Modernisation and Innovation Management: Developing a Digital Society

An investigation into public sector modernisation and innovation management in its introduction of wireless technology

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ABSTRACT

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Keywords: Technology Management, Modernisation, Electronic Government, Digital Britain, Wireless Mesh Networks, Technology Cycles, Digital Society, Innovation Strategy, Innovation Management, Broadband Public Access

This thesis presents an exploratory study into the development of digital societies and it examines public sector modernization and innovation from a technology management perspective.

The study presents reasons why most city-wide or council-wide development of wireless broadband access networks currently end in failure or are unsustainable. It also suggests its links with wider problems of innovation management and the commercial failure of otherwise technically competent solutions

It explores the modernisation of society, government, the underlying theories that influence it as well as the innovations triggered by its wake. The exercise reveals a myriad of innovations; firstly in the modernisation of the infrastructure of government and secondly in the development of societal infrastructure in the form of broadband networks.

To God only wise

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ABBREVIATIONS

ADSL	Asynchronous Digital Subscriber Line
ANSI	American National Standards Institute
AP	Access Points
BBC	British Broadcasting Corporation
BSI	British Standards Institution
BT	British Telecoms
BTE	Behind the Ear
CEO	Chief Executive Officer
CRM	Customer Relationship Management
DAB	Digital Audio Broadcasting
DIN	Deutsches Institut für Normung
DOCSIS	Data Over Cable Service Interface Specification
DOS	Disk Operating System
EEDA	East of England Development Agency
EMI	Electromagnetic interference
FDDI	Fibre Distributed Data Interface
FM	Frequency Modulation
FTTC	Fibre To The Cabinet
FTTH	Fibre To The Home
FTTL	Fibre To The Loop
G2B	Government to Business
G2C	Government to Citizen
G2G	Government to Government
GM	Genetically Modified
GUI	Graphical User Interface
HFC	Hybrid Fibre Coax
IBM	International Business Machines
ICT	Information Computing Technology

IEEE	Institute of Electrical and Electronic Engineers
IMF	International Monetary Funds
ISO	International Standards Organisation
ISP	Internet Service Provider
ITE	In the Ear
ITU	International Telecommunications Union
LAN	Local Area Networks
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LLC	local loop circuit
LTE	Long Term Evolution
MAN	Metropolitan Area Networks
NHS	National Health Service
NPM	New Public Management
ODPM	Office of the Deputy Prime Minister
POE	Power-over-Ethernet
PPP	Public-private Partnerships
PSTN	Public Switched Telephone Network
RDA	Regional Development Agency
RFI	Radio-frequency interference
RG	Radio Grade
SSID	Service Set Identifier
STP	Shielded Twisted Pair Cable
UTP	Unshielded Twisted Pair Cable
VOIP	Voice over Internet Protocol
VSAT	Very Small Aperture Terminal
WAN	Wide Area Networks
WiFi	Wireless Fidelity
WIMAX	Worldwide Interoperability of Microwave Access

"Throughout history those who have the information have the power. I think the challenge for us in dealing with this suite of things called "e-government" is that there is no way of predicting the potential of the technology, the further demands that will be created when individuals and communities are empowered by technology, and the speed with which their ingenuity will create new pressures and challenges for us. This has the potential to make our views about structure outdated, (and even modes of government dated) and bring more crowding to a crowded age."

-Michael Wintringham, 18 October 2001.

Chapter One

Making Sense of It All

1 Introduction

Engineering and Strategic Management

This is a study on public sector innovation in the United Kingdom (UK) and it is set on the backdrop of the modernisation efforts of the new-labour government from 1997. It highlights the effects of strategy, an often forgotten ingredient in engineering concoctions that tends more often than not to spoil the broth. Frequently, the emphasis of engineering management is on the development of technically competent solutions and managing operations to produce the required products or services more efficiently and effectively to the detriment of the other seemly silent forces. This has led to a generation of engineering managers steeped in the intricacies of production and operations management as well as the economics of investment appraisal to the detriment of strategic thinking. This narrow scope has in turn obscured a full appreciation of the forces at play resulting in the failures of otherwise technically competent solutions of which the Motorolla Iridium™ satellite phone easily comes to mind. While this is by no means an attempt to belittle the importance and contributions of these areas to engineering, it is necessary to point out the neglect of the string – strategy - that binds them all together which could also be argued as hubris, arising from the empirical nature of engineering to the softer elements.

Strategy in Action

Nucor Corporation, with headquarters at Charlotte, North Carolina was founded as Reo Motor Cars in 1905 by Ransom Olds of the Oldsmobile car fame. They diversified into the nuclear and steel industries transforming into the Nuclear Corporation of America and ultimately Nucor. While on the verge of bankruptcy Ken Inversen, an engineer, became CEO, it was not just operations management that

prompted his decision to move all operations from urban to rural areas, it would be found more in the logic of the best paying or leading local employer. This coupled with some inventive pay schemes helped to transform his workers into a fully committed work force that bought into the vision of the organisation (Govindarajan, 2000).

An important aspect of strategy is the ability to understand the times, the ability to scan the environment and to see the big picture. Jorma Ollila became the Nokia CEO in 1992 and it was his remarkable understanding of the times that transformed Nokia from a broad based agricultural conglomerate to one of the world's foremost technology firms accounting for 30% of the global mobile phone market (Tidd et al, 2001). He observed in his speech to the European Commission in 1993 that "He thought Europe has lost the computer market to the USA, and consumer electronics to Japan, but could still dominate the emerging telecom market" (Tidd et al, 2001). So he set about positioning Nokia for the anticipated telecommunications revolution, divesting most of their non-technical subsidiaries and acquiring the British Telecoms (BT) company Technophone in 1991.

Strategic Outlook

An appreciation of the times will show there is a silent revolution taking place, the digital revolution, and it is being implemented incrementally. It is a revolution of no lesser proportions than the industrial revolution but it is happening so casually. Its showing could be likened to the analogy of the boiled frog. For the purpose of clarity, any frog dropped in boiling water would immediately jump out but same frog in cold water, with heat slowly turned on would be oblivious to danger. Society like a frog in cold water is being slowly cooked by the forces of digital technology and it's none the wiser. This indifference draws on the natural tendency to be hung-up on the details and failing to see the big picture. The replacement of the Sony Walkman ™

by the Apple iPod ™; the Internet, file sharing and downloading of music; short messaging service (SMS); mobile phones; video calls, video conferencing; electronic/digital medical equipments to name but a few. Are they part of the digital revolution? Sure! But, even more profound is their role as indicators or symptoms of a larger revolution taking place. They could be compared to the bubbles that accompany the boiling frog which will increase as the conditions tend to boiling point.

An illustration may suffice. A few years ago, in the not so distant past, the University of Bradford kept a schedule for the opening of laboratories and reading rooms for students. It also required members of staff to open and lock up after students. Today, the digital revolution has enabled the programming of permissions such that a student has access into any room or laboratory they need to use without staff escort. Better still, all access can be tracked, enabling security to verify movements if and when necessary. This may still not seem significant but a locksmith that does not migrate to the digital platform would be left behind (Yale ™? Chubb ™?). Access to the University network has also gone wireless with "uobroamnet" - the University Wireless Fidelity (WiFi) network – fully accessible from all areas of the University. The thought, the realisation that the same changes are going on right across the private sector puts in perspective the dimensions of changes taking place in the public sector and society in general.

This is exactly what Norfolk Open Link is about; a strategic outlook. It is a pilot wireless WiFi network set up by the Norfolk County Council in collaboration with the East of England Development Agency (EEDA) to investigate how the modernisation of public services would be impacted by the wireless phenomenon. There is also a desire to assess its impact on the economic development of the region which brings to the fore the social and political dimensions of technical innovations

from that of merely enabling financial advantage to that of an agent of change in societal development.

1.1 Background

Computer networking is the compelling innovation of our time and through the course of this study, its influence would be no different. The adoption of computer networking fully into the workings of government has been achieved through the concept of Modernisation. Although networking innovation was already out, the modernisation agenda was the innovation strategy to bring it into the public sector. Thus, modernisation could be regarded as a conceptual innovation, an exercise in public sector innovation while the agenda, the innovation strategy to aid the adoption of new technologies into public sector service delivery and society in general.

This strategy precipitated the launch of two process innovations Electronic government (E-government) and more recently Digital Britain. E-government has in turn introduced with the help of computer networking, innovative processes that have enable joined-up services between government agencies and organisations. Digital Britain could be regarded as the next phase in the modernisation agenda of government with the focus not primarily on government processes as in E-government but on the processes of society at large. The focus of Digital Britain is on the creation of new societal infrastructure to reflect the realities of the digital age. It involves the development of broadband networks to drive the emerging digital economy. Modernisation is also the driving force behind the trial of wireless broadband technologies in the delivery of government services of which Norfolk Open Link is one of such initiatives – a wireless mesh broadband network.

1.2 The Goal of the Study

This thesis is the final report for the Total Technology professional doctorate programme. It is a course of study that combines taught management courses and

individual research with the objective of producing engineers who are able to analyse situations they encounter in the course of their careers and make informed decisions. This objective of the programme has been reflected in this research which assumes an analytical form in its search for answers.

The study presents reasons why most city-wide or council-wide developments of wireless broadband access networks currently end in failure or are unsustainable. It also suggests links with wider problems of innovation management and the commercial failure of otherwise technically competent solutions

The outcome of this research is of interest to Norfolk County Council and to any other city embarking on modernisation programmes using wireless technology. It is also of interest to wireless broadband technology companies that want to forward integrate into service providers. It also contributes to the discussion on innovation management strategies.

1.3 Research Objectives

The objectives of the study are to investigate public sector modernisation and innovation management in the introduction of wireless technology (which in this study will refer to Wireless Fidelity (WiFi) with a view of:

- Understanding how the innovation is being implemented
- Identifying technology management problems in is implementation
- Investigating why the problems arose
- Proffering solutions to the observed problems

1.4 Research Plan

The research plan for this study starts off as an exploratory study and concludes as an explanatory one. This is a pathway that is conversant with other exploratory studies as attested by Saunders et al, (2009). It was chosen because it is a fit with the programme of study. The exploratory plan of study is a well known research design

for probing issues while explanatory studies are appropriate for cause and effect situations (Saunders et al, 2009). The thesis is also presented in a narrative format which aids theory building (McNabb, 2004)

1.5 Structure of Thesis

This thesis is presented in the following order. Chapter one is the introduction and sets the scene for the study by providing the context, goals, objectives and plans for the study. It is also the chapter that presents how the thesis is organised.

Common to exploratory studies is the examination of literature, to which this report is not an exception. Due to the multi-disciplinary nature of this study, this would also be reflected in the literature review.

Chapter two is a review of literature that focuses on modernisation in the society; in government and the underlying theories that influence it. It will also focus on process innovations triggered by its wake. Chapter three will focus on innovation and its management. It will also provide the theoretical understanding for the innovative changes taking place in chapter two as well as Chapter four which is a technological overview of computer networking technology and how it relates to wireless networking.

A formal presentation of the research methods follows in Chapter five while Chapter six is the presentation of the exploratory study, a case study in Norfolk Open Link. Also included in Chapter six are two secondary case studies on wireless deployments in Philadelphia and Milton Keynes. Analysis and discussions of problems identified are presented in Chapter seven. This thesis concludes with contributions and recommendations in Chapter eight.

Chapter Two

Modernisation and government

2 Introduction

This chapter is essentially a review of government, its policies and programmes on modernisation and the attendant offshoots that are relevant to the understanding of this study. Pertinent to the understanding of these policies and programmes is a historical odyssey into the theoretical foundations underpinning these policies and programmes. The sociological and political theories it presents though less relevant in the private sector assume far reaching effects in the public sector because unlike the private sector, they are the cradle of strategic direction for the public sector.

The review of government and its policies is a necessity because it is the core stakeholder in the development of the United Kingdom. It is also the 'patient' for modernisation.

Immediately following this overview will be a section on modernisation theory. In addition to providing the theoretical understanding for the section on modernising government - for which the next section on Electronic government is a requirement - it will also provide the fundamental ideas on the development of societies relevant in the evolution of digital societies and cities. A review of the Digital Britain policy will conclude this chapter.

2.1 Modernisation

It is commonly said that one of the constant things in life is change. This could be a change for the better or for the worse but change all the same. Change could occur involuntarily or voluntarily. It follows as a corollary that should an involuntary change occur, it could be as a response to stimuli or a reaction to a pleasant or unpleasant situation. The trend of the above discussion suggests that an involuntary

change is a necessary response dictated by circumstances or the operating environment. It also indicates an element of compulsion in its operation irrespective of its consequence which could be for the better or worse. Voluntary change on the other hand is a change that is not driven by compulsion, a change mostly embarked upon for the benefit of the originator or subject that attempts to modify an existing situation to bring about improvements. In this context, modernisation could be regarded as planned change from one social and/or economic state to another. While it could be associated with a number of complex changes it is not a function of individual endeavour because it requires the active participation of a number of stakeholders usually driven by a common over-arching theory. This common theory in certain management circles could be referred to as its enabling strategy. It follows from the above that the modernisation strategy for a nation requires the participation of different groups, agencies, departments, services and organisations (depending on how the nation is constituted) working together within a common ideology and framework towards a common goal. Modernisation theory in nations could be examined in a variety of ways which could include physical development, economic development, social development, technical development, legal/legislative development and environmental development just to mention a few. But for the purpose of this study it would be examined in two broad contexts namely social and economic developments.

2.2 Social Modernisation Theory

A theme common to all theories of social evolution was the quest to find the "general trends in the development of all human societies" (Roxborough, 1979). Modernisation theory is a social evolutionary theory that seeks to transform the traditional society to a modern one with a better standard of living by the use of

science and technology. This transformation is founded on the premise that all societies still in a state of pre-Newtonian flux are traditional and as such need to be modernised into a post-Newtonian society. This is a premise that has its roots in the writings of the "enlightenment" thinkers of Condorcet and Durkheim (Tijssen, 1995) but was revived in the late 1950s and early 1960s by modernisation theorists. Although modernisation theory has its critics which include the post-modern theorists, world systems theory, dependency theory etc., this thesis is in no way attempting to delve into the sociological debate but it is being reviewed due to the observation that despite its purported short comings, the underlying principles it advocated are still at play in government circles, shaping domestic and international policies.

An idea common to social modernisation theory is the notion that technology and its attendant innovations are crucial to the modernity of any society. This is illustrated in the following review of Parson's social theory amid the interesting observation that technology occupies in its classifications of societal modernisation.

2.2.1 Parson's Evolution of societies

Talcott Parsons was a thinker who greatly influenced the theory of social evolution (Parsons, 1977, 1966). Parsons supported the idea that if societies were considered on a longer timeline, there was a general direction through which the society tends to evolve within that timeline. He also commended historical and comparative analysis as a way of understanding the sequence of societal evolutions which he classified as follows:

- Primitive Society
- The intermediate Society (Archaic and advanced intermediate)
- The modern society

Parsons (1977) also contends that four components are necessary for the formation of a society. These four components are as follows:

1. Religion
2. Kinship
3. Communication
4. Technology

2.2.1.1 Primitive Society

Religion in the primitive society in his view consisted of a set of beliefs to answer the questions of 'who' and 'what' thereby providing "self-definition or collective identity" (Parsons, 1977). Kinship provided the order for social co-existence, communication the means of interaction while technology consisted of the physical skills needed for the economic activities of hunting, gathering fruits and other edible materials.

2.2.1.2 The Intermediate Society (Archaic and advanced intermediate)

In classifying the intermediate society, Parsons gave credence to the technology of a written language. He differentiated the early form of this stage as "Archaic" due to their practice of what he called "craft literacy and cosmological religion" (Parsons, 1977) from the latter stages which he referred to as the "advanced intermediate" form because of the development of a religious order that has a concept of a supernatural order that is different from that found in nature (Parsons, 1977). He lumps all the civilizations prior to the Industrial revolution which include ancient Egypt, Israel, Greece, Rome, Persia, Babylon, China etc. in this stage using one factor TECHNOLOGY. He contends that prior to the industrial revolution the only form of energy known to man was 'animal power' and as such their societies were limited in scope.

2.2.1.3 Modern Society

The third stage in the social evolution of societies according to Parsons was the modern society. He classified this society as one that had experienced the three revolutions that he views as vital to be transformed into a modern society. These revolutions are the

- Industrial revolution
- Democratic revolution
- Educational revolution

Fundamental to these revolutions was the role of technology in developing an alternative form of energy to that of 'animal power' which in turn reinforced the democratic and educational revolutions. Although he ascribes the stimulus for the democratic revolution to the French revolution and the educational revolution to the separation of church and state, a notion reverberating from his work is the idea – in common with other 'enlightenment' thinkers - that technology vis-à-vis innovation is a shaping factor in making a society modern. It could be seen from the foregoing that these revolutions impacted the four basic components of the society replacing the ascription of kingship with democratic authority due to achievement, the collectivism of kinship with individualism and Particularism with Universalism in the application of laws.

Primitive Societal Values	Modern Societal Values
Ascription	Achievement
Collectivism	Individualism
Particularism	Universalism

Table 2.1 Societal Values

2.2.2 Criticism

A fall-out from the theories of the preceding section is the ideology that the modernisation process is required to transform developing countries into developed ones. Cantwell Smith (1965) argues that though "modernisation is a process, it is not a goal that can be achieved; a process to participate in and not something to be adopted; what one does and not something one has" (ibid) since all societies are in a state of constant flux with different physical and social challenges. He prefers to define it as "a process of rendering feasible the gradual transformation of human life from what it has been into what we choose to make it" (Smith, 1965) and as such he contends that modernity is the ability to choose from an expanded set of possibilities due to technology that were not hitherto available and not what the eventual choice is since we could chose the status quo. A case in question could be the debate over Genetically Modified (GM) foods where despite the high yield and pest resistance of such varieties, its adoption is not wide-spread. He concludes in his objection to the definition of modernity as the development of a western type society by averring to the ability to choose. This is choice in his opinion, occasioned by the availability of alternatives, resulting from innovations in technologies which were unavailable to past generations. The exposure to make an informed choice from an expanded set of outcomes is in his opinion modernity. And if this is being modern, it has nothing to do with living in any particular kind of society. He asserts that "the power and the knowledge of ever new possibilities and the techniques of implementing these, this is modernity" (Smith, 1965). If the power, knowledge and techniques of science is modernity as Cantwell Smith argues then he is in agreement with the modernisation theorists on the role of science and technology as one of the defining factors in the classifications of traditional versus modern societies as advocated by the

modernisation theorists. There are other criticisms of the theory from a host of sources which include the various sociological schools of thought but as earlier stated it is not the intention of this study to dwell on this sociological debate but has been reviewed because as acknowledged by Preston (1996), it has found acceptance in policy circles.

2.3 Economic Modernisation Theory

While social modernisation is engrossed with the transformation of society based on the development of technology, democracy and universal laws, economic modernisation on the other hand is driven by two schools of thought namely:

1. The interventionist school
2. The neo-classical/liberal school

2.3.1 The interventionist school

This is a school of thought that advocates the deliberate intervention in economic activities by the organs of state in order to achieve a preferred set of outcomes in economic development. Prominent in this line of thought are the influences of Keynes, Harrod in legitimising the intervention of state (Preston, 1996). While their motives could be depicted solely as an intellectual pursuit of economic development, the same could not be said of modernisation theorists who saw intervention as a link between economic and social development and as such a vehicle for achieving economic and social development. This is amply demonstrated in Rostow's stages of growth model which seeks to classify societies in their economic dimensions.

2.3.1.1 Rostow's stages of growth model:

This model by Rostow (1990) proposes that "it is possible to identify all societies, in their economic dimensions, as lying within one of five categories: The traditional society, The preconditions for take-off, the take-off, the drive to maturity and the age

of high mass consumption" (Rostow,1990). Rostow also subscribes to the notion of technology as the underlying factor in the stratification of the societies he advocates but his model is different from that of Parsons because it employs the technological notion to the economic development of the society in classifying in its economic dimensions as a modernised society.

1. The Traditional Society

The traditional society according to Rostow (1990) is the first category of economic dimension that a society could be identified in. He describes a traditional society as "one whose structure is developed within limited production functions, based on pre-Newtonian science and technology and on pre-Newtonian attitudes towards the physical world" (Rostow, 1990). He argues that Isaac Newton is that great reference point in history when it came into the hearts of men that the elements of the physical world were subject to governing laws which could be favourably manipulated if they were known and understood. In defining the traditional society, Rostow makes provision that these societies could be dynamic, developing what he called "ad-hoc technical innovations" which could improve productivity or introduce a new crop but he contends that there will be a defining underlying factor common to them all which is the existence of a "ceiling" on the level of attainable output per head. He contends that "this ceiling results from the fact that the potentialities which flow from modern science and technology were either not available or not regularly and systematically applied" (Rostow, 1990).

He also makes the observation that traditional societies are characterised by political and social instabilities where the value system could be best described as "fatalism" (ibid) with land ownership exerting an overt political influence on the society.

The result of this historical reference is the definition as "traditional societies" of the pre-Newtonian world which include the Chinese dynasties, Middle Eastern and Mediterranean civilizations, medieval Europe and post-Newtonian societies which could not overcome the "ceiling" (Rostow, 1990).

2. Preconditions for Take-off:

The preconditions for take-off represent the second stage of growth in the economic topology of a society or nation according to Rostow in his theory. This is the period a society requires to attain the conditions for sustained growth. These conditions could also be imposed by external forces on the society as in the case of a colonial power that can be observed in the history of Hong Kong. Rostow contends that a decisive feature of this phase is the political building of an effective centralized national state. A national state that is prepared to move beyond the economics of the traditional society and alter substantially three core attributes of the traditional society which in his view inhibited economic growth namely:

1. The social structure
2. The political structure
3. The techniques of production

The essential aim for the alteration of these attributes is to set the stage for the creation of "social overhead capital" (Rostow, 1990). An exception to this structure is a small group of nations that were offshoots of the British nation that ware already on an advanced stage of economic growth and as such did not have to transplant their traditional society but took advantage of the economic incentives in the new environments they found themselves to set the path for sustained economic growth by developing "social overhead capital" (ibid) such as railways, ports, roads etc. needed for the modernisation. These nations include Canada, New Zealand, Australia

and the United States of America. If the main aim of this stage is the creation of social overhead capital or social economic infrastructure, the working capital for its development must be realised from the aforementioned structural alterations in the society and in the case of the exceptions, this is obtained from the abundant natural resources in their new environments. In situations where there is not enough economic activity to finance the working capital needed to provide the necessary conditions for economic growth the support of donor agencies such as the world bank, International Monetary Fund (IMF) and other regional development financial institutions is required to alter the traditional landscape to one more amenable to modernisation.

3. The Take-off

This is the period when all opposition to the realization of steady economic growth is extinguished to make room for sustained economic progress. The dearth of opposition to the steady build up of social overhead capital, technological development and a political leadership that is focused on the modernisation of the society results in the take-off of steady economic growth. In the case of the exception, the main determinant for the take-off of steady economic growth could be approximated to the development of technology and innovation management (ibid).

4. The Drive to Maturity

This is a period of sustained growth after the economy has taken off. It is characterised by a development of core competences that are now been leveraged into other areas of the economy. Rostow defined this period as when "an economy demonstrates the capacity to move beyond the original industries which powered its take-off and to absorb and to apply efficiently over a very wide range of its resources the most advanced fruits of modern technology" (ibid). The decision not to

manufacture an item becomes more of a strategic one and less of a lack of technological know-how to achieve its purpose. The societies becomes "caught up in the power of compound interest and in the possibilities of transforming one sector after another of the society by extending the tricks of modern technology" (ibid)

5. The Age of High Mass-Consumption

This stage is marked with a shift to social and welfare concerns. It is characterised by a society that is moving beyond achieving technical maturity to reconsider the aims and objectives of the society. Rostow (1990) postulates that there are three main objectives that will compete for the attention of the society which could be summarised as follows:

1. A focus on foreign power and influence resulting in increased military spending
2. A focus on social and humane objectives which include the redistribution of wealth to accommodate the less privileged in the society. In other words the creation of a welfare oriented society inclined towards social security and increasing the comforts of the society.
3. A focus on living beyond the bare necessities of life demonstrated by an increased number of individuals with incomes above providing the bare necessities and as such begins to demand a more differentiated goods and services market.

2.3.1.2 Challenges of the Welfare State

While the age of high mass consumption brought about the growth of social and welfare concerns resulting in the intervention of government to establish the welfare state. Though laudable and creating a better standard of living, it also presented its own problems.

Financial burden

While modernisation brought great wealth, it provided no insulation against periods of recession or depression when there are reduced public funds available to fund welfare programs. The provision of health care, social benefits, elderly care, public safety and inefficiencies from 'bureaucratic red tape' induces a strain in government finances which become even more evident in a recession prompting the search for more efficient ways of doing government (Bekkers et al, 2006).

Welfare Rules and Regulations

The implementation of a welfare state is founded on the establishment of rules and regulations that govern the conditions for qualification or loss of such benefits. These rules and regulations are normally achieved through legislation which may not be perfect first-time and would require fine-tuning as unforeseen circumstances manifest. This commitment to fine-tune legislation imposes a bureaucratic burden on the legislation in trying to find the right balance between opposing legitimate forces. On one hand the task of providing welfare to those who genuinely need it and on the other hand the need to protect the system from fraudsters (Bekkers et al, 2006).

Representation and Individualisation

Part of the tenets of modernisation is the introduction of democratic representation and the growth of individualisation as opposed to collectivism. But individualism is at odds with the ideals of the welfare state since it seeks collective provision for the less privileged in the society. It is also at play when elected representatives start representing themselves and their own interest as opposed to the will of the people they were elected to represent. This has imposed an expectation on technology as a medium of scrutiny on the activities of government and its officials (Bekkers et al, 2006).

2.3.2 The neo-classical/liberal school

This is a school of thought that is founded on the works of equilibrium economic theorists like Alfred Marshall, Vilfredo Pareto who argued that in order to maximize economic reward the free market must be protected from state interventions which tend to distort the self regulatory effects of the free market (Preston, 1996). In recent years, the encroachment of this form of thinking in government is the theory of New Public Management (NPM) which acts as a reform ideology to the regime of government interventions culminating in the welfare state. It tends to arrogate to the public sector the role of "steering" the ship of government and the private sector the role of "rowing" the ship of government because it regards all acts of "rowing" by the government as acts of intervention resulting in distortions in the self regulatory actions of the free market and as such cannot ensure efficient use of government resources (Andrisani et al, 2002). This thinking can also be observed in the regulations governing state intervention in the form of State Aid laws in the European Union (EU).

2.3.2.1 New Public Management (NPM)

This is the quest to modernize the public sector anchored on a customer and service delivery ethos. Osborne and Gaebler (1992) in their studies of the United States government - Reinventing Government – presented their ideas which among others are collectively referred to as the philosophy of NPM (New Public Management) or public sector modernisation (Beynon-Davies, 2007). It is a "management culture that emphasizes the centrality of the citizen or customer, as well as accountability for results" (Manning, 2000). While the foregoing could be regarded as its ideology, its policies tend to advocate the use of private sector type competition as a vehicle for achieving efficiency savings by creating a market oriented public sector. It also suggests structural organisational choices that promote decentralized control through

a wide variety of alternative service delivery mechanisms including quasi-markets with public and private service providers competing for resources from policy makers and donors (Beynon-Davies, 2007, Manning, 2000). The take-up of NPM ideology in government has seen the public sector evolve into a more business oriented concern, spotting a host of private sector management support techniques. It is also a factor in the application of technology in the affairs of government.

2.3.2.2 Characteristics of NPM

The characteristics of NPM as a policy are summarised by Beynon-Davies (2007) as follows:

Process

There is a belief that specialization is required in government leading to the processes of government being separated. This belief is centred on the public sector having no business in the structures of government but should be restricted to the instruments of governance. One consequence of this is the belief that government should be engrossed in "steering" not "rowing" – which should be outsourced to the private sector.

Management

NPM is also seen as a shift from the limitations of the rational bureaucracy of public management into the realm of business management and its use of strategic management as a tool for analysis and planning.

Markets

NPM promotes collaboration in a market-based approach between the public and private sectors as a means of introducing more competition in the public sector. This involves the introductions of joint ventures and partnerships between the public and private sectors which are commonly known as public-private partnerships (PPP), where the public sector pool resources with private organisations.

Monitoring

NPM enables the development of performance measurement standards. This involves the introduction of market based performance measurement techniques such as benchmarking, balanced score card etc. in the evaluation of public sector performance. This is turns promotes the drive towards excellence in the provision of public services. Due to the greater attention given to results, there is an organisational goal against which performance is compared allowing public sector organisations to benchmark their performance against the best public and private sector results.

Customers

NPM assists government and its agencies to re-engineer public service delivery with a customer service ethos. This has seen the deployment of private sector customer relationship management (CRM) software and techniques into Government to Citizen (G2C) relationship management.

2.3.2.3 Elements of NPM

The main elements of its policy prescriptions for government according to Andrisani et al (2002) are as follows:

1. Reverting to core functions of governance: This involves the disengagement of government from activities that have very little to do with government such as operating a diary farm. It is envisaged that the time recovered from such distractions would translate into better core services from government.
2. Decentralizing and devolving authority: This is based on the realisation that as part of the six tenets of classic public administration (Bekkers & Homburg, 2005) the structures of government are often highly hierarchal and centralised resulting in slow decision making processes that stifle development. It is proposed that decentralizing and devolving authority in government would

result in more nimble government structures that are able to tackle societal problems quickly (Andrisani et al, 2002).

3. Limiting the size and scope of government: This involves the reduction in the scope of the welfare state to free up resources for other core government activities.
4. Restoring civil society: This is the recognition by government that there are also other sectors in society apart from government and as such must be allowed to play their role in society. It flows from the realisation that other sectors like the non-profit sector is sometimes more effective in solving social problems than the public sector just as the private sector is also more effective in business.
5. Adopting market principles: This involves the introduction of competition, privatization and deregulation into the affairs of government. The use of lowest cost tenders, auctions etc. to create a climate of competition in the provision of government supplies and services. Privatization is also employed as a means of involving the private sector in delivering public services. It is deployed in three forms; delegation, divestment and displacement. Delegation involves contracting or outsourcing service delivery while divestment requires government to pull-out from service delivery. Displacement involves the private sector being encouraged to compete with government services. Deregulation is the reduction in government requirements to make it easier for the private sector to compete in sectors where barriers previously existed. Deregulation could be used to encourage displacement or to attract investment by reducing business costs.

6. Managing for results, satisfying citizens, and holding government accountable: This involves the use of performance management techniques for the reporting and evaluation of citizen expectations in order to satisfy them.
7. Empowering employees, citizens, and communities: This involves redesigning government jobs so that frontline employees have the tools and authority to solve citizen queries and problems quickly.
8. Introducing e-government and modern technology: This involves the re-engineering of government to reflect the advances in technology. E-government is seen as a means of extending the contact hours of government with the citizens. It is also a platform for delivering frontline services to the homes of citizens.

2.3.3 State Aid

The EU State aid law is a policy prescription setup by the European Union for the sole purpose of promoting free market conditions and competition within the community. It was developed to counteract the effects of arbitrary state interference in economic activities by ensuring that all European companies operate under the same rules by eliminating any "unfair" advantage to any one or group of companies. This is a situation that could come to fore if "member states engage in wasteful subsidy races, which are non-sustainable for the individual Member States and detrimental to the EU as a whole" (EU, 2008). It was also developed to mitigate any other action by member states which could be deemed to undermine group and regional cohesion. State aid could be defined as an "advantage in any form whatsoever conferred on a selective basis to undertakings by national public authorities" (EU, 2010). Although the EU treaty prohibits State aid, it also recognises

the possibility of situations when state intervention is a necessity and thus compensates for these situations by providing a legal framework subject to continuous review for determining exemption in these areas. While Member states are required to agree on the legal framework and its attendant continuous reviews, it is the sole preserve of the European Commission to exercise and enforce its provisions. It is also worth noting that no state aid can occur without the approval of the Commission.

2.4 Modernisation and the United Kingdom

The Collins' dictionary defines modernising something as "to change it by replacing old equipments or methods with new ones" (Collins, 2005). The free online dictionary defines it as "The act of improving something". Modernisation could also be defined as "a word and concept that attempts to organise and structure thinking and action" (Finlayson, 2003). This is because it is able to exude positive energy to the audience and elicit an expectation of an improvement in the current state, although it could be argued that not all modernisation efforts result in an improved outcome. Finlayson (2003) demonstrated that the meaning or concept of modernisation could be examined in three dimensions which are its literal, tangible and strategic dimensions. The literal meaning refers to the rhetorical use of modernisation where the message being conveyed is to inspire or to imply updating something to the current age. He asserts that the declaration as an act of modernisation is one way in which a thing becomes so. This in his opinion is because the word modernisation is one of those statements "that acquire meaning and force only in the moment of usage" (Finlayson, 2003). The tangible dimension refers to modernisation is an act and as such could be used to refer to things that are technically advanced, effective, efficient and user friendly. This meaning could

involve a process of converting or transforming something from a state of being obsolete to an acceptable state that could perform better than its predecessor. This is a meaning that is derived from its physical use. The last dimension of modernisation has to do with its strategic use as being analogous with an upgrade. It is a strategy that connotes an 'upliftment' from the present situation and as such very difficult to oppose since no one wants to be seen as opposing an improvement. This is a use that draws its meaning from the field of strategic management and to be specific strategic positioning which tends to set the vision of how a entity wants to be seen among its peers and competitors. This is the positioning that enables an ideology to be referred to as "right wing", "left wing", centre-right, and centre-left. When modernisation is used in this context it tends to present a discrete field comprising of two quadrants – up and down – where modernisation has been positioned in the upper quadrant due to its association with the notion of an upgrade and everything else that it opposed to it in a lower quadrant which includes the status quo. This strategic use could be typified by the speech by Harold Wilson in 1964 (cited in Finlayson, 2003) where he made a strategic positioning of the then conservative (Tory) government as being in the past or obsolete and as such there was need to modernise the government.

