call, with charges possibly split between caller and called party at different points in the call. Added to this complexity is the inter-Operator accounting information that has to be captured as the call progresses.

An example of the potential complexity of a call for which Operator charging information needs to be captured, is a customer telephoning a financial company. The initial call may be free, originate on network A and terminate on an interactive unit on network B. The customer may choose a service that provides share purchase recommendations charged at a premium rate. The call drops back to network A and routes to an interactive unit on Network C. After playing the customer the pre-recorded advice, the call drops back to network A and automatically re-routes to the interactive unit on network B, the charging reverts to freephone and the customer is able to make further choices.

Although such a mixture of services is quite advanced, the lack of a standardised billing record to capture charging information indicates that service complexity is growing faster than can be matched by the standardisation process and its implementation. Coupled with the need to capture charging information on a single bill necessitating an interface to an existing billing system, with its own inherent limitations, billing appears to be a major problem limiting the positioning of IN products in a competitive market through an inability to provide flexible pricing.

Integration of Management Systems

Analysis of Survey 2 showed that 8 out of 29 respondents identified that management interfaces were a problem, particularly the integration and interaction with existing systems, e.g. 'Interaction with PTTs legacy (OSS) systems' (IN36) and '...merging IN OSS into the central n/w maintenance sys*tem*' (IN14). This compares favourably with an earlier public survey where 51% of respondents identified network management as their biggest headache (Network Briefing 1996).

Management standards for Intelligent Networks were negligible up until 2000 (interview Anderson 1999) when the ratification of CS3 introduced specific management recommendations. The recommendations are sufficiently high level that they could be argued to ease the process of integration, rather than enabling it, but as yet they have not been implemented. Were they to be implemented, the lack of standards of the existing systems to which they have to interface would impede immediate benefits.

Summary

This section has shown that interconnection with the Internet would allow enhanced support services to be offered in conjunction with Intelligent Networks. In the main these would be to allow the customer to gain access to a particular facility or service, the way this would be offered varying from Operator to Operator. By this means, the Internet is being used as a simple access mechanism; the interface to it is independent of the use to which it is being put. The only real issue of the interface therefore, is the provision of secure access/firewalling for access to confidential data (IN54).

Billing has also been shown to be an issue, owing to the inflexibility of the content of the Call Detail Record and/or the systems used to process them. Similarly, the need to integrate with legacy management systems, in order to provide end-to-end management visibility, is problematic owing to the lack of management standards.

This section has shown that the interconnection of Intelligent Networks with existing support systems is essential for the offering of telecommunication services. The flexibility of such systems potentially limits how Intelligent Networks may be exploited. Thus in addressing the research questions raised in Chapter 1:

- 'Is legislative regulation the appropriate means to shape a technology in rapid change?'; and
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?';

there is a danger that regulation to a particular standard could force stakeholders to adopt changes which they are unable to exploit, owing to the inherent limitations of their support systems. This would impair Service Delivery.

6.7 Intelligent Networks as a part of a Company's Strategy

The focus of this chapter thus far has been the physical aspects of an Intelligent Network, that is, its structure, interconnections and integration. However Intelligent Networks could be used as a tool in order to aid the strategy of a company. This section examines the interaction between the stakeholder groups in the offering IN services and in the process, addresses the Chapter 1 hypothesis questions:

- 'Is legislative regulation the appropriate means to shape a technology in rapid change?'; and
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'

Many of the respondents (19) to Survey 1 felt their company had taken INs into account in formulating their company's strategy[15]. The exceptions were a respondent from a Private Branch Exchange (PBX) manufacturer[16] and (understandably) the consultants. Of those respondents whose companies were considering INs, all bar one regarded INs as either very (10) or fairly (8) important for their companies. One respondent (an Operator) found the survey to be thought provoking in that '...it has raised some problems and issues we weren't previously aware of' (cba12).

Eight of the respondents to Survey 2 felt positioning IN services correctly was the key issue. The comments made by these respondents indicated they viewed the problem from

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[15] The role INs would play in a company's strategy would vary depending upon their stakeholder segment. For a Supplier, it would be manufacturing IN components, for an Operator, it would be offering IN services.

both a 'market driven product' position, for example '...understand the marketing requirements' (IN26) and a 'product driven market' position, that is '...identifying right market segment' (IN32). Five respondents identified that there was a problem meeting market requirements with the capabilities in hand. One respondent indicated 'Adapt*ing* off-the-shelf services to mkt.' (IN8) and another '...customising to different mkt. segments' (IN20); the underlying causes of these problems being discussed in section 6.8 of this chapter.

Six of the respondents (employed by Operators) to Survey 1 said their companies were negotiating with other Operators to offer IN services. Such negotiations might represent the seamless operation of services between networks or offering one Operator's services to the customers of another. Either way, such co-operation in the EU could not be verified from other sources, although such co-operation occurred in the US (Shepherd 1996, Cullin 1996).

Four of the respondents (employed by Operators) indicated their companies were talking to switch Suppliers and conversely, four of the respondents (employed by Suppliers) indicated their companies were talking to Operators about technical solutions for IN marketing opportunities. This is as expected, since it is normal for both stakeholder groups to have ongoing communication about future products and technology (which would include INs). What is surprising is that only 8, from a combined Operator/Supplier stakeholder group of 18[17], respondents indicated that such discussions were taking place, although a small allowance might be made for those Operators not having, and not intending to have, an IN.

Only two respondents (an Operator and a Supplier), indicated their companies were in co-operation with a computer manufacturer. The early implementation of INs, that is prior to standardisation, saw the exchange Suppliers producing their own Service Control Point hardware, thereby retaining total control of their product. With the introduction of standardised interfaces and computing becoming core to the centralised processing

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[16] PBX manufacturers not considering the impact of INs would not be in a position to benefit from IN/CPE (Customer Premise Equipment) type services such as Computer Telephony Integration (CTI) in the future (Shepherd 1998, Shepherd 1999c). Computer Telephony Integration is discussed in more detail in Chapter 4.

[17] Two Operator respondents did not reply to this question possibly because they considered the information commercially sensitive.

capability of INs, I would have expected all the Suppliers to have been in communication with computer manufacturers in order to offer a joint product, rather than have the computer manufacturers dilute market share by offering a product directly to the Operators. Within two years of Survey 1, it was observed that IN Suppliers were offering SCPs combining computer manufacturers' hardware and the Suppliers software (Shepherd 1999a,b).

Four of the respondents (Operators) indicated that their companies were in co-operation with Service Providers in providing services, but these were probably non-IN offerings, since no third party IN services were identified as being launched in the years immediately following Survey 1.

Summary

The survey data indicated that although a significant majority of respondents viewed Intelligent Networks as important to their companies, it appeared that few of the stakeholders were actively co-operating with each other (be it Supplier, Operator, Computer Manufacturer or Service Provider) to offer IN services. Personal observations at the time of Survey 1 suggested a weak Computer Manufacturer/Supplier relationship, as previously identified by Mansell (1993). However, I had a different perception to that indicated by the respondents to Survey 1 regarding the lack of discussions between Operators and Supplier. In all the projects with which I have been involved and at all the conferences at which I have presented, Suppliers have taken the opportunity to 'network', seeking to learn how network design and capability is expected to develop and investigating how their products could meet future network needs.

The data in this area therefore appears inconclusive. In addressing the Chapter 1 questions:

- 'Is legislative regulation the appropriate means to shape a technology in rapid change?';
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?';

there appeared to be little communication between the stakeholder groups in discussing interconnection and interworking needs. This might be interpreted as a need for standardisation to define interconnection criteria. Alternatively, it could be argued that legislative regulation could be used to encourage discussions about interconnection. One respondent employed by a small Operator identified that the questionnaire had identified issues of which he was previously unaware, revealing that legislation which imposes INs or IN interconnection upon Operators could result in unforeseen problems.

6.8 The need for Standardisation

The previous section suggested that standardisation might have a role to play in the interconnection of INs, given the perceived lack of activity between the stakeholders. Thus this section looks at the need for Intelligent Network standards and addresses the following questions raised from the hypothesis:

- Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?
- How can it be ensured that robust technical and architectural models exist before standards are ratified?
- Do the members of the standardisation bodies (often the employees of the incumbent monopolies) subvert the goals of the regulators?

Twenty of the respondents to Survey 1 thought open standards very or fairly important for interconnection, with 15 indicating there should be an EU led, agreed design for INs to encourage interconnect. All the Suppliers supported this viewpoint, together with three of the Operators. One respondent felt that 'Standards...are the fundamental requirement in developing networks across Europe' (cba18). Another said that 'Standards will lead to more competition and should force the cost of IN down' (bby44). The cost aspect was noted by a number of respondents (cbb25, bay48, bby44, cbc13, cbc09). One Operator cited the success of GSM as justification for an EU led IN design (cba12).

Standardisation would similarly address concerns raised by respondents to Survey 2. These were the '...inter-working to different standards + proprietary interfaces' (IN32) in order to allow inter-working with other Supplier's equipment, both within a network (purchasing power) and between IN networks (to offer seamless services) (IN54).

These survey responses perhaps demonstrate that the ETSI work of standardising interfaces and identifying a minimum feature-set is appropriate. It forces Operators implementing INs to adhere to a basic set of standard services whilst allowing them the freedom to innovate for their more advanced services. A problem arises when an Operator has its own (adequate) set operating, because then there is little incentive for it to upgrade to an enhanced service set.

Another respondent to Survey 1 stated that '...standards are not compatible; the holy grail of complete interoperability is unlikely to be achievable' (cbb25), indicating that despite standardisation there was a sufficient mix of established proprietary INs such as to hinder complete interconnection.

There were a few further dissenters to an EU led, IN agreed design. One respondent, a consultant, said that standards were not needed to get customers to open interfaces (day14). Another respondent said that

> 'It would be most proper to speak about requirements to be fulfilled by the respective interconnecting networks *rather than standard interfaces*' (cbc28).

This respondent also indicated that standardisation was not the way to achieve the ultimate aim of interconnect and that it would be more appropriate to identify what needs to be achieved by interconnection and let the interconnecting network Operators decide how this could be achieved. As has been shown with Operator C7 interconnect in the UK, agreement frequently cannot be reached. The standardisation of the C7 protocol means this inability to reach an agreement is not from a technical perspective; rather it is from an inability to agree the accounting rates. OFTEL is asked to adjudicate such cases. A lack of IN standards would therefore exacerbate the problem of IN interconnect, increasing the cost of interconnect and reinforce the already high chance of agreement not being reached, except with the involvement of a third party.

A third respondent stated:

> 'Demand will increase, ... freephone/local call/premium rate will be their mainstay for a long time with VPNs being key for private networks' (day22).

This respondent was arguing the point that standardisation was not needed, since the current services would prove adequate for a long time to come. However this argument appears to contradict itself, since it implies the need for at least a minimum standardised feature set of non-geographic and VPN capability to ensure efficient interworking.

The issue of 'competing protocols' (IN32), leading to the problem of 'interoperability' (IN36) was raised by several Survey 2 respondents. For instance, Asynchronous Transfer Mode (ATM), Global System for Mobile (GSM), Intelligent Networks and Integrated Services Digital Network (ISDN), were all developed in isolation from each other, with no consideration for interworking with each other[18] (EU 1986, EU 1989, interview Guram 1995, interview Paterson 1994). The success of INs has meant that all these standards have had to develop interfaces for working with (fixed) Intelligent Networks, but not necessarily with each other. From this evidence, INs can be argued to be an enabling technology (Mansell 1993, Hawkins 1996, Shepherd 1996) and one that other technologies need to work with, in order to be successful (Christiansen 1997).

Although the standards groups have now developed integrating standards (e.g. ISDN and IN), it was too late for those Operators that had already implemented their networks, because the cost of upgrading to the latest standards would show negligible commercial benefit (interview Paterson 1994). This indicated a lack of interaction or co-operation between the standardisation working groups when initially developing their standards; an area outside the scope of this thesis, but perhaps worthy of future research.

The problems of network interfacing extends to existing non-IN networks, as evidenced by two of Survey 1 respondents (cbb25, cbc28) and five of Survey 2 respondents identifying issues interfacing with legacy technology. One Survey 1 respondent, employed by a Supplier, said that even the existing (CS1) standards were not defined to a sufficient level for true multi-vendor, multi-Operator implementation (bay05). For example, each Supplier, although implementing IN CS1, will have proprietary supersets[19] that can cause problems in one of two ways. Firstly, if an Operator implements a basic service using some superset features, then interconnection will need to employ a strategy that identifies how these

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[18] The problem associated with ISDN and IN interworking is discussed in detail in Chapter 4.

[19] One Supplier told the researcher that their company's IN implementation was a 'superset and subset' of ETSI IN CS1. i.e. at that point in time, it was mainly proprietary (Shepherd 1993)

superset capabilities are handled at the interconnect boundary (i.e. ceased, created or mapped[20]). Secondly, Operator interconnect services which implement primarily (proprietary) superset features, will need to adopt an interconnect strategy which determines how these capabilities are mapped onto another Operator's IN environment, which is likely to use proprietary features of another Supplier's equipment. The point to be made, is that standards aid and ease the interconnection process, but do not solve it.

The ability to develop services within the confines of a standardised Supplier's product, that is, to produce a service differentiated from the competition, was cited by many as an area for concern (IN12, IN14, IN18, IN26, IN50). As discussed in Chapter 4, the problem is that differentiation cannot be achieved utilising standard Service Independent building Blocks (SIBs), since anyone with a standard IN can replicate the services. Services employing proprietary SIBs can help produce differentiated services, which are only replicable by Operators using the same Supplier, but reduce the likelihood of the service operating between networks. (Chapter 4 discusses the different options available in this area in greater detail).