> "We are living in a jet age but we are governed by an Edwardian establishment mentality….Their approach and methods are fifty years out of date" (Wilson, 1964)

His solution was to "modernise methods of government" (ibid). This was also the strategy employed years later to transform the labour party into new labour which stood for reforms and change and old labour which represented the status quo. It is this strategic positioning of new labour that branded it as "modernised". With the advent of the Blair government in 1997, this winning brand was simply in some cases extended or stretched into other areas of government. If it could be said that Harold Wilson positioned the Labour party as the strategic modernisers, Tony Blair

went a step further by not only positioning the new Labour party as a party of modernisers but he positioned the British as a people given to modernisation supported by a heritage etched in a history that is given to modernisation (as did Rostow, 1990; Finlayson, 2003) and as such not to modernise was 'unBritish' and an abdication of Britishness. This can be seen in the following excerpt from his speech to the labour party at the annual convention at Brighton in 1997 that

> "The British don't fear change. We are one of the great innovative peoples. From the Magna Carta to the first Parliament to the industrial revolution to an empire that covered the world; most of the great inventions of modern times with Britain stamped on them: the telephone; the television; the computer; penicillin; the hovercraft; radar. Change is in the blood and bones of the British we are by our nature and tradition innovators, adventurers, pioneers. As our great poet of renewal and recovery, John Milton, put it, we are "A nation not slow or dull, but of quick, ingenious and piercing spirit, acute to invent, subtle and sinewy to discourse, not beneath the reach of any point that human capacity can soar to". Even today, we lead the world, in design, pharmaceuticals, financial services, telecommunications. We have the world's first language. Britain today is an exciting, inspiring place to be" (Blair, 1997).

A closer examination of this excerpt will reveal its roots in the modernisation theories of Parsons (1966, 1977) and Rostow (1990). The illumination afforded by this observation will assist in understanding the following sections on the modernisation of government and the infusion of technology into the rational bureaucracy called government.

2.4.1 Modernisation of Government

The use of technology to modernise the society and by extension government is just one half of the public management theories driving the rational bureaucracy called government. The quest to modernise the public sector anchored on a customer and service delivery ethos is another which is collectively referred to as the philosophy of NPM (New Public Management) or public sector modernisation (Beynon-Davies, 2007). The elements of its policy prescriptions for government according to

Andrisani et al (2002) include the introduction of e-government and modern technology. The government of the United Kingdom in 1999 embarked on an ambitious project of change to modernise the government. It is no surprise the White paper to usher in needed changes was none other than the "modernisation of government" white paper of 1999; a revolutionary policy document whose effect is still reverberating over ten years after it was promulgated. The vision of this policy was to create a "better government to make life better for people" (Cabinet Office, 1999). An assessment of the scope of changes being canvassed by the policy reveals a combination of public management theories. An adoption of modernisation theory that seeks to transform society by the use of technology infused with NPM thinking that promotes private sector ideas anchored on the citizen as a customer. It is a remit that covers key governmental bodies, involves new studies, anchored on a realistic implementation plan.

2.4.2 Aims and Objectives of modernising government

The modernising government white paper of 1999 clearly set out the aims and objectives of the programme. With regard to its aims, they are listed below:

1. Making strategic and joined up government policies
2. Reorientation of public service on users not providers
3. Public services that are efficient and of a high quality

The above stated aims were to achieve the strategic objective of an inclusive and integrated government. It also advocated a number of reforms geared to achieving these aims and objectives. These reforms are listed as follows

- A requirement that public services be available twenty-four hours a day, seven days a week.
- The co-ordination of public services to make more strategic policies

- The requirement that new regulations undergo regulatory impact assessment
- A conscious target of 2008 for the electronic delivery of government
- A promotion of new frontline ways of working and stimulating innovation
- An incentive scheme for identifying cost savings
- Reorder government delivery by making permanent secretaries personally responsible for government targets.

2.4.3 Implementation Plan

A Modernising Public Services Group was created within the Cabinet Office (Jones et al, 2006) and assigned the responsibility of implementing the reforms stated in the preceding section. This group in conjunction with a Prince 2 project board consisting of external and civil service members developed the implementation plan that was based on some key commitments, studies and bodies. The key commitments were:

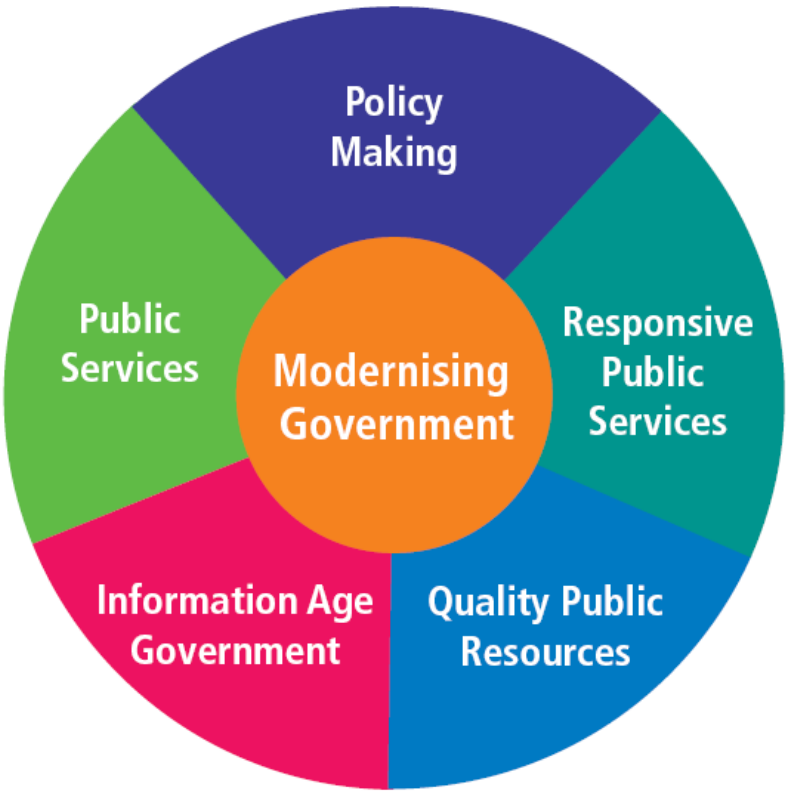
- The development of forward looking policies that will identify and spread best practice by training ministers and civil servants while engaging in departmental peer reviews
- The creation of quality public services by setting targets that focus on real improvements in quality and effectiveness
- The creation of responsive public services designed to engage and satisfy the needs of different citizen groups by removing bottlenecks to joined-up working
- Invigorate the civil service to reflect the diversity in the society by tackling under-representation and also encouraging innovation

- The development of an IT strategy to co-ordinate machinery and frameworks for the creation of electronic services

These commitments resulted in key studies in the following areas namely:

- Joined-up government
- Electronic government
- Best value
- Joined-up audit
- Procurement
- Cross-cutting issues

Fig 2.1: Modernising Government



Source: (Cabinet Office, 1999)

It also saw the identification of key bodies needed in order to address cross-cutting issues in government. These are the social exclusion unit, the women's unit, the

performance and innovation unit, the criminal justice system, Custom & excise/Internal revenue, the UK Anti-drugs co-ordinator, better regulation task force, small business service, civil service management, centre for management and policy studies, cabinet committee, public service productivity panel, public sector bench marking project.

The requirement that government be accessible 'twenty-four seven' is a constraint that can only be satisfied with the help of the internet. A list of desirable outcomes, the information age government was expected to deliver at a minimum by 2002 was set out spanning the booking of theory and practical driving tests online, carrying out job searches, submitting self-assessment tax forms, getting educational information, getting health information, applying for training loans and student support, completing value added tax registration and returns, filing company house returns, receiving payment from government, applying for regional support grants (Cabinet Office, 1999). This saw the creation of another body to oversee the realization of "information age government" (Cabinet Office, 1999) called the Office of the e-Envoy (1998-2004) charged with delivering Electronic Government. Electronic government as such becomes one of the many strands of modernising government and not the all in all. A very important strand nevertheless because it provides the infrastructure for the various 'joined-up' initiatives advocated by the white paper.

2.5 Electronic Government

Electronic government (e-government) is one of the innovations touted as a panacea for modernising government. It is founded on a theory that advocates the strategic use of information systems to support and transform government. However, in reviewing Electronic Government, two bodies of literature exist. They are the official government publications that pervade the process and the academic or scholastic

publications that assess, analyse and investigate the process. As stated in the previous section, Electronic government though an established academic field of study, in terms of the UK governments' modernisation agenda, it is just one of the strands of modernisation. This view is amply demonstrated by the 'official' definition of Electronic government in the national strategy for local e-government published by the Office of the Deputy Prime Minister (ODPM) that

> "E-government is not an end in itself. It is at the heart of the drive to modernise government… e-government means exploiting the power of information and communications technology to help transform the accessibility, quality and cost-effectiveness of public services and to help revitalise the relationship between customers and citizens and the public bodies who work on their behalf" (ODPM, 2002).

This is a definition that clearly identifies e-government as a means and not an end product of modernisation. Which could be from the realization that e-government straddles a number of public services, providing solutions which are geared towards improving the efficiency and effectiveness of government. Although it clearly identifies accessibility, quality and cost efficiency as three areas that the use of technology is expected to impact positively, it exposes its NPM leaning in its reference to citizens as customers in need of a better relationship with their government.

While from an academic point of view, there is no consensus on the definition of Electronic government, as a review of literature will show. It is littered with various definitions that could be best described literally as the descriptions of blind men touching different parts of an elephant. Al Sebie & Irani (2003) captured it best with their conclusion that "the definition of e-government varies according to the values, goals and cultures of a community" and the different perspectives from which it could be viewed which include society, politics, economics, business, services and organisational (Al Sebie & Irani, 2003). Their study of e-government definitions

revealed that there are six underlying factors that influence the various definitions which are listed below:

1. Use of technology
2. Electronic process
3. Benefits of electronic delivery
4. Citizen/customer centric considerations
5. Joined-up delivery
6. Phenomenon

Table 2.2 Definitions of E-government

Factor	**Definition**	**Reference**
Process	Electronic government or "e-government," is the process of transacting business between the public and government through the use of automated systems and the internet network, more commonly referred to as the world wide web	Legislative analyst office, 2001
	E-government means exploiting the power of information to help transform the accessibility, quality and to help revitalize the relationship between customers and citizens and public bodies who work on their behalf	Aldrich, 2002
	Electronic Government (e-Government) refers to the processes and structures pertinent to the electronic delivery of government services to the public	Okot-uma, 2001

Factor	Definition	Reference
Technology	Broadly defined, e-government includes the usage of all information and communication technologies from fax machines to wireless palm pilots, to facilitate the daily administration of government	UN and ASPA 2001 cited in Moon 2002
	E-government is the use of technology to enhance the access to and delivery of government services to benefit citizens, business partners and employees	Silcock, 2001
	Electronic government refers to government's use of technology particularly web-based Internet application to enhance the access to and delivery of government information and service to citizen, business partners, employees, other agencies and government entities	McClure 2000 cited in Layne and Lee 2001
	E-government is simply using IT to deliver government services directly to the customer 24/7. The customer can be a citizen, a business or even another government entity.	Duffy, 2000
	E-government is the use of information technology to support government operations, engage citizens, and provide government services.	Cook et al, 2002
Phenomenon	Indeed, e-government is a concept that exists without a firm definition. To some, it represents traditional government with an 'e', providing an alternative delivery method for government services. For others, it is a social, economic and political phenomenon, which promises to re-engineer the nature of democratic government itself	Riley, 2001

Factor	Definition	Reference
Joined-up delivery	E-government is usually explained as a way of improving the delivery of government services by making them available through a single point of access on the Internet – so called "one stop shopping".	Mitchinson, 2001
Citizen-Centric concerns	An e-government is a government that makes full use of the potential of technology to help put its citizens at the centre of everything it does, and which makes its citizens it purpose	Waller et al, 2001
Benefits of electronic delivery	E-government has been defined as: implementing cost-effective models for citizens, industry, federal employees, and other stakeholders to conduct business transactions online. The concept integrates strategy, process organization and technology	Lieber, 2000 cited in Whitson and Davils, 2001
	E-government involves access to government information and services 24 hours a day, 7 days a week, in a way that is focused on the needs of our citizens and businesses. E-government relies heavily on agency use of the Internet and other emerging technologies to receive and deliver information and serves easily, quickly, efficiently, and inexpensively	Katzen, 2000

Source: Al Sebie & Irani, 2003

2.5.1 Forms of E-Government

There are three main forms of E-government based on the different interactions between government and the various stakeholders. They are as follows namely:

1. Government to government (G2G)
2. Government to business (G2B)
3. Government to Citizens (G2C)

2.5.1.1 Government to government (G2G)

This form of e-government represents the interactions between the core internal processes, culture and infrastructure that make up e-government. It consists of the back office operations that join-up government to enable the other forms of e-government to take place effectively. It is founded on the notion of data sharing across government agencies and departments so that there is increased co-operation and collaboration within government. A significant feature of this form of e-government is the interoperability of systems between various local governments, agencies and departments.

2.5.1.2 Government to business (G2B)

This is the form of e-government that is concerned with the interaction between the private and public sector. It is driven by two forces: the private sector and the quest for efficient procurement in public services (Seifert, 2003). While it is common knowledge that the private sector is a vital link in the supply chain of the public sector (since it provides partners for procurement activities in government), it is also an outlet for the disposal of government goods ranging from impounded cars, buildings and government surplus. The ability to embark on effective e-procurement solutions is reliant on the strength of the processes and systems existing between government and business.

2.5.1.3 Government to Citizens (G2C)

This is the form of e-government most commonly recognized as "e-government" because is involves interaction between citizens and state. It is driven by two main forces – the quest by government to achieve better value for money by reducing the cost of government and governmental 'peer' pressure arising from all the governments of the world doing it and as such not to be left out. It involves the provision new access channels to the citizens to improve interaction with government while deemphasizing the multi-agency nature of government to ease citizens' experience of government.

2.5.2 Benefits of E-Government

A synopsis of the potential benefits that could accrue from electronic government could be seen from the various definitions reviewed in the previous section. In line with the various factors that inspired the different definitions is a clue to the expected benefit that championed its cause. From a technological point of view it is expected that there will be cost savings derived from greater efficiencies resulting from automation and process re-engineering, which would also result in a better quality of service (Duffy 2000, Heeks 2001). Another potential benefit of e-government was in "enabling public sector organisations to interact directly and work better with businesses, irrespective of their locations within the physical world" (Ebrahim et al, 2003).

Table 2.3 Benefits of Electronic Government

Benefits of Electronic Government		
Citizens	Government	Business
Efficient use of time and resources. Access to Multiple services from an access channel. Availability of services whenever, wherever. Increased access channels to public services. Quicker responses to enquires.	Effective and efficient administrative processes. Reduced operational cost of service delivery. Better understanding and collaboration in public service delivery. Quicker process of adopting citizen needs. Improved efficiency in the delivery of government services Improvement of staff efficiency.	Strategic partnerships for delivering services. Faster transactions with government agencies.

Source: Adapted from (Al Sebie & Irani, 2003; Chen et al, 2007, Ebrahim et al, 2003)

But as observed from the modernisation of government white paper, this, though a laudable objective, was not the main reason for implementing electronic government in the United Kingdom (UK). One of the key reforms advocated was the delivery of government twenty-four hours a day, seven days a week. This is a benefit only available via electronic government. Just as another key objective of the white paper, the development of a joined-up government, a feature characteristic of networking technology. To derive such benefits from technology calls for some concerted efforts in crafting a suitable strategic initiative to co-ordinate its delivery.

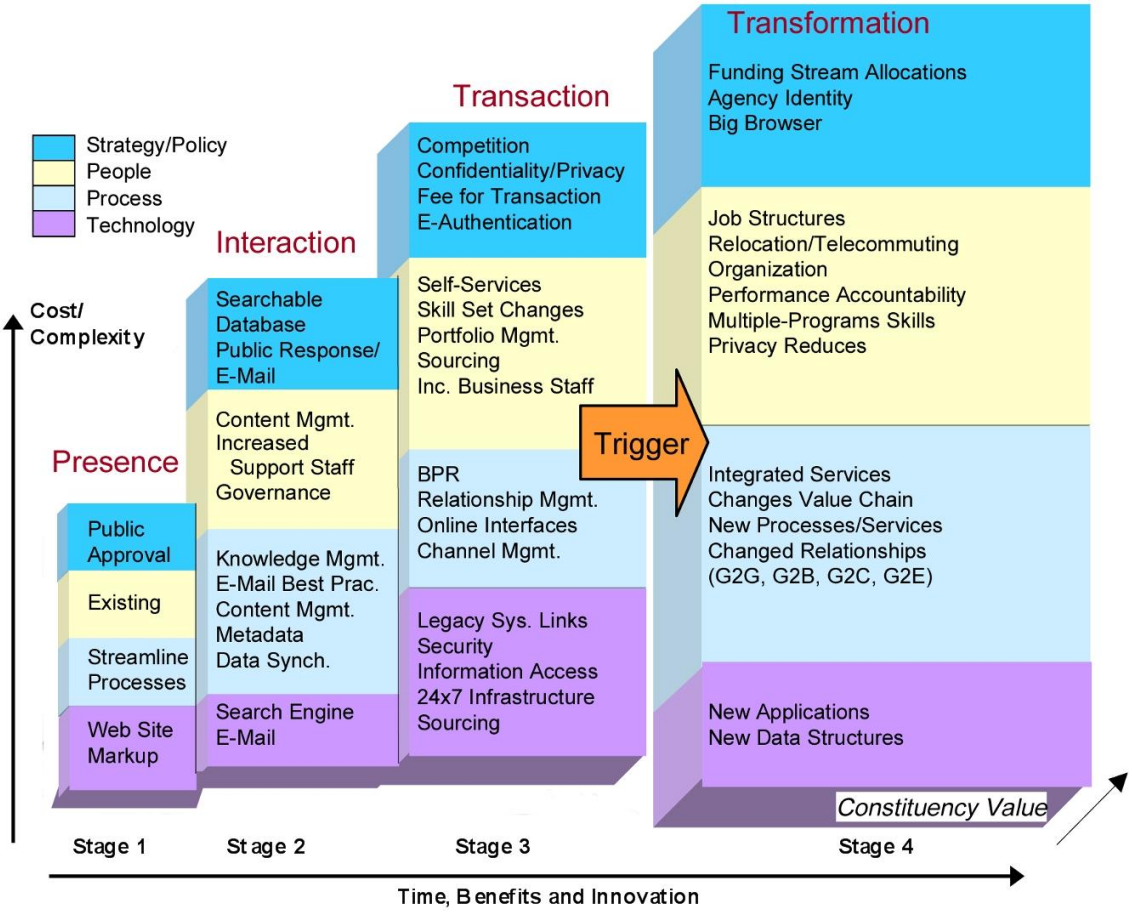
2.5.3 E-Government Maturity Growth Models

It is a common feature in the field of project management for a project plan to proceed from inception to completion. A journey with intermediate stages between inception and completion that could be termed 'milestones' depending on the significance accorded the achievement recorded at those stages. The e-government system also passes through various stages as it develops from infancy to maturity. These stages of growth have been an area of interest to e-government academics and experts. E-government researchers have studied these stages of growth and have devised a number of classifications on how the process develops. These have been based on a host of comparative studies that have in turn resulted in models with different numbers of stages which in a lot of cases were essentially the same differentiated only by the 'stage labels' they bear. It could be observed from these models that most of them were developed on the premise of the Internet being not just the access channel of delivering e-government but being e-government i.e. government on the web. While these studies focussed on the virtual government created, the isolation of developments outside the Internet (one-stop shops, contact centres etc.), created a vacuum in the development of a corresponding growth model for digital government. In this study and for the purpose of discussion, the model proposed by Baum and Di Maio (2000) would be adopted. It consists of four stages:

1. Presence: This is the first and simplest representation of e-government. It is characterised with the provision of brochure-like information on a government agency or department. It is typified by the simple static website that provides "about us", "contact us" etc. information without any further interaction with the visitor. It serves as a virtual address for the body in question (Baum & Di Maio, 2000).

2. Interaction: In this stage of e-government, there is dissatisfaction with the status quo and a desire for the information to do 'something' to reduce the workload. This is achieved by automating and streamlining government functions so that commonly requested services would be available at all times. These initiatives include automated telephone services that provide information, access to download official forms, reports, travelling advice search abilities and other frequently asked questions (FAQs) thereby reducing the need to be at the government office physically (Baum & Di Maio, 2000).
3. Transaction: This is a stage of e-government that is characterised by self-service operations. E-Government initiatives are concerned with the connection of internal government processes to on-line interfaces which would allow citizens to carry out transactions with the government electronically (Al-hashmi & Darem, 2008). It enables citizens to pay their bills, apply and renew licences 24/7 through the Internet or telephones (Baum & Di Maio, 2000).
4. Transformation: this involves the blurring of the identities of the governmental agencies involved in providing the service to a focus on the service requested which could be assessed through a one stop shop or web portal. It is founded on the integration of government services, information and processes customary boundaries that hitherto existed between central, regional and local governments, governmental agencies, departments and the private sector (Baum & Di Maio, 2000).

Fig 2.3: Stages of E-government Maturity



Source: Adapted from Baum & Di Maio (2000)

The model depicted above is the Gartner e-government model (Baum & Di Maio, 2000; Al-hashmi & Darem, 2008) on which most e-government programs around the world are based. There are other models of e-government development as acknowledged by other researchers; a summary of their findings are shown in the table overleaf.

Table 2.4: Summary of E-government Stages of growth models

STAGES	STAGE NAME	REFERENCES
Stage 1	Initiation	Kim et al. 2008
Stage 2	Application Development	
Stage 3	Integration	
Stage 1	Publish	Howard, 2001
Stage 2	Interact	
Stage 3	Transact	
Stage 1	Presence	Atallah 2001, Chandler et al 2002, Baum and Di Maio 2000, Seifert et al. 2002
Stage 2	Interaction	
Stage 3	Transactions	
Stage 4	Transformation (Integration)	
Stage 1	Information Publishing/Dissemination	Deloitte Research 2000 Tambouris Et Al. 2001
Stage 2	Official Two-Way Transactions	
Stage 3	Multi-Purpose Portals	
Stage 4	Portal Personalisation	
Stage 5	Clustering Of Common Services	
Stage 6	Full Integration An Enterprise Transformation	
Stage 1	Simple Information	Mcdonagh 2002, Moon 2002, Chen et al, 2007
Stage 2	Electronic Submission	
Stage 3	Transactions	
Stage 4	Access To Single Portal (Integration)	
Stage 5	Government And Business Integration with Political Participation	

STAGES	STAGE NAME	REFERENCES
Stage 1	Information	Wimmer et al. 2002
Stage 2	Contracting	
Stage 3	Service Delivery And Payment	
Stage 4	Aftercare Phase	
Stage 1	Emerging Presence	Ronaghan, 2002
Stage 2	Enhanced Presence	
Stage 3	Interactive Presence	
Stage 4	Transactional Presence	
Stage 5	Seamless Or Fully Integrated	

Source: Adapted from Ebrahimi et al. 2003, Al Siebe & Irani, 2003

2.5.4 National Strategy for Local E-government

An "e-government strategy is a fundamental element in modernising the public sector organisations, because it identifies and develops a common framework and direction for change across them" (Tyndale 2002). This is exactly in line with the reasons proffered in the UK national strategy for local E-government. It identifies that local governments would need to work with other central government departments and agencies using a common framework that will enable them to share information over secure networks (ODPM, 2002). The stated aims of the national strategy are to:

1. Create the common framework for all local strategies
2. Specify national needs
3. Identify joined-up services and technology for common development

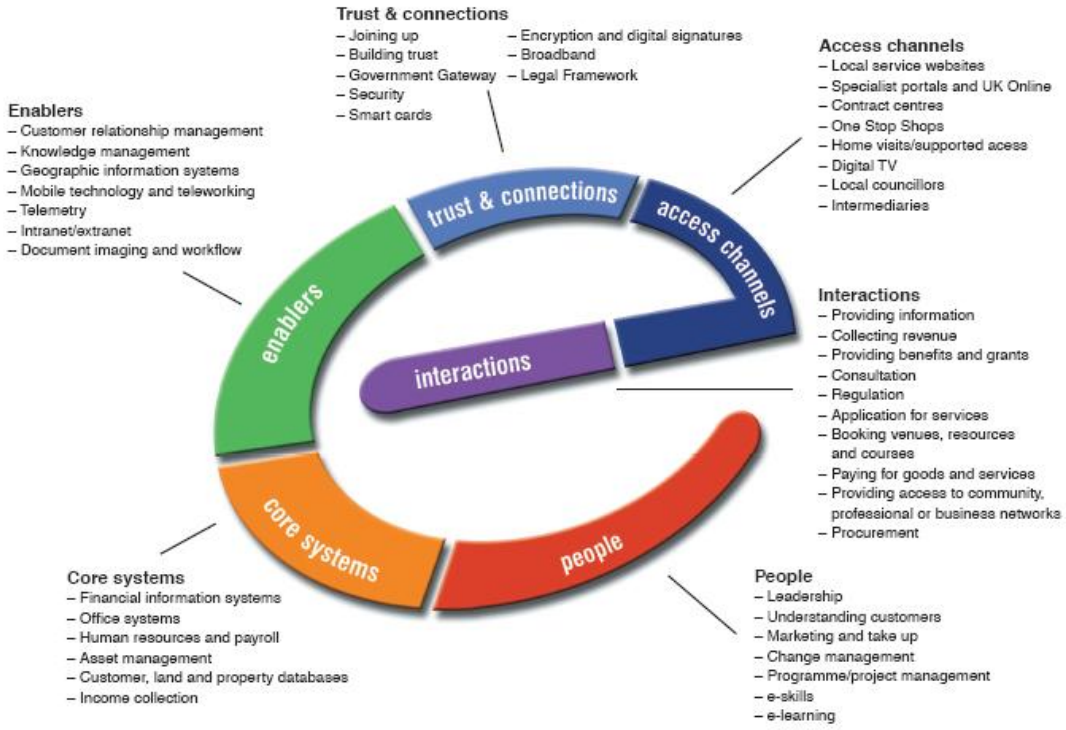
There was also emphasis on the need for local councils to provide innovative solutions to transform service delivery which could be shared nationally between local governments. It is argued that such transformations while improving service quality could also improve the speed and efficiency of such services. This is because "e-government technologies provide the opportunity to overhaul the way the 'back office' works, making it easier, faster and cheaper to process information, to share it between services and to present it to customers, staff and partners" (ODPM, 2002). While the national strategy concedes that it is up to each local council to define the access method it intends to pursue in exploiting e-government, it recognises that there are some shared priority areas which should be focussed on. These priority areas are:

1. Services to business
2. Benefits and personal taxation
3. Transport and travel
4. Education
5. Health
6. Citizen's interaction with the criminal justice system
7. Land and property services
8. Agricultural services
9. E-Democracy

In line with the second aim of the strategy to specify national needs, a programme of national projects for local e-government was devised to develop national e-government infrastructure. To achieve the third aim of joined-up services and technology for common development, among other initiatives, the strategy proposes to develop "a national framework of technical and legal standards so that key issues

such as authenticating the identity of electronic service users and the capacity of public organisations to share information can be resolved nationally" (ODPM, 2002). A model to present a holistic representation of e-government was also produced to assist local 'e-champions' to develop local strategies. This model is shown below:

Fig: 2.2: E-government blocks



Source: (ODPM, 2002)

It was developed to assist local e-champions to appreciate the existence of non technical requirements inherent in the development of e-government. It was also designed to compel e-champions to be alive to the inter-personal as well as organisational interactions involved in e-government development.

2.5.5 Implementing Electronic Government

The implementation of electronic government in the United Kingdom was accomplished through the local governments. With respect to strategy, the national implementation strategy involved the micro-management of local government councils into developing yearly implementation statements called "IEG statements" from 2001 to 2004 for which they received £200, 000 (ODPM, 2003). This saw the

development of IEG 1, 2 & 3 statements which could be aligned to the different stages of the development growth models as shown in the figure below. A stage for transforming government was introduced in 2006.

Fig 2.5: Implementing E-government in the UK

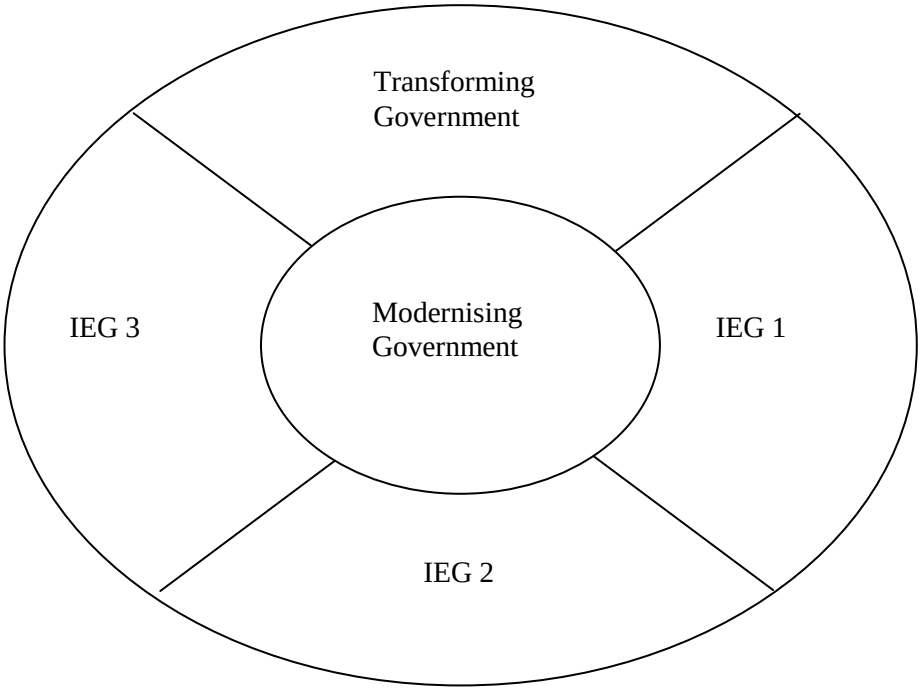


Fig 2.6: Interactions between UK E-government Stages and Implementation

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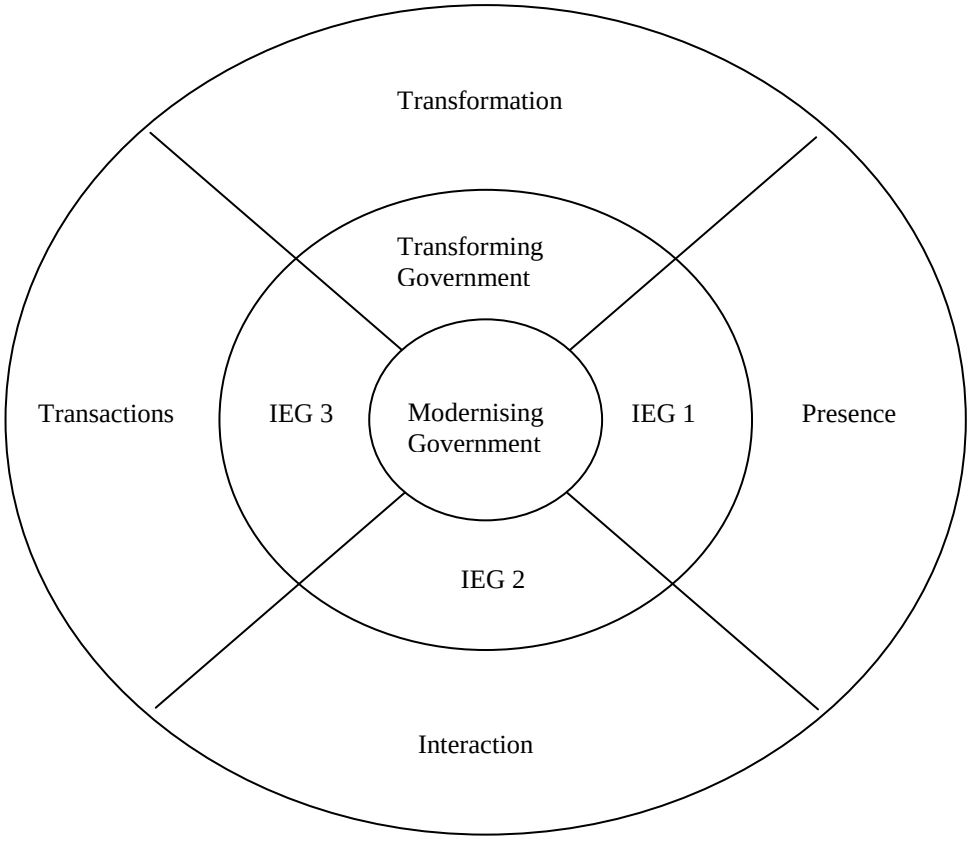
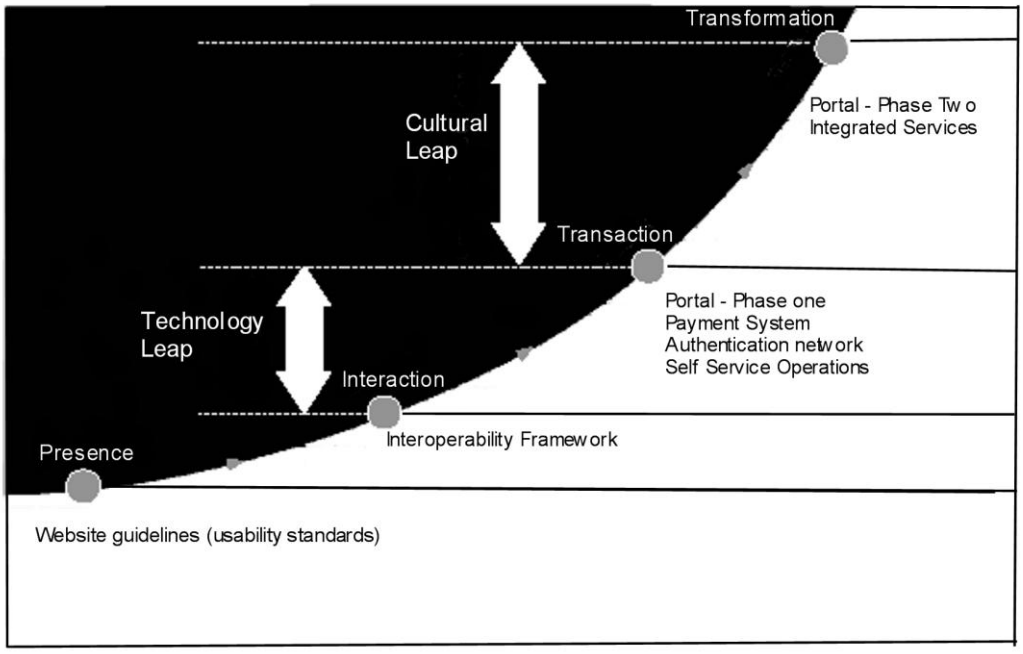


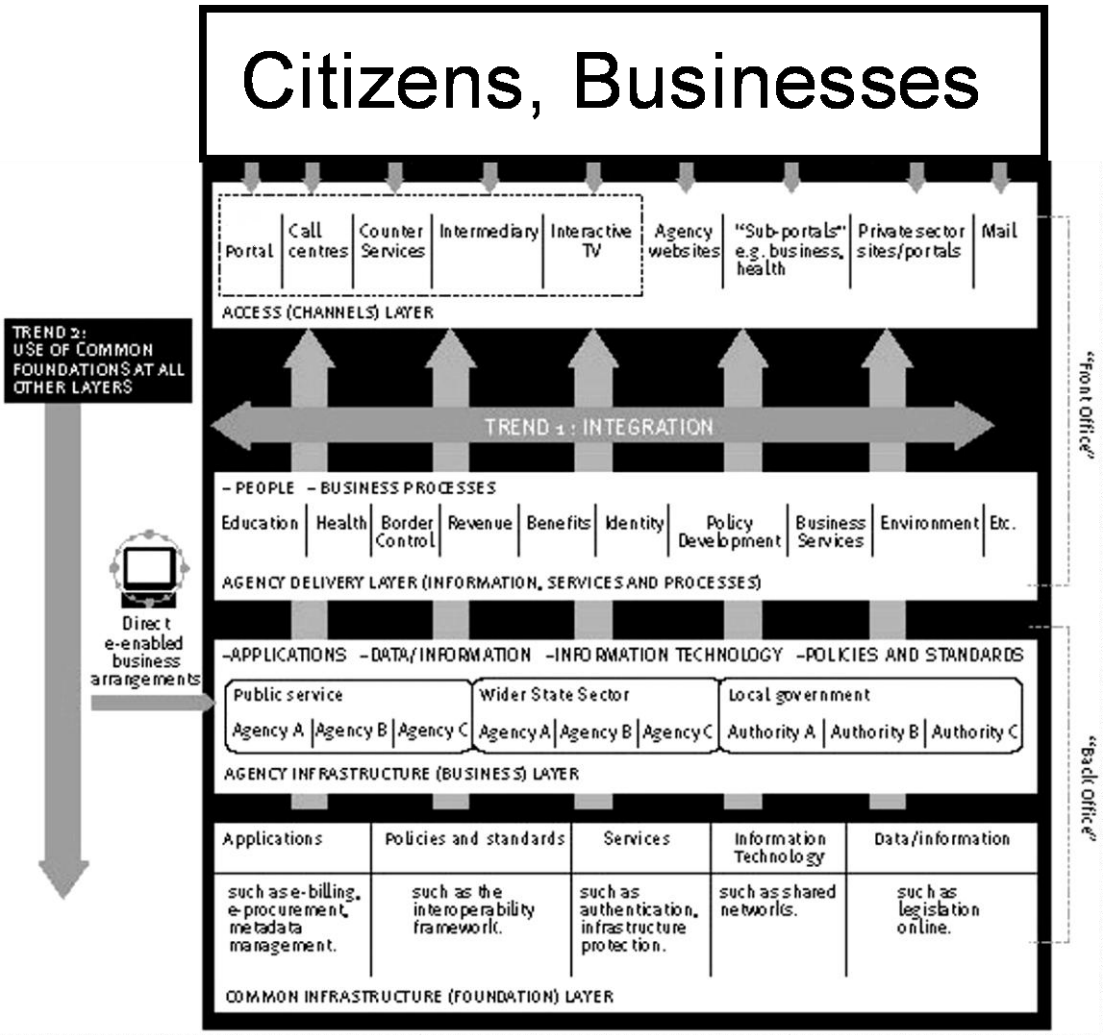
Whereas on the technical front, there were different requirements for the various stages which required different applications, policies, standards and infrastructure to contend with the front and back office operations. The figures below show the stages and their diverse technical requirements.

Fig 2.7: E-government Stages and Technical Requirements



Source: Adapted from Mallard (2001)

Fig 2.8: E-government Infrastructure



Source: adapted from www.e.govt.nz ,

It can be observed from the fig 2.7 and fig 2.8 that there are back office and front office operations that have to be developed to deliver the required services.

2.5.5.1 The Front Office

The front office refers to the operations that citizens interact with and are developed to provide answers to the following questions:

1. What mediums are available to access information and services?
2. How can information and services be integrated to deliver an effective and efficient service?

The solutions to the above questions are found in Fig 2.8 in two layers namely the access and agency layers.

2.5.5.1.1 Access Layer

This is the layer that serves as a container housing the various access mediums available to the citizens to access e-government information and services. It is not restricted to one medium but is made up of a myriad of options including information kiosks, portals, call centres, one-stop-shops, counter services and websites (Ebrahim & Irani, 2005).

2.5.5.1.2 Agency Layer

This is the layer that serves to aggregate information and services that were previously held by different government agencies into a common 'agency' such that these information and services could be obtained from a single source. It is the basis for the one-stop-shop; it is also the technology that makes it possible to deliver on integrated services or joined-up working (Ebrahim & Irani, 2005).

2.5.5.2 The Back Office

The back office refers to the operations that though unseen enable the front office to succeed. While it is common place to regard the technology on which e-government is built as the back office, it usually consists of more than technology. It includes the culture and work ethic of the various agencies and organisations and crucially the absence of a silo mentality among the different government departments and agencies. The back office exists to provide answers to the following questions:

1. Is there a joined-up e-government infrastructure between agencies and departments?
2. Is there a common platform of applications, specifications that e-government is built on?

The solution to these questions can be seen in fig 2.8 in the development of two back office layers.

2.5.5.2.1 Agency Layer

This is the layer that integrates the infrastructure of the different government agencies into a joined-up "agency" such that information and services held by multiple agencies could be obtained from a single source (Ebrahim & Irani, 2005).

2.5.5.2.2 Common Layer

This is the layer that provides the foundation for e-government. It is made up of technology and processes that are common to all e-government service providers. In the UK, it was developed by the central government through its national local e-government strategy to aid the activities of central and local government in the provision of services. It includes the development of an interoperability framework that sets the standards and policies for shared services in authentication, network security, network management and data management (Ebrahim & Irani, 2005).

2.5.6 Challenges of Electronic Government

There are numerous challenges to the implementation of e-government. While some of these challenges are independent of the stage of maturity or growth some are not.

2.5.6.1 Technological challenges

Prior to the e-government revolution, there existed information systems that supported operations of the different government agencies. This collection of systems was generally made up of bespoke system, legacy systems, suppliers and databases of differing schemas that made integration and collaboration tedious or downright impossible to attain (Gichoya, 2005). This also increases the cost of integration since embracing e-government now comes with some painful choices on which processes and systems to retain or phase out especially as there is nothing wrong (performance wise) with the existing system (Ezz & Papazaferopoulou, 2006). Phasing out a favourite system just because it is incompatible with an agreed new

framework of standards raises a number of organisational issues besides cost like staff training for new systems and a new human support infrastructure.

This human support infrastructure includes the technocrats that are needed to install and maintain the new system or process. The system could be alien to existing staff and as such there arises the need to either employ new members of staff or re-train existing members of staff to deliver the new system. In the case of delivering a new process, it would involve the re-engineering of business processes such that the envisaged benefits could be realised. Research has also shown that a lack of technical and business process re-engineering skills is a factor impacting on the development of e-government (Ramaswamy & Selian, 2007).

Another technological challenge impacting on e-government development is the security of network installations (Seifert, 2003). The threat of viruses and hackers is a very evident 'real and present danger' that networks are exposed to in the development of public sector networks. The aspiration of achieving joined-up networks, results in large local area networks (LAN), Wide area Networks (WAN), Metropolitan area Networks (MAN) – depending on the geographical locations of the agencies in question – which in turn increases the points of vulnerability within the network to the activity of hackers.

Data fragmentation is also a very significant challenge affecting e-government. Due to the number of government agencies that citizens interact with, there are multiple government databases that contain information about the same individual. There will be in the United Kingdom tax information about a citizen on the Internal Revenue service computers, health records with the National Health Service (NHS), Council Tax records with the local government council, voter registration on the electoral row etc. The likelihood of these databases containing significantly different information

about the same individual is very real and presents a challenge for data administrators.

2.5.6.2 Organisational challenges

Every organisation prides itself on its ability to deliver quick and efficient service to its customers. It becomes an irony in its self when this ability becomes an impediment to embrace change. This lack of motivation to embrace the change in working conditions could be as a result of having a difficulty in accepting the need to change a perfecting working solution which members of staff have perfected and specialised on in preference to a new and untested system. The unwillingness to embrace change could also be as a result of a view within the organisation that the change is short-term in nature and as such could be abandoned within a few months or years (Beynon-Davies & Martin, 2004). This kind of thinking within an organisation or agency breeds confusion in its processes and systems that need to be managed (Wimmer, 2001). The development of an appropriate change management strategy to decide how the change is applied to the agency or department is vital since it will specify if the change could be accommodated radically or incrementally (Beynon-Davies & Martin, 2004) to achieve the end that current processes are not impacted negatively. This could be achieved with the appointment of a change leader or agent to manage and drive the change process to negate the problems associated with the absence of one (Beynon-Davies & Martin, 2004).

A top-heavy hierarchical organisational structure would also pose a challenge for the implementation of e-government. The reason for this is found in the number of middle managers that are involved in the decision process. The development of a business system that models the existing process would be very ineffective while the re-engineering of the existing process to make it leaner, flatter and more effective

could imply the loss of middle management jobs which would be resisted by the middle managers (Hu et al, 2006; Robinson & Griffiths, 2005).

2.5.6.3 Socio-cultural challenges

The organisational culture of the public service is also a factor in the challenges affecting the development of e-government. The existence of 'tenured' positions in the public sector results in a laid-back approach to work when compared to private sector employees. The existence of militant public sector unions also tends to give the public sector a unique organisation culture that must be factored in any proposal of change (Ebrahim & Irani, 2005). A follow-up on the organisational culture of the public sector is the 'silo' mentality that exists between government agencies, departments within the same local council, central and local government and the various government services. This culture breeds reluctance on the part of different government agencies to share information, systems and processes (Beynon-Davies & Martin, 2004).

The development of vast databases to store the data accumulated by e-government also presents a new challenge in the form of data protection. Data protection becomes more pertinent in a climate of identity theft and financial fraud arising from stolen personal data. The need to create laws to control and organise the way data is handled and how has permission to view and process such data is a critical part of the e-government process (Beynon-Davies & Martin, 2004).

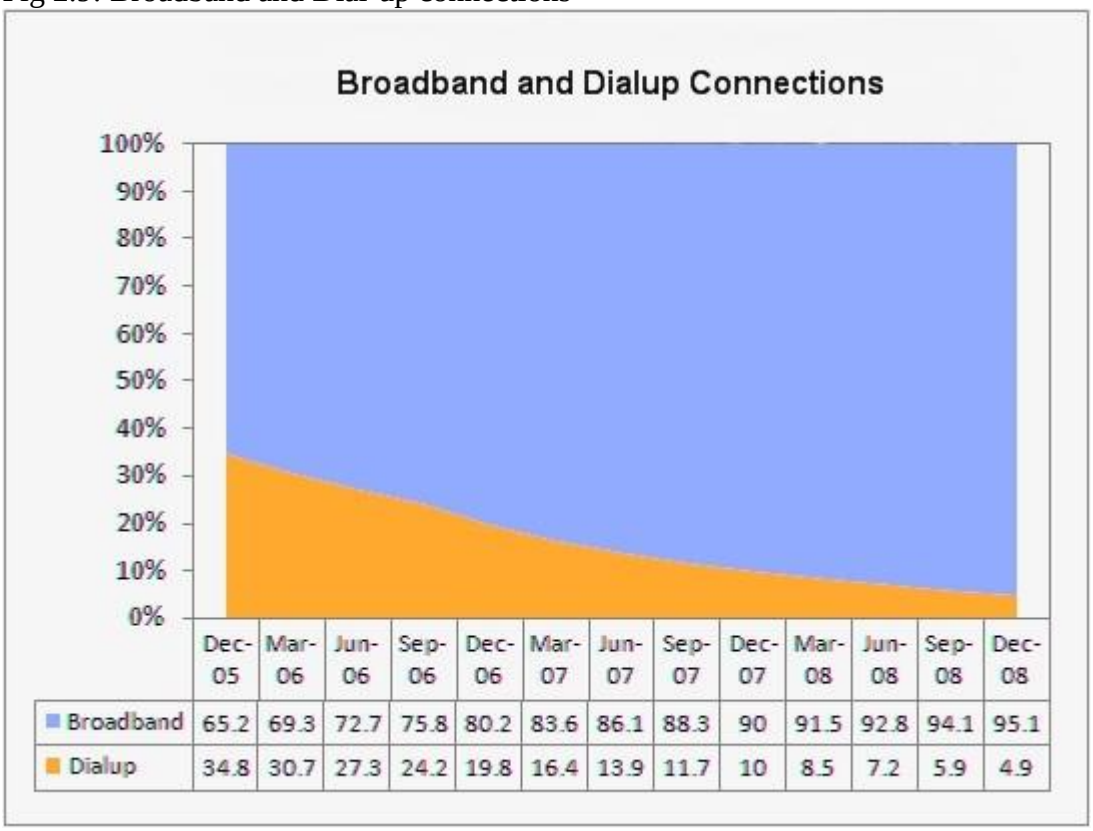
2.6 Digital Britain

The Digital Britain policy is designed to make the UK government a major factor in the shaping of the digital economy. It is intended as a continuation to the modernisation policies of the nineties with e-government and the creation of UK online. There is recognition that digital developments have occurred in three phases

with the first phase characterised by the creation of the office of the e-envoy, e-minister, a regulator for the Office of Communication (Ofcom) and the first three stages of e-government. Transformational government is regarded as the second phase while the quest for digital Britain is the third. The development of joined-up government involves the integration of processes, services and systems in a networked environment which makes an understatement the importance of networking technology. Equally vital in the development of joined-up services is the international network of computers commonly referred to as the Internet. While it is pertinent to note that networking is the technology that drives the Internet, the effectiveness of the Internet as a communication channel is dependent on its bandwidth and as such the deciding factor in the classification of the Internet type.

Dial-up Internet connection offered over a 56k modem is commonly referred to as narrowband Internet while "'Broadband' is the term used for 'always on' higher speed access to the Internet" (Cabinet Office, 2001). Broadband Internet has a higher bandwidth and channel capacity which enables it to provide new and faster value-added services. The UK online annual report of 2001 shows that in 2001, 60-65% of the population was covered by broadband Internet services.

Fig 2.9: Broadband and Dial-up connections



	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07	Jun-07	Sep-07	Dec-07	Mar-08	Jun-08	Sep-08	Dec-08
Broadband	65.2	69.3	72.7	75.8	80.2	83.6	86.1	88.3	90	91.5	92.8	94.1	95.1
Dialup	34.8	30.7	27.3	24.2	19.8	16.4	13.9	11.7	10	8.5	7.2	5.9	4.9

Source: Office of National Statistics, 2009

Between 2005 and 2008 however, the office of national statistics recorded an impressive growth of broadband connections such that only 1 in 20 Internet connections translated to a dial-up connection.

This resulted in a 95% broadband coverage by 2008. It was such a remarkable feat the office of national statistics suspended its quarterly broadband growth updates as it was no longer necessary. But an achievement of this scale poses its own challenges in terms of sustainability and complacency. It is this challenge that the Digital Britain report of 2009 and its attendant Digital Economy Act seek to meet.

Digital Britain is an industrial development strategy started in 2008 for the expansion of the digital industry in the UK which culminated in a Digital economy Act of April 2010. It was as a result of the Prime Minister, Gordon Brown's belief that such a strategy would "unlock the imagination and creativity that will secure …. the highly

skilled jobs of the future" (Digital Britain Report, 2009). It is envisaged that a well crafted digital strategy would yield benefits in commerce, transport and the health sectors such that the operation of street traffic lights, railway signals, financial services and the academic community would be impacted positively. It is also driven by the desire of the government to embark on some sort of "Industrial Activism" (Digital Britain, 2009) to develop a new industry and jobs in Britain.

> "Industrial Activism is at the centre of the Digital Britain Report. It is about the considered application of Government resources and policy-making across the areas where public policy and the market meet" (Digital Britain, 2009).

2.6.1 Aims and Objectives of Digital Britain

The development of Digital Britain is driven by social and economic considerations. The aim of the Digital Britain strategy is to be a "guide-path for how Britain can sustain its position as a leading digital economy and society" (Digital Britain report, 2009). It has five policy objectives which are:

1. Modernisation of the wired, wireless and broadcasting infrastructure.
2. Developing a highly skilled digital workforce
3. Securing a range of high quality public service digital content
4. Creating favourable conditions for innovation and investment in digital content, applications and services
5. Achieving universal access to broadband, increasing its take-up and delivering more efficient and effective public services

Though these objectives are laudable they have been soundly criticized by the former shadow culture secretary (who is now the culture secretary) Jeremy Hunt MP who remarked that "the government's ambitions are pitifully low" (Bailey, 2009). The strategy proposes changes to a number of sectors which include Broadband, Digital Radio, Digital Content creation, Digital Media and media literacy.

2.6.2 Digital Strategy

The digital strategy could be examined in terms of the following sectors:

Broadband Networks

The short term broadband strategy of Digital Britain is centred on the availability of the "right network today" (Digital Britain report, 2009). To this end, a commitment to deliver 2Mbps to all households by 2012 is made. It is expected that this commitment would be delivered by a host of technologies led by the Network Design and Procurement group and funded by the surplus from the digital switchover fund. This commitment was also criticized by Jeremy Hunt MP as wanting to "ensure the whole population has access to half the current average speed by 2012" (Bailey, 2009). This criticism seems so true when viewed on the backdrop that according to the UK office of national statistics broadband connections report of December 2008, 95% of the population accounting for 58m of the 61m UK population already enjoyed broadband facilities. The report also reveals a further 59.4% of the population have access to broadband speeds above 2Mbps with 40.4% having a broadband connection with a speed equal or less than 2Mbps as shown in the figure below.

Table 2.5: UK Broadband speeds

		Broadband speed		
		<=2 Mbps	>2 Mbps and <=8 Mbps	>8 Mbps
2006	December	62.0	35.1	2.4
2007	March	56.7	39.9	3.3
	June	52.8	43.3	3.9
	September	51.0	45.0	4.0
	December	48.9	46.9r	4.1
2008	March	47.7	47.8	4.5
	June	44.2	51.0	4.8
	September	42.3	47.9	9.8
	December	40.4	48.9	10.7

Source: Office of national statistics

But on close examination, the office of national statistics report does not tell the whole story. 40% is a very large proportion of broadband connections not attaining over 2Mbps connection speed. These figures make even more interesting reading when coupled with the fact that the report was compiled using headline or advertised broadband rates and not the actual values obtained by customers in their homes. This piece of information becomes important in the light of a recent Ofcom survey of April 2009 that found broadband connections were 57% of the average rated headline speed (Ofcom, 2009). The report also found that 17% of customers with a headline speed of more than 2Mbps only obtained an average speed of less than 2Mbps. 11% of lines could not achieve 2Mbps (Ofcom, 2009).

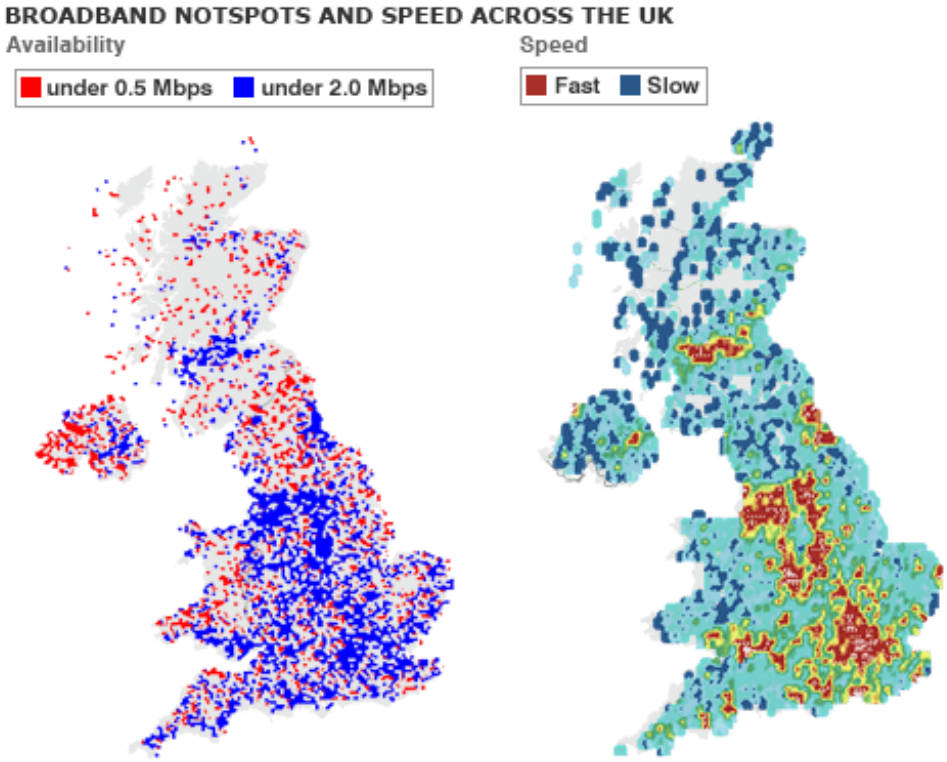
The table below shows the average speeds observed by the Ofcom research team for UK Internet Service Provider (ISP).

Table 2.6: Average Broadband Speeds

ISP and package	Average speed
AOL Broadband ('up to' 8Mbit/s)	3.3 to 3.9Mbit/s
BT ('up to' 8Mbit/s)	3.8 to 4.2Mbit/s
O2 ('up to' 8Mbit/s)*	4.1 to 5.1Mbit/s
Orange ('up to' 8Mbit/s)	3.8 to 4.5Mbit/s
Plusnet ('up to' 8Mbit/s)*	3.8 to 4.9Mbit/s
Sky ('up to' 8Mbit/s)	4.0 to 4.7Mbit/s
Talk Talk ('up to' 8Mbit/s)	3.8 to 4.6Mbit/s
Tiscali ('up to' 8Mbit/s)	3.2 to 3.7Mbit/s
Virgin Media('up to' 10Mbit/s)	8.1 to 8.7Mbit/s

Source: OFCOM (2009)

FIG 2.10: Broadband Not spots UK



Source: BBC News (2009)

Despite the criticisms, the Communications Minister Lord Carter is unfazed by his critics as he demonstrated in a BBC report that

> "Those who say that a Universal Service Obligation of 2Mbps is a ludicrously low ambition miss the point" ….."There is going to be 30% of the country not covered by traditional markets and I'm not prepared to leave them behind. It is not an option to say that we will find a mop-up solution in 10 years' time," ….."In our judgement two megabits is a base level that means people can access government services and have an acceptable user experience," (BBC News, 2009)

It is expected that this short term broadband strategy tagged "Universal Service Commitment" (Digital Britain, 2009) would be delivered by a cocktail of technologies which include DSL, Fibre to the street cabinet, wireless and satellite technologies. It is expected that a surplus of £200m expected from the digital switchover in 2012, would be used to fund this short term strategy.

The long term broadband strategy is based on the development of "Next Generation Networks" (ibid). These next generation networks are expected to offer connection

speeds of 50-100Mbps. It is expected that two-thirds of the country would be covered by the market within ten years but it is expected also that the same third of the country that is currently been poorly served by the market would also be short-changed without some form of intervention by the government. A state-aid solution is being proposed for these areas.

Wireless Networks

The wireless strategy is fully focussed on the mobile platform (mobile wireless). It is designed to develop the mobile platform in three stages. Firstly, the introduction of what the report calls "next generation mobile broadband", which would be assumed, refers to fourth generation mobile networks. Given there are a number of fourth generation mobile network implementations like mobile Wimax, 3GPP Long Term Evolution (LTE), Long Term Evolution Advanced (LTE advanced), it is not clear which implementation is been advocated for the country but a speed of 50Mbps is desired. Secondly, the plan is to attain complete 3G mobile and Next Generation Mobile coverage especially on trains and the London Underground. The final goal of the wireless strategy is to maintain competition within the mobile platform. The government is proposing to do all this by modernising the mobile spectrum. There are suggestions that the current 2G spectrum would be freed up while the current 3G licences would assume an indefinite time scale allowing the current holders the needed stability to plan and invest for future networks. There is also to plan to auction new spectrum made up in part by the spectrum retrieved from the digital switch over from analogue to digital television.

Digital Radio

The strategy for digital radio is to promote a switch over from Frequency Modulation (FM) radio to Digital Audio Broadcasting (DAB) radio by the end of 2015 (ibid).

The BBC is expected to champion this change while the car industry would be encouraged to fit new cars with DAB radios.

Digital Content Creation

It is estimated that the UK digital content industry is worth six billion pounds (£6bn) and as such rivals the financial services industry in its importance to the UK economy (Geereon, 2009). This importance is underscored by the desire of the government to protect the creative capital established by existing business models that are increasingly been made irrelevant in a rapidly changing world. It is no secret that with the advent of digital technology previously existing industry barriers have broken down, lowering the cost of entry into these industries and allowing more competition. Sectors like the music industry have seen dramatic reductions in the costs for recording studio setup that have seen the growth of independent artists and recording labels. Innovation has also made it easier to copy and share digital works with little loss in quality. This poses a new problem for existing copyright laws, intellectual rights, piracy control and legislation. The government is proposing the creation of cheap and accessible legal markets for the sale of digital works. It is also proposing the education of ignorant customers on recognising illegal works while advocating prosecution for unrepentant offenders. It hopes to achieve this by empowering the regulator Ofcom to compel Internet Service Providers (ISP) to 'police' their networks, giving-up the identity of illegal file sharers including employing bandwidth reduction and protocol blocking tactics against them. These measures have been criticized by human rights campaigners like the Open rights group (BBC News, 2010)[2] as being undemocratic while the same BBC report refer to its critics branding its provisions on digital content "draconian" (BBC News, 2010)[2].

2.6.3 Challenges and Limitations

The development of Digital Britain is beleaguered with challenges, some acknowledged by the government while others are not. In the provision of broadband, the figure below shows the difficulties associated with its development outside the urban areas. While the urban regions are adequately serviced by the market, the rural and remote regions of the United Kingdom have been left without service by the market because it was not economically viable to service such out of the way locations.

Fig 2.11: Broadband Outlook

	Phase One **High speed**	Phase Two **High volume**	Phase Three **Next generation**
Urban	Delivered by LLU ISPs	May be delivered by LLU ISPs?	Market delivering e.g. Virgin, BT
Rural	BT Wholesale pricing issues	Pricing & congestion issues - no solution yet?	No market solution yet
Remote	Market failure	Market failure	Market failure

Source: BBC (2009)

So while it is desirable to provide a broadband service to every house in Britain that demands it, the costs associated with it does not outstrip the financial returns for such an investment which does not constitute a viable business model nor is there an alternative model. The most important challenge facing Digital Britain is the question of - who will pay for it. - the digital strategy is currently proposing the development of a Next Generation high speed broadband network based on benefits that can not be predicted today. While it might prove a shrewd strategy the move to prepare for the digital revolution, it does not negate the fact that businesses exist to make profit and would only invest in profit making ventures.

> "BT - or Virgin for that matter - isn't saying it out loud but the message to the government is clear. If you really want us to build Digital Britain, you're going to have to pay for it (Cellan-Jones, 2009)"

Whilst the government is pre-occupied with state aid concerns, it is also besieged with the problem of not distorting competition within the broadband market. Also, the digital content creation proposals currently elicit more questions than answers. The unavailability of sufficiently trained competent digital practitioners has exposed a skills shortage in need of urgent attention.

2.7 Modernisation and the Digital Society

There are certain observations that can be made from the foregoing:

Modernisation is an innovative process that is highly linked with technology which has been shown to be an important factor in the development of societies. It can also be observed that with the advent of the digital revolution, the societal classifications based on the effects of the industrial and other past revolutions have become outdated. The effects of globalisation, twenty-four hours satellite television and advances in communication have influenced societies and altered the perceptions of life. There are now genuine societal fears on the creation of a digital divide and demands for broadband Internet services as some sort of basic necessity of life. This calls for a rethink on what constitutes a traditional society and the stages of growth required to become a modern digital society.

2.7.1 The Traditional society

This is a society that may have experienced the industrial, educational and democratic revolutions but not presently operating in the digital economy. It is not connected to the Internet and as such operating with a ceiling, a restriction imposed by being disconnected from the global community. This restriction results in the denial of access to global markets and the digital economy it supports. These are the

online markets which have grown in scope beyond the traditional buying and selling to include the financial and commodities markets; in reach both locally and internationally.

2.7.2 The Transition or Crossover

This is the period required to transform into a modern digital society. It involves the alteration of the political, social and technological structures of the society to generate 'digital momentum' that would provide a platform for the development of a digital economy and society. This digital momentum is achieved by the creation of digital capacity through high speed, high capacity broadband networks and the digitisation of the industrial, educational and democratic structures of the society. In line with observations from other technologies like the telephone, it is expected that these networks will tend towards a wireless resolution. These networks would in turn alter (as they are presently doing) the status quo in the delivery and activities of goods and services into new forms not previously imagined.

2.7.3 The Digital Society

This is a society fuelled by digital momentum and reaping the efficiencies and conveniences associated with it. The digitisation of industry, education and democratic structures would enable present day events to become common place and gravitate towards real-time solutions. Real-time utility billing, voting and referendums become possible radicalising government decision processes. The importance of authorised access would be vital in this society, demanding better authentication and identity verification technologies and regimes. It would also be grappling with new forms of crimes and as such information security would remain a factor.

2.8 Conclusion

This chapter examined modernisation in its social as well as its economic dimensions. In its social dimensions, it established the pivotal role technology plays in the sociological representation of societies and the notion that technology and its attendant innovations are crucial to the modernity of any society. It also examined the dual role of technology as an agent of economic development and modernisation in the creation of the welfare state. While acknowledging the role of the Industrial, Democratic and Educational revolutions, it was pertinent to note that the development of social overhead capital is crucial for economic development. This could also be said of government interventions in the creation of the welfare state. Despite the benefits of having a welfare state, the challenges arising from the implementation of the welfare state dictate the need for more efficient and effective ways of delivering government welfare, demanding new tools and thinking for modernising government. This has been provided by the new public management theory (NPM) which emphasized the centrality of the citizen in the design of government. It also promoted the decentralization of government and the introduction of private sector market and management principles in the working of government. These market principles involved the introduction of competition in the affairs of government. The need to maintain competition was also highlighted by the State Aid law which constraints EU member states to account for effects of competition in all interventions of state.