Operational Support Systems (OSS) were also identified as a problem by some respondents of Survey 2. Management standards have always lagged network standards, hence many Operators have developed bespoke management systems conforming to no general standards, which prevent an integrated service management approach. For instance, a customer requiring Time of Day routeing to a voice mail system will need their data entered into both the IN and voice mail management systems. Failure of the voice mail system will be detected by the voice mail management system, but it will be unable to notify the appropriate IN services application to prevent calls being routed to it. With an integrated management system, proactive action could be possible.

Five respondents to Survey 2, indicated the need for a standardised interconnect with the Internet. As discussed previously, this simple statement belies a number of different types of interconnection for different purposes and is discussed in detail in the 'Interconnecting with the Internet' section in this chapter.

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[20] A message needs to be ceased if it cannot be understood by the second network. A message needs to be created if it is expected by a service application, but the second network is unable to supply it. A message

Problem areas identified by respondents as most hindering the implementation of INs is the speed of development of the standards (also highlighted by Hawkins 1996) and the cost of implementation of standards (cbb25).

> 'The delay in bringing the ETSI or ITU standards through to delivery …leads to proprietary 'leaps of faith' by equipment manufacturers' (bby44).

Consortia (e.g. 3GPP, Parlay Forum etc.) are often created by industry to develop relevant standards, particularly in new technology areas. Initially, this would speed the standardisation process. With time however, acceptance can lead to bureaucracy and a slowing of the process, as highlighted by Hawkins (interview 1997). He mentions that Brian Carpenter at the IGF, when head of the Internet Protocol Architecture Board, said that their open standards enquiry and contribution processes were getting so much input that they couldn't possibly deal with it all and that they were trying to introduce levels of bureaucracy to filter out the contributions from the 'hackers and cranks' and start thinking seriously about what was of real value.

Eighteen of the respondents to Survey 1 indicated their companies were represented on relevant standardisation bodies. Although all the Suppliers were on both the ITU and ETSI bodies, the majority of the Operators were on ETSI (rather than the ITU). This reflects the European nature of the investigation, since ETSI works out the details of the implementation of ITU standards in Europe. The responses to this question also identified an interesting situation with the ETSI standardisation process. Where the EU Commission perceives that the availability of standards would prove useful to legislation, it direct ETSI to develop appropriate standards. If the key players setting the standards are those who will be most impacted by the legislation (i.e. the Operators), then surely they will design the standards to best benefit themselves and possibly minimise the impact of the legislation[21]. This argument helps reaffirm the OECD (1995) and McGowan et al.'s (1995) views, which

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needs to be mapped (i.e. transferred or altered in form or structure) in order that it can be understood by the second network's equipment.

[21] With time, personal experience has shown that the liberalised market and competition has increased the level of budgetary constraints within organisations. Telecommunications companies have consequently reduced their overall involvement in standards setting bodies, becoming much more selective of the areas in which they participate and focussing upon those which they feel will be of greatest benefit to their organisation. Thus the overall domination by Operators may have now reduced.

expressed concern with the domination of the European agencies by special interest groups.

Summary

This section has shown that the stakeholder community generally supports standardisation, particularly Suppliers who perceive benefits from supporting a standardised product. It also invalidates the view that Suppliers prefer proprietary standards, the thinking being that once an Operator has committed to a proprietary product, it would mean a captive market and reduced competition. In answering the question

- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?';

there is concern that standardisation to too great a detail, such as for SIBs, would create a situation where there was little service differentiation. Any Operator could easily replicate a competitor's service. Such action would therefore constrain innovative services, by restricting Operators to the standardised capability.

In answering

- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?';

this section adds to the evidence that for complex technologies such as INs, this is extremely difficult. Technology is continuously evolving and an architecture model cannot be future proofed; it is only appropriate at the instant in time at which it is created. Thus architectures will need to evolve to accommodate interconnection with other emerging technologies. What has been identified is that more care should have been taken with evolving the initial IN model, since it omitted interfaces to a number of established technologies, causing subsequent interworking limitations. Whilst standards are being developed, proper consideration should be given to integrating with other standards being developed in parallel.

Similarly, standardisation for supporting systems, such as management and billing, should be developed in parallel with those of the technology, to ease the process of support system integration.

Finally in answering

- 'Do the members of the standardisation bodies (often the employees of the incumbent monopolies) subvert the goals of the regulators';

it has been shown that the Suppliers and Operators actively participated in setting IN standards and have the opportunity to implement what is best for themselves. Where such standardisation is used in support of legislation, its impact will be weakened by the resulting standards. Similarly, if technology such as INs were forced on Operators, the Operators would have a vested interest with what happens within standardisation bodies, which could lead to an increase in contributions and greater bureaucracy, thus slowing progress and lessening the potential of the technology's future.

This section has examined the need for standardisation and shown that adherence to detailed standardisation can restrict service differentiation and hence delivery. This aspect is researched further in the next section.

6.9 The Impact of Regulation upon Service Delivery

The large majority (19) of the respondents to Survey 1 thought priority should be given to regulating interconnections between Operators. Given the nature of the survey, it is reasonable to conclude that all considered a level of interconnect between Operators at a higher level in the model hierarchy was required. This section examines the perceived impact of regulation upon service delivery, addressing in the process the research questions:

- 'Is legislative regulation the appropriate means to shape a technology in rapid change?'; and
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'

Ten of the respondents to Survey 1, thought priority should be given to regulating interconnection standards between Operators & Carriers, and Operators & Service Providers. Interconnect regulation between Operators & Information Providers was of a lower priority with only seven respondents selecting it. This aligns with the findings in the 'Standardisation' section, where 15 of the respondents thought there should be an EU led, agreed design for INs to allow interconnect, because 'Standards ...are the fundamental requirement in developing networks across Europe' (cba18) and '...adherence to minimum agreed standards' (cbb25), would help new entrants interconnect with existing Operators, encouraging '...market stimulation and growth' (bay01).

The key areas identified as needing regulation were access and network standards, closely followed by network integrity and data security (bay05, bay16, bay59). The use of personal data in telephony, within the bounds of the EU (1990) data security directive (which protects an individual's personal data by restricting what it can be used for), appears difficult. The directive appears contradictory in that it indicates data can be used for routeing a telephone call, but states that data must not be disclosed outside the organisation without prior authorisation. Operators work on the basis that a customer purchasing a service accepts such use of their data. There is a further problem though, in that in routeing a telephone call, some of a customer's personal data, or access to that data, may be given to another Operator to aid with the routeing. If for some reason that data is not used, then the directive is infringed. Such occurrences are very difficult to detect and police.

Some respondents thought that there should be no regulation regarding access (cbb25, day07, cbb14, bay59), since '...if interconnection is fixed, the development is difficult' (cbd03). The concern being voiced is that if a particular IN interface is deemed appropriate for interconnection, as intimated by the DTI (1992) survey and KPMG (1993) report, then future developments would be constrained within the stated bounds of the capability of that interface. Thus services that might make use of that interface may never be developed.

The UK, one of the earliest liberalised telecommunication environments in Europe, attracted the criticism that 'Government attitude *was* protecting existing Operators' (day08). A second consultant thought the regulators incompetent and proposed that regulation should be no more than implementation of articles 85/86[22] (day 14). The danger here is that in order to meet the requirements of Articles 85/86, an Operator may grant access to a non standard interface. Small Operators however, may not be able to use such an interface, being unable to justify the cost of developing a non standard interconnection. Offsetting this, UK and EU experience has shown that although there may be a plethora of small Operators following de-regulation, with time, these would have consolidated to a smaller number of larger players[23]. Longer term, access to non standard interfaces may not prove a barrier to interconnect, owing to the larger companies being able to justify the cost of developing such interfaces.

The cost theme is taken up by other respondents to Survey 2.

> 'The packaging of IN capability by a switch manufacturer makes IN offerings prohibitive in the start-up phases of an Operator introducing IN'[24] (bby44, supported by cbb25, bay48, cbc13, cbc09).

Although standardisation would lead to more competition and should force the cost of INs down, the introduction of INs is still an expensive option for small Operators. It could be argued that if, for regulatory purposes, an IN were forced upon an Operator it could cause them financial difficulties. A similar argument is that regulations compelling implementation of standardised INs, could financially disadvantage Operators should a proprietary IN being cheaper. In practice there now are no wholly proprietary INs and this situation is only likely to have occurred during a Supplier's transition between proprietary and standardised offerings.

A few respondents to Survey 2 commented that interconnection regulation with mobiles should be given priority and hence categorised separately. Since the protocols used for cellular INs are totally different from fixed INs and interconnect between the networks already exist at C7 level, the respondents must be inferring interconnect at a higher level in

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[22] Articles 85 and 86 refer to sections in the 'Treaty of Rome' (1957), upon which the structure of the European Union is based. Article 85 guards against anti-competitive practices and article 86 guards against the abuse of a dominant (market) position.

[23] Examples are the consolidation of Cable TV companies in the UK between 1996 and 2001 and in Europe the merging of telecommunications companies such as MFS, MCI and WorldCom.

[24] Suppliers don't necessarily allow Operators to select only the elements of their product which the Operator might be able to develop into a financially viable service. Making Operators purchase unnecessary capability together with than needed, could make the Operator's resulting service financially unattractive.

the architecture. This appears a valid point, since mobiles are increasingly prevalent and mobile/fixed line integrated services would be desirable.

Summary

This section has identified that there is a general need to regulate interconnection standards between competing Operators and between Operators and Service/Information Providers. In addressing the question:

- 'Is legislative regulation the appropriate means to shape a technology in rapid change?';

it appears that legislative regulation is appropriate to encourage interconnection and hence competition. This however requires more than just standardisation, extending to a level where the interconnecting parties are confident that operation of such interfaces will not compromise the operation or data security of their networks. In answering the question

- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?';

this section has also identified that tightly defined regulation of interfaces could restrict the use to which those interfaces are put and thus constrain the development of new services.

6.10 Chapter Summary

This chapter has drawn on primary data sources to address several of the research questions posed in Chapter 1. This summary considers each of the questions in turn and indicates from the gathered evidence, what a suitable answer might be. The questions addressed are:

- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'
- 'Is legislative regulation the appropriate means to shape a technology in rapid change?'
- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?'
- 'Do the members of the standardisation bodies (often the employees of the incumbent monopolies) subvert the goals of the regulators?'

In preparing this chapter, it was noted that a number of issues were echoed in different sections and whilst perhaps not significant within each individual area, they grow in importance with each iteration. For this reason they have been identified in this summary.

Intelligent Network Architecture

Examining the combined responses of the Suppliers and Operators there was little preference for any one of the three architecture models, with four of the Suppliers indicating that different models would be appropriate for different situations. There was a slight preference for the two alternative IN architecture models (Centralised and Mixed Distributed Processing) compared to the standardised centralised processing model. However, taking into account the Service Providers and Consultants, with their preference for a more open architecture and possible lack of awareness of the issues associated with such an architecture, the Mixed Distributed Processing model gains the greatest support due to its flexibility and/or speed of response.

A number of respondents to Survey 1 indicated that the various models were ideal for different product offerings (e.g. cellular or fixed), or as a migration stage - starting small and evolving. Such support highlights the fact that standardisation organisations need to expand the scope of their activity to embrace (or enable) a variety of evolving architectures, perhaps by reassessing the validity of their selected Architecture as part of 'next release' standard discussions. For example, the architecture required by a new Operator may need to be different to the architecture required by a large Operator introducing an IN as an overlay network, with a third architecture required by a large Operator employing an IN as their core network.

Survey 1 has therefore demonstrated that the standardised IN architecture is not necessarily the favoured model, since no one architecture can be described as being the optimum, as varying circumstances will favour differing models.

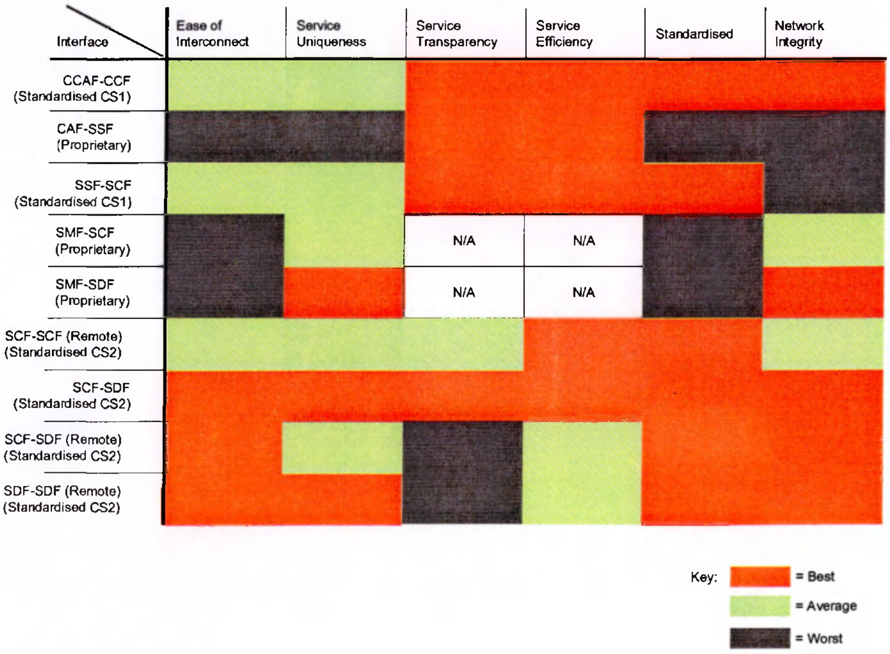
Although the architecture provides a high-level operating model, in order to provide a telephony connection across networks, the networks need to be interconnected. This chapter has shown that the interconnection of INs with existing support systems is essential in the offering of telecommunication services. With INs, the point of interconnection can be made at several points in the network, depending upon the level of sophistication and functionality the Operators want to provide. The flexibility of such interfaces governs the potential of INs which may be exploited.

Survey 1 identified the most appropriate interconnect points for the different stakeholders as follows:

- Service Provider	SSF - SCF (E);
- Customer	CCAF - CCF (A);
- Operator	CCAF - CCF (A); SCF - SCF (G); SSF-SCF (F);
- Carrier	CCAF - CCF (A); SSF-SCF (F).

The letters refer to those assigned to the interfaces in Figure 6.3

The responses to Survey 1 also identified the problems associated with the different interfaces. This together with additional information from interviews, publications and personal experience (Shepherd 1997), has been summarised in Table 6.10.



Interface	Ease of Interconnect	Service Uniqueness	Service Transparency	Service Efficiency	Standardised	Network Integrity
CCAF-CCF (Standardised CS1)	🟩	🟩	🟥	🟥	🟥	🟥
CAF-SSF (Proprietary)	⬛	⬛	🟥	🟥	⬛	⬛
SSF-SCF (Standardised CS1)	🟩	🟩	🟥	🟥	🟥	⬛
SMF-SCF (Proprietary)	⬛	🟩	N/A	N/A	⬛	🟩
SMF-SDF (Proprietary)	⬛	🟥	N/A	N/A	⬛	🟥
SCF-SCF (Remote) (Standardised CS2)	🟩	🟩	🟩	🟥	🟥	🟩
SCF-SDF (Standardised CS2)	🟥	🟥	🟥	🟥	🟥	🟥
SCF-SDF (Remote) (Standardised CS2)	🟥	🟩	⬛	🟩	🟥	🟥
SDF-SDF (Remote) (Standardised CS2)	🟥	🟥	⬛	🟩	🟥	🟥

Key:
🟥 = Best
🟩 = Average
⬛ = Worst

Table 6.10 Points of Interconnect - Ease and Value of Implementation

The columns of the table categorise the characteristics exhibited by each of the interfaces shown in the table rows. The colour of each cell indicates the ability of the interface to meet that feature requirement. An explanation of the key is given in Section 6.5.

The key problems identified with interconnecting different stakeholders were:

- Interconnect Compliance Testing - ensuring all signalling messages are understood and acted upon;
- Data Security - ensuring that only the specific data needed to process a particular service (e.g. call) is made available for that service;
- Network Integrity - ensuring messages cannot cause problems for each of the connecting networks;
- Highly Proprietary Interfaces, leading to integration difficulties with:
    - legacy networks;
    - existing Management systems;
    - existing Billing Systems;
    - other IN Suppliers equipment (e.g. GSM, billing and management systems);
    - the Internet.

All these 'problems' are interrelated. The use of proprietary interfaces generally means that the interface specification has not been released by the Supplier and that interconnection is not possible, except to more of the same Supplier's equipment. If the interface is open, then Interconnect Compliance Testing is needed to ensure that rogue commands from one network to another do not compromise Network Integrity (i.e. causing it to fail in some way) and that customer specific data held on the network cannot be retrieved by commands from a third party's network, except on a 'need to know' basis. This latter point highlights a grey area of what information should be considered essential for the efficient (intelligent) routeing of a call and could be released, and what should be withheld. The requirements will vary from network to network and service to service, depending upon their implementation. Regulatory agreements will not, and cannot, cover every eventuality and trust has to exist between the parties to instil confidence that a particular interface will be used in a sensible manner.

In answering the question:

- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?';

it is unlikely that exhaustive technical architecture models will ever exist prior to standard ratification, owing to differing and changing circumstances making alternative architectures attractive to different stakeholders at different points in time. Technology is continuously evolving and a model cannot be future proofed; it is only appropriate at the instant in time at which it is created. Thus architecture models will need to evolve to accommodate interconnection with other emerging technologies.

IN standards should be sufficiently flexible to accommodate differing architectures, including those not envisaged when the standards were initially ratified. This chapter also indicates that using the IN standardised model as the basis of regulation to open IN interfaces and interconnect could be inappropriate.

Similarly, standardisation for supporting systems, such as management and billing standards, should be developed in parallel with those of the technology, to ease the process of support system integration.

What has also been identified is that more care should have been taken with evolving the initial IN architecture model, since it omitted interfaces to a number of technologies established at the time, causing later interworking limitations. Whilst standards are being developed, proper consideration should be given to integrating with other standards being developed in parallel.

Industry Dynamics

The survey data indicated that although a significant majority viewed Intelligent Networks as important to their companies, few of the stakeholders were co-operating with each other (be it Supplier, Operator, Computer Manufacturer or Service Provider) to offer IN services. Personal perception at the time of Survey 1 confirmed a weak Computer Manufacturer/Supplier relationship. However, personal experience is that Operators are continually talking to their Suppliers about potential developments. The researcher is unable to satisfactorily explain the variance between the survey findings and personal experience, but it may be due to the fact that the majority of respondents come from areas within their organisations that do not have regular contact with their customers/Suppliers. The data in this area therefore appears inconclusive.

The surveys reveal a dilemma, in that the respondents wanted standardised INs (because it gives Operators purchasing power and easier interconnect) whilst retaining the ability to provide service differentiation. These two needs conflict. Services constructed from standardised Supplier offerings are easily replicated, therefore the use of highly standardised INs would force a change in focus in the Operators product strategy. The service differentiation from the customer's viewpoint would no longer be so much the service capability as the peripheral capability. Customers would place greater emphasis on the range of products, the level of service automation and support available and indeed the cost, to determine who gains their custom.

There is therefore a fine balance between standardising to great detail and stifling innovation and market development, and pitching standards at a level where the benefits of standardisation are minimised. Currently the (ETSI) standards define a feature set for universal working, allowing Suppliers to add their own SIBs and developing a super-set[25] of the standardised capability for innovative services. Regulation of interfaces may limit the use of such supersets.

Finally, it appears that one of the key advantages of INs, that of offering customers bespoke services, is limited (principally) by the SIBs available. Thus INs produce products that seek a market, rather than the reverse, this sector being a product driven market (OU 1985).

In answering the question:

- 'Is legislative regulation the appropriate means to shape a technology in rapid change?';

there appeared to be little communication between the stakeholder groups in discussing interconnection and interworking needs. It appears that legislative regulation is appropriate to encourage discussions about interconnection and hence promote competition. This is however more than just standardisation, extending to a level where the interconnecting

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[25] No Supplier produces equipment with a strictly standardised INAP. They all provide capability in addition to what has been standardised (i.e. the super-set), in order to provide different and supposedly more useful functionality than their competitors. This is in order to make their equipment more attractive to the Operators.

parties are confident that operation of such interfaces will not compromise the operation or data security of their networks.

However there is a danger that too tight a regulation or too detailed a standard could force stakeholders to adopt changes that can't be exploited, owing to the inherent limitations of their support systems, impairing the level of service able to be offered.

Standardisation

This chapter has demonstrated that the stakeholder community generally supports standardisation, particularly Suppliers who perceive benefits from implementing a standardised product. It also invalidates the view that Suppliers prefer proprietary standards in order to commit an Operator to their products. The issues identified by the surveys that are related to standardisation are, the interworking with other technologies, distributed processing standards, support system standards and standards Setting. These are considered individually.

i. Interworking with other Technologies

IN standards did not concentrate sufficiently on inter-working with the existing telephony infrastructure. Looking at the structure of the ETSI IN Working Group one year after Survey 1 (1997), the focus was still primarily on enhanced functionality and development of open interfaces (of limited benefit where the established communications network is of a different technology). One topic being discussed at the time, but only partially exploited, was CAMEL (Customised Applications for Mobile network Enhanced Logic), the intelligent interconnection of INs with Mobiles. CAMEL has (in the main) been used to develop pre-paid calling capability for mobiles. There was still an opportunity (arguably now missed), for using CAMEL to better integrate the fixed network and mobile network services.

As has been explained in Chapter 4, the development of fixed network IN standards has effectively ceased due to the shift in focus to other technologies. However, in the later versions of the standards (CS2 and CS4), interfaces to allow interworking with ISUP and packet networks were ratified.

ii. Distributed Processing Standards

Many of the issues related to distributed systems could have been resolved by closer examination of the computing industry. In particular, the telephony industry needed to adopt existing computing standards, architectures and protocols, in order to allow efficient distributed processing within INs. Distributed processing would have allowed several remotely located processors to appear as a single 'virtual' computer, aiding a movement away from the rigid IN standards model, without compromising its efficient mode of operation.

iii. Support System Standards

IN standardisation organisations needed to expand their scope of activity to include management and billing applications, in addition to the development of 'feature' specifications, in order to integrate with legacy management systems and provide end-to-end management visibility. Such standards should (as far as possible) have followed established generic standards to ease the process of integrating INs with the support systems of other technologies, providing an integrated service management capability.

This chapter has also shown that interconnection with the Internet would allow enhanced support services to be offered in conjunction with Intelligent Networks. In the main, these would be to allow the customer to gain access to a particular facility or service. In this way, the Internet is being used as a simple access mechanism, thus the interface to it is independent of the use to which it is being put. The only real issue of the interface is the provision of secure access/firewalling to protect confidential data.

iv. Standard Setting

The lengthy periods taken to ratify standards, leaves Suppliers (and Operators) with little option but to create proprietary solutions in order to enter the market first and capture market share. The associated risk is that their offerings will be so vastly different from standards when they are ratified, that inter-Operator working is made difficult.

When the standards are ratified, there is the additional danger that they are not necessarily designed for the needs of the market, leading to products for which a market must be sought. A specific example of this was described by Herian (interview 1996) in relation to IN standards. In this particular case, elements of the functionality enshrined in the standards were originally created to achieve targets, rather than have any marketable justification.

A related issue is that of standardisation body participation. In addressing the question raised in Chapter 1:

- 'Do the members of the standardisation bodies (often the employees of the incumbent monopolies) subvert the goals of the regulators?';

it has been shown that the Suppliers and Operators are the dominant participants in the ETSI standardisation body working groups that set the standards. Where such standardisation is used in support of legislation, the Operators, a primary target of regulation, could potentially endeavour to reduce the effectiveness of the standards created. Similarly if technology such as INs were forced on Operators, then the Operators would have a vested interest in what happens within standards groups, and the increase in technical contributions and resulting bureaucracy could slow the process and hence longer term impact of the technology.

Regulatory Environment

This section has indicated that interconnection at various points of the IN model may be desirable, but is not always possible owing to the proprietary nature of the interface. Adherence to minimum standards would facilitate interconnection (particularly benefiting new Operators interconnecting with existing Operators) and the universal adoption of a set of standard services would foster growth, resulting in lower costs. Thus there appears to be a general need to regulate interconnection[26].

Opponents of such regulation highlight the slowness of the standards definition process. They also argue that the implementation of a common level of functionality would restrict service differentiation and limit Operator opportunity, allowing successful services to be easily replicated by competitors. Defining a narrow regulatory framework, within which to offer IN type services, would give an Operator negligible opportunity for competitive differentiation of their services. Such an argument (although perhaps not the cause cited) is supported by Ungarer who writes that '…technology must be allowed to adapt to user requirements' (Ungarer 1990 p194).

GSM was cited several times as an example of what could be achieved with EU led regulation and standardisation. Examining the GSM service in 2000 there appeared little uniquely innovative development (i.e. new services which could not be replicated on a competitor's network) in the eight years since it was first implemented. An exception is 'Pre-pay', a service provided by a standardised IN solution (Camel) added to the GSM architecture, which took several years to be defined. Standardisation ensured that this new capability would interwork with GSM and thus was made available on all Operators networks within a short period of each other. It could be argued that without the need to standardise, an Operator would have implemented a proprietary solution earlier.

In answering the question,

- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?';

detailed standardisation in its own right has not been shown to constrain service delivery, since its adoption is voluntary and it is clear that standardisation will help regulation by easing the process of interconnection. However, there are a number of interconnection issues that need to be addressed in order to ensure satisfactory operation of that interface by both parties. In particular, it should be ensured that each party's network operation is not compromised by the other.

There is a danger that regulations that force stakeholders to implement a particular standardised technology could result in under-exploitation, owing to unforeseen issues or the inherent limitations of the existing support systems, and hence impair Service Delivery. There is also the concern that there appeared to be weak communications between the different technology groups in the standardisation forums. This resulted in INs not necessarily inter-operating with other technology protocols. Again, if the technology were forced upon an Operator, they might be limited by the level to which they could exploit it.

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[26] To some extent, regulation in the UK has forced the opening of IN interfaces through the regulation of products falling within the Supplementary Services Business (SSB) category having to have interfaces for

If INs as a technology was not forced upon stakeholders, but the need to standardise existing INs was, then a different range of issues arises. There is concern that standardisation at too great a detail, such as for SIBs, would create a situation where there was little service differentiation. Any Operator could easily replicate a competitor's service. Such action would therefore constrain innovative services, by restricting Operators to the standardised capability. Similarly, regulation that binds too tightly to standards will tend to inhibit innovative new services, which might make use of proprietary elements not yet standardised. The same applies to interfaces, the regulation of which, if too tightly defined, could restrict the use to which that interface is put and thus constrain the development of new services.

Afterword

Although the findings given in this chapter have been based on fixed network INs, they are applicable across a range of technologies. For instance, 3rd Generation (3G) mobile networks employ a centralised intelligence architecture. Similarly, centralised intelligence is being considered for offering services on packet networks, addressing the scalability issues which have traditionally limited the scope of their operation.