This chapter also examined modernisation of government in the United Kingdom and its adoption of NPM principles in the decentralization and devolution of powers from Whitehall. It also examined the implementation of one of the elements of NPM in the form of Electronic government (e-government) as the flagship for modernising public services into a twenty-four hours a day, seven days a week event. E-

government saw the re-engineering of government processes and structures to reveal enhanced front and back office operations that developed numerous access channels to government services in the front office. It also saw the development of an impressive government network that has enabled the delivery of back offices operations in a networked environment. E-government revealed the application of the strategic capabilities acquired from the industrial revolution being replicated in the development of "digital overhead capital" in the development of digital infrastructure to power e-government. This was also exhibited in the creation of Digital Britain vis-à-vis the strategic plans for the development of high speed broadband in anticipation of the future digital economy. These are the strategic plans to which this study finds relevance with regard to the plans for wireless networking and technology. These strategic plans and how they interlace with the strategic management of innovation would form the basis for the next chapter.

Chapter Three

Innovation Management

3 Introduction

This chapter is a review of literature on innovation and its management. Critical to this examination is an understanding of the key concepts involved and how they affect the management of innovation.

This chapter will also bring to fore the important relationships that exist between innovation management and strategic management on one hand; and on the other hand with marketing (both strategic and tactical).

The significance of this chapter is that embedded in it are some of the core ideas that would form the basis for further analysis in subsequent chapters.

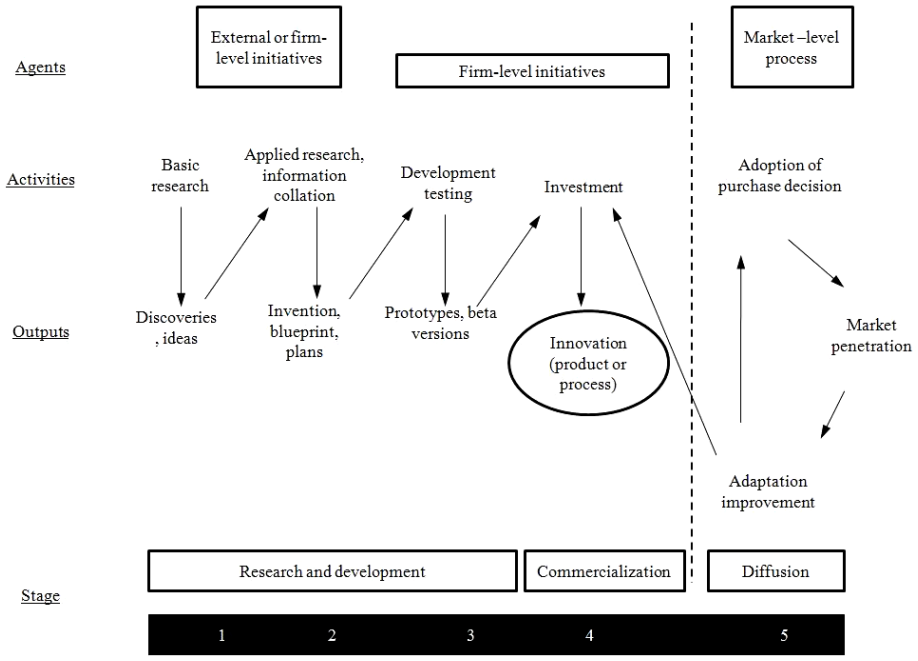
3.1 Innovation

There are few words or subjects that are able to generate the amount of interest as innovation does. It tends to exist as a sort of enigma, the thought that it is so common yet so rare, how much it is discussed yet how little is really known about it. While this may be the case, what cannot be denied is the fact it is a 'game changer' leaving in its wake a profound effect that could be creative as well as destructive at the same time. This raises questions how a phenomenon such as innovation could be defined. Rainey (2005) defines innovation as a "creative new solution to the prevailing conditions and trends, and fulfils the expressed and latent needs and wants of customers and stakeholders". While Smale (1998) seems to agree with the following definition that "An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. It maters little, so far as human behaviour is concerned, whether or not an idea is objectively new as measured by the lapse of time since its first use or discovery. The perceived newness of the idea for the individual determines his or her reaction to it. If the idea seems new to the individual,

it is an innovation" (Rogers, 1996). In his adoption of this definition, there is an acceptance that the new idea in question could be an amalgam of previous ideas; the creation of a unique approach; or the embracing of an idea from others (Smale, 1998). It could also be understood from the definition that an attempt is being made to distinguish an innovation from an invention by lowering the burden of originality required for an idea to become an innovation. While it could be accepted that an innovation could be made up of previous ideas put together to become something new or the creation of a unique approach or product, the assertion that accepting an idea from others is innovation seems to set the bar of originality too low since it begs the question what then is an imitation?

This requires an alternative viewpoint which is provided by the following definition which describes Innovation as "the application of new ideas to the products, processes, or other aspects of the activities of a firm that lead to increased 'value'. This 'value' is defined in a broad way to include higher value added for the firm and also benefits to consumers or other firms" (Greenhalgh & Rogers, 2010). Intrinsic to their definition is an effort to make a distinction between an innovation which they regard as the marketing of a new item, as opposed to an imitation, which they regard as the reproduction of an idea, new technique or design that is already in the market. This from the foregoing is completely opposed to the position taken by Smale (1998) in its definition of innovation. They justify their stance by making the argument that a product or process though new to an organisation and its local market, could not be regarded as an innovation by introducing the concept of innovation diffusion as "the firm in question could simply be adopting a product design or production method, introduced by a competitor" (Greenhalgh & Rogers, 2010).

Figure 3.1: Stages of the innovation Process



Source: Greenhalgh & Rogers, (2010).

They argue that innovation has to be new to firm, new to its relevant market and such that it is beneficial to its consumers or other firms in its industry. This move to the market they contend is the main factor that differentiates an innovation from an invention or discovery. While an invention or discovery could be acknowledged as a contribution to knowledge, it needs to be commercialized for it to assume the status of an innovation. Thus "Innovation is a process, not a single event" (Tidd et al, 2001) and the journey from invention to innovation requires the market.

> "Innovation occurs at the point of bringing to the commercial market new products and processes arising from applications of both existing and new knowledge. Thus we can see that innovation occurs at the kernel of a complex process, preceded by inventions and succeeded by the widespread adopting of the new genre of products by customers or the adoption of best practice processes in the majority of firms. We call this final stage diffusion and it is clear that the benefits of innovation to the economy and its citizens are not fully realised until this has taken place" (Greenhalgh & Rogers, 2010).

This view is also shared by Sawyer (2006) who asserts that innovation is not merely the development of a new creation, backing up this assertion by recalling that in the development of the Apple Macintosh in 1984, its famed Windows Graphical User

Interface (GUI) made use of previously unviable technological inventions created in the 1960s and 1970s until they were combined by Apple. He also cited (West, 2002, 2003) who stated that innovation is made up of four stages namely:

1. The creation of an idea, process or product
2. The implementation of the idea, process or product
3. The dissemination of the idea, process or product
4. The adoption of the idea, process or product

The implication of the above discussions carry grave consequences for engineers and scientists since it presents an explanation why numerous research inventions and discoveries are languishing in research labs and cannot take their pride of place as innovations. The foregoing also show that there is a process involved with innovation that needs to be fully understood and managed by inventors, engineers and scientists in order to reduce the number of inventions left on the shelves.

3.2 Innovation management

An important deduction from the discussions in the preceding section is the existence of a process required to convert inventions or ideas into innovations and the need to manage this process effectively. It follows that the administration of this process is what is referred to as innovation management. It could be defined as "the management of all the activities involved in the process of idea generation, technology development, manufacturing and marketing of a new (or improved) product or manufacturing process or equipment" (Trott, 2008). Innovation management "involves the means, mechanisms, and methods for leading change through developing new technologies, products and processes. It includes changes in business models and organisational structure" (Rainey, 2005). It is worth noting at this juncture that the management process can be carried out by an individual or a group of individuals. When it is carried out by an individual they are mostly referred

to as entrepreneurs who through history as noted by Schumpeter (1983) have been a vital source of innovations. It is equally true that innovations are not the exclusive preserve of entrepreneurs; they are also brought about by group of individuals, organisations and governments.

3.2.1 Importance of Innovation Management

The importance of innovation management cannot be overemphasized. The more obvious is that of a medium of transformation in the pathway to achieving innovations. Innovation management is required to transmit past, present and future inventions and ideas to the market where they can fulfil their potential and perform the service or functions they were designed to do. Another reason underscoring the importance of innovation management is in the value of innovations. Innovations are a valuable source of competitive advantage to their protagonists. Far beyond their generally accepted role of creating new products or processes that have conferred financial rewards in the form of revenue accruing from patents or downright commercial success, innovations have also shown to be invaluable in the perpetuating of patents long after their expiry dates as amply demonstrated by the pharmaceutical industry. In addition to the huge financial benefits associated with innovations, they have also been a very important source of modernisation in the society. The place of innovations in the societal context is clearly demonstrated in the sociological classifications of Parsons (1966, 1977); in the advances in healthcare, transport, communication, energy generation and in the transformation of government.

3.2.2 Functions of Innovation Management

The effects of innovation management is manifested in three forms

1. The development of innovations
2. The development of successful innovations

3. The diffusion of innovations

It has been established in the foregoing the function of innovation management in bringing to the market novel ideas, inventions, products and processes which would seem its primary function. What has not been highlighted is the fact that not all innovations are successful. This distinction becomes necessary because there are inventions that make it to the market but falter due to a number of reasons which could range from a poor business model; inadequate finance; fierce competition from alternative products, de facto market leader, poor marketing, to wrong timing. The fact is these inventions are no longer inventions but innovations since they got to the market. They are just failed innovations which highlights another important function of innovation management, the process of developing of successful innovations.

Another function of innovation management just as important as developing successful innovation is the diffusion of innovations. Innovation diffusion had previously assumed a salient persona in the innovation process. This is often due to the fact that innovation has been deployed to the market successfully. Recent events have however shown the error of such presumptions as amply demonstrated by Microsoft Corporation and Apple Macintosh who both had successful windows operating systems in 1984. While Microsoft implemented a successful diffusion strategy that saw it become the de facto operating system, Apple's strategy, on the other hand, was disastrous. They implemented a closed diffusion strategy that restricted and controlled access to their operating system. This resulted in Apple, despite having a better operating system (Linzmayer, 2004), lost market share resulting in the Microsoft's operating system Windows™ being adopted as the de facto standard by the computing industry.

3.2.3 Challenges of Innovation Management

While it is clear that there are undeniable benefits associated with innovation management there are also challenges involved. One of the difficulties observed is the reluctance with doing new things. This reluctance could be due to the national culture of the country involved or it could be due to the organisational culture prevailing in the firm. Where culture could be described as "the pattern of basic assumptions that a given group has invented, discovered or developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid and therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems" (Schein, 1990). This suggests that organisational or national culture is a source of strength (Cameron & Green, 2004) not some fad but an institutionalised coping mechanism developed to confront or survive challenges. Thus a form of de facto best practise model devised for controlling situations including change. This control may be irrespective of the benefits of the perceived change. Since all innovations involve some sort of change while not all change results from an innovation (Trott, 2008) it follows that innovation management always has to contend with culture in the realisation of its objectives. A case in point would be that of the French innovator, Barthelemy Thimonnier (1793-1857), who invented a sewing machine in 1830 - actually produced eighty units by 1841 – and in the process won a contract to produce uniforms for the French army. However he did not contend with the reactions of fellow French tailors who saw the innovation as a threat to their livelihood, so attacked and burned down his factory (www.moah.org , 2004).

Another difficulty of innovation management is associated with recognising when a successful culture or strategy starts inhibiting innovation. This could arise from a culture of persistence that was crucial in the survival and success of an organisation

or a reputation for quality built over a long time. This could become an obstacle to embracing or adopting innovations because they don't conform to their established culture or strategy. This was demonstrated by formula one car racing teams who due to their culture of maintaining high quality and safety standards did not want to adopt carbon fibre as the material for manufacturing car body parts.

Discontinuous innovative change dictates a shift by all existing stakeholders which in turn presents a challenge to the established industry leaders in the form of sunk costs in their present product or production process or system. It induces a reluctance to adapt and embrace the new resulting in a defence of the status quo which has been shown to lead to disappearance of once prosperous firms.

The market is also an important aspect with innovation and the advent of globalisation has presented a new challenge to its management. Globalisation has expanded the boundaries of the market presenting opportunities in the form of more customers as well as threats from increased competition. "the major challenge to innovation management is one of managing the same basic principles but on a much bigger stage… competition has intensified and much of it is being driven by innovation in products, services and processes" (Tidd et al, 2001).

3.3 Types of innovation

It was shown in the previous section that competition is been driven by innovations which to all intent and purposes have become multifaceted. This many-sided view of innovation naturally brings the review to an examination of the types of innovation at play. There are different classifications of innovation which despite their differences tend to be common in certain regard. An examination of the literature seems to suggest some confusion among authors between the classes or dimensions of innovation and its types. This could be attributed to the previously held notion that innovations were the preserve of the technological sector and as such just one type of

innovation – technical innovation – translating the discussion to the classes or dimensions of technical innovation. With the advent of time, as in Dalton's atomic theory, this has been shown to not be exactly the case. Just as the atom was shown to be made up of constituents – protons, neutrons and electrons – technical innovations have been shown to include process and product innovations. While there are outside suggestions for a third group in the form of component innovations to account for architecture and component innovations that can't stand-alone but are dependent on other products (Tidd et al, 2004). There is also a view that product and process innovation can't take place independent of each other (Davenport, 1993). The growth of the Internet and information computing technology (ICT) has also enabled other types of innovations.

3.3.1 Process Innovation

This is a type of innovation that is concerned with the "improvement of the quality and efficiency of the internal and external processes" (Bekkers et al, 2006). It is an innovation type that does not end in a typical 'product'. On the contrary, it is associated with the alteration of the product delivery mechanism such that the product is delivered in superior conditions than had been previously possible. Thus, a process defined as a "set of logically related tasks performed to achieve a defined business outcome" (Davenport & Short, 1990) still achieves the same business outcome but utilizes a different set of tasks. The objectives for embarking on process innovation could be related to "process time reduction" (Davenport, 1993) which has an economic impact in terms of efficiency savings arising from shorter process times. It could also yield higher returns as a result of increased production. Another effect of process innovation is in the support of low cost production strategies which minimize waste by eliminating or re-engineering tasks.

In the public sector, the innovation of government processes is vital to the improvement of public service delivery (Snijkers, 2006). There is a contention that the "Weberian bureaucracy, with its specialized administrations, strict task allocation, formalization and hierarchy has led to a fragmented, compartmentalized and supply-oriented policy and public service delivery" (Snijkers, 2006). This criticism is not new but only seems to add to the wider perception of public service administration as inept and full of 'red tape'. Advances in information computing technologies have given rise to innovations in public sector processes resulting in new access channels to government and the integration of back offices processes that have enabled the development of one-stop shops, joined-up services between agencies and local government councils that were from a Weberian point of view practically impossible.

3.3.2 Product Innovation

Product innovation involves "the conceptualization, design, development, validation and commercialization of new products that provide superior solutions to the needs and expectation of customers, stakeholders and society" (Rainey, 2005). This is the most well known type of innovation. Its main objective is to create value by securing a competitive advantage through the provision of new solutions to old problems; creation of new opportunities to take advantage of existing capabilities, competencies, resources and assets such that guarantees sustainable results through the methodical replacement of obsolete products; and building of new capabilities and resources for sustaining the future (Rainey, 2005). An important requirement for innovative product is the need to know what the customer wants. Hallmarks of successful innovations have been the ability to satisfy the needs of its customers, stakeholders or society. This imposes the need to know what the customer wants in the development of innovative products. This trend of thought resonates with the

thinking of NPM in its advocacy for a customer-centric focus in public service delivery as discussed in chapter two. This is also demonstrated by the 'voice of the customer' routine utilized to capture the expectations of the customer.

3.3.3 Organisational Innovation

Innovations are not the select preserve of technology; there are also non technical innovations of which organisational innovations is one. Organisational innovation can be defined as "the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations" (OECD, 2010). Innovations relating to outsourcing of operations, creation of formal or informal work teams, supply chain management and scientific work management practices such as Taylorism are featured in this category. An example of this could be found in the promise of Domino Pizzas to charge customer less if they take more than thirty minutes to deliver (Goldberg & Mazursky, 2002). The use of ICT and organisational innovations has led to the creation of twenty-four hour firms that co-ordinate shift working patterns spanning different time zones. This is a practise that eliminates overtime working hours because while a customer may be contacting an organisation after working hours (after 9-5pm) in their time zone, they are being attended to by employees working a normal 9-5pm work shift in a different time zone. This is far more cost effective than recruiting after-hours staff especially as there is normally a reduction in customer queries during such off-peak hours.

3.3.4 Conceptual Innovation

Conceptual innovation is "the development of new world views that challenge assumptions that underpin existing service products, processes and organisational forms" (Windrum et al, 2002). This is a type of innovation that is commonly omitted in the classifications of innovation but has had profound effects on human development. These innovations have not been restricted to a particular field but

have pervaded many sectors. In computing; it was seen the creation of concepts such as parallel computing, concurrent programming or multiprogramming (Hansen, 2002), multithreading. In politics/ government, non-violent concepts such as civil disobedience employed by Ghandi in India, "the 'minimalist state' … prompted in the late 1970s by a perceived crisis in a post-war consensus based on the interventionist state support of private sector capital" (Windrum et al, 2002), human rights etc. Another conceptual innovation in public services has been the "paradigm shift from government to governance" (Bekkers & Korteland, 2006). This has resulted in the creation of new ways or modes of governance which include governing from a distance, self-governance, participation and NPM.

3.4 Dimensions and Classes of innovation

A follow-up from the types of innovation reviewed in the last section is the dimensions in which these innovations occur. A review of literature shows that with regard to all the types of innovation previously considered, there exist two dimensions in which they occur (Tidd et al, 2001). They are:

1. The extent of innovation
2. The object of innovation

3.4.1 The extent of innovation

This is a dimension that has to do with the degree of change as a result of the innovation. The degree of change experienced can be grouped into three classes which are

1. Incremental innovations
2. Radical innovations
3. Transformational innovations

1. Incremental innovations

These innovations do not create new products or processes, on the contrary; they "build on existing knowledge bases and provide small improvements in well-defined current product lines". They could also be described as "evolutionary and linear in nature" (Hoskisson et al, 2008). This can be amply demonstrated with innovations such as the television which has continue to enjoy incremental innovations from a black & white beginning to a colour television; from cathode ray tubes to Plasma, Liquid Crystal Display (LCD), Light Emitting Diode (LED) screens; from analogue to digital. In spite of these changes it is pertinent to note that the original product innovation – television- though modified by these innovations, has remained intact. It has also been suggested that over time, when compared with radical innovations, the cumulative gains from incremental innovation is greater (Tidd et al, 2001).

2. Radical innovations

Radical innovations are a class of innovations "with either unprecedented performance features or familiar features that offer potential for significant improvements in performance or cost … that they transform existing markets or industries, or create new ones" (Leifer, 2000). While incremental innovations could be described as evolutionary and linear; radical innovations on the other hand are sporadic and non-linear (Leifer, 2000). Compared to incremental innovations, they require a longer time to gain acceptability which is a function of the risk associated with them. Thus it becomes academic to state they posses the greatest degree of uncertainty and unpredictability both in terms of market perception and technology (Leifer, 2000; Arnold et al, 2010).

This could be attributed to the obstacles associated with developing radical innovations. Stefik & Stefik (2004) had an excellent take on this by proposing that there are three types of obstacles connected with innovations. The first type of obstacles they referred to as "innovation obstacles" (ibid) which are common to all

innovations and include challenges such as consensus building, financial support, mastering the technology and marketing. The second type of obstacle is what they referred to as "breakthrough obstacles" (ibid) as a result of the insight required to achieve breakthroughs which are unexpected and beyond conventional thought. The third type of obstacle the called "change obstacles" (ibid). They ascribe this to the nature of radical innovations to invoke widespread and disruptive change that in turn provokes widespread resistance and obstacles. Obstacles that in their opinion are proportional to the changes advocated. They also attribute the time span required to achieve radical innovations to the time required to overcome the resistance and effect widespread change (ibid). They conclude that the "big challenges for radical innovations are often economic and social" (Stefik & Stefik, 2004) because they are obstacles emanating from resistance to change and as such least predictable to address (ibid). This quickly develops into a situation that is pregnant with competing scenarios such as old technology leaders fighting to prolong their businesses by developing incremental innovations; resistance from employee arising from having to learn new skills, resistance from managers due to the changes that are envisaged in working practices and patterns. These fears amplify the thresholds needed to overcome the normal 'innovation obstacles' such as consensus building or achieving buy-in from stakeholders.

3. Transformational innovations

These are new innovations that unlike incremental innovations create new products, process or services but do not bring about any disruptive or radical change. They exist side by side with the technology or service they are replacing. They become more or less an alternative to the other. Examples of such innovations could be found in the lighting industry where the wax candle has existed side by side with other

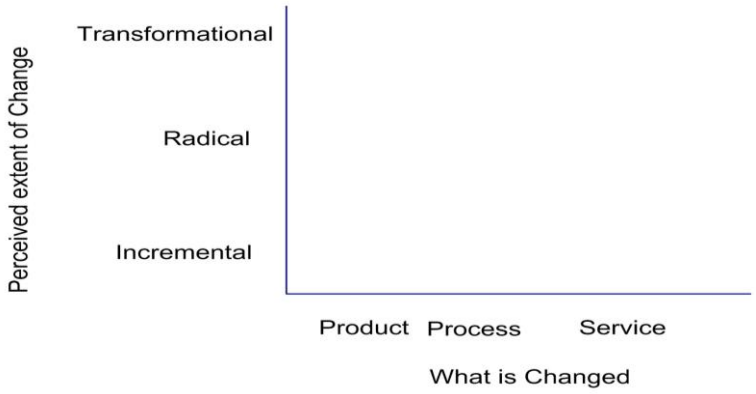
lighting innovations, cutting across gas lamps, tungsten lamps, florescent lamps and presently LEDs.

Transformational innovations were also employed in public sector in the form of transformational government (the fourth stage of e-government), where the focus was not on disrupting established modes of transacting government business but in the development of alternative streams that are innovative to enhance the delivery of public services but not disruptive to cannibalise existing government. Examples abound in the UK such as being able to obtain road tax on a vehicle online and also at the post office.

3.4.2 The Object of Innovation

This dimension refers to the subject of interest attracting the effects of innovation at that particular instant. It could be a product, process, service, notion, organisation etc. this is the dimension of innovation that gives rise to the type of innovation achieved. Assuming the focus is on the creation of a new product, product innovation results. This is also the case in the development of process, organisational and conceptual innovation as the case may be.

Fig 3.2: Dimensions of Innovation



Source: Tidd et al, (2001)

The relationship between the objects of innovation and the extent of change is shown in this matrix developed by Tidd et al (2001)

3.4.3 Effect of Innovation

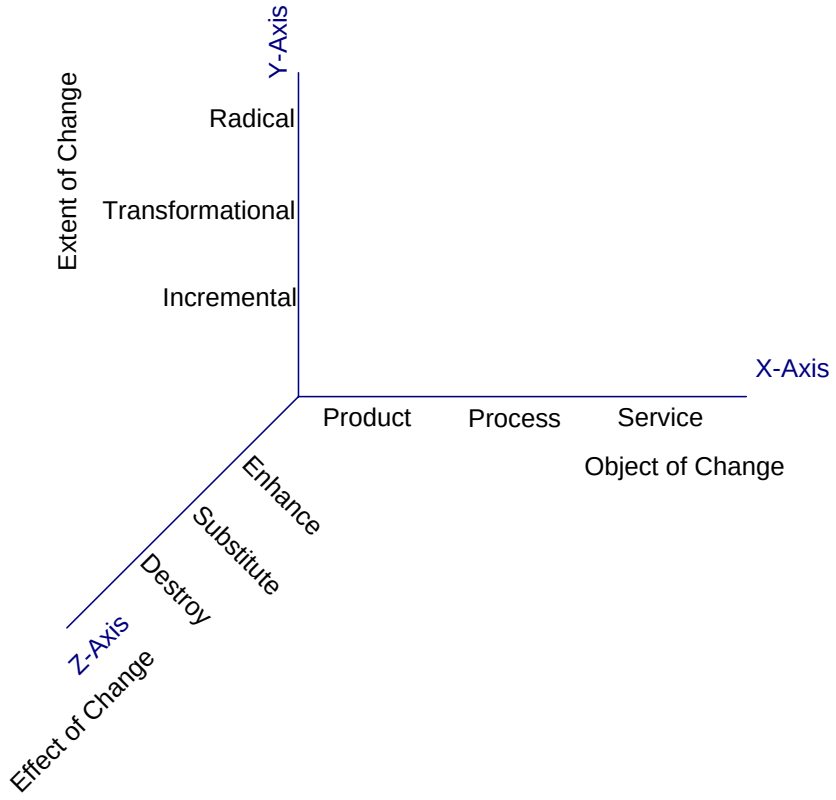
A critical examination of the text suggests the existence of a third dimension, to account for the effects of change. It follows from the examination that there are three implications arising from innovations. They can

1. Preserve the existing innovation
2. Destroy the existing innovation
3. Accommodate the existing innovation

The extent of change dimension commonly referred to is a dimension of degree. It does not account for the implications of innovations which are usually assumed because they exist in the third plane or axis. It could be argued that this was the dimension Schumpeter recognised in his description of innovation as "creative destruction" (Schumpeter, 1934) - a dimension that has to do with the effects of innovation. The relevance of this dimension becomes more apparent when we consider the relationship between radical and transformational innovations. It becomes obvious that the relationship is not one of degree but effect because radical innovations are discontinuous and tend to destroy the existing innovation by replacing it. Transformational innovations on the other hand don't destroy the existing innovation but accommodate it along side while retaining the dominant role.

In a three dimensional plane of axis x, y, z. and extending Tidd et al, (2001)

Fig 3.3: Effect of Innovation



3.5 Understanding Innovation

3.5.1 Models of Innovation

The simplest description of the innovation process involves the creation of an invention and the subsequent commercialization of this invention. This is a linear representation of the innovation process which is called the technology-push model and actually dominated the understanding of innovation up to the second half of the 1960s (Backer, 2008). It is founded on "new ideas from research laboratories that seek applications and markets" (Swamidass, 2008). Another model called the market- pull model was developed in the 1970s (Backer, 2008) which though a linear model, was a representation of the effects of market forces in driving the innovation process. It advances the argument "that articulated customer requirements should drive new product development decisions" (Swamidass, 2008). Roy Rothwell developed a model that has proved valuable in the understanding of the innovation

process (Backer, 2008; Tidd et al, 2001). He regarded the linear technology-push and market-pull models as the first and second generation models to explain the innovation process. He also identifies the third generation models to be a combination of first and second generation models resulting in a coupling that could be referred to as a technology-push, market-pull with feedback loops and linkages from the market and research laboratories (Backer, 2008; Tidd et al, 2001). The fourth generation of innovation models for the 1980s could be referred to as a 'parallel model' relying on linkages and alliances within the organisation and its key partners (Tidd et al, 2001). Rothwell proposed a fifth generation model that "sees innovation as a multi-actor process which requires high levels of integration at both intra- and inter-firm levels and which is increasingly facilitated by IT-based networking" (Tidd et al, 2001).

Table 3.1: Rothwell's Five generations of Innovation Models

Technology- push	Market-Pull	Push -Pull	Parallel	Integrated Networking
First Generation	Second Generation	Third Generation	Fourth Generation	Fifth Generation
- Late 1960s	Late 1960s – 1970s	1970s – 1980s	1980s – 1990s	1990s - date

Source: Adapted from (Tidd et al, 2001)

3.5.2 Innovation streams

This is a concept in innovation management that involves the development of a range of incremental, architectural and radical innovations simultaneously over time in a bid to defeat the introduction of radical innovations from outside the organisation

(Tushman & O'Reilly, 2002). It is summed up by this statement credited to the CEO of Hewlett Packard as "the philosophy of killing off our products with new technology" (Tushman & O'Reilly, 2002). It involves the deliberate and proactive development of innovations to improve existing products, processes and services while actively searching for a replacement radical innovation to destroy them. This concept is excellently demonstrated by Microsoft in its development as a software company. Microsoft produced the software 'Disk Operating System' (DOS) – a command line based software program - for the International Business Machines (IBM) Corporation. It however continued to implement incremental innovations to the software that resulted in upgrades starting from 1.0 to 6.0 and then 6.1 and 6.2. It is also important to note that while these upgrades were taking place, Microsoft continued simultaneously to search for a radical innovation in the form of a graphical user interface. This culminated in the release of the graphical user interface for DOS called Window 1.1 in 1985, Windows 2.03 in 1988 and Windows 3.0 May 22, 1990 (Linzmayer, 2004). In 1995, Microsoft released a radical innovation called Windows 95 which unlike Windows 3.0 - a graphical user interface (GUI) – was a complete GUI operating system, effectively destroying their product, the operating system DOS. The reward for ensuring Microsoft and not a competitor developed the innovation to kill off the command line operating system DOS was becoming the world's richest corporation and in the process making its founder Bill Gates the world's richest man.

3.5.3 Technology cycles

Technology cycles represent an attempt to explain the behaviour of technical innovations. It bears a marked difference from 3.5.1 which is an attempt to explain the workings of the innovation process. Technology is said to develop in cycles

(Baum & Singh, 1994; Baum, 2002) and a number of researchers have tried to explain how it works.

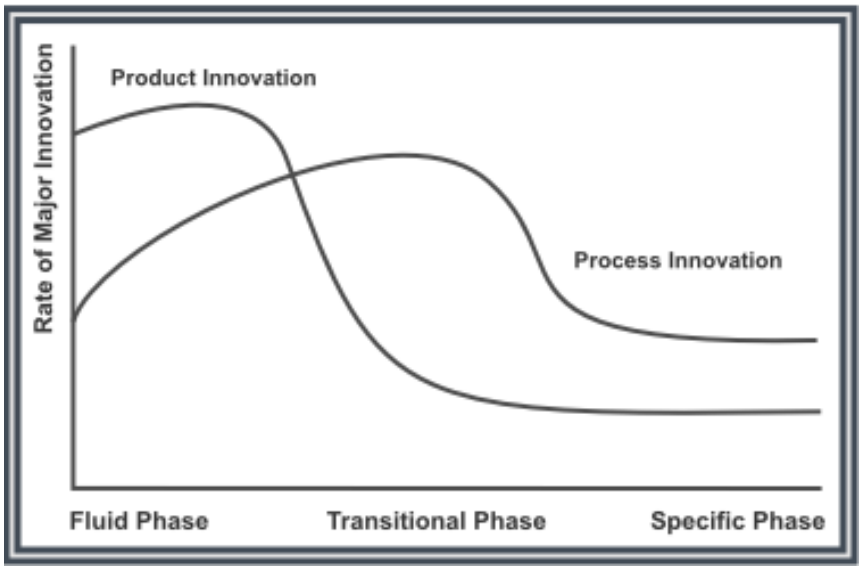
Utterback and Abernathy

Utterback and Abernathy in 1978 (Utterback, 1994) proposed a model to describe how technology develops which is called the Utterback-Abernathy model. The model proposes that technology evolves through three distinct phases which they called

1. The fluid phase
2. The transitional phase
3. The specific phase

The model describes the fluid phase as a period of uncertainty characterised by the absence of a clearly accepted design or solution by the technological community and the market. There is a proliferation of custom designs to address niche markets and minimal process innovation (Narayanan & O'Connor, 2010). The transitional phase is characterised by the emergence of a dominant design as a result of the twin forces of market interactions and standardization. The dominant design in turn dispels the uncertainty enveloping the product to usher in a period on calm called the specific phase, a period that encourages the development of complementary products to the dominant design. This period also records a shift in attention to process innovations for the dominant design while any developments on the dominant design are incremental in nature (Narayanan & O'Connor, 2010). An examination of the model shows that it does not account for other types of innovation except product and process innovation.

Fig 3.4: Utterback and Abernathy Technology cycle



Source: www.zanthus.com

Tushman - Rosenkopf

The Tushman-Rosenkopf model of 1992 (Buam, 2002; Narayanan & O'Connor, 2010) also advocates the cyclic evolution of technology through four phases consisting

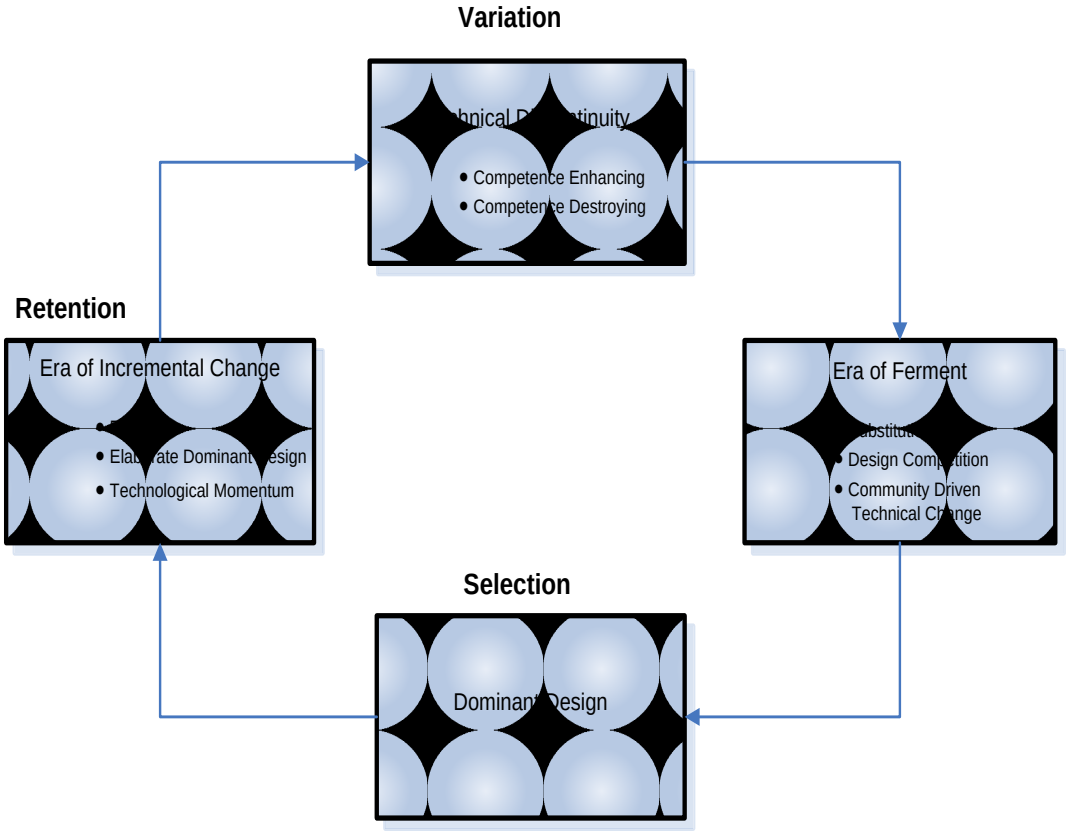
1. A technological discontinuity
2. An era of ferment
3. A dominant design
4. An era of incremental change

The first stage, a technological discontinuity, accounts for the emergence of a radical innovation that changes the landscape. They can be described as "unpredictable innovations which advance a relevant technological frontier substantially" (Narayanan & O'Connor, 2010). This phase is characterised by the emergence of a product or process that offers superior value in comparison to its competitors before the discontinuity and in the process damaging them.

The era of ferment is the period "from the emergence of a technological discontinuity until convergence on a dominant design" (Baum & Singh, 1994). It is a period of

technological and industrial competition that is determined by the dynamics between the major players, their linkages and the power they wield (ibid).

Fig 3.5: Tushman-Rosenkopf Technology Cycle



Source: Tushman & Rosenkopf (1992)

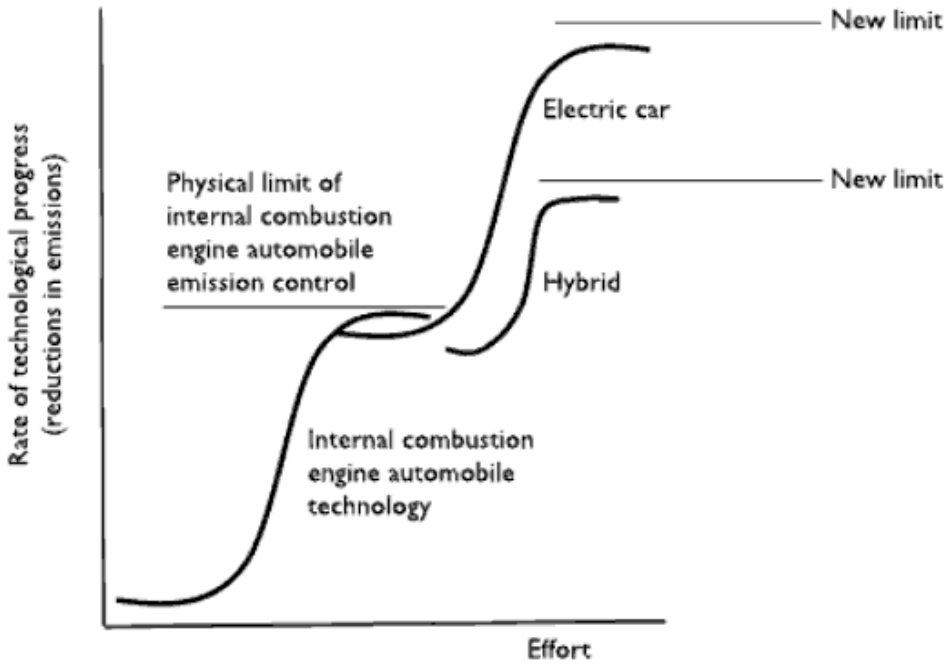
It is a period of great uncertainty arising from the competition for survival between the new and old technology and between the variants of the new technology. This jostling continues until a dominant design emerges from the variants of the new technology ushering a period of stability. The stability in turn starts the era of incremental change which continues until the next technological discontinuity.

Foster's S-curve

This is a model for predicting the end of an existing technology based on the knowledge of its physical limits. It was developed by Dr. Richard Foster who argued that "by observing the evolution of an established technology, a firm can tell when a new radical technology is around the corner about to displace the established

technology" (Afuah, 2009). The S-curve is constructed by plotting an independent variable given by the rate of technological progress against the dependent variable which is given by the effort required to develop the technology. The plot of the various competing technologies reveals the limits of each technology and when further technological advances can no longer be sustained leading to the emergence of a new technology as shown below.

Fig 3.6: Foster's S-Curve



Source: Afuah, 2009

In the figure above, Afuah (2009) alludes to the existence of a limit on the reduction of carbon emissions possible from the internal combustion engine of an automobile. It also shows that it is possible to obtain further carbon emissions from hybrid and electric cars than is possible with combustion engines. If there is demand for further reductions in carbon emissions, it imposes the requirement of the emergence of a new dominant technology in the form of the hybrid or Electric car. It was also proposed that these "cycles continued indefinitely: as one technology matures, another replaces it" (Nel, 2007)

3.5.3.1 Alternative Technology Cycle

It is clear from the above discussions that the technology models described above though informative in the understanding of innovation do not totally represent the intricacies involved. The Utterback-Abernathy model is more representative of product innovation and regards process innovation as a result of product innovation. The Tushman-Rosenkopf model does not account for the emergence of innovations which though dominant designs, do not necessarily destroy the established technology.

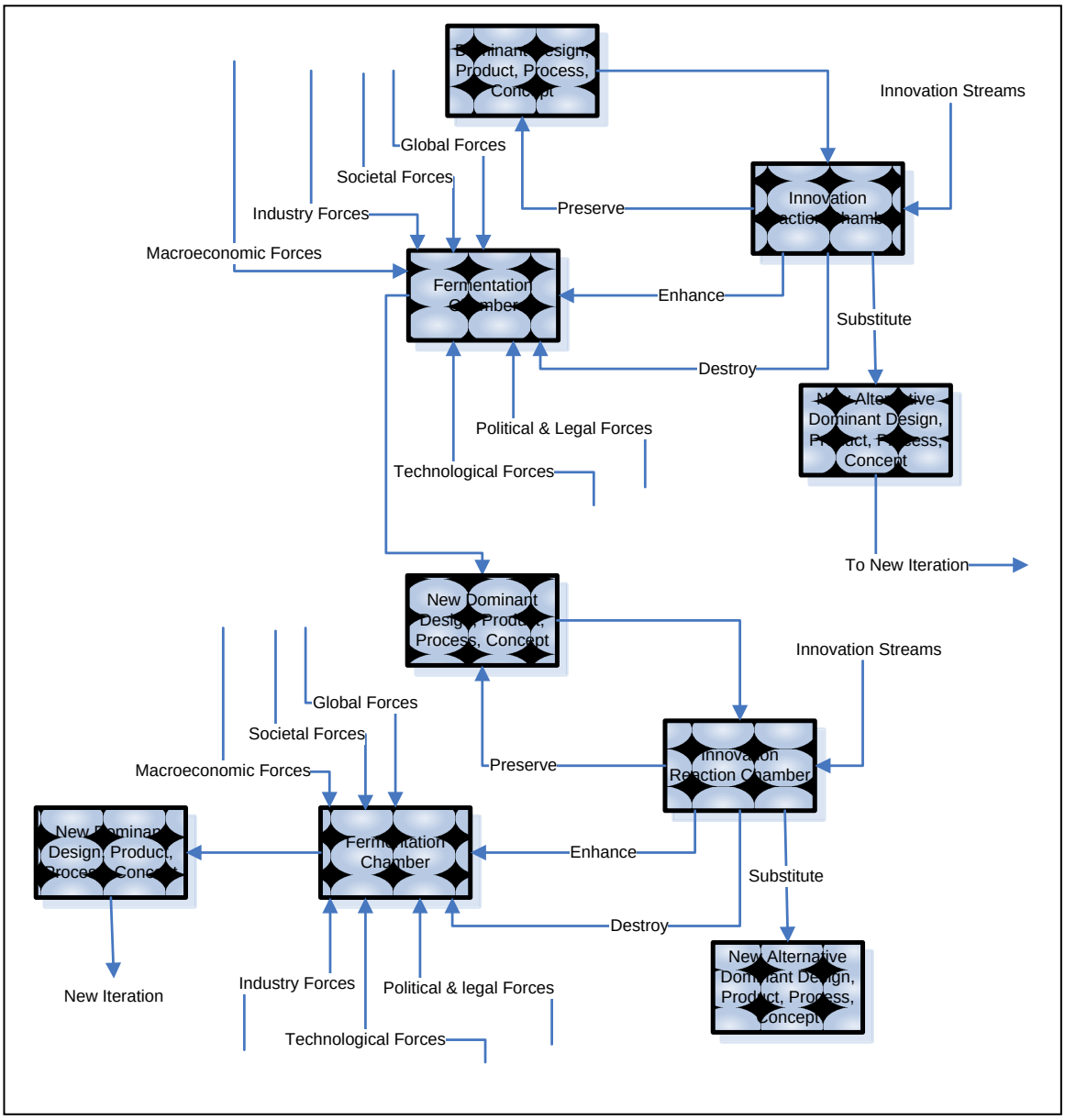


Fig 3.7 Alternative Technology Cycle

Phase one: Dominant Design or Innovation

In this model, the cycle starts with a dominant innovation (product, process, service, concept etc.) that has achieved acceptability as the standard (de facto or industry).

Phase two: Innovation Reaction Chamber

This phase comes to life with the introduction of 'innovation streams' to the dominant design. The parameter of interest will be the effect of change occasioned by the introduction of these innovation streams. This becomes important because an incremental change in terms of degree could have devastating consequences as was demonstrated in the Oticon debacle, where the reconfiguration of hearing aids from behind the ear (BTE) to in the ear (ITE) resulted in the destruction of BTE and Oticon losing 7% of its 15% market share in one year (Tushman & O'Reilly, 2002). In line with this reasoning, there are four possible outputs from the reaction chamber:

1. There is no new innovation stream in the reaction chamber or the new streams preserve the dominant innovation like the development of a new process innovation or organisational innovation for the production of the dominant design.
2. The new innovation stream in the reaction chamber enhances the dominant design (also referred to as an incremental innovation) resulting in its delivery into the 'fermentation chamber'.
3. The presence of a new innovation in the stream that destroys the dominant design (also referred to as a radical innovation). This type of innovation would act to destroy the dominant innovation or any variant that enhances it. It is delivered into the fermentation chamber for further processing.
4. The presence of an innovation in the stream that acts as an alternative or substitute to the dominant design. It does not destroy the dominant design but co-exists with it and as such it is delivered as an alternative dominant design to start off its own process of iterative refinement.

Phase Three: Fermentation Chamber

External forces

The fermentation chamber is subject to external influences which may drive or inhibit the development of the inputs from the reaction chamber. These external influences include

- Global forces
- Political & Legal forces
- Macroeconomic forces (growth rate, interest rates, exchange rate and inflation)
- Technological forces
- Societal forces (demographics, environmental issues, ethical issues and aesthetics)
- Industry forces (buyers, suppliers, competitors and substitutes)

These external forces may impact on the development of certain innovations like encryption technologies or raise environmental concerns regarding carbon emissions. Supposing an innovative voice over Internet protocol (VOIP) product like Skype were to develop an enhanced encryption technology so advanced, it enabled political dissidents, terrorists and the like to communicate without detection. There will be political pressure to bear on Skype not to release such an innovation. This was exactly the scenario between Research in Motion (RIM) the Blackberry smartphones manufacturer and the Saudi Arabian government that was demanding encryption codes to the Blackberry messenger application (Johnson, 2010). On the other hand, there could be political pressure on defence contractors to develop enhanced voice encrypting technology to secure government secrets. The preceding arguments could be advanced for each of the external forces acting on the fermentation chamber. This just goes to illustrate the complexities involved and the effect of external forces on the output from the fermentation chamber.

Inputs

The inputs into the fermentation chamber are given by scenarios two and three above.

1. If scenario two is considered and an innovation that enhances the dominant design is delivered into the chamber, it would be subjected to Foster's S-curve in the limits set by the external forces at play. There is little or no uncertainty about it development and as such it is expected that the external forces would be favourable. Thus, a new incremental dominant design results and carries on the iteration.
2. If scenario three is considered and an innovation that destroys the enhanced or dominant design gets into the fermentation chamber. It would also be subjected to Foster's S-curve in the limits set by the external forces at play. There will be a lot of uncertainty about its development for a number of reasons. Firstly, there is the competition between the enhanced dominant design and the disruptive new innovation. Secondly, there will be competition between the new disruptive innovations on which should be the dominant design. Thirdly, it has been observed, and there is the possibility that new disruptive innovations don't immediately get their technology right. There may be some teething problems which are represented by the forces acting on the fermentation chamber. The presence of these competing issues makes it likely that the enhanced dominant design remains the new dominant design as it embarks on a new iteration. These iterations continue until the physical limit given by the S-curve is reached, enabling the radical innovation to overtake it or the radical innovation dispels uncertainty surrounding it quickly as it iterates with the enhanced dominant design to replace it as the new dominant design. Dispelling the uncertainty could be as a result of the

industry adopting a standard or any other configuration obtained from the manipulation of the forces acting on the fermentation chamber. It is also important to note that while there is one dominant design at a time, it no way bars the subordinated designs from being promoted in niche and other markets.

Phase four: New Dominant Design

This is a new dominant design which could be an incremental innovation or a radical innovation. It is also the starting point for a new iteration to the reaction chamber where it is impacted by existing and new innovation streams.

Phase Five: New Alternative Dominant Design

This is essentially a substitute to the dominant design. It does not destroy it, but it is competitor to it within the same industry. Its existence is also acknowledged by Michael Porter in his five forces industry analysis model as the "threat of substitutes" (Porter, 1998)

3.6 Innovation and Corporate strategy

Strategy can be defined as "the way in which decisions are made" (McAfee, 2002). It could also be defined as "the direction and scope of an organisation over the long term which achieves advantage for the organisation through its configuration of resources within a challenging environment and fulfil stakeholder expectations" (Johnson & Scholes, 2002). It derives its origins from the military where it was used to direct operations. In business, strategy has been deployed as a tool for achieving the aims and objectives of an organisation. It is "usually aimed at creating and sustaining high profits" (McAfee, 2002). There are three types of strategies that exist in organisations. They are the

1. Corporate strategy
2. Business unit strategy

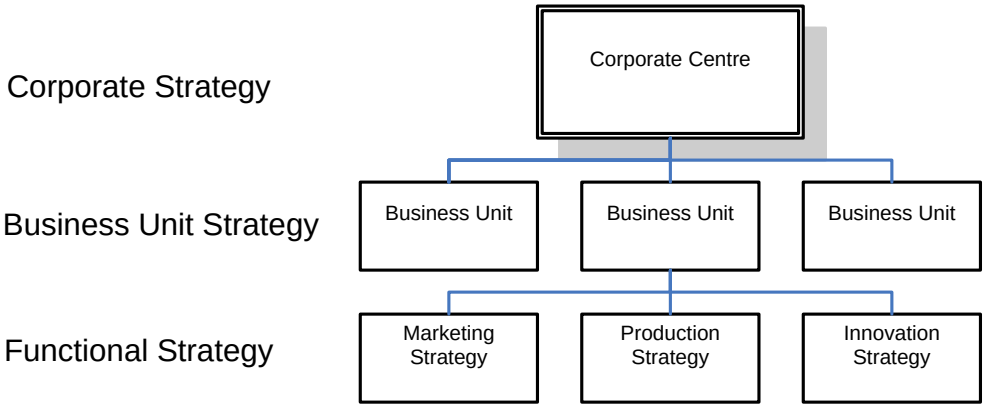
3. Functional strategy

Corporate Strategy: This is concerned with the "overall purpose and scope of an organisation and how value will be added to the different parts (business units) of the organisation" (Johnson & Scholes, 2002). It draws its relevance from the fact the future is indeterminate and as such is concerned with the long-term development of the organisation (Sutton, 1980). It handles issues such as mergers and acquisitions, closure of business units, new market developments and new technologies (Johnson & Scholes, 2002; Harris, 2006; Hill & Jones, 2008). It is worth noting that in the public sector, while there are genuine efforts to add value to the different parts of government, profit is not the overriding factor and as such ideologies play a more prominent role. This is usually evident in the strategic positioning of the various political parties as left, right, centre-left, centre right etc. as the case may be. These posturing usually set the tone for the government and could be argued as corporate strategy driving the government.

Business Unit Strategy: These are strategies that "determine the nature and future direction of each business unit including its competitive advantages, the allocation of its resources and the co-ordination of the functional business areas (marketing, production, finance etc)" (Ferrell & Hartline, 2008). It is usually developed within the confines of the corporate strategy and is responsible for creating and maintaining a competitive advantage over its rivals (Harris, 2008; Johnson & Scholes, 2002).

Functional Strategies: These are "concerned with how the component parts of an organisation deliver effectively the corporate and business level strategies in terms of resources, processes and people" (Johnson & Scholes, 2002). They provide a means of incorporating the skills and competencies of the organisation to bear its objectives (Ferrell & Hartline, 2008).

Fig 3.8: Levels of Strategy



3.6.1 Innovation strategy

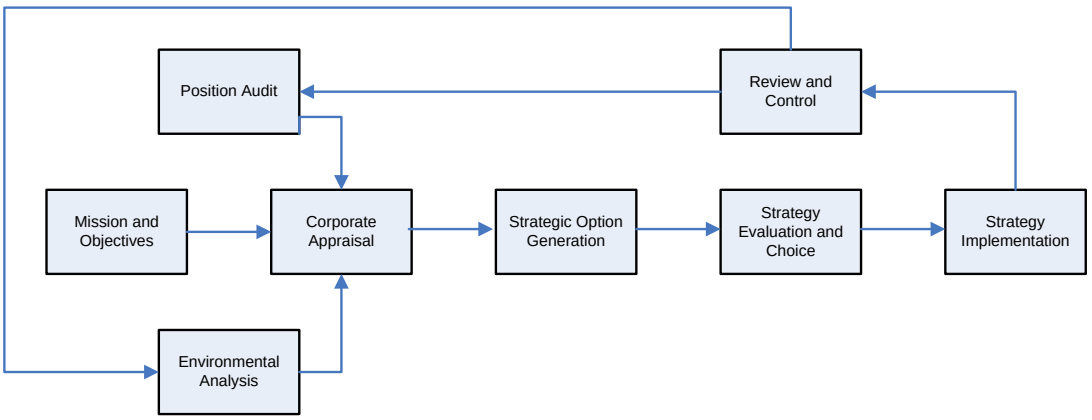
An innovation strategy is a functional strategy and as such is saddled with the responsibility of mobilising the resources of an organisation in delivering its aims and objectives in line with the corporate and business unit strategies. There are two approaches to the development of these strategies, they are

1. The rational or formal strategy planning process
2. The emergent strategy planning process

3.6.1.1 The Rational Or Formal Planning Process

This is a form of strategy development process that is founded on its military origins and envisions the strategic process as a mission (like having a military objective); the identification of the goals or objectives of this mission, and the policies or plans required to achieve this mission.

Fig 3.9: Rational Planning Process



Source: Harris (2006)

The major stages of the process are shown in the figure above.

1. Stage one: Defining the mission and objectives of the innovation strategy such that it is line with the corporate and business level strategies.
2. Stage two: This is the corporate appraisal of the circumstances of the organisation. It involves the internal and external auditing of the organisation. The position audit refers to the internal audit of the organisation. It involves the evaluation of the strengths and weaknesses of the organisation, achieved by a SWOT analysis. On the other hand, the external audit involves the carrying out of some environmental scanning which may include an industry analysis, competitor analysis, scenario building etc.
3. Stage three: This stage is required to proffer strategic options available to the organisation on the basis of the information obtained in stage two.
4. Stage four: This stage is charged with the selection of the best strategic option presented from stages three. It is concerned with the evaluation of the risks and competencies involved in pursuing any form of innovation.
5. Stage five: This is stage is responsible for the implementation of the selected strategic option. It is also responsible for the mobilisation of the organisations resources towards this end. It usually involves a lot of other strategies and sub-strategies required to mobilise the internal organisation as well as confronting the external environment.
6. Stage Six: This stage (review) provides feedback to the organisation on the success or failures of their initiatives which are supposed to enable the organisation make any adjustments necessary.

An evaluation of the above steps would seem all well and proper. The stages and the order in which they appear all seem logical. This is precisely why it is referred to as the rational or formal process of developing strategies. But experiences in life have

shown that this is not exactly the case and some researchers have rightly pointed this out. Prominent in the opposition of this process is Henry Minzberg, who refers to the rational process as more of "strategic programming" (Minzberg, 1994). He advances to the notion that "strategic thinking" and not "strategic programming" is what is needed. He contends that rational planning "represents a calculating style of management, not a committing style…strategic thinking, in contrast, is about synthesis, it involves intuition and creativity" (Minzberg, 1994). The rational model has also been criticised as being based on an assumption that the future is predictable and not acknowledging the importance of lower-level managers in the strategic process (Hill & Jones, 2007)

3.6.1.2 The Emergent Strategic Process

It is a form of strategy development that recognises the uncertainty in the future. It also recognises the dominance of complexities and ambiguities in our everyday lives resulting in the need to react quickly to counteract the effects of rapidly changing situations in order to attain an advantage (Hill & Jones, 2007; Tidd el al, 2001). This kind of strategic thinking could be described as being modelled after the characteristics of the typical entrepreneur, who recognises an opportunity and quickly seizes it. It is more suited for uncertain environments that require adaptation as opposed to control. It is a mixture of "planned strategy and another unanticipated emergent strategy …often a response to unexpected contingencies and the resulting realised strategy may, in the circumstances, be superior to the intended strategy" (Harris, 2006).

3.6.2 Implications for Innovation Strategy

The implications arising from the arguments in the previous section show it is not a 'one size fits all' proposition. It imposes on strategic thinkers a requirement of

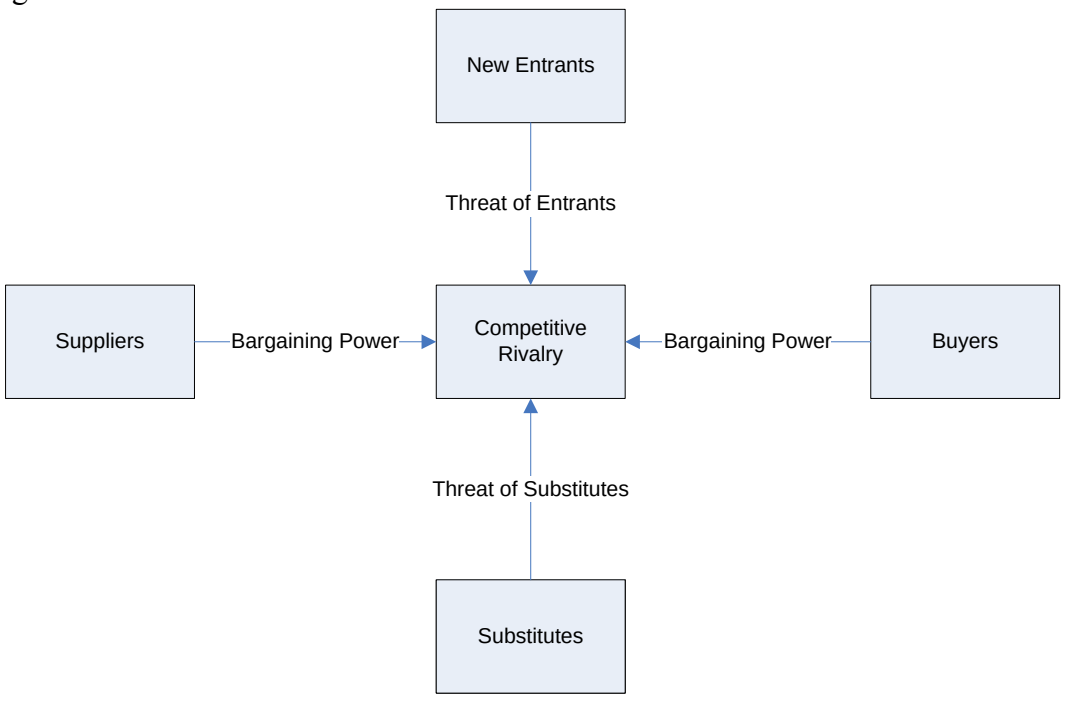
understanding the rational strategic process in addition to a willingness to adapt to changing circumstances quickly.

The five forces model

This is an industry analysis tool developed by Michael Porter (1998) for understanding the dynamics associated with competition. He regards competition as the main determinant in assessing the suitability of innovations that contribute positively to an organisation. It is his opinion that the aim of an innovative strategy is to "establish a profitable and sustainable position against the forces that determine industry competition" (Porter, 1985). The five forces that control industry profitability are

1. The threat of substitutes
2. The entry of new competitors
3. The bargaining power of buyers
4. The bargaining power of suppliers
5. The rivalry among existing competitors

Fig 3.10 Porter's Five Forces Model



Source Porter, (1985)

Generic Innovation Strategies

The generic innovation strategies were also proposed by Porter (1985) to address the issue of strategic positioning within an industry. It is his assertion that positioning "determines whether a firm's profitability is above or below the industry average" (ibid). There are three generic strategies namely:

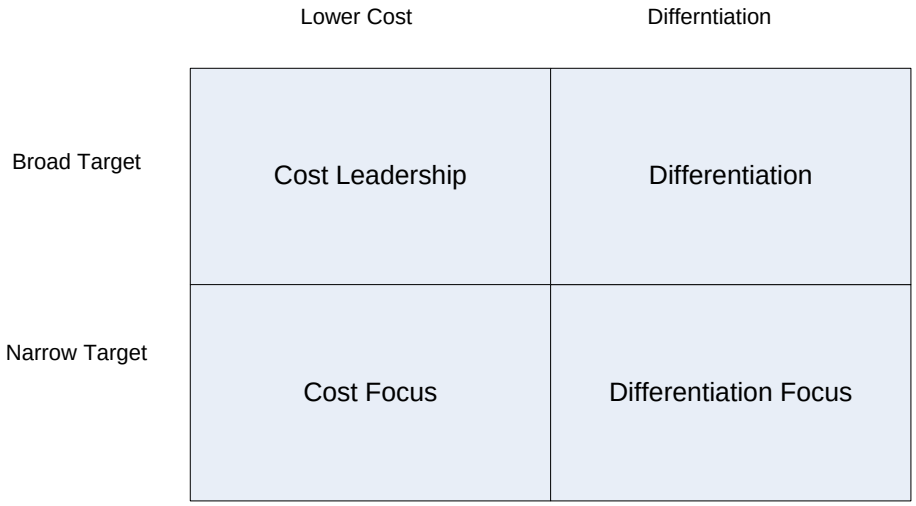
1. Overall cost leadership
2. Differentiation
3. Focus

Overall cost leadership: The aim of an organisation that assumes this position is to be the low-cost producer in the industry. This may inform the development of innovative strategies that seek process efficiencies or economies of scale to achieve its purpose. The invention of the 'Lister nip comb' and mechanized silk mill, allowed Lister mills of Bradford to occupy a dominant position in wool and silk production (Classic Encyclopaedia, 2006). There is only one low-cost producer in an industry.

Differentiation: this is a strategy where an organisation tries to be distinct in a way that is appreciated in its industry such that it commands a price premium that can offset the cost of being distinct (Porter, 1985)

Focus: This is a strategy in which an organisation "selects a segment or group of segments in the industry and tailors its strategy to serving them to the exclusion of others" (Porter, 1985)

Fig 3.11: Generic Strategies



Source: Porter, (1985)

3.6.3 Strategic issues

The development of an innovation strategy requires the consideration of certain questions because the answers have far reaching effects to the success of the strategy. These are the questions that the internal and external audits in the rational process are supposed to provide information to assist decision making because they represent the strategic choices to be made. They are independent on the strategy making process.

3.6.3.1 Innovation diffusion strategies

Innovation diffusion strategies are crucial for the competitive well being of an organisation and there are certain choices to be considered. This include

- Licensing strategies: The risks associated with this option are low and it also offers limited returns. The contents of the licensing contract are crucial as the events of Apple-Macintosh versus Microsoft have shown (linzmayer, 2004). It also requires few resources to effect.
- Strategic alliances: This option allows an organisation to access resources and competencies outside their capabilities. This breeds dependence on strategic partners resulting in reduced organisational investments

- Joint venture: This is an option that allows organisations to pool resources together to exploit an innovation. It has the benefits of sharing the risks involved but it also carries the threat of clashes in organisational culture or personalities involved.
- Internal commercialisation: This is the option that carries the biggest threat and rewards. It allows an organisation to be in total control of the exploitation of its innovation and this implies that the resources required would be provided alone.
- Outsourcing: This is an option that enables the use of superior external resources to exploit an innovation. It requires limited investment by the innovator.

3.6.3.2 Alternative development models

There is a strategic choice on how innovations are to be the developed. This comes down to just two options

1. In-house model
2. Collaborative model

The in-house model involves the innovation process being nurtured and controlled by an individual (entrepreneur) or an organisation. This is easily typified by research and development in the large corporations

The collaborative model involves the innovation process being nurtured and controlled by various collaborative relationships which could include joint ventures, loose networks. This has given rise in some cases to the development of open source applications that are very robust due to the numerous contributors that have scrutinised the application for bugs and flaws.

3.6.3.3 Timing: to lead or to follow

This is a strategic option that centres on positioning. It is a follow-up on Porter's generic strategies and allows an organisation to determine how they will attack their industry.

Innovation Leader:

This is an option that though risky, could presents first mover advantages or products that confer a competitive advantage over the competition. An observation of the pharmaceutical industry will reveal that the large corporations like GlaxoSmithKline operate innovation strategies that position them as innovation leaders. They commit a lot of resources to research and development (R&D) and in turn maintain a dominant position in the industry through the patents they have.

Innovation Follower:

This is a strategic option that is favoured during periods of uncertainty occasioned by technological discontinuities, erratic buyer behaviour and capital intensive ventures. The decision to be late to the market may be an attempt to avoid the failures of the leaders. Apple in its development of the 'Ipod' did not invent Mp3 players; it was just able to present a better product to the market.

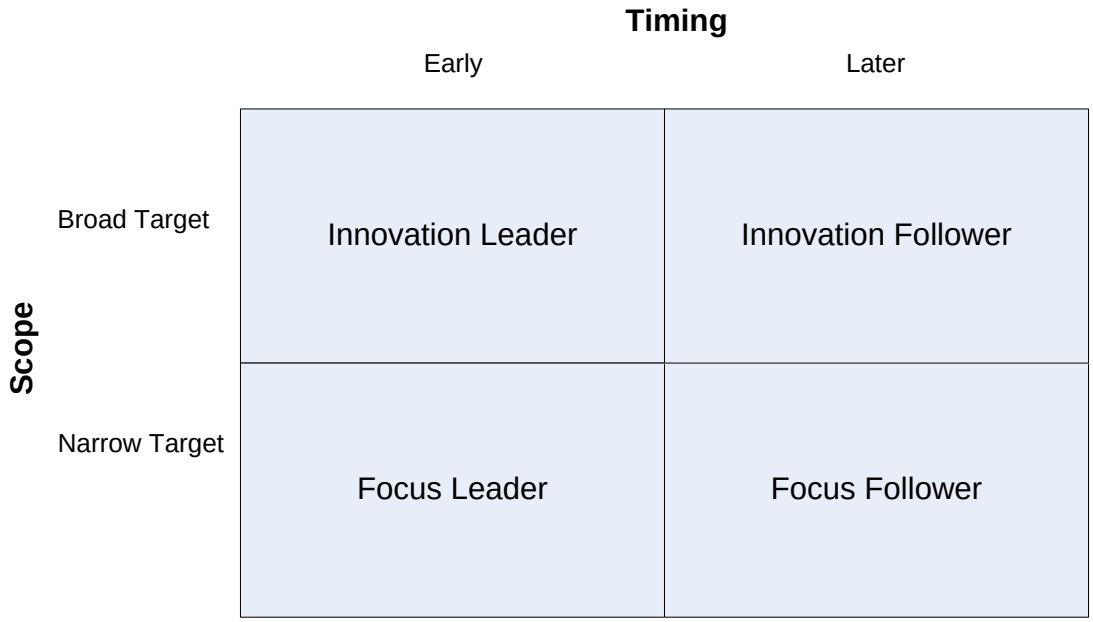
Focus Leader:

These are innovators that focus on a niche like Formula one racing teams, while their innovations may be ground-braking, they have a narrow focus.