This chapter has addressed a number of the questions arising from the hypothesis stated in Chapter 1. It has drawn-in primary data gathered from surveys and interviews undertaken as part of this research. The next chapter summarises the findings discussed in Chapters 4,5 and 6 to assess the validity or otherwise of the hypothesis.

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third parties to interconnect to, in order that another Operator can offer the same service on their network. This was discussed in detail in Chapter 5.

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7 The Implications and Issues for the Regulation and Standardisation of Different Intelligent Network Models

7.1 Introduction

The focus of this research originally stemmed from an industry perception that Intelligent Networks in the UK would be directly regulated in some way. This and other observations, in the context of the emergence of Intelligent Networks, led to the development of the following hypothesis:

> *Tight architecture-based regulation is inappropriate for a rapidly changing[1] telecommunications environment, since that environment is continually challenging and redefining the boundaries of technological change.*

The hypothesis and associated arguments led to the development of a range of research questions:

- 'Are INs a service in themselves or simply a means to deliver services?'
- 'Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?'
- 'Is legislative regulation the appropriate means to shape a technology in rapid change?'
- 'How can it be ensured that robust technical and architectural models exist before standards are ratified?'
- 'Do the members of the standardisation bodies (often the employees of the incumbent monopolies) subvert the goals of the regulators?'

The goal of this thesis was to address these questions and contribute to their debate. It does this in the form of a series of observations and consequent recommendations. These address the micro level, such as the architecture of Intelligent Networks and specific standards, as well as the macro level, such as the standardisation framework.

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[1] 'Rapidly Changing' in this context indicates the continuous demand for new innovative telecommunication services overlaid with the frequent arrival of new technology. A compromise is always being sought for the benefits it brings and its potential longevity, verses developing what exists to meet market needs.

In addressing the questions a range of original research was undertaken. This included:

- an historical review of regulatory patterns for the UK telecommunications industry between 1837 & 2002;
- the development of original IN architectures and comparison analysis with the ITU-T architecture;
- the completion of a Stakeholder analysis and study of stakeholder attitudes;
- investigation of the impact of the UK telecommunications business model and development of alternative models;
- identification of stakeholder attitudes to IN architectures, the standardisation process and regulation, through surveys and interviews;
- identification of the preferred interconnection points for different stakeholder groups and the associated issues, through surveys and interviews;
- identification of the characteristics associated with different types of telecommunication traffic;
- development of UK and EU standardisation regulatory models, through literary research and interviews;
- development of an EU telecommunication regulatory model, through literary research and interviews;
- identification of the steps taken when implementing voice technology;
- development of a series of design considerations for the implementation of voice technology.

This chapter therefore considers the implications of the findings of the research, making appropriate recommendations. The research has shown itself to be centred around four key themes - Intelligent Network Architecture, Industry Dynamics, Standardisation and regulatory environment. The conclusions are presented according to these themes.

7.2 Intelligent Network Architecture

A number of IN architecture models were developed and evaluated for this research. They were analysed to assess their appropriateness for helping achieve a company's telecommunications product strategy and their ability to carry different traffic types. The research results suggested a marginal preference in using the Centralised and Mixed

Distributed Processing models compared to the standardised ITU-T model. The principle reasons identified were the flexibility and/or speed of response.

The optimum choice of Intelligent Network architecture was contingent upon a large number of variables, which differed between Operators. Furthermore, the models were seen as having differing benefits and hence ideal for different product offerings (e.g. cellular or fixed), or as a migration stage, such as starting small and evolving. This clearly indicates that the single model adopted by the ITU-T was not appropriate for all situations and that IN standards developed to this model may be inappropriate and non-optimal for alternative architecture models. The single model approach may even have hindered IN development.

The research also found that some Operators had developed non-standard architectures that provided optimal performance for their networks. The application of regulations developed assuming the standardised model, when applied to non standard models, could have restricted the optimum operation of those Operators' networks employing them. The research also showed that it was possible to develop models, which whilst utilising standardised interfaces, would create a barrier to interconnection. Wide deployment of such models would have inhibited the success of 'regulated interconnection' using the standardised interface.

The resulting standards are therefore a compromise and the associated technical architecture models will never receive unanimous agreement. The pace of change of technology is such that a model has most validity around the time it is created. Standards therefore needed to exhibit greater flexibility, so as to accommodate and evolve to architecture models never envisaged when the standards were conceived. Furthermore, they require a framework which eases the process of interconnection and interworking whilst such changes are occurring.

Although the architecture provides a high level operating model, telephony connections between customers serviced by different Operators necessitates interconnection. With INs, the point of interconnection depends upon the level of sophistication and functionality the Operators want to provide. The flexibility of such interfaces governs the exploitation potential of INs. The research analysed and summarised the advantages/disadvantages of different IN interfaces for interconnect. The most appropriate ITU-T IN architecture model interconnect points for the different stakeholders were identified as:

Service Provider	SSF - SCF;
Customer	CCAF - CCF;
Operator	CCAF - CCF; SCF - SCF; SSF - SCF;
Carrier	CCAF - CCF; SSF - SCF.

These interfaces are all signalling interfaces. Currently, Operators do not charge for signalling traffic but it has been found that this method of operation is open to abuse. Obviously the way of curbing any abuse is for operators to start charging for signalling queries, but this would necessitate an expensive revision of their billing capability.

Along with the preferred points of interconnect, the research also identified the problems associated with interconnecting via the different interfaces. The key issues raised by stakeholders were:

- Interconnect Compliance Testing - ensuring all signalling messages are understood and acted upon;
- Data Security - ensuring that only the specific data needed to process a particular service (i.e. call) is released for that service. The requirements depend upon the service implementation and will vary between networks, making it difficult to police;
- Maintaining Network Integrity - ensuring rogue messages cannot create fault conditions for either of the connecting networks;
- Proprietary Interfaces, leading to interworking difficulties with:
    - legacy networks;
    - existing network and service management systems;
    - existing Billing Systems;
    - other IN Suppliers equipment;
    - other technology standards.

The research clearly indicates that interconnection at various points of the IN model may be desirable, but is not always possible owing to the proprietary nature of the interfaces. Adherence to minimum standards would facilitate interconnection (particularly new

- Strategy – does the chosen architecture compromise or complement the company's development strategy?;
- Market - does the target market and the network's targeted traffic mix relate to the chosen architecture? Does it address each traffic type individually, or is it the best compromise?
- Delay - would the network be sufficiently large or geographically spread, or the centralised database have a large number of interactions (such as external database queries), where the query response time of centralised processing is unacceptable?;
- Reliability – would the network be geographically spread so that the reliability of centralised processing is unacceptable?;
- Churn - is there is a sufficient base of stable application or data, or significantly low churn of customer data or application changes, that a more distributed architecture appears attractive?;
- Updates - the volume and frequency of updates need to be reconciled with the management system capability, to ensure data population occurs in an acceptable time;
- Interworking - how conducive the architecture is to interworking with other networks/technologies and offering a seamless service between them;
- Integration – how well the architecture will integrate with existing technology, management and billing systems;
- Technology – is the ideal architecture able to be implemented, or do the Supplier's offerings impose a limitation?;
- Scalable – can the network architecture upgrade and develop when carrying live traffic?;
- Cost – is the architecture or size of network cost effective?

The consideration of 'Market' in the checklist identified the need to categorise the different traffic types likely to be expected by a network. The analysis of telephony network traffic records allowed the characteristics of different types of telephony traffic to be mapped and summarised. The types categorised were Basic Telephony, Televoting, Internet Access, Calling Card and Freephone. These can be used in the assessment of the appropriateness of a particular IN architecture.

Operators interconnecting with existing Operators) and universal adoption of a set of standard services would foster growth, resulting from lower costs. Regulatory agreements will not, and cannot, cover every eventuality, and trust needs to exist between the parties to instil confidence that a particular interface will be used in a sensible manner.

7.3 Industry Dynamics

The research has found that 'intelligence' in the network is not new and draws a parallel with the services originally provided by a human switchboard operator and some of those typically provided by an Intelligent Network. It has also found from the examination of different Operators' implementations of Intelligent Networks, that Operators progressively implemented INs in a series of four discernible steps depending upon the maturity of the technology and the role the Operator wanted it to perform in their telephony network. These steps were:

- Proprietary;
- Standardisation;
- Overlay (high in network hierarchy); and
- Fully Integrated.

The initial steps involve operating INs in conjunction with the Operator's existing network, which may include previous implementations of INs. The level of integration increases in complexity as the final step of 'Fully Integrated' is approached, at which point the whole Operator's network is an Intelligent Network. However, as the last step is approached, experience has shown that the problem of integration begins to include that of integrating with newer technologies (itself typically pursuing the four step cycle), or newer protocols. The need for integration has also been shown by the surveys to extend to the management and billing systems.

The need for such considerations gave rise to the development of the following list of design factors, appropriate when implementing a network. The list systematically identifies considerations to focus the Operator on checking whether an IN is an appropriate technology, which architecture might be best and other technical considerations affecting its success:

7.4 Standardisation

The research has shown that the action of standardisation is a generic activity shown to be necessary in the facilitation of regulation. It generates discussion among competitors that generally achieves an optimum compromise for the specification of a standard, maximising usefulness, technological benefit and potential adoption. However it has also found that external influences (e.g. time constraints and quotas) can have a detrimental impact upon the content of standards. The impracticality of 'compromised' standards are obvious only after time and non-adoption. Similarly the usefulness of standards varies with the economy. It is no use developing a network to the latest standard if the economy is such that Operators are unable to recoup their investment. Competing technology will also render the most excellent of standards obsolete, as has been demonstrated with the IN standards beyond CS2.

To aid the investigation of UK telecommunications standardisation, a UK standardisation model was developed. It shows the standardisation process is initiated by OFTEL, either through an Operator submitting an application for a new Supplementary Services Business[2] service or through a decision being made to develop a UK variant of an international standard. The specification of that interface is referred to the appropriate Network Interoperability Consultative Committee (NICC), which comprises all the interested parties (i.e. stakeholders likely to use that interface). The output of the committee is a binding UK specific specification.

Similarly the research investigated and developed a European standardisation regulatory system model in order to assess the interaction of standardisation and regulation. The model is shown to be centred around ETSI. The EU recognised that a European integrated telecommunications infrastructure was necessary for economic growth. ETSI aided the regulations put in place to achieve that growth, by producing pan-European standards which would be used for telecommunications interconnect by the different Operators, ensuring customers a seamless service across Europe.

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[2] In the UK, the DTI recognised that telecommunications liberalisation which introduced competition with the incumbent's (BT's) services, would not be by competitors covering all market segments, but by many competitors addressing individual market segments. To avoid unfair competition from BT cross subsidising services, OFTEL adopted the Systems Business/Supplementary Services Business accounting model, to help identify areas which needed to be accounted separately.

The EU Commission therefore directs ETSI to focus on the development of standards in areas which are envisaged as necessary to encourage technological development (e.g. GSM), or in support of legislation (such as ONP in support of liberalisation) and for these standards to be produced in a timely manner.

Interconnect (and influencing the standards to achieve it), also has a political agenda and shapes the form of the technology policy and regulation to encourage service interworking and prevent interconnect barriers from arising. Standards by their very nature need people with specialist knowledge and skills in their production. Survey 1 has shown that these specialists principally comprise telecommunications Operators and Suppliers, with the Operators arguably having influence over the Suppliers (whose equipment they will use to offer their services) in the form of purchasing power. Thus the model presents a situation where the standards which may be used in support of its legislation are influenced by the very group of stakeholders (the Operators) to which the legislation is directed. Thus although the EU/government may set the overall policy, the fine detail is still in the hands of the Operators. This would inevitably reduce the impact of any legislation which might rely heavily upon the support of certain standards in order to achieve its desired outcome.

IN standards do not focus sufficiently on interworking with the existing telephony infrastructure. It has been noticed that (prior to the Internet), more technologies/protocols have developed to work with INs than with each other (e.g. ISDN allowing SCP triggering). This flexibility, not shown with other technologies, (perhaps) indicates a characteristic which would encourage its longevity. INs could therefore be viewed as an 'enabling' technology, since standards-makers appear to need to make their standards work with INs in order to help their technology gain acceptability. Thus standards bodies should give greater thought to developing interfaces between existing and emerging standards to ensure an acceptable level of interconnect from the outset. Similarly standardisation for supporting systems, such as those related to management and billing, should be developed in parallel with those of the technology, to ease the process of integration with existing systems.

Thus liaison is needed between different standards bodies and between the different interest groups within a body to ensure that optimum standards are developed. However, liaison between interest groups with their own agendas makes the whole standards process more complex and slows it down. Other difficulties result from the perceived need of two co-operating bodies each to retain/own the developing standard, or by the very different operational nature of the two standards organisations. For example, the bureaucratic and hence typical slowness of the ITU-T compared with the speed of the IETF, has hindered their co-operation and led to the development of competing standards (e.g. H323 & SIP).

The different IN architectures developed for the research identified the necessity of additional interface standards. Standards existed within the computer environment and needed to be ported, adapted and adopted by the telephony environment.

IN standard organisations needed to expand their scope of activity to include management and billing applications, in addition to the development of 'feature' specifications, in order to integrate with legacy management systems and provide end-to-end management visibility. The surveys have also shown that interconnection with the Internet would allow enhanced support services to be offered in conjunction with Intelligent Networks.

The lengthy periods taken to ratify standards leave Suppliers (and Operators) with little option but to create proprietary solutions, in order to enter the market first and capture market share. The associated risk is that their offering, being so vastly different from standards when they are ratified, make inter-Operator working difficult.

Information arising from the interviews showed that ratified standards were not necessarily designed for the needs of the market, this leading to products for which a market is sought. Elements of the functionality enshrined in the standards were originally created to achieve targets rather than have any marketable justification.