Focus Follower:

This is an option suited to a niche where the strategy is to watch out for innovations in the niche and imitate them. The advantage is in lower R&D costs. This could also apply to the Formula One racing teams and other specialised segments.

Fig 3.12: Generic Innovation Strategies



Source: adapted from Porter, (1985)

3.6.3.4 Controlling industry standards

Industry standard refer to the dominant design or architecture in an industry that all operators in that industry conform or work to. When an innovation becomes the industry standard, it dictates the pace to the industry. This is evident in the computing industry where Microsoft is the de facto standard on operating system software. If Microsoft upgrades it software from for example 'Windows XP' to 'Windows Vista', all software products written for 'Windows XP' are forced to also upgrade their product to be compatible with the new 'Windows Vista'.

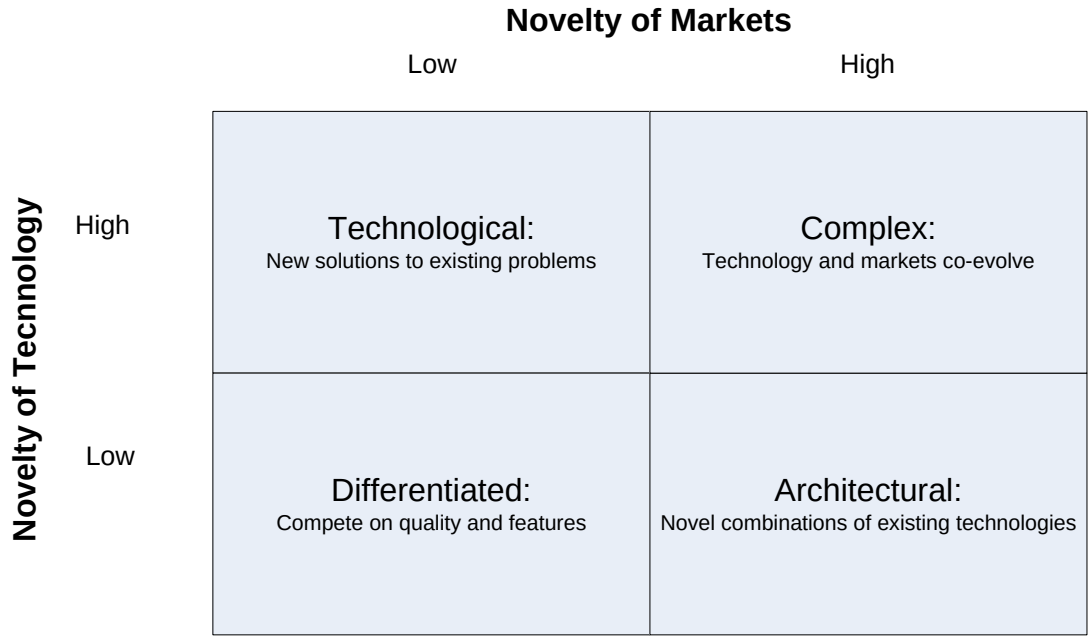
3.7 Innovation, Marketing and Modernisation

3.7.1 Innovation and Marketing

Innovation management and marketing are concepts that have something in common, they both involve the commercialisation. While the former concerns novel items, the latter is concerned with any item. Tidd et al, (2001) have shown that an organisation could innovate based on the application of the four 'P's of marketing namely Price, Product, Place and Promotion. There is a need to have an understanding of strategic marketing which is concerned with the decisions of market development and tactical

marketing which is involved in the extension or differentiation of products and services (ibid). Their ideas on the relationships existing between innovation and the market is summed up in the matrix below

Fig 3.13 Relationship between Innovation and Markets



Source: Tidd et al, 2001

Market Segmentation

This is the process of splitting customers or potential customers, in a market into different groups, or segments (McDonald & Dunbar, 2005). It is recognition that in spite of all customers not being the same, there are groups that share similar characteristics and as such could be regarded as a niche.

Business models

Although there is a body of literature on business models, there is no clear consensus on how it should be defined (Janssen & Kuk, 2007). For the purpose of this study, it would be defined as the format an organisation employs in the exploitation of its product or service. It could also be described as the system in which a product of service is offered or presented to the customers.

Subscription based model

This is a business model in which the users pay for the service. It is the model currently being employed for the sale of broadband Internet services in the UK. It requires that any potential customer contact the service provider and commit to pay for their use of the product or service.

Advertising based model

This is a business model in which the users of the service do not pay for the service. The revenue for providing the service is paid for by advertisers. This model is popular with Internet companies such as Google, Yahoo, Hotmail etc.

Community based model

This is model that is not profit based. It is based on the government or community pooling together to fulfil the identified need. There is no restriction on how big the community should be but it is subject to EEC state aid controls if provided by government.

3.7.2 Innovation and Modernisation

In the light of the above discussions on innovation and its management, the developments in chapter two could be re-examined with a view of exploring the links and relationships that exists between them. Modernisation could be view as a conceptual innovation, enacted to bring changes in the public sector. The three dimensions of innovation could also be observed in the form of government and society being the objects of change while the implementation of E-government testifies to the dimensions of the perceived extent of change and the effects of change.

The modernisation agenda could also be regarded as the innovation strategy employed to drive through the conceptual innovation while E-government and

Digital Britain are process innovations to transform the infrastructures of government and society. The devolution of powers resulting in the creation of regional development agencies in England and houses in Scotland, Wales and Northern Ireland would then be examples of Organisational innovations.

Table 3.2: Public Sector Innovations

Innovation	**Example**
Conceptual	Modernisation, NPM
Process	E-government, Digital Britain
Product	One stop shops, DAB radio, Online road tax, Online booking for theory and driving test, vehicle enquiry
Organisational	Devolution of powers to Welsh, Scottish and Irish assemblies, creation of Regional Development Agencies

3.8 Conclusion

This chapter examined innovation, its process and how it is managed. A number of key concepts associated with innovation management were also reviewed. Key concept like the types of innovation, dimensions of innovation, innovation streams, technology cycles and innovation development models were examined with contributions made to the discussions on dimensions of innovation and technology cycles.

The intricacies involved in crafting of an innovation strategy and its attendant links to the strategic marketing and management provide an interesting insight to the challenges associated with developing sustainable successful innovations.

It also presented the relationship between innovation and modernisation.

Chapter Four

Networking Technology

4 Introduction

The development of a digital society cannot be achieved without an understanding of the technologies that drive and support its growth. Networking is the enabling technology that has so revolutionized our lives and how we communicate with each other that it is not far-fetched to wonder how we survived all these years without it. This chapter explores its evolution and what it portends for the future.

4.1 Networking Overview

A network can be defined as an interconnection of devices or people structured to perform a specific task. The concept of networks or networking is not new since society is conversant with the power systems network that deliver electricity to their homes; the gas piping network that delivers gas for heating and cooking to their homes; the telephone or PSTN network; television and radio network; railway network and road network. In fact, the proliferation of networks could be said to be one of the enduring legacies of the 20th century. The creation of computer networks is no different, where they are interconnected to enable them communicate and share resources. While the first set of computers were 'dumb' terminals attached to a mainframe computer, modern computer networks are made up of smart terminals that can process, store data and have their own memory.

The main reason for developing computer networks is the convenience of being able to share resources and services. While it is common place to expect the sharing of information on a computer network, it also facilitates the sharing of network resources like printers, scanners and Servers. Paradoxically, this also poses the greatest risk in network creation, the potential for unauthorised access to information.

4.1.1 Types of Networks

The types of computer networks are classified based on geographical reach. They are the Local Area Network (LAN), Metropolitan Area Network (MAN) and Wide Area Networks (WAN).

Local Area Network (LAN)

This is the most common type network and it usually operates in a small area. It is the building block for all other forms of computer networks. This is the network that users normally connect to because it houses the network devices in one location.

Metropolitan Area Network (MAN)

This is a network that enables the connection of LANs across a metropolitan area hence its name. it enable LANs spanning several buildings across a city to be connected into one network that can be administered from one point or just enable them share resources.

Wide Area Networks Internet (WAN)

These are networks that span a large geographical area. They could interconnect MANs or LANs between two cities, the main criteria is distance. Traditionally, WANs made use of lease lines to achieve interconnections but other technologies such as Very Small Aperture Terminal (VSAT) and satellite links have become part of the fray.

4.1.2 Network architecture

The network architecture refers to how computers interact on a network (Ciccarelli et al, 2007). There are two main types

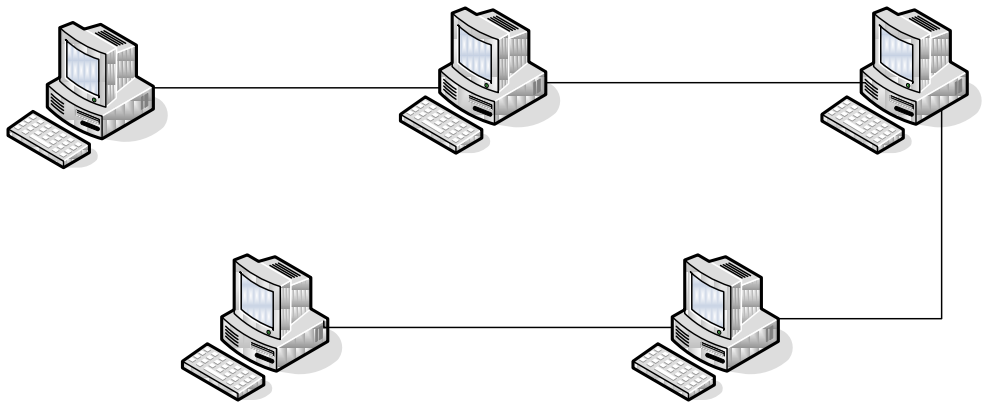
1. Peer-to-peer
2. Client/server

Peer-to-peer Network

This is a computer network where all the computers on the network share resources with each other without a dedicated resource provider (Hallberg, 2009). Resources

are not centralised resulting in the need to contact individual computers for the information stored on them or the service provided by them. It usually works best for ten or less computers due to network traffic collisions.

Fig 4.1: Peer-to-peer Network



Advantages

There is no need for a network administrator to manage resources and users.

It is fast and cheap to implement

Disadvantages

The network performance deteriorates as the computers increase above ten

The computer hosting the resource reduces performance as it is accessed

Security is poor and as such suited for home networking

Client/Server Network

The Client/Server logical networking model is a network where all the computers on the network share resources residing on a dedicated provider called the Server (Hallberg, 2009). This has become the most pervasive architecture driving networking. The Server acts as a gate-keeper to the resources stored on it making the network very secure. It requires a dedicated network administrator for its proper

functioning. There are different types of Servers; some are domain servers while others perform services like file server, print server, web server, DHCP server, DNS server, mail server etc. File servers allow the sharing of files while print servers allow the sharing of printers. Websites are hosted on web servers, Domain Name Service servers allow us to type the names of websites while it resolves it to display the right website.

Advantages

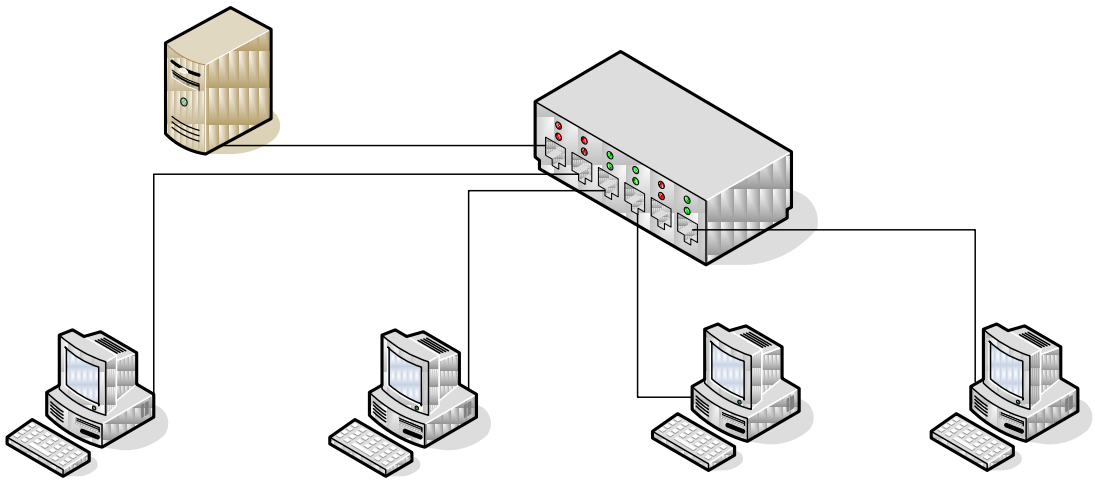
It allows information and services to be centralised for easy management

It can handle large number of users with less loss of performance

It is more secure and security is managed from the server

It enables the sharing of scarce or expensive network resources

Fig. 4.2: Client/Server Network



Disadvantages

It is expensive and complicated to implement

Network administrators are required to manage the servers

4.1.3 Network topologies

While the network architecture refers to the way the computers interact, the network topology on the other hand refers to how the network is physically connected. The physical topology describes how the devices on the network are connected by the network media which could be wired or wireless. The logical topology on the other hand shows how the devices are 'really' connected or how the network actually operates (Barrett & King, 2005).

Wired Networks

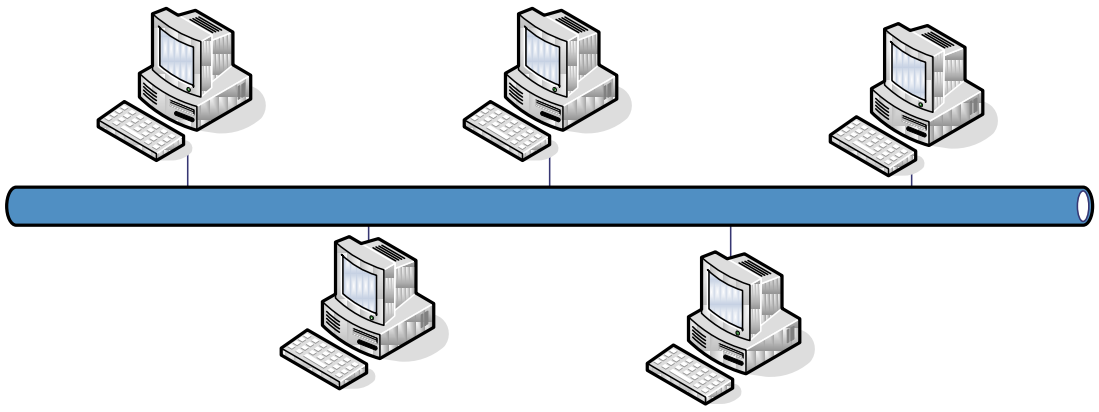
There are four types of wired network topologies namely

1. Bus
2. Ring
3. Star
4. Mesh

Bus Topology

This is a network design where all computers on a network are connected to a single cable as shown in fig 3.3. It has the advantage of being very easy to extend making scalability easy but its main disadvantage is that any break in the cable brings down the network (Hallberg, 2009)

Fig 4.3: Bus topology



Ring Topology

This is a network design where all the computers on a network are connected in a circle and data also flows in this form. It is implemented by the IEEE token ring standard 802.5. It is made up of a single copper wire ring but the fibre optic implementation makes use of a dual ring and it is referred to as Fibre Distributed Data Interface (FDDI) (Ciccarelli et al, 2007).

Fig 4.4: Ring Topology (Token Ring)

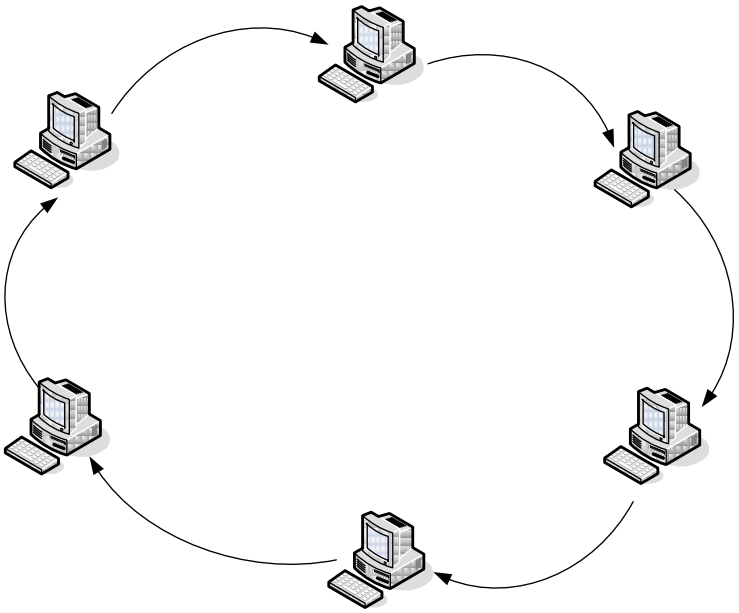
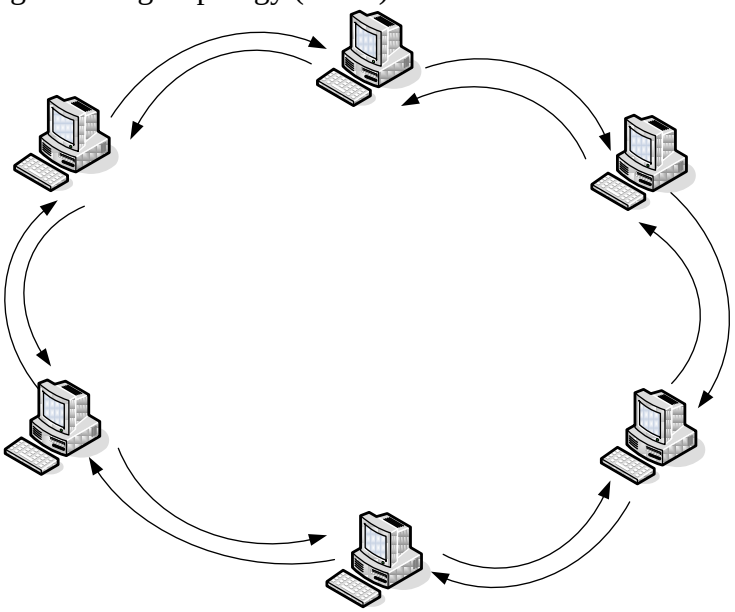


Fig 4.5: Ring Topology (FDDI)



Source: Ciccarelli et al, 2007

Advantages

Fault location and resolution is easily performed

It is quite reliable

Due to the passing of tokens there are no collisions

Disadvantages

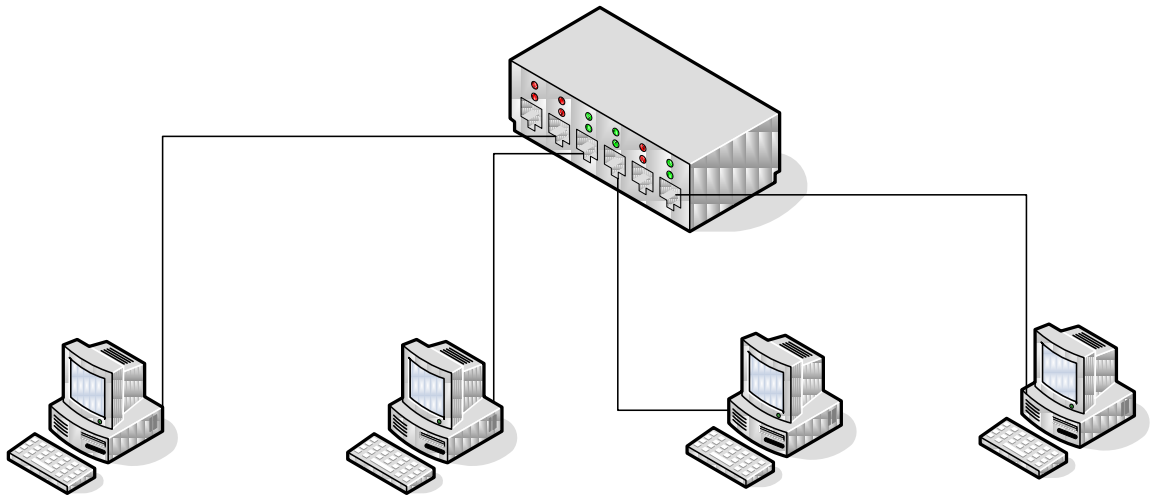
Its implementation demands more cables than implementing a bus topology

Only one computer can transmit information at a time and as such not very suited for very large networks of computer since token must travel to all computers

Star Topology

The star topology is a configuration in which all the computers on a network are connected to a central point from which connections fan out hence the name star. It is the most implemented network topology because although it requires more cables to implement, it is highly scalable, cheap and easy to implement (Hallberg, 2009).

Fig 4.6: Star Network Topology



Advantages

It is highly scalable which has made it the topology of choice for most networks

It is easy to implement or upgrade since only the connecting device (hub, switch or router) needs changing

A fault on one of the terminals does not cause the network to fail

Fault resolution is fairly easy and not complicated

It allows all computers to transmit at the same time

Disadvantages

The failure of the connection device (hub, switch or router) results in network failure

It uses up more cables than the bus and ring topologies

Mesh Topology

This is a network topology that supports multiple connections and multiple paths and results in a fault resistant reliable network with redundancies. It is like a fusion of the star and ring topologies, carrying their advantages but negating their disadvantages.

It is the ideal network configuration but very expensive to implement due to the inherent redundancies. It is mainly used for critical networks ((Hallberg, 2009; Barrett & King, 2005).

Advantages

It is very robust, fault tolerant and resistant to network failure

It results in a decongested network since there are multiple paths for network traffic

it is ideal for critical networks

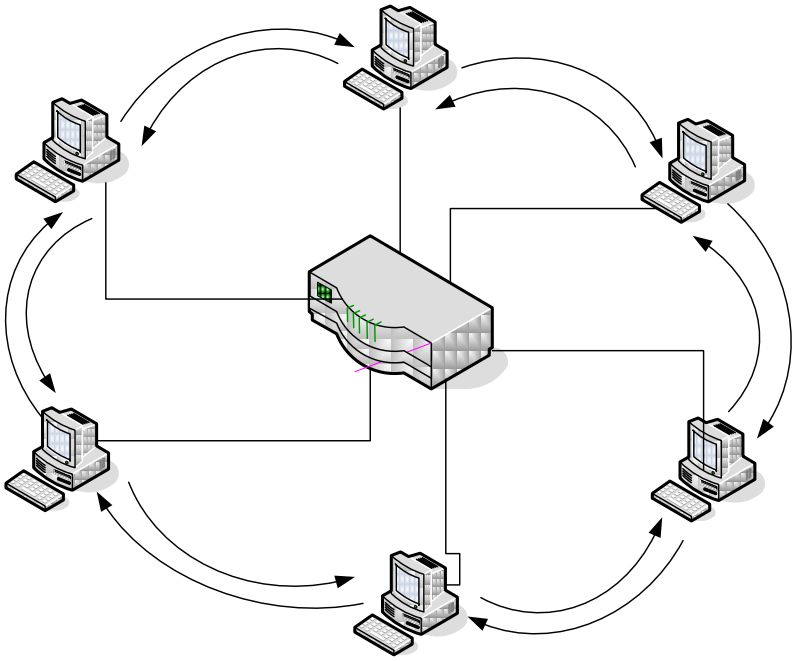
Disadvantages

It is very expensive to implement due to the number of redundancies built in it.

It requires the most use of network media

It is difficult locate faults due to the number of redundant links

Fig 4.7: Mesh Network Topology



Wireless Networks

Wireless network topologies are in a sense a form of wireless implementation of wired network topology. There are three main wireless network topologies namely

1. Ad Hoc
2. Infrastructure
3. Mesh

Wireless Ad Hoc Network Topology

The wireless Ad Hoc network topology is a wireless implementation of the peer-to-peer network architecture. It allows wireless devices to communicate and share resources without any centralized network connection device.

Advantages

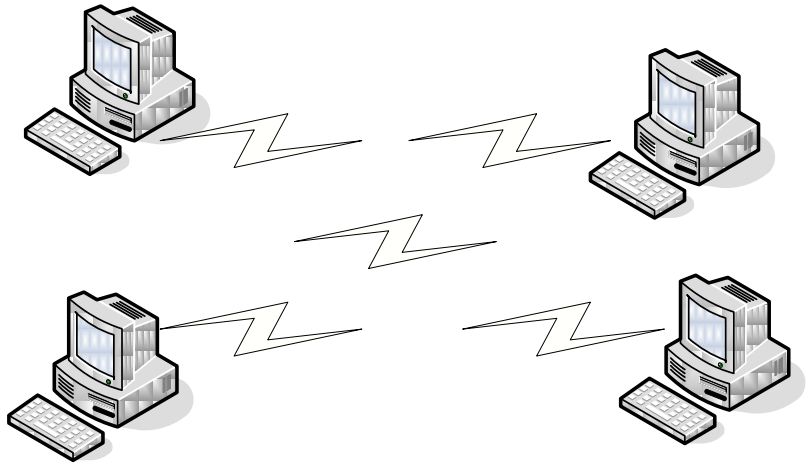
It only requires configuration since the hardware is already in the computer

It is cheap and easy to maintain

Disadvantages

It is not secure and can be accessed by other wireless computer in the vicinity

Fig 4.8: Wireless Ad Hoc Network Topology



Wireless Infrastructure Network Topology

This is a wireless network that allows computers to connect to each other through a connection device (Access Point (AP)). It could be described as the wireless equivalent of the wired star topology. It is also just like the star topology, the most implemented form of wireless network topology. It is usually implemented in two forms, as a pure wireless network or in conjunction with a wired network (Ciccarelli et al, 2007)

Fig 4.9: Wireless Infrastructure Network Topology

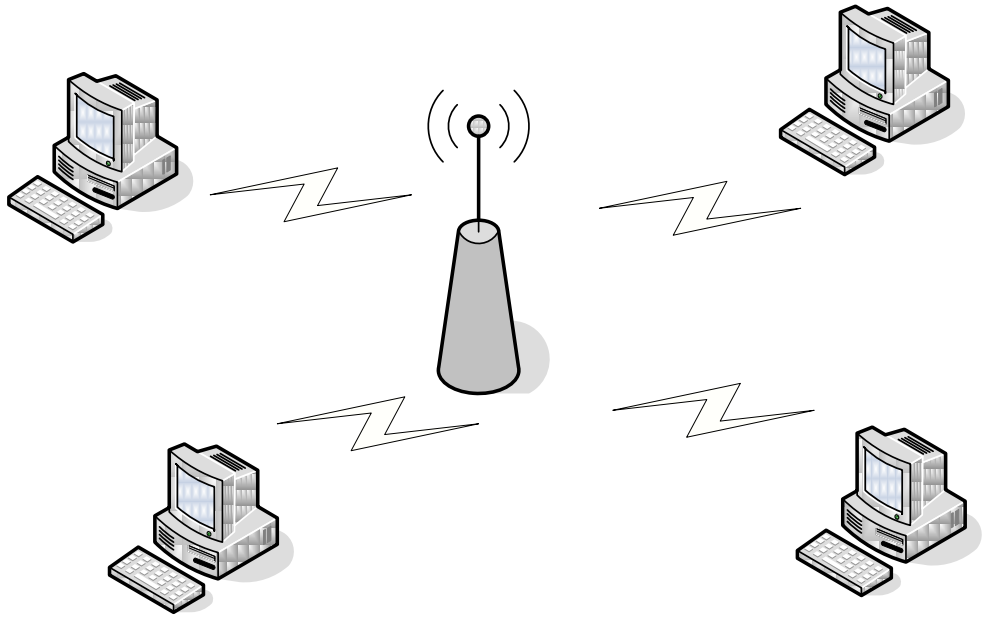
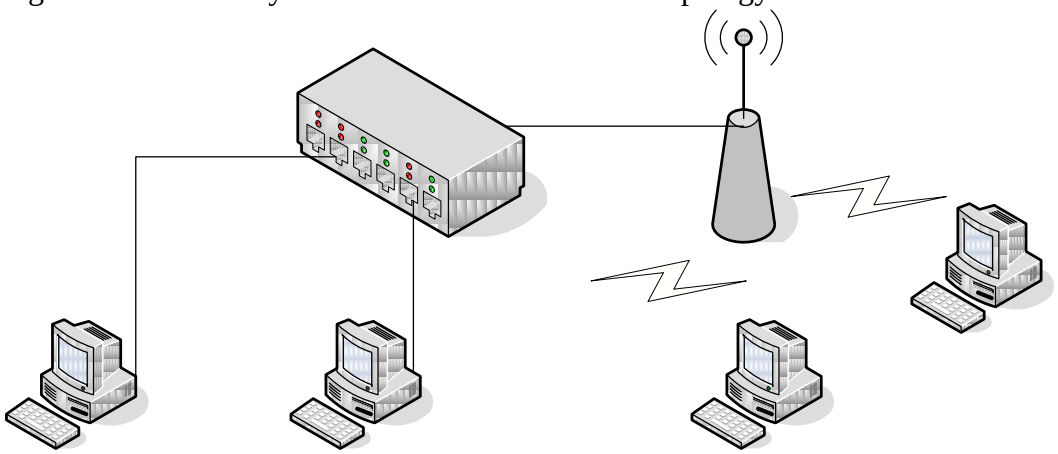


Fig 4.10: Wireless Hybrid Infrastructure Network Topology



Advantages

It is easy to implement and maintain

It enables wireless network to be created off existing wired networks quickly

It is scalable

Disadvantages

The security of the network is the main consideration since the radio waves it broadcasts are all terminals soliciting connections. It is even more risky if its Service Set Identifier (SSID) is being broadcasted and there is no access control security.

Wireless Mesh Network Topology

This is a wireless implementation of the wired mesh network. This network topology is achieved when the wireless access points interconnect themselves such that the network achieves multiple paths and multiple connections between them (Ciccarelli et al, 2007).

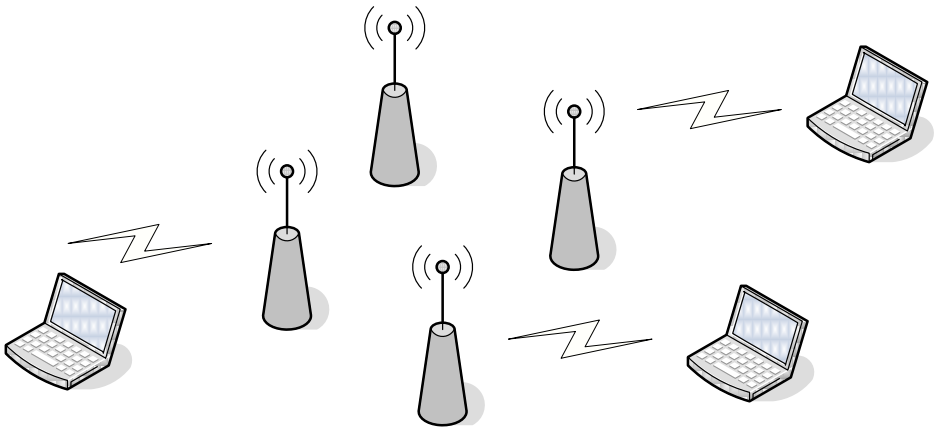
Advantage

It implements the highly desirable wired mesh topology without the associated high costs encountered in the wired implementation.

Disadvantage

The security issues in wireless networking

Fig 4.11: Wireless Mesh Network Topology



Physical Network Media

Networking Cables

Wired computer networks are connected using cables and there are four main types:

1. Coaxial
2. Shielded Twisted Pair (STP)
3. Unshielded Twisted Pair (UTP)
4. Fibre Optic

Coaxial Cable

This type of cable is made of copper and it consists of a "hollow outer cylindrical conductor that surrounds a single inner wire made of two conducting elements" (Cisco, 2002). The central copper wire is covered with an insulator that is shielded from interference by a metallic foil and a braid of copper wire which acts as the second conductor. The cable jacket made of PVC or Plenum covers and protects the assembly (Ciccarelli et al, 2007; Cisco, 2002). The shielding protects the cable from Electromagnetic (EMI) and Radio-frequency interference (RFI) All coaxial cables are constructed in the same way; the main difference between them is in the thickness of the central conductor which determines the resistance of the cable to the flow of electrical signals and is classified using Radio Grade (RG) as shown below

Table 4.1: Coaxial Cable Types

Type	Impedance	Description
RG 6	93 Ωs	Thick copper core, also used for Cable TV
RG 8	50 Ωs	Thick Ethernet (Thicknet), core 0.4inches in diameter
RG 11	75 Ωs	It has 4 layers of shielding, used in Cable TV
RG 58/U	50 Ωs	Thin Ethernet (Thinnet), core less than 0.2inches
RG 58 A/U	50 Ωs	Thinnet like RG 58/U, Stranded copper core
RG 58 C/U	50 Ωs	Thinnet like RG 58 A/U, Military use (10Base2)
RG 59	75 Ωs	Thick copper core used in Arcnet and Cable TV
RG 62	93 Ωs	Used in IBM 3270 legacy systems and Arcnet

Source: Ciccarelli et al (2007)

Shielded Twisted Pair Cable (STP)

This type of cable is constructed using copper wires that have been twisted to provide protection against Crosstalk, EMI and RFI (Cisco, 2002). The cable pairs within it are wrapped with foil to shield it further but this poses a problem during installation because the foil shield must be grounded. It has a resistance of 150 ohms and transmits at 10-100 Mbps (Cisco, 2002; Ciccarelli et al 2007).