Another view was that the demand for new features exceeded the rate at which standards were agreed and thus could be helped by speeding the standardisation process. Countering this was the view that standardisation prevented an Operator from producing unique services. The surveys revealed a dilemma, in that the respondents wanted standardised INs (because it gave Operators purchasing power and easier interconnect), and they also wanted the ability to provide service differentiation. These two needs conflict. Services constructed from standardised Supplier offerings could be easily replicated, therefore the use of highly standardised INs would force a change in focus in the Operators' product strategy. There is therefore a fine balance between standardising to great detail and stifling innovation and market development, and pitching standards at a level where the benefits of standardisation are minimised.

The findings therefore tend to suggest that standardisation organisations should concentrate on making IN standards more applicable and flexible to encourage innovation. Additionally they should start developing management interface standards. This is unlikely to help interfacing with legacy systems, but should aid future technology integration with the IN support systems.

Opponents of such regulation highlight the slow standards definition process. They also argue that the implementation of a common level of functionality would restrict service differentiation and limit Operator opportunity, allowing successful services to be easily replicated by competitors. That is, defining a narrow regulatory framework within which to offer IN type services would give an Operator negligible opportunity for competitive differentiation of its services.

7.5 Regulatory Environment

Research of the history of telecommunications regulation, has shown that the attitude to, and hence the regulation of, the telecommunications market in the UK has been cyclical, as the technology developed. Both Telegraphy and Telephony have followed similar regulatory courses. As the new technology developed and was implemented to offer a public service, a free market was created, which was subsequently licensed/nationalised by the government. It was argued that this would encourage efficiency, quality of service and be in the defence interests of the country. In the case of telephony, a retreat occurred when telephony was de-nationalised and reverted to licensing in 1984. Such cycles reveal a restrictive set of tools with which to implement telecommunications regulation, these being licensing and nationalisation. This trend of innovation, licensing, nationalisation etc. could perhaps be used to predict the future regulative position of newer communications technology such as the Internet.

The current UK regulatory regime is heavily influenced by a business model dividing products into the three categories of Network Business, Systems Business and Supplementary Services Business. The research perceived anomalies within the UK licensing regime based around this model (since rectified), with a number of Service Providers being allocated Operator licences which gave them an interconnection rate advantage over other Service Providers. The research also discovered limitations associated with applying the business model to other technologies and developed alternative business models which were less technology orientated.

In the UK, EU telecommunications directives are generally passed into law and implemented and enforced by the UK regulator OFTEL. Telecommunication Service Providers (Operators etc.) are licensed; the type of licence indicates the scope of the services they can offer and the conditions under which they can offer that service.

Information from literature and interviews allowed the investigation of the EU regulatory process and development of the European Telecommunications Regulatory model. The model links with the EU standardising process model through DGXIII, indicating that regulation operates at both the competitive (regulatory) level and also arguably, the technical (standards) level. The regulatory system also links the EU commission with Member State regulators.

A concern identified by the regulatory model is that the Commission can take unilateral action, independent of the Council of Ministers or European Parliament. That is, there is no accountability to Member State representatives for its actions. However this has not shown itself to be a problem in the telecommunications environment.

The application of regulation can be supported by appropriate standards. The danger with this is that the standardisation process can be considered relatively slow, especially when the technology reaches maturity.

Across the EU there are a number of anomalies between the licensing structure and hence accounting model; consequentially, companies find a number of countries in which it is easier to gain a foothold compared to others. Although such biases have been reduced since 1998, regulation in the form of new EU directives due to be implemented in June 2003, is designed to further ease and equalise regulation by Member States.

The Surveys revealed that the majority of respondents thought there should be an EU led, agreed design for INs. The reasons given were that adherence to minimum standards, would facilitate both interconnection, (particularly by new Operators with existing Operators), and the universal adoption of a set of standard services encouraging market stimulation and growth, resulting in lower costs. However, with standards being developed and Suppliers supporting those new standards, Operators adopting/upgrading an IN will purchase new kit conforming to standards. Thus if the standards are in place, they will be implemented by default, giving Operators buying power, reducing costs and encouraging new entrants through reduced costs and standardisation. Alternatively, the application of regulations to INs (as was hinted at by the DTI in 1992 (DTI 1992)) which force Operators to (potentially adopt an inappropriate IN model and then) open those IN interfaces to access to other Operators could reduce the efficient operation of that Operator's telecommunications network.

Similarly the research has shown that it is possible to adopt an architecture model which is different to the standardised model, yet adheres to the standard interface specifications. This has demonstrated that should regulation be applied to open those standardised interfaces (without considering the underlying architecture model), then the regulation could be made ineffective.

The research also raised the question of what the outcome would be if Operators utilising proprietary INs were made to open interfaces for interconnect. Being proprietary the manufacturers would almost certainly not allow this to be done. The EU could then apply anti-competitive regulations to the manufacturer, if there was sufficient evidence that not opening the interface led directly or indirectly to a detrimental effect on the telecommunications service industry. Although opening such interfaces was researched, time has shown that proprietary interfaces were not regulated, due to the prohibitively high cost of adaptive engineering for other supplier equipment to work with such interfaces and the development of open IN standards which were adopted by the Suppliers. Thus in practice, it was found (certainly in the UK) that upgrading IN capability and introducing a new IN, involved implementing equipment which conformed to international standards.

The functionality required by interfaces, was limited to only that required for the services affected and interconnect has been left to apply/negotiate by the individual country regulators.

It has been shown that strong standards can be put in place without regulation (e.g. GSM), but not necessarily without being given a formal focus (such as by the EU commission). However, (using the example of GSM again), it has also been shown that tight specifications, although aiding initial implementation, has long term stifled innovation due to the tight regulation of interfaces.

7.6 Conclusion

Although the focus of this research has been upon Intelligent Networks, the conclusions arising from it can be applied to a range of technologies and situations. For instance, the research has shown that the introduction of (voice) technology follows a series of four stages - these being Proprietary, Standardisation, Overlay and Fully Integrated. The steps taken by an Operator in implementing a particular technology will depend upon a series of factors including the appropriateness of its existing network, the level of investment available and the maturity of the standards of the new technology.

The research has also found that the process of standardisation is a generic activity shown to be necessary in the facilitation of the regulation of interconnection. Standards generation is organised primarily by international standardisation organisations. The standardisation process generates discussion among competitors, the resulting standards being a compromise maximising usefulness, technological benefit and potential adoption. However, they will not be ideal for everyone. Any technical architectures associated with the standards will therefore never receive unanimous agreement. Additionally, technology is continuously evolving and differing and changing circumstances will mean an architecture is only appropriate at the instant in time at which it is created. Standards therefore need to exhibit sufficient flexibility to accommodate and evolve to differing architectures perhaps never envisaged when the standards were conceived, yet create a framework which eases the process of interconnection and interworking whilst such changes are occurring.

The literary research and interviews also found that external influences such as time constraints and quotas can have a detrimental impact upon the content of standards. The impracticality of such 'compromised' standards are not immediately obvious, this only being revealed with time by their non-adoption. Other influences similarly reduce the usefulness of standards. A weak or failing market economy would prevent Operators from adopting the latest standards, since they would most likely be unable to recoup their investment. Similarly, competing technology will also render the most excellent of standards obsolete.

Legislative regulation encourages discussions about standards and interconnection, with both the EU and the World Trade Organisation (WTO) having an influence on the standards produced by ETSI and the ITU-T respectively. The ultimate aim is to use the standards to help promote competition. However to maximise usefulness, such standards need to be more than just interconnect; the scope needs to broaden to encompass operation (secure operation) and management standards in order to enable integration with similar elements of different technologies.

It has also been shown from the surveys, that the Suppliers and Operators are the dominant participants in the ETSI standardisation body working groups. Where the resulting standardisation is used in support of legislation, the Operators, a group such legislative regulation is likely to target, are in a position to potentially reduce the effectiveness of the standards created.

The application of regulation can therefore be supported by appropriate standards. History has shown that regulations formulated for one situation often expand to embrace other situations not envisaged at the time they were conceived. It is therefore possible that if regulation were not carefully chosen, it would effectively restrict the types and flexibility of the services offered to customers.

The danger with this is that the surveys showed that the standardisation process was considered by some to be relatively slow, especially when the technology reaches maturity. Operators bound to adherence to the standards through regulation, would perhaps tend to get frustrated by the slow process limiting the speed at which they can introduce new services.

Depending upon the level of regulation and the supporting standards, a number of problems could arise. Implementation of inappropriate standardised technology would mismatch with company strategy, resulting in the danger of under-exploitation owing to unforeseen issues or the inherent limitations of the existing support systems. This will impair the level of service able to be offered. Similarly, binding regulation to over-detailed standards would create a situation where there was little service differentiation and a constraint on innovative new services which might normally make use of proprietary elements. Likewise with interfaces, the regulation of the use of which, if too tightly defined, will restrict the use to which that interface is put and thus constrain the development of new services. Thus any Operator could easily replicate a competitor's service. Regulation should therefore take account of the level of detail of supporting standards and should not be applied at a level which would inhibit service development.

The research commenced with five research questions (Chapter 1):

- Are INs a service in themselves or simply a means to deliver services?
- Does regulation or detailed standardisation constrain technical innovation, service delivery, or both?
- Is legislative regulation the appropriate means to shape a technology in rapid change?
- How can it be ensured that robust technical and architectural models exist before standards are ratified?
- Do the members of the standardisation bodies (often the employees of the incumbent monopolies) subvert the goals of the regulators?

The research has demonstrated that association of rigid architectures with standards will inhibit Operator flexibility and hence product development. It has identified the EU and UK regulatory and standardisation processes and shown that in the case where standardisation is used to support regulation, the development of the standards is subject to the influence of those parties to whom the regulation will eventually apply. Regulation should not therefore be shaping the technology, but encouraging its implementation and interconnection through the development and adoption of its standardised capability.

In essence, the research has contributed to the debate, helping to confirm that

> *'Tight architecture-based regulation is inappropriate for a rapidly changing telecommunications environment, since that environment is continually challenging and redefining the boundaries of technological change.'*

7.7 Future Research

Although the focus of this research has been upon Intelligent Networks, the conclusions and recommendations arising from it can be applied to a range of technologies and situations. Such new technologies including the 3rd Generation (3G) mobile telecommunication systems (UMTS), which employs an Intelligent Network architecture (albeit with different terms and functions to those used for the fixed line network), and Voice over Internet Protocol (VOIP) which use centralised call servers. As connectionless networks are more widely employed and carry ever increasing traffic, many issues addressed in fixed line networks, are being discovered anew (e.g. point to point links reducing network traffic and guaranteeing an acceptable Quality of Service)[3]. The focus for future research, although arising from that based on fixed network INs, is just as applicable to these new technologies.

The concept of centralised intelligence can still be seen to have benefits in Internet protocol (IP) networks. The functions performed by an Intelligent Network's SCP and SDP will still need to exist within the new technologies[4] and thus the lessons learnt are still applicable. An example of a new service on an Internet Network is a centralised application, accessible by Customer Premise Equipment (CPE), which determines the Quality of Service across the Internet. The application could send test messages and/or interrogate the management network to gather information on Network Performance at that point in time and this could be reported back to the CPE to adjust the requirements of the application (such as a video conference).

Future research focussed on the Internet could not only address architecture and interconnect issues, building upon the work undertaken with Intelligent Networks, but could also observe its regulatory development to determine if the phases traversed follow a similar course to that of telegraphy and telephony in the past, even though the majority of changes in regulation to these occurred a century or more ago.

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[3] These 'scaling' issues have served to reduce the cost advantage of connectionless networks over TDM the Atlantic and four times cheaper compared to TDM land lines in the UK (interview Topliss 1998).networks, from initial estimates of ten times cheaper to less than half the cost in some cases.

[4] For instance the routers in an IP network are analogous to a distributed intelligence structure, the capability of which is easily able to be changed via a management network. The Domain Name Server (DNS) serves as a central translation capability converting Universal Resource Locators (URLs) to Internet Protocol (IP) addresses.

This proposition is supported by the similarity between the arguments of 'better quality of service', 'universal service' and 'national interest (security)', originally used to justify greater controls of telegraphy and telephony and those currently being directed at the Internet. For instance, numerous court cases in the US against Internet Content Providers (for typically defamatory matter) may lead to licensing ('better quality of service'). Greater access for all could lead to government investment (and associated control - 'universal service'). Terrorist web sites and those inciting civil unrest may be perceived as a national security threat and result in greater government control ('national interest'). That is, the arguments used for licensing telegraphy and telephony in the 19th & 20th Centuries can be applied with equal validity to the Internet in the 20th & 21st Centuries.

However, Intelligent Networks will continue as legacy networks for many years and the emergence of Voice over Internet Protocol technology identifies its integration with INs as crucial to offering the technology in a public network environment. It could perhaps be argued that the responses to Survey 2 were an early indicator of this. Thus the Optimum architecture model and operation for Intelligent Network/Internet interworking could be investigated.

A further area of research would be to confirm the survey findings that the lengthy time setting periods for standardisation or over-detailed standardisation were limiting factors in offering services, as claimed. Alternatively it may be found that Supplier-provided super-sets to the standardised requirements negated this.

The research additionally identified a lack of co-ordination (and possibly co-operation) within and between standardisation organisations when initially developing standards, leading to restricted operation (e.g. ISDN and CS1). Research could examine this and compare it with the way the Internet Engineering Technology Forum (IETF) operates in producing standards. With telephony standards and Internet standards becoming closely related, it would be interesting to examine the mutual impact of the organisations, given their vastly different ways of working.

7.8 Chapter 7 References

DTI 1992: 'Intelligent Networks, a consultative document', DTI, December

Appendix A.1 Copy of Postal Questionnaire (Survey 1)

Open University Survey of the Regulation of Intelligent Networks

Fax Return Box

Only to be completed if you wish to receive a report of the survey.

For the Attention of John Shepherd or Nick Heap

Fax To: + 44 1908-653658

From: ____________________

Company: ____________________

Position: ____________________

Address: ____________________

1. General

1.1 Your Organisation is? (Mark the one which best applies from your viewpoint)

Public Telephone Operator[1]
Supplier
Regulator
Standards Body
Service Provider
Consultant
Government Body
Customer (End User)
Other (Please State) ____________________

1.2 Your area of expertise is? (Mark one only)

Sales
Network Strategy
Network Implementation
Marketing
Network Design/Development
Network Operations
Other (Please State) ____________________

2. Technical Strategy

2.1 Has the concept of Intelligent Networks (IN) been considered in formulating your organisation's plans for Telecommunications?

Yes No

2.2 How important is IN for your organisation? (please circle one option)

Very Important | Fairly Important | Not Very Important | Not at all Important | No Opinion

2.3 Is your organisation (directly or in co-operation with any other organisation) considering offerings in the provision of IN services (Free Phone, Call Distribution etc.)? (Mark all that apply)

Public Telephone Operator
Switch Manufacturer/Supplier
Computer Manufacturer/Supplier
Service Provider
Information Provider
Not Applicable
Other (please state) ____________________

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[1] The term 'Public Telephone Operator' (PTO) was common at the time of the survey, but now appears dated. This thesis therefore uses the shortened form 'Operator' in its discussions.

3. Architecture and Services

3.1 Which of the IN architectures/models, shown in Figure 1, do you think is most appropriate?

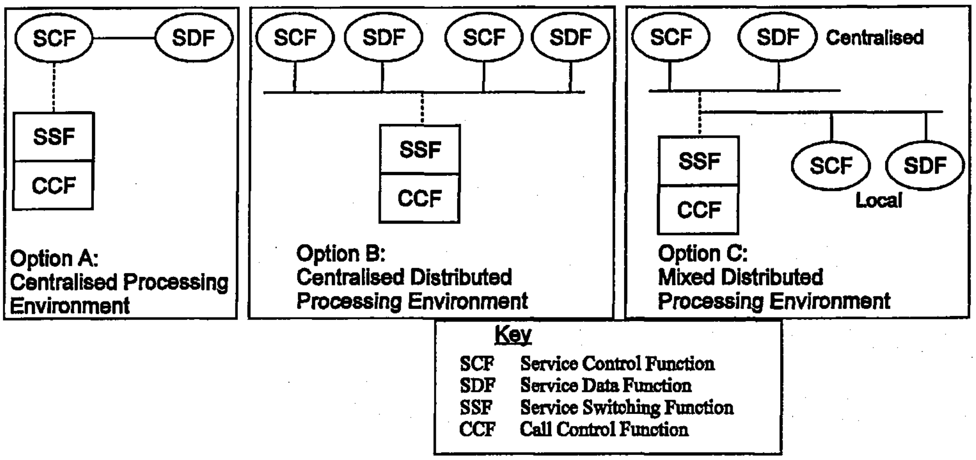


Figure 1 CS1-IN Architectures

Option A Option B Option C

Other (Please State) ______________________

3.2 What is the main reason for your choice of architecture in answering Question 3.1?

(Please write in)

____

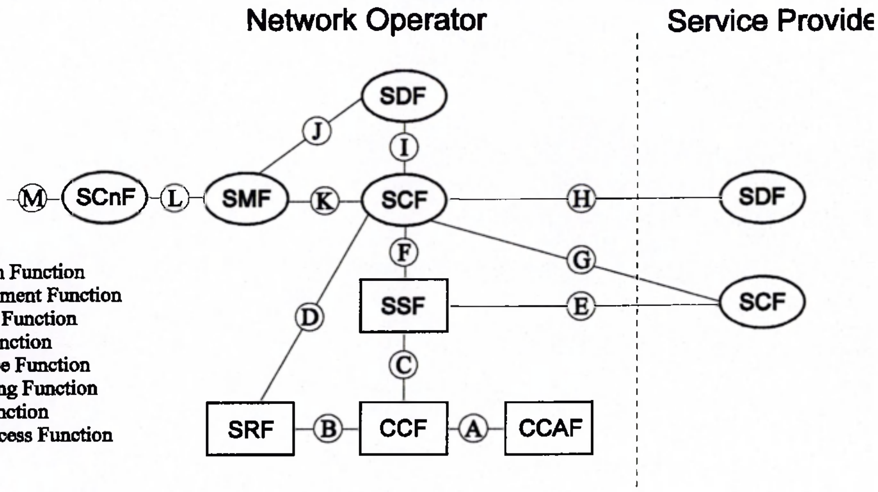
____

3.3 What do you regard as the priorities that should be agreed from a regulatory viewpoint regarding IN interconnect access by third parties and the reason why?

(Please mark in order of priority 1=most important, 5=least important)

Interconnect by	**Priority**	**Reasons for priority**
PTO		
Carriers		
Service Providers		
Information Provider		
Other (Please State)		
None		

The following diagram should be used to answer questions 3.4 and 3.5. If the terminology is unfamiliar, please mark the 'Don't Know' boxes.



Key

SCnF	**Service Creation Function**
SMF	**Service Management Function**
SCF	**Service Control Function**
SDF	**Service Data Function**
SRF	**Service Resource Function**
SSF	**Service Switching Function**
CCF	**Call Control Function**
CCAF	**Call Control Access Function**

Figure 2 IN Interconnect Points

3.4 **What do you feel is the most appropriate interconnect point for each of the following operators?** (Ring the appropriate letter by reference to the Figure 2.)

Operator	**Interconnect Point**												
Public Telephone Operator	A	B	C	D	E	F	G	H	I	J	K	L	M
Carrier	A	B	C	D	E	F	G	H	I	J	K	L	M
Service Provider	A	B	C	D	E	F	G	H	I	J	K	L	M
Customer (End User)	A	B	C	D	E	F	G	H	I	J	K	L	M
Other Operator (Please State)	A	B	C	D	E	F	G	H	I	J	K	L	M
Don't Know	A	B	C	D	E	F	G	H	I	J	K	L	M

3.5 **What are the associated problems with the interconnection points you have chosen for Q 3.4?** (Ring the letters of the problems which apply - see Key below - and add any additional problems you feel are relevant.)

Operator	**What are the Problems**					
Public Telephone Operator	*IC*	*IP*	*CR*	*DS*	*NI*	*SD*
Carrier	*IC*	*IP*	*CR*	*DS*	*NI*	*SD*
Service Provider	*IC*	*IP*	*CR*	*DS*	*NI*	*SD*
Customer (End User)	*IC*	*IP*	*CR*	*DS*	*NI*	*SD*
Other Operator (Please State)	*IC*	*IP*	*CR*	*DS*	*NI*	*SD*
Don't Know						

Key (for Q 3.5)

Interconnect Compliance Testing	*IC* *DS*	Data Security
Interface highly proprietary	*IP* *NI*	Network Integrity
Conflict with current Regulations	*CR* *SD*	Service Differentiation

3.6 **How important would you rate the use of open interconnect standards for INs?** (Mark the one which best applies)

Very Important	Fairly Important	Not Very Important	Not at all Important	No Opinion

3.7 Should there be an EU led, agreed design for INs in each EU state to allow interconnect (with transparency of services across networks)?

Yes No Don't Know

3.8 What is the main reason for choosing the answer you have, to Q3.7
(Please write in)

3.9 What key regulations and limitations should be imposed on Licensed Operator's INs?
(Please write in)

3.10 What is the one major problem that would hinder the implementation of INs in your country, Europe and World-wide?(e.g. standards, regulations, interconnect, government attitude etc.) (Please write in)

3.11 Is your company involved in any (IN) standardisation or policy setting groups?
(Mark all that apply)

ETSI
EURESCOM
Bellcore
Other (please state)

ITU (CCITT)
TINA
RBOC (please state which)

4. Other Comments

If there are any other comments you would like to add, please use the space below:

Thank you for your help and mark here if you would like a copy of the summary of the study

Yes
Please enclose a business card with your reply or
complete the fax return box on page 1

No

Appendix A.2 The Reference Code, Adopted for the Postal Questionnaire (Survey 1)

An example reference code is *c:\surv\xxxn1n2p.c*, where

xxx	industry sector (see list below). e.g. *bay*
n1	Company identifier. e.g. *09*
n2	Recipient. e.g. *01*
p	identifies the format of the survey used. If a major error with the survey contents was discovered and its contents altered, the letter (*p*) would have changed. This would have allowed the version of the survey to have been tracked. Since the content of the survey did not need to change after the trial, only one letter has been used. e.g. *p*
c	identifies if the recipient has returned the initial (*i*) copy of the questionnaire or a copy enclosed with the reminder(s) e.g. *c*

1. POLICY	(a)
1.1. Europe	(aa)
1.1.1. UK #	(aaa)
1.1.2. European Union #	(aab)
1.1.3. Rest of Europe	(aac)
1.2. North America	(aby)
1.3. Pacific Rim	(acy)
1.4. Rest of the World	(ady)
2. SUPPLIER	(b)
2.1. Switch #	(bay)
2.2. Computer/Software #	(bby)
3. OPERATORS	(c)
3.1. International #	(cay)
3.2. National - Europe	(cb)
3.2.1. UK Local #	(cba)
3.2.2. UK National #	(cbb)
3.2.3. European Union #	(cbc)
3.2.4. Rest of Europe	(cbd)
3.3. National - North America	(ccy)
3.4. National - Pacific Rim	(cdy)
3.5. National - Rest of the World	(cey)
3.6. Service Providers- Europe #	(cf)
3.6.1. UK	(cfa)
3.6.2. European Union	(cfb)
3.6.3. Rest of Europe	(cfc)
3.7. Service Providers - North America	(cgy)
3.8. Service Providers - Pacific Rim	(chy)
3.9. Service Providers - Rest of the World	(ciy)

4. CONSULTANTS	(d)
4.1. Europe #	(day)
4.2. North America	(dby)
4.3. Pacific Rim	(dcy)
4.4. Rest of the World	(ddy)
5. USERS	(e)
5.1. Europe	(ea)
5.1.1. UK #	(eaa)
5.1.2. European Union #	(eab)
5.1.3. Rest of Europe	(eac)
5.2. North America	(eby)
5.3. Pacific Rim	(ecy)
5.4. Rest of the World	(edy)
6. Standards	(f)
6.1. Telecommunications	(fa)
6.1.1. World-wide	(faa)
6.1.2. European Union	(fab)
6.1.3. North America	(fac)
6.1.4. Pacific Rim	(fad)
6.1.5. Others	(fae)
6.2. Computer	(fa)
6.2.1. World-wide	(faa)
6.2.2. European Union	(fab)
6.2.3. North America	(fac)
6.2.4. Pacific Rim	(fad)
6.2.5. Others	(fae)

An example of a questionnaire reference therefore would be *c:\surv\bay0901p.i* indicating a response from person 1 in company 9 which is a switch supplier.

Appendix B Copy of Conference Questionnaire

(Survey 2)

Intelligent Networks '99

(IIR Telecoms & Technology LONDON)

Dear Delegate,

I hope you have found this year's conference useful and informative ... and fun! I am now in the process of planning our next IN conference for May '99 in London, and would like to get some specific feedback from you on the programme content, so that I can ensure your most critical questions are answered at IN'99. So, I'd be grateful if you would kindly take a few minutes to answer the following questions, and hand this form back to me at the end of the day.

Thanks in advance and enjoy the rest of the event!

Regards
Mandana

Your Name: ....

Your Job Title: ....

Your Company: ....

1) What is the biggest IN challenge facing you on a daily basis, as an individual working in this sector, and why?

....

....

....

2) What are the most critical challenges currently facing your organisation in terms of:

a. IN Network Design & Implementation

....

....

....

b. IN Operational Support Systems

....

....

....

c. IN Service Development

....

....

....

d. IN Services Marketing

....

....

....

e. IN & Internet Convergence

....

....

....

3) What topics were missing from this year's event that you would like to have addressed at next year's event?

....

....

....

4) Which operator case studies are you most interested in & why?

....

....

....

5) Which Vendors are you most interested in hearing from & why?

....

....

....

Please hand this form in at the registration desk.
Thanks again and I look forward to welcoming you to our future events.

Appendix C UK Licence Types (correct as of 1998)

The UK Telecommunications Act (DTI 1984) with a subsequent amendment, the 1991 White Paper (DTI 1991c), detailed the two categories of telecommunications licence available. These were:

- Class Licence;
- Individual Licence.

Class Licences

A Class licence authorised the operation of telecommunication systems which match a pre-defined type. These licences applied automatically to any person or company who met the requirements set out in the licence and did not have to be specifically applied for, or granted. In this way, (together with the individual licences) the operation of essentially all the UK telecommunications equipment was subject to a licence. The advantage of this, was that OFTEL who granted and oversaw the operation of licences, could, should the need arise, alter licensing conditions fairly easily, without recourse to government. If no licences addressing these areas existed, changing conditions of operation such as new areas needing individual licences would require an act of parliament.

Two of the more important Class Licences, were 'Self Provision' and 'Telecommunications Service'. The Self Provision Licence (SPL) authorised the self-provision of any telecommunication system provided that the system was not used to provide service to third parties for profit. Additionally, a message conveyed on the system must either originate or terminate with the Licensee. At the simplest level, the licence allows a person to use a telephone at their home. On a more complex level, the licence allows companies to own and operate their own internal telecommunications equipment. The Telecommunication Service Licence (TSL) is very similar to the SPL except that it allows the provision of data service to third parties for profit. i.e. the provision of International Simple Data Resale to specified countries and offshore systems.