Table 4.2: STP Cable Types

Type	Transmission Rate	Number of Pairs
Type 1	16 MHz	2
Type 2	16 MHz	4
Type 6	16 MHz	2
Type 8	16 MHz	2
Type 9	16 MHz	2

Source: Adapted from Ciccarelli et al (2007) and www.techfeast.com

Unshielded Twisted Pair Cable (UTP)

This is a type of cable constructed using copper wires that have been twisted to provide protection against Crosstalk, EMI and RFI (Cisco, 2002). It differs from STP that the cable pairs within it are not wrapped with foil to shield it any further and as such does not need to be grounded. It has a resistance of 100 ohms and transmits at 10-10000 Mbps (Cisco, 2002; Ciccarelli et al 2007). It is also cheaper than STP.

Table 4.3: UTP Cable Development

Type	Transmission Rate	Number of Pairs
Category 1	Voice Only	2
Category 2	4 Mbps	2
Category 3	10 Mbps	4
Category 4	16 Mbps	4
Category 5	100 Mbps	4
Category 5e	100 Mbps – 1 Gbps	4
Category 6	100 Mbps – 10 Gbps	4
Category 6e	10 Gbps	4
Category 7	1.2 Gbps	4

Source: Ciccarelli et al (2007)

Fibre Optic Cable

This type of cable is constructed with a centre core made of silica, extruded glass or plastic which allows light to pass through it hence the name (Ciccarelli et al, 2007). It is not affected by EMI, RFI or crosstalk. It is also very secure and not easy to tap into due to the inner insulation that protects it from damage. This insulation is made of Kevlar, same material used in bullet-proof vests (Ciccarelli et al, 2007). There are two types of fibre optic cables namely

Single-mode fibre: this type of fibre optic cable is made up of a small core that supports the transmission of a single signal. Its size is about 8/125 microns

Multimode fibre: this type of fibre optic cable is made up of a large core that enables it to support the transmission of multiple signals. Its size is about 62.5/125 microns (Cisco, 2002; Ciccarelli et al 2007).

Table 4.4: Media Comparison

Media Type	Maximum Segment Length	Speed	Cost	Advantages	Disadvantages
Coaxial	500m Thicknet 185m Thinnet	10 Mbps to 100 Mbps	Relatively inexpensive but more costly than UTP	Less susceptible to EMI than other types of copper media	Thicknet is difficult to work with; damage to cable can brings down network
STP	100m	10 Mbps to 100 Mbps	More costly than UTP	Reduced crosstalk,	Difficult to work with (grounding)
UTP	100m	10 Mbps to 100 Mbps	Least expensive	Easy to install, widely used and available	Susceptible to interference
Fibre Optic	10km and 2km for single and multimode	Single 0.1 -100 Gbps multi 0.1-9.92 Gbps	Most Expensive	Secure; no EMI, RFI; supports long distances	Difficult to terminate

Source: Cisco, 2002

4.2 Networking Standards

Standards are required to co-ordinate how things are done. They are an agree code of practice or convention to guide the development, production or implementation of a given interest. There are two main ways in which standards get adopted

- De facto
- De jure

De facto standards get their name from Latin which means 'from the fact' and they represent standards that came into force without any formal arrangement or plan. They became the agreed code of practice or reference point not by consensus but by relevance. De facto standards by their nature are not formally regulated.

De jure standards also get their name from Latin and it means 'by law' and they represent standards that came into force by a formal arrangement or plan. They are formally regulated and require consensus from all parties involved. These de jure standards are controlled by international standards bodies which include the International Telecommunications Union (ITU), which is made up of the International Standards Organisation (ISO). The ISO is made up of the standards bodies of countries resulting in American National Standards Institute (ANSI), British Standards Institution (BSI), Deutsches Institut für Normung (DIN) (Germany) etc. being members of the international body. Another important body in the standardization of computer networking is the Institute of Electrical and Electronic Engineers (IEEE). It has a group within it that develops standards for Electrical, Electronic and Computer engineering. The IEEE has created a number of working groups that have done a lot in the standardization of computer networking which is generally referred to as the 802 group. Each group handles a different area or issue with networking with the view of developing an acceptable standard for that area. The table below shows the working groups and areas of interest.

Table 4.5: IEEE Networking Standard Groups

IEEE Working Group	Topic
802.1	Overview and architecture of LANs
802.2	Logical link control
802.3	Ethernet
802.4	Token bus
802.5	Token ring
802.6	Dual queue dual bus
802.7	Technical advisory group on broadband technologies
802.8	Technical advisory group on fibre optic technologies
802.9	Isochronous LANs
802.10	Virtual LANs and security
802.11	Wireless LANs
802.12	Demand priority
802.13	
802.14	Cable modems (defunct)
802.15	Personal area networks (Bluetooth)
802.16	Broadband wireless
802.17	Resilient packet ring

Source: Tanenbaum, 2003

A search on the European patent office (EPO) shows that there have been 12,754 patents given worldwide for the Ethernet technology (802.3); 6,999 patents for wireless LANs; 904 patents for WiFi and 1,505 patents given for wireless mesh networks. Thus, the importance of standards cannot be over-emphasized in innovation management.

4.3 The Internet

The Internet is a very important innovation in the history networking. Its origins could be traced to a network of four computers created in 1969 by the US Department of Defence called the ARPANET (Ciccarelli et al 2007). It was actually developed as part of a military project to provide communication capabilities in the event of a nuclear attack but became a vital tool of communication for the academic community (Tanenbaum, 2003). This continued until 1987 when the US Internet joined-up to its Canadian counterparts creating a network that supported approximately 11,000 servers. This grew to 200,000 servers by 1989 due to efforts to improve network performance and by the end of 1992; most countries in the world had connected their networks (EuropaNet, EBONE) resulting in a network of million servers (Ciccarelli et al 2007; Tanenbaum, 2003). The Internet and its predecessors up to 1990 according to Tanenbaum (2003) only ran four applications namely:

1. Email
2. News
3. Remote login
4. File transfer

This all changed in 1990 with the creation of hyper test mark-up language (HTTP) by Tim Berners-Lee (Tanenbaum, 2003). Also until 1990, the Internet was only used by academics, government and industrial researcher – not commercial. This also changed with the formation of Advanced Networks and Services (ANS) by a consortium of MERIT, MCI and IBM, as a non-profit organisation to take control of the Internet from the US National Science Foundation (NSF) in 1990 to form ANSNET which they sold to America Online in 1995 (Tanenbaum, 2003). Narrowband (Dial-up) access was the initial method of connection but this is being replaced by broadband access.

4.4 Broadband Access Technologies

Broadband access technologies are slowly but surely taking over from the initial narrow band access that enabled the Internet. This has been driven in part by the commercialisation of the Internet which has enabled more people to get online and the growth of streaming video as an Internet commodity. The following are the wired technologies that have championed this growth.

4.4.1 Asynchronous Digital Subscriber Line (ADSL)

This is a broadband access technology that makes use of the existing category 3 twisted pair copper telephone cable to deliver data signal at a higher speed to the customer. It functions by creating three separate channels on a subscribers local loop circuit (LLC) where the first channel carries voice, the second downstream data and the third upstream data (Ciccarelli et al 2007). It is described as being asynchronous because the upstream and downstream speeds are different from each other. The ADSL standard (ANSI T1.413 and ITU G.992) allow speeds of 8 Mbps downstream and 1 Mbps upstream (Tanenbaum, 2003).

It can be observed from the ongoing that the data speed deliverable to the customer is subject to the capacity of the category 3 twisted pair copper cable utilised in the subscriber LLC. Thus a change in the medium to one of a higher bandwidth would greatly increase data speeds. This has influenced the development of fibre optic solutions in the delivery of broadband access but this is a very costly endeavour which could be observed in the undertones of the Digital Britain debate – who will pay for it? - Prominent amongst such schemes include the following

- Fibre To The Home (FTTH)
- Fibre To The Cabinet (FTTC)
- Fibre To The Loop (FTTL)

4.4.2 Cable Modem Broadband

This is a broadband access technology that makes use of the digital service offered by the cable television companies. The technology differs from that of ADSL in offering shared multipoint circuits as opposed to the point-to-point circuits offered by ADSL (Ciccarelli et al 2007). There is no formal standard for its transmission but the dominant format amongst companies that utilise Hybrid Fibre Coax (HFC) is the Data Over Cable Service Interface Specification (DOCSIS) (Ciccarelli et al 2007).

The multipoint circuits broadcast messages to all modems on the circuit. This imposes a security risk which the DOCSIS 1.1 cable modem standard was supposed to address. Turnbull & Garrett (2003) states that there has not been one widespread adoption of cable modem standards in Europe. They allude further of an impending struggle between two standards – DVB/DAVIC and EuroDOCSIS.

4.5 Wireless Broadband Technologies

Wireless broadband access technologies are actually wireless implementations of wired access. They draw relevance from being able to offer freedom of mobility to their users which is not possible with the wired access technologies. The aim of emerging wireless data networks is to fully replicate wired services (Kuran & Tugcu, 2007) and develop corresponding LANs, MANs and WANs. Only in this case they would become WLAN, WMAN and WWAN. In line with this fact, research in this area has not been static as shown by the patents issued on wireless technologies. Kuran & Tugcu (2007) also state that wireless LAN (WLAN) is the most deployed wireless technology due the unification of two standards – IEEE 802.11 and the HiperLAN family of standards developed by the European Telecommunication Standards Institute (ETSI) to form the Wireless Fidelity (WiFi) alliance. The need to also meet the aims of wireless data networks have given rise to a family of standards focusing on various strands of interest.

Table 4.6: Wireless Technology Patents

Technology	Patents
Wireless LAN	6,999
Wireless Fidelity (WiFi)	904
Wireless Mesh Networks	1,505

Source: European Patent Office

Table 4.7: IEEE 802.11 Family

IEEE Standard	Purpose
802.11	2 Mbps, 2.4 GHz original standard
802.11a	54 Mbps, 5 GHz Physical Layer standard
802.11b	11 Mbps, 2.4 GHz Physical Layer standard
802.11d	International roaming extensions for 5 GHz band
802.11e	Quality of Service enhancements
802.11g	54 Mbps, 2.4 GHz Physical Layer standard
802.11h	Spectrum managed 802.11a for radar and satellite working
802.11i	Security enhancements
802.11j	Extensions for Japan
802.11k	Radio resource measurement extensions (multiple APs)
802.11n	600 Mbps, 2.4, 5 GHz higher throughput current standard
802.11p	Wireless access for vehicular environment (WAVE)
802.11r	Fast roaming between WLANs
802.11s	Mesh topology support
802.11u	Internet working between different WLANs
802.11v	Wireless network management
802.11w	Protected management frames
802.11y	3.65-3.7 GHz physical layer standard

Source: adapted from Kuran & Tugcu, 2007

4.5.1 Wireless Local Area Network (WLAN IEEE802.11)

WiFi is the implementation of WLAN and by default the wireless broadband platform. The preceding table shows the development of the 802.11 standard from its initial offering as a 2 Mbps standard in 1999 to a 600 Mbps standard in October 2009. It is a progression that has seen adoption of 802.11a 54 Mbps (1999); 802.11b 11 Mbps (1999) and 802.11g 54 Mbps (2003) preceding the present amendment that saw the adoption of the 802.11n 600 Mbps (IEEE802.11n, 2009).

4.5.2 Wireless Metropolitan Network (WMAN IEEE802.16)

IEEE802.16 also referred to as Wireless MAN is the implementation of WMAN. The standard was initially established in 1999 by the IEEE but commercialisation by the industry alliance for the Worldwide Interoperability of Microwave Access (WIMAX) forum has seen it being referred to as WIMAX. The first version was published in 2004 but was quickly superseded by the wireless broadband (WIBROS) standard developed by South Korea (Kuran & Tugcu, 2007) and adopted by the IEEE as 802.16e in 2005. The current version is the IEEE802.16j which supersedes 802.16e, 802.16f, 802.16g and 802.16i (http://standards.ieee.org/).

4.5.3 Wireless Mesh Networks (IEEE802.11s)

Wireless Mesh Networks (WMN) has emerged as a significant innovation in wireless technology that can be implemented as WLANs and WMANs due to their unique characteristics. They are "dynamically self-organized, self-healing and self-configured, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves (creating in effect an ad hoc network)" (Akylidiz et al, 2005). They also possess gateway or bridging capabilities that enable them to operate as routers and clients at the same time, as well as integrate into other wireless networks like the wireless sensor network, WiFi, WIMAX, WiMedia etc.

(Akylidiz et al, 2005). These unique characteristics have enabled WMNs to be robust, easy to deploy and configure, produce reliable service coverage, are fault tolerant and can implement wirelessly the highly desirable wired mesh topologies at a fraction of the cost (Akylidiz et al, 2005). They also support multiple Set Service Identifier (SSID) that enables multiple networks to be configured on the same physical wireless network. A comprehensive standard (IEEE802.11S) on its operation is due for release in September 2010. But there are industry offerings from a number of vendors which include Cisco systems, Intel, Telebria, Motorolla, Nortel Networks, BellAir Networks, Firetide, SkyPilot Networks, Topos Networks etc.

4.6 Networking and Innovation management

An important feature of the discussion on networking produces an undeniable fact that computer networking is a significant technological innovation. Another feature that has become apparent from the foregoing review is the make up of this technology. Networking could be described by the following features

1. The type of networking
2. The architecture of network
3. The topology of network
4. The network media

It is can be observed that

- Networking is a process innovation
- Networking architecture is a conceptual innovation
- Networking topology is conceptual innovation
- Networking media are product innovations

The discussion has also showed how these features have been implemented initially as wired solutions and the subsequent wireless implementations. The is summarized in the following table

Table 4.8: Networking Media Comparison

NETWORKING INNOVATION		
Feature	Wired Implementation	Wireless Implementation
Type	LAN	WLAN
	MAN	WMAN
	WAN	WWAN
Architecture	Peer-to-peer	Peer-to-peer
	Client/Server	Client/Server
Topology	Bus	Ad hoc (easier cheaper)
	Ring	Infrastructure: Wireless Access Point (AP) (easier cheaper)
	Star	
	Mesh	WMN (Mesh router) (easier cheaper)
Media	Coaxial	Radios: (WiFi – 802.11a, 802.11b, 802.11g, 802.11n) (easier cheaper)
	STP	
	UTP	
	Fibre Optic	

It could also be observed that:

- The wired and wireless implementations are innovations that preserve Networking as an innovation
- Wireless media do not enhance or preserve wired media

- Wireless media solutions are easier to implement and cheaper
- The innovations in wired media all act to enhance the wireline media but are substitutes to each other (coaxial, copper core; fibre optic, glass core) (STP, UTP)
- WiFi 802.11a, b, g, n are progressive enhancement of wireless innovation

It could be insinuated from the above that wireless networking innovations are destructive to wired networking technology. They represent a discontinuity in networking media that seeks to destroy wired networking media while preserving and enhancing the networking innovation.

4.7 Conclusion

The development of a digital society cannot be achieved without an understanding of the technologies that drive and support its growth. Networking is the enabling technology that is impacting the society. This chapter reviewed the technology and from the overview, presented the main characteristics of the technology. The various forms, architecture, topologies and connecting media associated with it were introduced. A synopsis of the international standards regulating its propagation was also examined. Its relations with innovation management were also explored.

The examination showed it usually exists in three forms that are related to its location. These are the local area network (LAN), metropolitan area network (MAN) and wide area network (WAN) which could be implemented though wired and wireless media. It was also shown that its architecture and topologies were initially implemented as wireline solutions which are currently been replicated as wireless media. The interactions between both media were also examined and they show that wireless networking media are discontinuous technologies that have a destructive effect on wired networking media.

Chapter Five

Research Methods

5 Introduction

This chapter provides an understanding of this study. It sets the underlying context on which it was carried out and how the questions emanating from the primary case study would be approached. The primary case study was undertaken as an exploratory study into the innovation management processes of Norfolk County Council as they evaluate the impact of wireless technology on their society and operations. It was also undertaken as part of the Total Technology program. It is expected that this chapter would provide an explanation on the activities of this study and proffer solutions to the observed discrepancies in the case study.

5.1 Background to Study

The PhD program in Total Technology is a unique program of developed by the University of Bradford. It is a program of study for an engineer that is designed to blend management studies, real life problems and research. The prospectus reveals that it is founded on the concept of the resolution of a real life problem being as demanding and challenging as other traditional forms of engineering research. The same view is held by Dryzek (1986) cited in McNabb (2004) who states that "the essence of scientific activity is solving problems". Due to its unique nature it falls into the group of programs categorised as professional doctorate programs. The "main objective of the program is to produce engineers who are competent to analyse each situation with which they are faced in their professional careers, and to take decisions in the light of all the information available" (Prospectus, 1999/2000).

The first stage of the program involved the acquisition of management skills and techniques through taught courses delivered by the Bradford School of Management

over a nine month period. This is followed by the identification of a real life problem on which demands resolution. The design of this stage culminated in the preceding chapter and the elicitation of this thesis.

5.2 Research design (Stage Two)

The design of stage two of the doctorate program was dictated by the purpose of the study. A review of the research methods literature shows that there are mainly three types of studies namely

1. The explanatory study
2. The descriptive study
3. The exploratory study

Explanatory study

These are studies that "establish causal relationships between variables" (Saunders et al, 2009, De Vaus, 2002). It is for this reason they are referred to by some authors as Causal studies (Cooper & Schindler, 2006; Zikmund, 2003). These studies are usually preceded by descriptive and exploratory studies because they are expected to explain some relationship when there has been already been a narrow definition of the research problem (Zikmund, 2003). Explanatory studies are also used to predict outcomes (Sekaran, 2000). The goal of such studies is to identify patterns in data so as to proffer suggestions that can explain the observed patterns. They can be carried out with both qualitative and quantitative data (Sekaran, 2000).

Descriptive study

This form of study is undertaken to "portray an accurate profile of persons, events or situations" (Robson, 2002 cited in Saunders et al, 2009). It is a form of research that "deals with questions of what things are like, not why they are that way" (De Vaus, 2002). Descriptive research also "seeks to determine the answers to who, what, when where and how questions" (Zikmound, 2003). These are studies "undertaken when

the characteristics or the phenomena to be tapped in a situation are known to exist and one wants to be able to describe them more clearly by offering a profile of the factors" (Sekaran, 2000). They are typified by the kind of research carried out by the office of national statistics that provide data on different profiles. It is the position of Cooper & Schindler (2006) that they serve three objectives namely:

1. To provide for a given population the characteristics and phenomena associated with it (who, what, when, where and how much not why or how)
2. To provide estimates of the said population that possess these characteristics
3. To provide insights to the existence of relationships between the various variables

Due to the nature of descriptive studies and the need for a better understanding of public sector modernisation and innovation management, this type of study was not seen to be a fit for the research objectives .

Exploratory study

This is a type of study that is conducted to "investigate an issue or topic in order to develop insight and ideas about its underlying nature. Topics are often a problem or issue that requires additional research study for problem resolution" (McNabb, 2004). Exploratory studies are not conducted to provide decisive evidence on a subject or choice of action but to elucidate vague problems, provide a better perception of the scope of a problem or provide information for examining a situation (Zikmund, 2003). It is a type of study that asks the 'how' and 'why' questions as it queries the situation. Exploratory studies are "undertaken when not much is known about the situation at hand, or when no information is available on how similar problems or research issues have been solved in the past" (Sekaran, 2000). It might involve the carrying out of extensive interviews in a bid to obtain a better understanding of the phenomena or situation (Sekaran, 2000). Sekaran (2000)

and Zikmund (2003) also concede that a lot of exploratory studies exist from qualitative studies where data had been obtained via interviews and observations. He further asserts their importance in theory building and hypothesis testing which results in a contribution to knowledge. Whereas Cooper & Schindler (2006) state that the purpose of exploratory studies is to develop hypothesis or questions for further research, Zikmund (2003) states that its purpose is for:

1. Diagnosing a situation
2. Screening alternatives
3. Discovering new ideas

These are the characteristics of exploratory studies that informed its selection for the second stage of the program. The need to identify real life problems required a type of study that will permit the investigation of how a topic or event is constituted. Its choice was to facilitate the identification of real life problems hence Norfolk Open Link. It was also chosen because it affords the flexibility of adopting or altering the study based on the results of the exploratory study.

5.2.1 Research strategy

Research strategy is concerned with selecting appropriate research technique(s) that is/are complementary to the purposes of the study. Zikmund (2003), states that there are four basic research techniques that can be employed when conducting exploratory studies for obtaining a better understanding of a problem namely:

1. Secondary Data Analysis
2. Pilot Studies
3. Experience Surveys
4. Case Studies

Secondary Data Analysis

In order to understand what construes secondary data analysis, it is necessary to define what secondary data is and to differentiate it from primary data. Secondary data are "data previously collected and assembled for some project other than the one at hand while Primary data are data gathered and assemble specifically for the project at hand" (Zikmund, 2003). When secondary data is preliminarily reviewed in order to clarify issues at the inception of a research study it is referred to as secondary data analysis (Zikmund, 2003). It is concerned with gathering background information and would be employed in this study.

Pilot Studies

These are small-scale studies "whose data collection methods are informal and whose findings may lack precision because rigorous standards are relaxed … a pilot study generates primary data, usually for qualitative analysis" (Zikmund, 2003). The information obtained from a pilot study could also serve as catalyst for further studies which could be quantitative in nature since they are meant to provide insight.

Experience Surveys

Experience surveys can be defined as "an exploratory research technique in which individuals who are knowledgeable about a particular research problem are surveyed … often an experience survey consists of interviews with a small number of people who have been carefully selected" (Zikmund, 2003). This technique requires talking to well-informed – either due to status, position or experience – in order to gain a better understanding of a situation.

Case Studies

The case study method is reputed to be ideal when the objective is to "gain understanding of the context of the research and the processes enacted" Morris & Wood, 1991 cited in Saunders et al, 2009). It is also a research strategy that allows

the researcher to ask the 'how' and 'why' questions. This view is also shared by Saunders et al, (2009) who conclude that the case study strategy is the most often employed research strategy in explanatory and exploratory studies. "The philosophy behind the case study is that sometimes only by looking carefully at a practical, real-life instance can a full picture be obtained of the actual interaction of variables or events (Remenyi et al, 1998). This research technique was adopted to investigate the exploratory study. It is also a fit with the program of studies. Due to the time constrained nature of academic studies, a cross-sectional study was adopted.

Data gathering

The following methods of data gathering were employed during the case study.

1. Documentation
2. Archival records
3. Interviews
4. Direct observation

These data gathering techniques resulted in the information presented in chapter six.

Data analysis

The data analysis technique utilized in the analysis of the data gathered during the case study is of the "explanation building" (Yin, 2009) analytic technique. This is a specialized form of pattern matching since it tries to develop an explanation, not to finalise the study but to build up ideas for further studies (Yin, 2009). This technique was employed in chapter six and has indeed identified further studies as acknowledged by the results of the analysis which forms the basis for the real problem identified from the study (Yin, 2009)

Research Limitations and Challenges

Access to the Norfolk Open Link project presented a challenge to due to the work load of the project managers overseeing the project.

The multidisciplinary nature of the study also presented a challenge since the study straddles the fields of politics, economics, management, engineering and information communication technology

5.3 Research problem

The case study on Norfolk Open Link showed **how** the wireless mesh network project was successfully developed, designed and implemented. It also presented astonishing results on the challenges facing the network.

There are a number of problems that could be identified from the exploratory case study but from a technology and innovation management perspective:

- Given the review on networking technology that identified wireless broadband technologies as destructive to wired broadband technologies
- Given the office of national statistics figures that 95% of the UK population make use of broadband Internet services and the less than 5% utilization figure obtained from the exploratory case study in Norfolk,

It would be safe to conclude that wireless broadband technology is not the dominant design in the Public Access Industry which contradicts the literature.

The primary research problem is to provide answers on:

- How wireless broadband technology can become the dominant design in the public access industry

The secondary research question is to provide answers on:

- Why wireless broadband technology is not the dominant design for the public access industry

In order to answer the primary research question on 'how' to become the dominant design in the public access industry, it is pertinent to find out why it is not. This in essence means the secondary question would be answered first due to its relevance in evaluating the primary question. Also, sustainability would be regarded as an

important feature of a dominant design and would be used interchangeably. The implication is that the primary question could be re-phrased as "How wireless broadband technology can become the sustainable design in the public access industry" and the secondary "why wireless broadband technology is not the sustainable design for public access industry"

Hypothesis

In developing this hypothesis, the following factors and have been taken into account

1. The fact that there are two academic institutions – University of East Anglia and City College - represented by two sectors in the trials which have also shown a decline in connections
2. The presence of these two institutions militate the argument of Internet awareness amongst users
3. The Office of National Statistics report that 19 of 20 connections in the UK is a broadband connection.
4. A sustainable design is a function of its innovation management strategy

Hypothesis: The innovation strategy for introducing wireless broadband technology is faulty in its choice of industry

5.4 Relevance of Research

The outcome of this research is of interest to Norfolk County Council and to any other city embarking on modernisation programmes using wireless technology. It is also of interest to wireless broadband technology companies that want to forward integrate into service providers. It also contributes to the discussion on innovation management strategies.

5.5 Research Design (Stage 3)

The research design for stage three of this programme will be an explanatory study. This change in research design is conversant with the exploratory studies as they allow a change in research design in response to the questions arising from the exploration to a more convenient one that can proffer solutions (Saunders et al, 2009). Explanatory studies "establish causal relationships between variables" (Saunders et al, 2009, De Vaus, 2002) which is what this stage requires.

5.5.1 Research Strategy

The research strategy adopted for this stage is a deductive reasoning approach. This is a strategy that researchers use to "form theories that explain events that they encounter in their daily life" (McNabb, 2004). This strategy was adopted because the hypothesis suggests a strategic management problem bordering on choice which cannot be evaluated by descriptive and empirical methods but strategic analysis due to the underlying issues of competition (Narayanan & O'Connor, 2010).

5.6 Conclusion

This chapter provided the major thinking behind this study. It evaluated the research design, method and strategies employed in the planning of the study. This chapter reveals that this is an exploratory study as part of the Total Technology program. The reasoning for the choice of an exploratory study was also explored culminating in the development of an appropriate research design and corresponding method. The research strategy adopted to investigate the exploratory study was the case study method. The research problem was also defined and a hypothesis proposed. An explanatory study was designed to investigate the hypothesis which would be carried out in chapter seven.

Chapter Six

Norfolk Open Link

6 Introduction

This chapter presents the primary case study on the Norfolk Open Link project. It is an exploratory investigation on wireless mesh networks trials in the Norfolk County. It is an innovation being introduced to the public sector as part of the modernisation initiatives sweeping across the country. Norfolk County Council is a beacon council, recognised by this status as a pacesetter to other local government councils. This study is also part of the requirements for the Total Technology program to identify problems in industry and to submit a thesis from the experience. The chapter also presents secondary case studies on Wireless Philadelphia and Milton Keynes.

6.1 Background

Norfolk county council is located in the east of England region sometimes referred to as East Anglia. It is a coastal council that boasts a sizeable share of the British countryside - especially South Norfolk - that is sparsely populated as it plays out the rural urban divide. Norfolk is a historical county with roots that stretch back to Roman times. It had an estimated population in 2009 of 853,000 of which 20% were over 65 years old and 10% over 75 years old (DIN, 2011). It is home to a number of educational institutions including the University of East Anglia and a tourist attraction boasting the largest concentration of medieval church buildings in the world of which 868 of such buildings still stands (Knott, 2009). Norfolk County Council is a beacon council, recognised by this status as a pacesetter to other local government councils in the modernisation efforts of the government. The county operates a three-tier hierarchical council structure made up of county, district and parish councils, in that order of authority.

The project

Norfolk Open Link is part of the public sector modernisation initiatives taking place in the United Kingdom. It is a two-year pilot wireless network project by the Norfolk County Council to evaluate the effects of mobile technology on economic development and the delivery of public services. It is a community wireless network designed to provide free Internet access to the public, local business and public sector employees. As a result of the community based business model being operated, the users are not liable for the cost of providing the services. The project is funded by the regional development agency, East of England Development Agency (EEDA) who earmarked £1.35 million for the venture. The ability to take on this project all stem from the modernisation agenda of government which devolved power within England to the regional development agencies (RDA) and is part of the development of digital infrastructure for the digital transition stage.

6.1.1 Reasons for the project

The project is borne out of recognition of the importance of wireless technology and the opportunities it could create. Norfolk County Council wanted "to understand if all public sector organisations – health, education, social services, police, fire service and public transport – could benefit from and improve their effectiveness by using wireless technology" (Orne, 2006). They also wanted to assess the impact of wireless technology on the economic development of the region (Moreton, 2006, 2009) so they approached EEDA with a project proposal (EDP24, 2006). The project was also expected to foster a culture of partnership amongst public sector organisations as well as the public. While the above was the stated aims at the beginning of the project under which funding was obtained from EEDA, the project final report (appendix 1) admits (at the end) that it was an unrealistic goal and as such the project

aims were scaled back to "encourage greater collaboration and enable public sector organisations to assess the feasibility of using 'joint funded, shared infrastructure' projects in the future" (Carey, 2009). The project objectives according to its project managers could be summarised as to:

- Provide flexible access to information for the region
- Encourage the trial of new wireless applications
- Increase awareness and understanding of the potential benefits of using wireless technology in the public sector
- Encourage the private sector to investment in wireless broadband
- Provide the public sector with an opportunity to collaborate and assess the benefits of having a shared network infrastructure
- Identify and develop new ways of service delivery

Stakeholders

In line with the stated aims of public sector involvement, the stakeholders were drawn from councils (Norfolk County Council (Lead Partner), Norwich City Council, South Norfolk District Council, Broadland District council), health (The Norfolk and Norwich University Hospital), education (University of East Anglia, Norwich City College), Police (Norfolk Constabulary) and the Forum trust (an iconic events hub for the region) (Frary & Carey, 2007).

Due to the lack of Specialist knowledge in the field of wireless technology, the council with the help of ADIT (North East) – a regional aggregation body that works with regional development agencies (Warren, 2007) – put together a competitive tendering process for the role of Technical partner or in more simpler terms, a service provider, charged with the responsibility for the design, construction and maintenance of the wireless network covering an area of four square miles. This was won by Synetrix "an experienced provider of integrated applications and managed

services" (Moreton, 2006). The main stakeholder is EEDA, the regional development agency that provided the funded the project for the development of the wireless network.

6.1.2 Regional Development Agency (RDA)

The East of England Development Agency (EEDA) is one of the regional development agencies in the UK. The RDAs were created by the regional development agencies Act of 1998 which created nine RDAs for the different regions in England. They were adopted by the Labour party into their general election manifesto out of the work of the Regional Policy Commission established by John Prescott (Allen, 2002)

The Minister for Regions, Regeneration and Planning, Richard Caborn, advanced their cause with a public consultation that culminated in the Building Partnerships for Prosperity White Paper (Allen, 2002). The RDA Act of 1998 defined the nine development agencies formed in terms of local government areas and were charged with the role of "strategic drivers of regional economic development following the 2000 Spending Review" (Allen, 2002). The aims of their establishment according to the act (RDA, 1998) were to:

- Promote economic development and regeneration
- Promote business efficiency, investment and competitiveness
- Promote employment
- Enhance the development and application of skill relevant to employment
- Contribute to the sustainable development of the UK

The funding for RDAs was also modified and they were allowed the on the basis of their strategic plans to reorganise their resources when the single pot was introduced (Allen, 2002). In view of its stated aims of economic development and efficiency, the

original stated aims of the Norfolk Openlink project were a perfect fit justifying its funding (EDP 24, 2006). The RDAs were scrapped and replaced by Local Enterprise Partnerships in June 2010 by the new coalition government as part of the cost cutting measures to reduce the budget deficit (BBC News, 2010)[1]

6.2 Development Plan

The network was designed by Synetrix – the technical partners- using wireless mesh technology spanning the Norwich City centre, some key stakeholder locations and twenty-eight hotspots in rural South Norfolk. The project involved the deploying of over two hundred access points (AP) in a network design centred on the Norfolk County hall from where access and backhaul operations originate and terminate respectively. The network made use of the Telebria ™ APM 300 wireless radio (Moreton, 2006, 2009).