Individual Licences

PTO Licence

If Section B of the 1984 Act was deemed to apply to a licence, then the DGT designated the system a 'Public Telecommunication System' and the associated licence was known as a Public Telecommunication Operator's (PTO) licence.

Between 1984 and 1991, numerous Individual licences were granted, especially for the provision of Cable TV (see later), but only two Public Telecommunication Operator licences were granted. These were to British Telecommunications plc. (BT) (DTI 1991a) and Mercury Communications Limited (MCL) (now Cable & Wireless (C&W)) (DTO 1991b) and were issued to allow the operation of a national public fixed networks for seven years. The aim of only granting two PTO licences[2] was to give MCL a period of minimum competition to establish its network. In 1991, the government White Paper (DTI 1991) reviewed this policy and ended the monopoly of these companies and allowed the renewal of BT's and MCL's licences as well as the issuing of further Public Telecommunication Operator licences.

Typical Licence Overview

The licence is for a 25 year period, subject to the Conditions and unless revoked. It authorises the running of telecommunication systems throughout the UK and provision of any telecommunication service except:

- International Simple Voice Resale, to a country not designated by the Secretary of State (SoS);
- International Simple Data Resale, without specific SoS agreement;
- the conveyance of television programmes for the use of more than one property, or at one place by members of the public;
- mobile telephony;
- the transmission/reception of live speech, to/from satellite if the speech originates or terminates on another country's Public Switched Telephone Network (also known as breakout).

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[2] Kingston Upon Hull Telecommunications was a third PTO licence which was issued, but being restricted to operation in a small geographical area, did not have a significant impact on the environment in which BT and MCL operated.

Interestingly there were a number of Conditions, common to BT's and C&W's Licence, which were absent from the post 1991 PTO licences. These included no conditions which:

- prohibited the licensees from providing a product to a customer on condition they must also take another product;
- prohibited cross-subsidisation between different parts of the licensee's business;
- restricted the abuse of intellectual property to gain an unfair market advantage (although if on a sufficiently large scale, EU competition law would apply).

Cable TV

Cable TV operators required two licences that enabled them to provide services. The first was granted under the Broadcasting Act 1990, which defines the area within which the Operator can provide television and radio services. The second was a licence issued under the Telecommunications Act 1984, which authorises the licensee to operate networks. The licence allows the provision of telecommunication services of all types including conveying television, radio and telephony, but not mobile telephony.

International Simple Resale Licences

International Simple Resale (ISR) was defined as the transmission of a message from the UK Public Switched Telephone Network (PSTN), via an international private leased circuit, to the PSTN of another country approved by the SoS. The ISR licence was similar to the TSL except: the TSL only allowed International Simple Data Resale (ISDR) to specified countries, whereas the ISR licence allowed ISDR and International Simple Voice Resale (ISVR) to specified countries. ACC Long Distance UK Ltd were the first to be granted such a licence on the 25th September 1992.

Appendix C References

DTI 1984: 'Telecommunications Act 1984', HMSO, London

DTI 1991a: 'Licence granted by The Secretary of State for Trade and Industry to British Telecommunications under Section 7 of the Telecommunications Act 1984', HMSO, London, (Revised December 1991 and amendments dated March 1993 & October 1993)

DTI 1991b: 'Licence granted by The Secretary of State for Trade and Industry to Mercury Communications Limited Telecommunications under Section 7 of the Telecommunications Act 1984', HMSO, London, Revised December

DTI 1991c: 'Competition and Choice: Telecommunications Policy for the 1990s', (Cm 1461), HMSO, London, March

Appendix D The EU Operating Structure

The operating structure of the EU comprises four key groups, the Council of Ministers, the European Parliament, the Commission and Court of Justice (Horrocks 1994), which all work together to agree, implement and ensure adherence to EU regulations.

Council of Minister

The Council of Ministers comprises a number of sub-councils which meet periodically. The appropriate minister of each country attends the appropriate sub-council, allowing countries to voice their views. In the area of telecommunications, there is a specific sub-council which meets every six months in Brussels, to discuss the development of EU policy in this area, the UK representative being the Secretary of State.

European Parliament

The European Parliament resides on two sites in Strasbourg and comprises more than five hundred European Members of Parliament, elected by the nationals of the EU member states. Similar to national parliaments, the European parliament is politically grouped. It oversees the operation of the EU (election of commissioners etc.) and can propose amendments to legislation being discussed by the Council of Ministers, but it cannot pass legislation; this is the role of the Council of Ministers.

Commission

The Commission is divided into groups termed Directorates General (DG), which support specific facets of the EU's operation. The staff of these groups are based in Brussels and form the core of the centralised operation of the European Union.

The key directorates and their commissioners which drove the reform of the telecommunication's environment in the early 1990s, establishing the 1998 liberalisation programme and referenced throughout the thesis, were:

- 1 - External Relations - Leon Brittan (UK);
- 3 - Internal Market and Industry Affairs (including Telecommunications Standards) - Martin Bannerman (Germany);
- 4 - Competition - Karl Van Miert (Belgium);
- 13 - Telecommunications - Martin Bannerman (Germany).

The directorates as part of their activity, drive a number of committees. Two key ones within DG 3 (Directorate B) were 'Senior Officials Group on Telecommunications' (SOGT) and 'Senior Officials Group on Information Technology' (SOGIT). These committees guided the EU development policy for their respective areas.

Court of Justice

The Court of Justice is located in Luxembourg and passes judgement upon member countries implementing EU legislation. In the case where individual companies break EU legislation (enshrined in national legislation), resolution is attempted at the national level, transgressing the national courts before reaching the European Court (typically in the form of an appeal). In cases where a Member State is in breech of regulations, the commission refers the matter to the court of justice directly. Unfavourable judgements typically result in fines.

Appendix E An example of the Documentation produced by the EU Legisiatory Process in the Telecommunications Sector

This appendix provides an example from the telecommunications sector of the documentation produced in the process of developing recommendations and converting them into legislation. It uses examples from the telecommunications sector, starting with the Green Papers and culminating in the 1998 liberalisation process. Its purpose is to provide an indication of the EU legislatory process by way of a selection of documentation produced by that process. It is not a comprehensive list of EU liberalisation-related documentation.

The commission regularly reviews a market sector, producing a report outlining the current position and making recommendations for the future. These reports are termed 'Green Papers', The key ones in the telecommunications sector that led up to the 1998 Liberalisation were the 'The Development of the Common Market for Telecommunications Services and Equipment' (EU 1987) and 'The Liberalisation of Telecommunications Infrastructure and Cable Television Networks' (EU 1994a, EU 1995a).

The first green paper led to a Commission competition Directive (EU 1990) and Guidelines (e.g. EU 1991). The guidelines led to Commission recommendations to the Council (e.g. EU 1992, EU 1993a, EU 1994c), which in turn, led to Council recommendations and resolutions, a number of the latter being ultimately enshrined in legislation (e.g. EU 1993b, EU 1994b, EU 1994d, EU 1995b).

Following the 1994/95 green paper, the process was repeated, leading to legislation which deregulated the EU telecommunications market in 1998.

While the opening and liberalising to the telecommunications market was being discussed and passed in council, there were a number of supporting topics being discussed, developed and adopted, such as Open Network Provision (ONP), defining 'a universal set of rules for network interfaces' (Cranston 1991 p20) (EU 1990b, EU 1994e, ETSI 1995).

For instance the 1987 Green Paper only refers to the ONP of ISDN where public Voice Technology is concerned, but its supportive development in the intervening years meant that it had developed sufficiently for it to be included in the 1994/95 Green Papers.

Similarly, to minimise the bureaucracy and speed the entry of companies into Member States' markets, the EU worked on another directive (EU 1994g), which aimed to streamline authorisation procedures as much as possible, issuing a general authorisation licence for telecommunication operators, rather than licensing for individual services (Eckert 1996).

Other relevant legislation was the directive on the 'Protection of personal data and privacy' (EU 1994h) and Article 85 (Anti-Competitive Practices) and Article 86 (Abuse of Dominant Position).

The (Treaty of Rome) Article 85 – 'Anti-Competitive Practices', is only applicable to Joint Ventures or agreements between a number of companies. The venture in the EU is regarded favourably if it allows the EU companies to be better positioned to compete outside the EU or results in a significant increase in benefit or significant reduction in cost to the EU consumer. It is difficult to obtain evidence from the EU, to indicate how ventures which have no affect upon trade between member countries within the EU, are likely to gain approval (EU 1994f). (Approval is obtained by the granting of an exemption under the act. i.e. Article 85 adopts the approach of disallowing an enterprise unless exempt.)

The (Treaty of Rome) Article 86 – 'Abuse of Dominant Position', addresses the potential abusive use of market power by a dominant operator, which affects trade in the EU. An example of this could be the application of unfair terms and conditions such as the high pricing of a scarce product.

Appendix E References

Eckart 1996: Quoted in 'EC vision of liberalised European telecoms market', network briefing, BT, 29th July

EIU 1996: 'Global Telecommunications to the year 2000', The Economist Intelligence Unit Limited, London

ETSI 1995: 'Voice Telephony Directive', ETSI ONP Group 28.09.95

EU 1990: 'Commission Directive (28.6.90) on competition in the markets for telecommunications services', (90/387/EEC-OJ L192/10, 24.7.90), EU

EU 1990b: 'Council Directive (28.6.90) on the establishment of the internal market for telecommunications services through the implementation of open network provisions (ONP)' (90/387/EED-OJ L192/1, 24.7.90), EU

EU 1991: 'Commission Guidelines (6.9.91) on the application of EEC competition rules in the telecommunications sector (OJ C 233/2, 6.9.91)', EU

EU 1992: '1992 Review of the situation in the telecommunications services sector', (SEC (92) 1048), EU

EU 1993a: 'Commission Communication to the Council and the European parliament on the consultation on the review of the situation in the telecommunications services sector', (COM (93) 159 final), EU

EU 1993b: 'Council resolution (26.7.93) on the review of the situation in the telecommunications sector and the need for further development in that market', (93/C 213/01-OJ C213/1, 6.8.93), EU

EU 1994a: 'Part I Commission Green paper (25.10.94) on the liberalisation of telecommunications infrastructure and cable television networks - Principle and Timetable', (COM (94) 440 final), EU

EU 1994b: 'Council Resolution (17.11.94) on the liberalisation of telecommunications infrastructure and cable television networks', EU

EU 1994c: 'Commission Communications (3.5.95) to the council and the European Parliament on the consultation on the Green Paper on the liberalisation of telecommunications infrastructure and cable TV networks', (COM (95) 158 final), EU

EU 1994d: 'The core EU legislation's and policy statement on telecoms Council Recommendation (12.11.84) on harmonisation in the field of telecommunications', (84/549/EEC-OJ L 298/49, 16.11.84), EU

EU 1994e: 'Council and European parliament directive; Application of principles of ONP to voice telephony', COM (94) 48, EU

EU 1994f: 'Article 85, Anti-Competitive Practices', EU

EU 1994g: 'Proposed Council and European Parliament directive - Mutual recognition of licences to operator telecoms services', (COM (94) 41 final - OJ C108, 16 Apr 1994), EU

EU 1994h: 'EU Framework directive - Protection of personal data and privacy', (Com (94) 128 final - CJ C2000, 22 Jul 1994), EU

EU 1995a: 'Part II Commission Green Paper (25.1.95) on the liberalisation of telecommunications infrastructure and cable television networks - A common approach to the provision of infrastructure for telecommunications in the European Union', (COM (94) 682 final), EU

EU 1995b: 'Council Resolution (13.6.95) on the future regulation of liberalised telecommunications markets in Europe', EU

Gillick, D 1992: 'Telecommunication Policies and Regulatory Structures', Telecommunications (International Edition), Horizon House Publications, London, June, pps. 33-34

Horrocks, J 1994: 'European Guide to Telecommunications Liberalisation', Horrocks Technology

OFTEL 1996b: 'OFTEL's Management Plan for 1996/97 and Beyond, Chapter 4: Promoting Network Competition', OFTEL, May

OFTEL 1996d: 'PAN-European Regulator: Oftel's View', OFTEL, June

Appendix F List of People Interviewed

Name	Position	Location	Date	Topics Covered
Alvestad, Torgeir	Post-og Teletilsynet (Norwegian Regulator) Chief Engineer.	Brussels	8th December 1997	IN Interconnect problems, Norwegian Telecommunications Regulation, Norway's relationship with the EU
Anderson, John	Telecommunications Consultant	Ipswich	October 1999	IN Standards, Standard Bodies, IN Architectures, INAP Messages
Banfield, Kenneth	BT manager European Regulations Manager, BT	Telephone	December 1994	UK and EU Telecommunications Regulations, BT's and UK licensing Conditions
Banks, John	Network Design, Nokia	London	28th January 1997	GSM, IN Historically
Barker, Laura	BT member Eurescom	Martlesham, Suffolk	7th May 1993	The role and structure of Eurescom, Its work and relationship with ETSI and ITU
Binning, Balbir	BT regulatory affairs -implements Oftel's licence directives.	Williams National House, London	March 1994	BT's Licence Conditions
Bowman, Keith	NICC Technical Secretary	Telephone	4th March 2003	NICC Standardisation Process, Directive 98/34

Braun, Ernest	OU Lecturer	OU, Milton Keynes	February 1993	BISDN, EU RACE project
Brown, David	Director (& founder) Schema	Brussels	8th December 1997	EU Regulations
Clark, Anthony	Regulatory Analysis, BT, London	Telephone	9th December 2002	BT's Licensing Conditions
Corkerry, Michael	Head of Regulatory Affairs, BT, Brussels	Angel Centre, London	21st January 1997	EU Regulations, BT's Licensing Conditions
Cretch, Phillip	BT manager, switching technologies, (latterly 7/2000 Director of Switching Strategy, Alcatel Europe)	Martlesham	December 1993	IN Standards, IN Standards bodies, Technologies
Cullen, John	BT Cellular Systems	Martlesham	May 1996	IN Architectures, US regulations
Davis, Andrew	SPRU, (Centre for information and communication technologies)	Brighton	18th September 1997	IN References, GSM Architecture, Manufactures
Gottleib, Lou	MCI Network Engineer	Garden of the Gods, Colorado Springs, US	July 1995	Operation of US telecommunications Networks, Audio Conferencing, Video Conferencing

Guram, Paul	Chair, ETSI INAP Working Group	City Forum, London	11th November 1995	ETSI IN Standards, Operation of the Standards Organisation, IN/ISDN Interworking
Hawkins, Richard	Centre for information and communication technologies, SPRU, University of Sussex	Sussex	12th September 1997	UK & EU Telecommunications regulation, the standards making process
Herian, Amer	Chairman, IN Global Function Plane Study Group, ETSI	City Forum, London	March 1996	ETSI IN Standards, Operation of the Standards Organisation
Jenkins, Ian	Manager, BT Network Intelligence Solution Design	Adastral Park, Martlesham	November 2001	IN current architecture and development potential
Leeson, John	BT Strategy	Williams National House, London	7th November 1995	UK & EU Telecommunications Regulation
Newman, Dr. Dave	Deputy Technical Director, OFTEL,	Telephone	14th October 1997	Oftel's Intelligent Network Strategy and Future work
Paterson, Malcolm	BT Advanced Services Unit, Technical Design Authority	Angel Centre, London	August 1994	IN/ISDN Inter-working
Rushton, Phillip	BT representative Eurescom	Martlesham	19th October 1994	The role of Eurescom, IN Standards

Russell, John	Director of Telecommunications, May & Baker	Dagenham, Essex	May 1995	The Impact of BT's licensing conditions upon their customers. Questionnaire 1 Trial
Russo, Peter	Bellcore, Director Advanced Services	Brussels	8th December 1997	IN Standards and standards bodies world-wide
Scott, Dr Peter	Director EU DG 13 (Telecommunications. Regulatory Unit)	Brussels	8th December 1997	EU Telecommunication Regulations
Scott, Michael	BT Engineering Manager	MLB, Martlesham	March 1993	IN and alternative Technologies
Spencer, Gerry	BT European Marketing	Farringdon, London	March 1994	UK & EU Telecommunications Regulation and the impact upon BT operating abroad
Spindley, Robert	BT Signalling Design	Telephone	6th May 2003	INAP Messages
Steggles, Jeffrey	BT regulatory affairs - implements Oftel's directives,	Williams National House, London	18th March 1994	BT Licensing Conditions, UK Telecommunications Regulations
Stretch, Richard	Vice Chair, ETSI Parlay Working Group	Telephone	12th February 2002	IN CS & Parlay Standards, Standards WG Structure
Thomas, Alwyn (a)	Telecommunications Division, DTI	Telephone	30th November 1994	DTI IN Consultation Document

Thomas, Alwyn (b)	Telecommunications Division, DTI	DTI offices, London	22nd December 1994	DTI IN Consultation Document, Future UK Regulations, Questionnaire 1 Pilot
Thompson, Joan	Regulatory Affairs Manager, BT	Williams National House, London	March 1994	BT's Licensing Conditions
Topliss, Andrew	Manager, BT Data Network Infrastructure design	Bibb Way, Ipswich	January 1998	High Speed IP Networks
Walters, Ronald	Consultant	London	19th February 2001	Intelligent Network Architecture
Ward, Keith	Director BT MBA college (latterly UCL Professor of Communications)	Stone, Staffordshire	March 1993	Intelligent Network Architecture, UK & EU Telecommunications Regulations, BT MBA
Woollard, Kevin	Head of Advanced Network Engineering, BT	Telephone	14th August 2002	IN Realisation, INs in Packet Networks
Ziemba, Robert	Bellcore, Director ISCP Marketing	Rome	1st October 1997	IN Standards

Glossary

ACA	Australian Communications Authority
ACCC	Australian Consumer and Competition Commission
Accounting Separation	The maintenance of separate accounts for different parts of the businesses run by the same company, so that any cross subsidisation can be clearly identified.
ACIF	Australian Carrier Industry Forum
AIN	Advanced Intelligent Network
AMA	Automated Message Accounting
ANSI	American National Standards Institute – A consortium of the USA NSO (American National Standards Institute) and the telecommunications industry. Generates the technical standards for the network infrastructure in the USA. Used by the US Regulator for the basis for regulation in the USA.
AP	Adjunct Processor
API	Application Programming Interface
AT&T	American Telephones and Telegraphs
ATM	Asynchronous Transfer Mode, a high throughput packet switching protocol, enabling all types of information (e.g. data, voice and video) to be transported by a single network infrastructure.
ATUG	Australian Telecommunications Users Group
Austel	(Former) Australian Telecommunications Regulatory Authority
BABT	British Approval Board for Telecommunications
BIIS	Binary Interchange of Information and Signalling
BSI	British Standards Institute
BT	British Telecommunications plc.
C13	Condition 13 - A UK telecommunications operator licence condition, which allows the sale/purchase of telecommunications capability at wholesale rates.
C7	CCITT Signalling System no. 7 - signalling specification from the ITU-T (UK variant) - it provides access to a wider range of services within BT's network than is available to customers.

Call Diversion	A service that allows customers to have their incoming telephone calls redirected to another number.
CAMEL	Customised Application for Mobile network Enhanced Logic – it allows a customer to invoke services whilst roaming away from their Home Mobile Network, via an IN platform located in the home network. It is based upon IN CS1.
CCAF	Call Control Agent Function
CCF	Call Control Function
CCITT	Committée Consultatif International Télégraphique et Téléphonique – Now ITU-T
CCITT 7	CCITT Signalling System no. 7 - signalling specification from the ITU-T
CDP	Centralised Distributed Processing (architecture model)
CEN	Comité Européen de coordination des Normes
CEPT	Conférence Européenne des Administrations des Postes et des Télécommunications
CLI	Calling Line Identity, a capability that enables identification of the number from which a call is made.
Commission	The executive body of the EU, with the power to create legislation
Communication	A non-binding statement of EU policy
Council of Ministers	The EU's legislative body, in which Member States are represented by government ministers
CP	Centralised Processing (architecture model)
CS	Capability Set
CS1	Capability Set . The first phase IN standards from the ITU-T
CTI	Computer Telephony Integration. Self-contained (i.e. not public) computer applications which add value to telephony
CUSF	Call Unrelated Service Function
DBT	Deutsche Bundespost Telekom
DG	Directorate General
DGT	Director General of Telecommunications
Directive	Legislation which defines the outcome to be achieved whilst leaving it to national regulators to decide how it should be achieved

DNS	Domain Name Server
DTI	Department of Trade and Industry
ECMA	European Computer Manufacturers Association
ECTEL	European Conference of Associations of Telecommunications and Professional Electronic Industries
ETCO	European Telecommunications Consultancy Organisation
ETNO	European Telecommunications Network Operators Association
ETSI	European Telecommunications Standards Institute
EU	European Union (previously the European Economic Community (ECC))
FCC	Federal Communications Commission (US)
FE	Functional Entity
FEA	Functional Entity Actions
FLU	Functional Logic Unit
GATT	General Agreement on Tariffs and Trade
GEC	General Electric Company, United Kingdom
GPRS	GSM Packet Radio Service
Green Paper	A consultative document prepared and issued by the Commission, on a particular area for which the EU has not yet produced legislation
GSM	Global System for Mobile (formerly Group Speciale Mobile) – Pan-European digital mobile cellphone technology
H323	H.323 is the underlying protocol used in the majority of VoIP phones and facilitates VOIP interconnection with C7.
ICT	Information and Computing Technologies
IETF	Internet Engineering Task Force
IN	Intelligent Network
INAP	Intelligent Network Application Protocol
Interconnect	The connection of separate telecommunication networks.
Interface	A set of technical characteristics describing the point of connection between two telecommunication networks.
INTUG	International Telecommunications User Group
IP	Intelligent Peripheral

IP	Internet Protocol (IETF) is a means which enables computers to communicate to each other over the Internet.
IPR	Intellectual Property Rights
ISDN	Integrated Services Digital Network. A network supporting a wider range of services than is possible over the PSTN.
ISO	International Standardisation Organisation
ISUP	ISDN User Part
ITC	Independent Television Commission
ITU	International Telecommunication Union
ITU-T	International Telecommunication Union - Telecommunications Standardisation Sector. The Main Global Organisation for telecommunications covering Standardisation
JAIN	Java API for Integrated Networks
LAN	Local Area Network
MDP	Mixed Distributed Processing (architecture model)
Member State	The countries forming the European Union
MF	Multi-frequency
MMC	Monopolies and Mergers Commission
MOU	Memorandum of Understanding
NA	North American
NAP	Network Access Point
NET	Normes Européennes de Télécommunication
Network Business	The running and maintenance of BT's network and the conveyance of voice telephony. It supplies network services to BT Systems Business (at transfer charges) or to operators with Relevant Connectable System status (i.e. Condition 13 rates)
NICC	Network Interoperability Consultative Committee – Formed by OFTEL to agree interoperability issues. Its membership comprises Interest Groups from the UK Telecommunications Industry. (Was the Network Interfaces Co-ordination Committee)
NRA	National Regulatory Authority
Number Translation	A facility whereby calls made to value added numbers (e.g. freephone - 0800), are translated and routed to PSTN number.

OECD	Organisation for Economic Co-operation and Development
OFT	Office of Fair Trading
OFTEL	Office of Telecommunications
ONP	Open Network Provision
Operator	Telecommunications operator. A company operating a public telecommunications infrastructure and offering services to the public.
ORB	Object Request Broker. A Microsoft Windows NT capability
OSS	Operational Service System
PABX	Private Automatic Branch Exchange - now known as PBX
PANS	Pretty Amazing New Stuff - Used in comparison between old and new technologies. e.g. POTS & PANS
PBX	Private Branch Exchange. A telecommunications switch within a company
PCM	Pulse Code Modulation (a method of passing signals over a conductor)
POTS	Plain Old Telephony Service (Voice Telephony)
PSTN	Public Switched Telephone Network, comprising the interconnected networks of PTOs
PTO	Public Telecommunications Operator. The operator of a telecommunication network which provides, telecommunications network services.
PTT	Post, Telegraph & Telephones
R & D	Research and Development
RACE	Research and Development in Advanced Communications Technologies in Europe
RBOC	Regional Bell Operating Company
SB	Systems Business. That part of BT's Business which obtains network services from BT Network Business in order to sell basic retail services to customers, whether that customer is an end user, a service provider or BT's Supplemental Services Business. It can only provide services which can only realistically be provided by a network operator.

SCE	Service Creation Environment
SCEF	Service Creation Environment Function
SCF	Service Control Function
SCnF	Service Creation Function
SCP	Service Control Point
SDF	Service Data Function
SDP	Service Data Point
SIB	Service Independent building Block
SIDA	Swedish International Development Agency
Sigtrans	Sigtrans covers a range of protocols defined by the IETF for providing the equivalent transport characteristics of C7 message transport on an IP network.
SIP	Session Initiation Protocol –a session set-up protocol for use in applications such as Internet telephony.
SLEE	Service Logic Execution Environment
SLP	Service Logic Platform
SMAF	Service Management Access Function
SMF	Service Management Function
SMS	Service Management System (ETSI)
SMS	Short Messaging Service (Mobile)
SN	Service Node
Soft PBX	PBX functionality contained in software on and operating from a computer
SOGIT	Senior Official Group on Information Technology
SOGT	Senior Official Group on Telecommunications
SP	Service Provider. Those service providers who are not network operators and who provide a telecommunications based service to the public.
SRF	Specialised Resource Function
SS7	CCITT Signalling System no. 7 - signalling specification from the ITU-T

SSB	Supplementary Services Business. All BT services with a telecommunications component which could be provided independently of the PSTN, i.e by a Service Provider.
SSF	Service Switching Function
SSP	Service switching Point
STC	Standard Telephones and Cables
STP	Signalling Transfer Point
TAC	Telecommunication Advisory Committee
TAPI	Telephony Applications Programming Interface
TCAP	Transactions Capability Application Part
TCP	Transaction Capabilities Part, now Transaction Capabilities (TC) - part of CCITT No.7 signalling system
Telecommunication Service	A service consisting of the transport of voice etc. by means of a telecommunication system.
Time of Day Routing	The routing of calls to different destinations depending on the time of day or the day of the week, according to instructions held in the telephone network relating to a particular number.
TMA	Telecommunication Managers Association. The main business communications user association, representing individuals who have responsibility for private communications systems in commerce, industry and the public sector in the UK. (now the Communications Management Association (CMA))
TTC	Telecommunications Technology Committee (Japan)
TUA	Telephone Users Association
TUP	Telephony User Part - A part of Signalling System No. 7 (SS7)
TV	Television
UK	United Kingdom
UMTS	Universal Mobile Telephony Service
US	United States (of America)
USA	United States of America
VAT	Value Added Tax
VOIP	Voice Over Internet Protocol

VPN	Virtual Private Network. A service for the interconnection of Company's PBXs over a network shared with other companies, but constructed such that each company appears to use the network independently of the others.
WTO	World Trade Organisation