Fig 6.1: Telebria APM 300 Radio

Source: Norfolk Open Link

These are dual radio, tri-band wireless mesh router and access point which are self-healing, highly scalable and do not require a line of sight as a condition for operation. It has a transmitting power of less than 100mW and also complies with the Wireless Fidelity (WiFi) 802.11 a/b/g standard (Blackwell, 2006).

Fig 6.2: Access Points on Street Furniture

Source: Norfolk Open Link

The plan centres on the fitting of these radios on lamp post and buildings to create the network. These wireless mesh routers have a reception radius of 150-250 metres and make use of wireless backhaul for feeding data back to its backhaul sites, which in turn pass traffic to its network gateway, a 40Mbps Internet pipe located at the city centre. This is made possible because the Telebria™ APM 300 is made up of two radios that operate at two different frequencies, 2.4 and 5 GHz. Power supply to the routers is provided via Power-over-Ethernet (PoE) through the lamp posts to which they are attached. They are designed to be operational irrespective of the lamp i.e. the lamp could be removed for maintenance without affecting the router's operation. Also, since the network makes use of wireless data links, it only requires power to become operational in extending the network. Due to State Aid consideration, there is a deliberate effort for the network not to compete with commercial broadband and as such there is a limitation on the connection speed obtained on the network. Internet access is provided to public sector users at 1 Mbps and 256 kbps for the general public. Internet usage is also limited to one hour with the option to login again at will.

6.3 Implementation and Challenges

The design was implemented in three stages as shown below

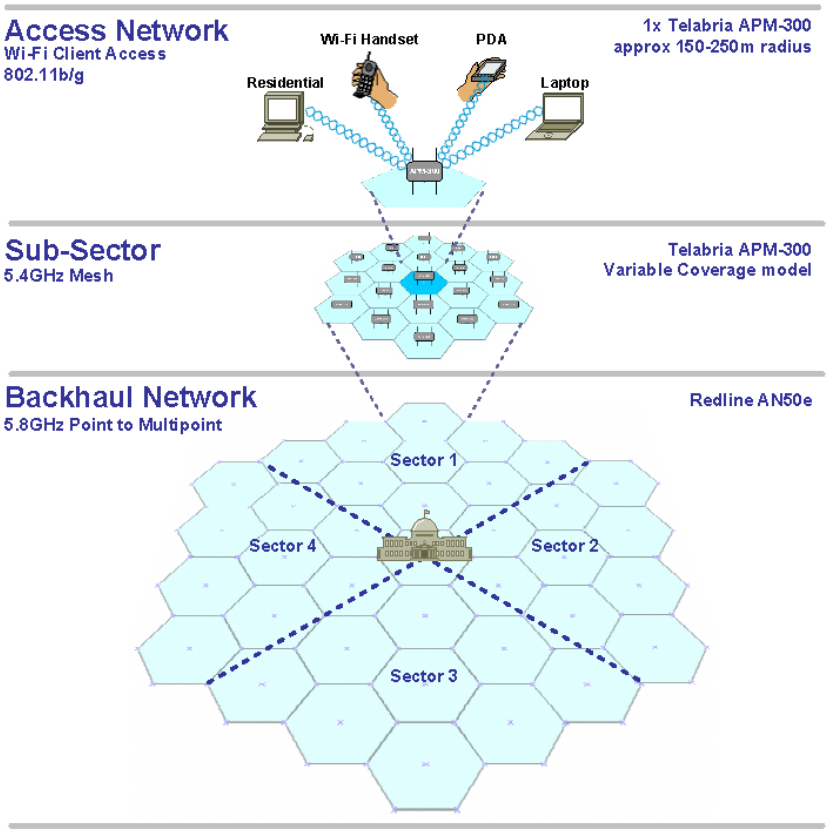
Table 6.1: Norfolk Open Link Implementation Stages

Stage One	Stage Two	Stage Three
County Hall	Grovesnor House	South Norfolk
City College	Earlham Library	
University of East Anglia	Open youth centre	
Norfolk & Norwich Hospital	Broadland Business Park	
The Forum trust	Broadland District Council	

Stages one and two

Stages one and two were implemented on the map shown overleaf. This involved the dense coverage of the city centre as shown in the area shaded blue. The selected area was divided into eleven sectors and four backhaul locations (backhaul shown below).

Fig 6.3: Network Design



Source: Norfolk Open Link

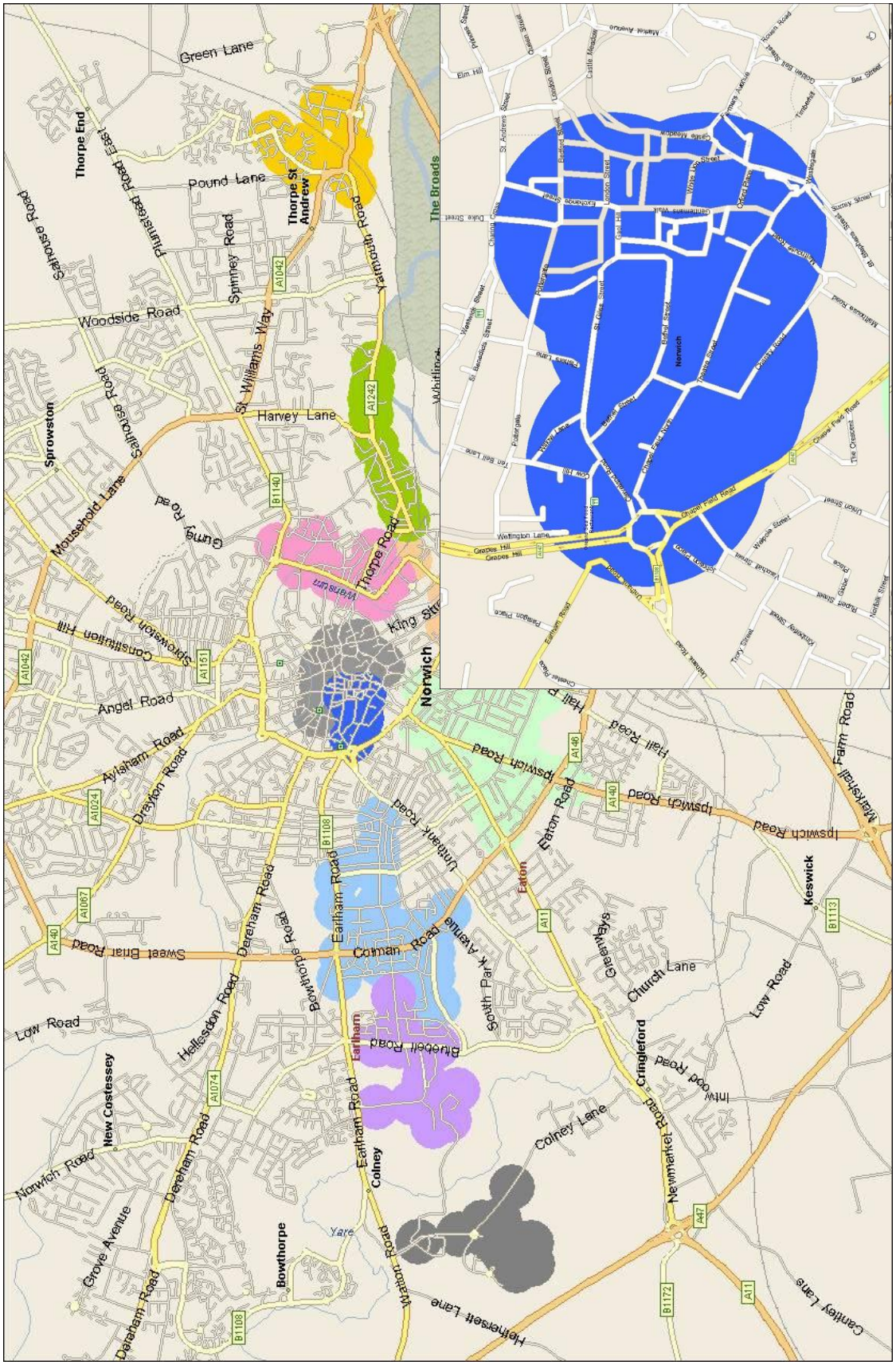


Fig 6.4: Stages One and Two Network Location
Source: Norfolk Open Link

They all link back to the County hall where the 40 Mbps Internet pipe is located. The implementation of phases one and two saw the installation of 260 Access points across the eleven sectors. The installed wireless infrastructure is supported by a website and portal that provides information on the use of the network. The portal enables the general public to read and accept the terms and conditions of using the network. It is configured such that access is only given to those who accept the conditions. There is also customer support information including availability times to users. The portal also has provision for public sector employees to log into the network. The implementation challenges and solutions are found in appendix two.

Fig 6.5: Norfolk Open Link Portal Page

Source: Norfolk Open Link

Stage three

The third stage of the project involved the coverage of South Norfolk, which could be described as a rural district stretching about 18 miles south of Norwich. Due to the terrain, it was not cost effective to blanket cover any particular area, this resulted in the adoption of a Hotspot solution to cover populated rural areas.

Fig 6.6: South Norfolk

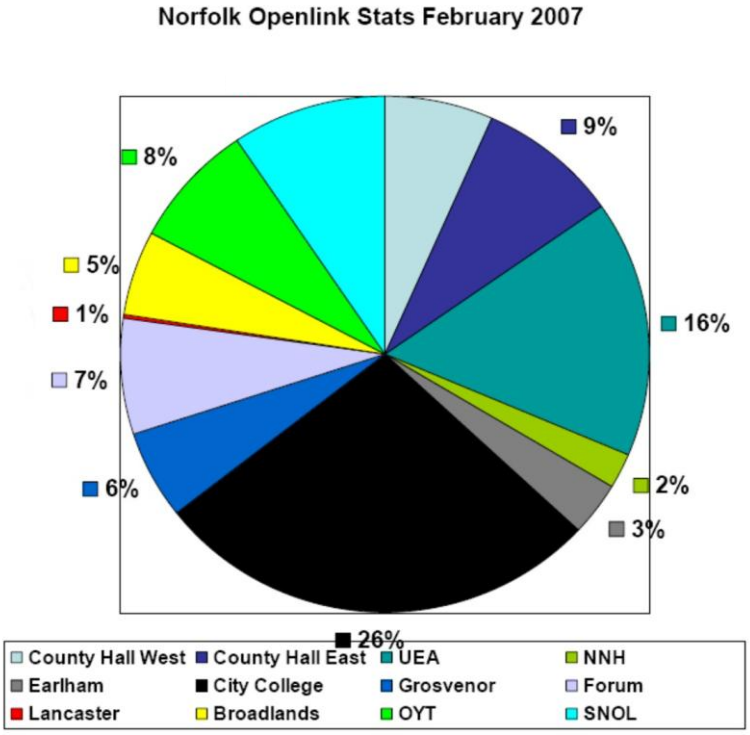
Source: Norfolk Open Link

This strategy saw the development of thirty-six rural hotspots made up of 32 villages and 4 market towns in South Norfolk that were also subject to the same service conditions as in Norwich. These thirty-six locations were implemented as 27 locations with single access points and 9 locations with multiple access points. All locations were populated by 69 Access points, with 18 Access points installed on lamp posts, 27 Access points installed on public sector building and the remaining 24 Access points installed on private premises. There were also 27 wireless and 9 ADSL backhaul sites for the 36 locations.

6.4 Testing and Results

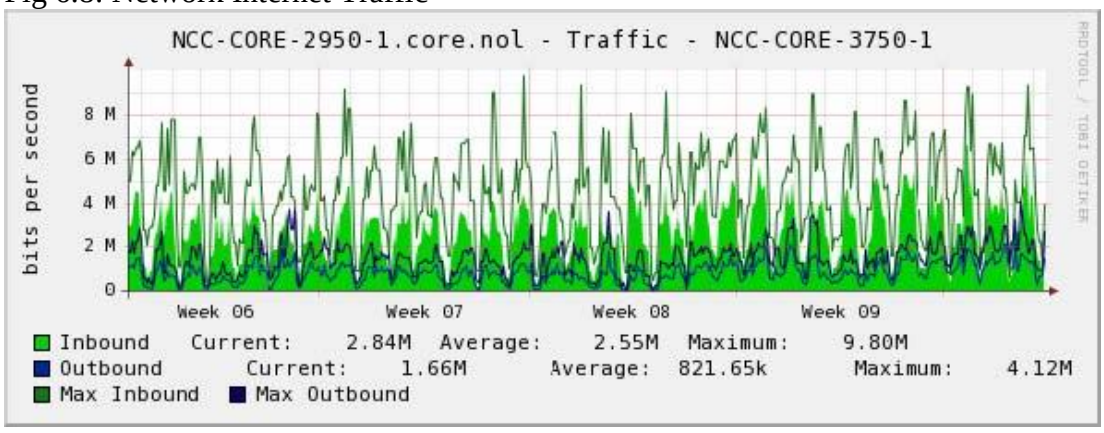
Testing on the network started during the deployment of Access points to ensure all devices on the network were performing satisfactory. The eleven sectors in stages one and two were tested and a summary of the results could be found in appendix one. Network statistics are shown below

Fig 6.7: Network Internet Connections



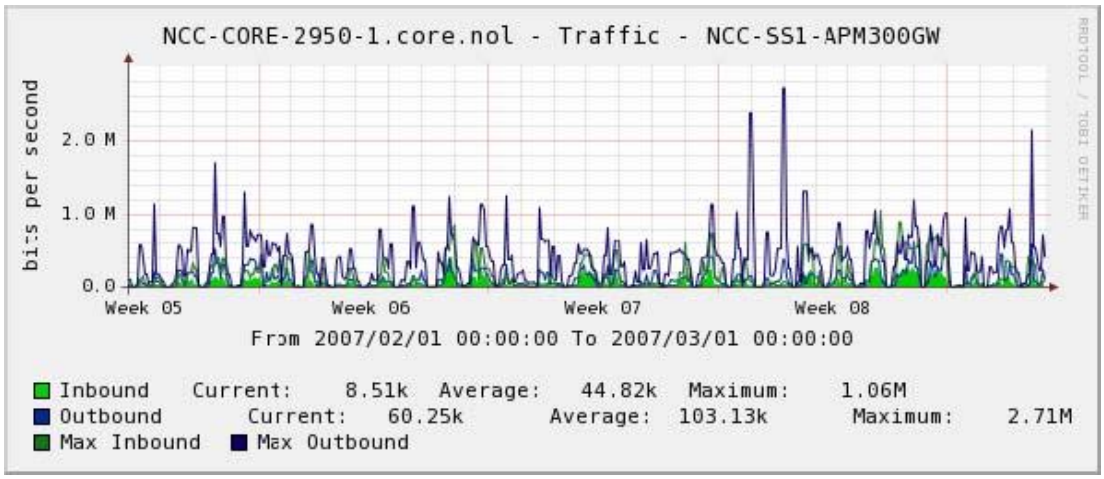
Source: Norfolk Open Link

Fig 6.8: Network Internet Traffic



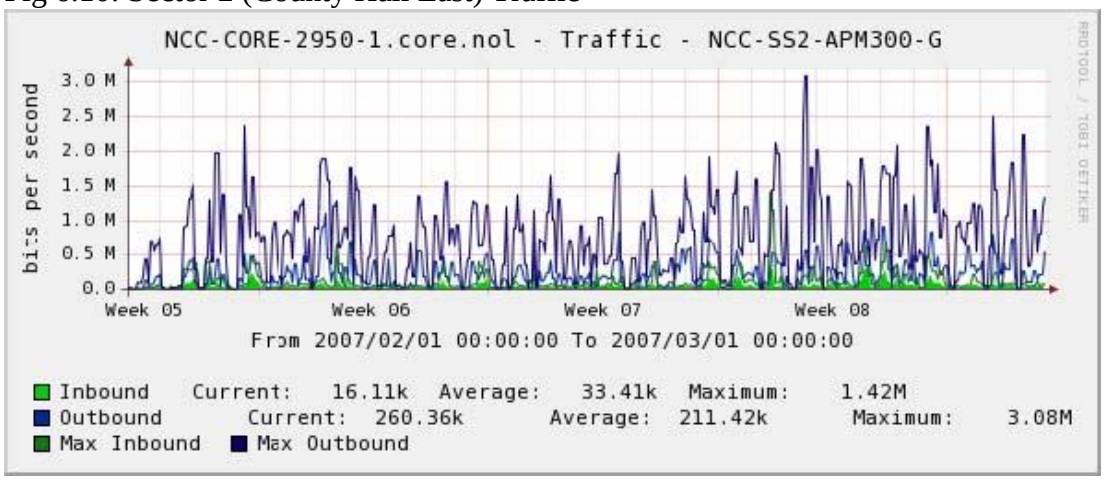
Source: Norfolk Open Link

Fig 6.9: Sector 1 (County Hall West) Traffic



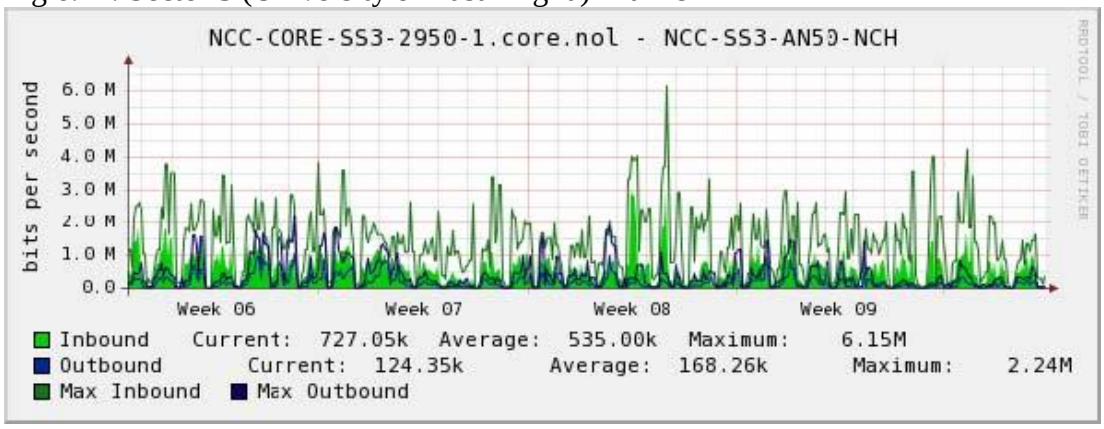
Source: Norfolk Open Link

Fig 6.10: Sector 2 (County Hall East) Traffic



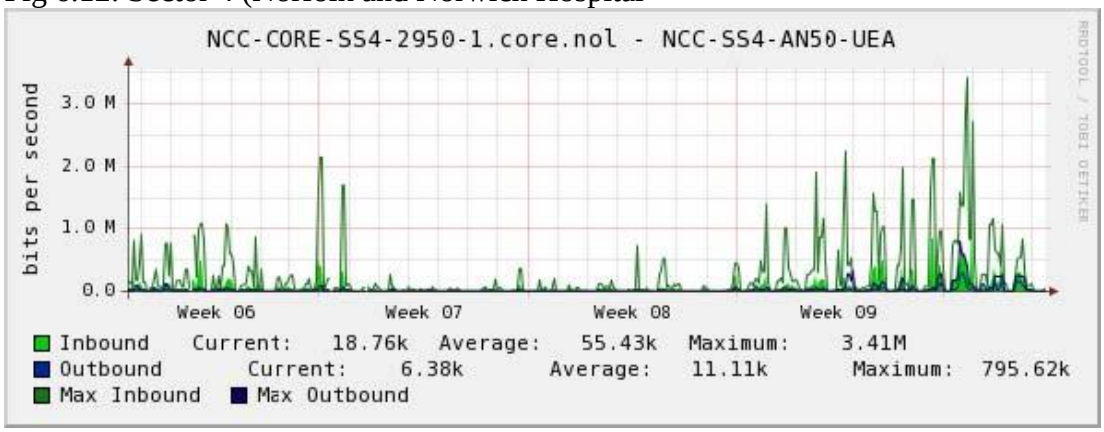
Source: Norfolk Open Link

Fig 6.11: Sector 3 (University of East Anglia) Traffic



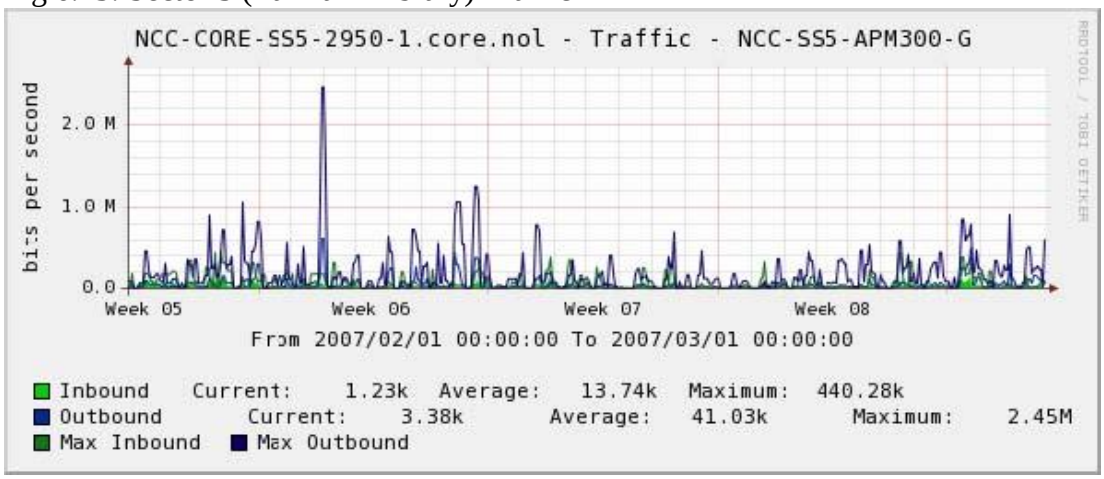
Source: Norfolk Open Link

Fig 6.12: Sector 4 (Norfolk and Norwich Hospital



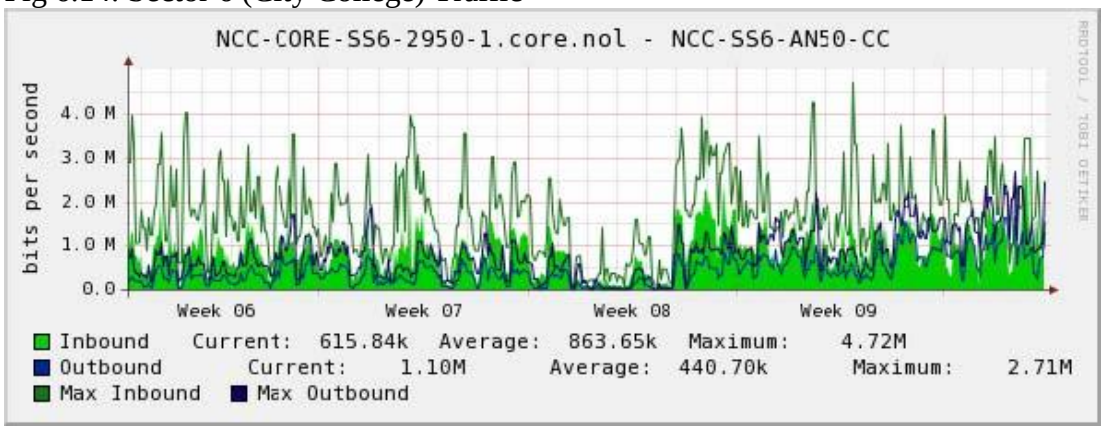
Source: Norfolk Open Link

Fig 6.13: Sector 5 (Earlham Library) Traffic



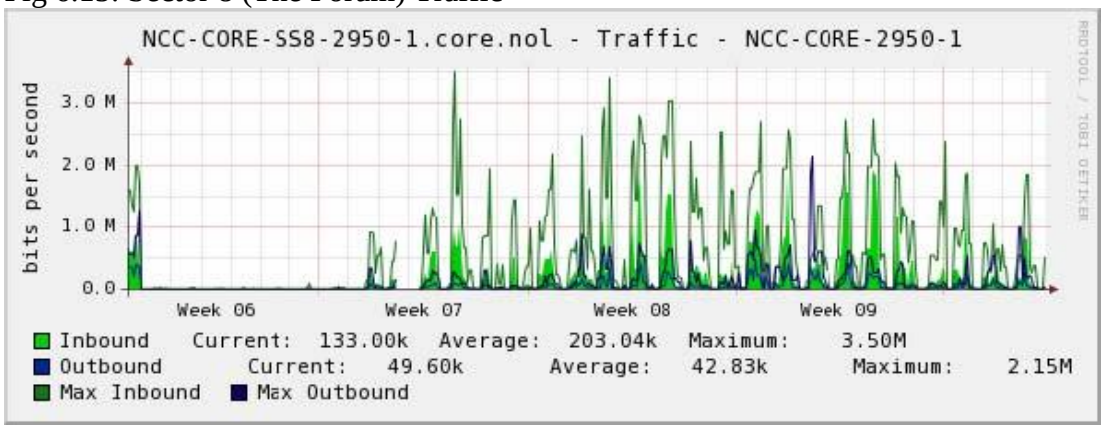
Source: Norfolk Open Link

Fig 6.14: Sector 6 (City College) Traffic



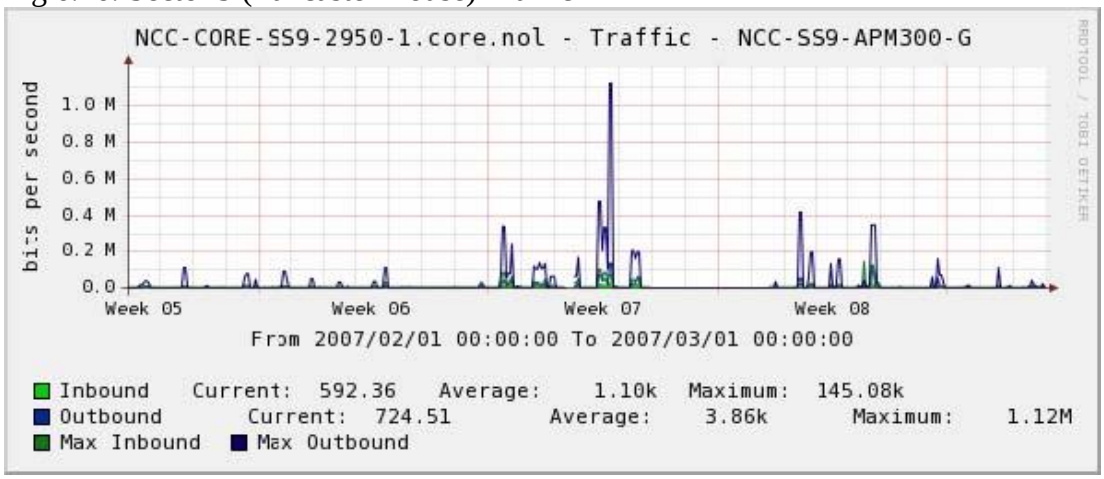
Source: Norfolk Open Link

Fig 6.15: Sector 8 (The Forum) Traffic



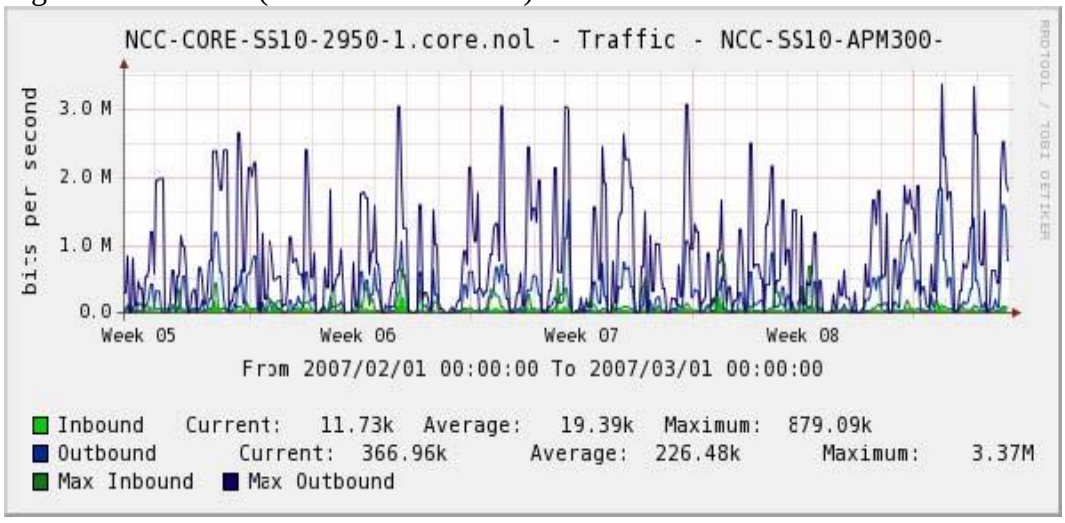
Source: Norfolk Open Link

Fig 6.16: Sector 9 (Lancaster House) Traffic



Source: Norfolk Open Link

Fig 6.17: Sector 10 (Broadlands Council) Traffic



Source: Norfolk Open Link

Table 6.2: Network Connections

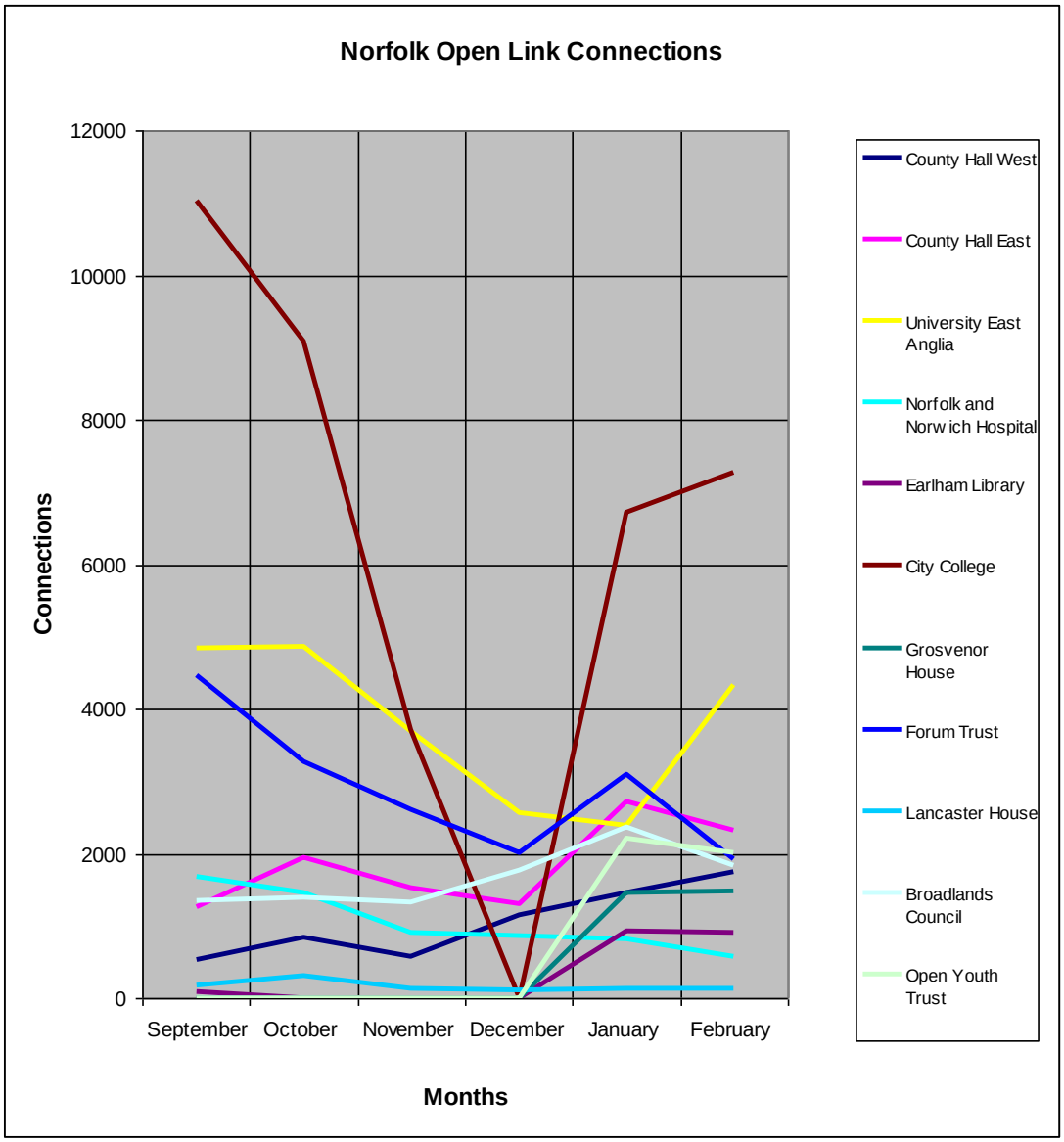
Service Sector	September	October	November	December	January	February
County Hall West	535	845	577	1144	1453	1743
County Hall East	1265	1951	1535	1306	2717	2320
University East Anglia	4838	4859	3686	2553	2387	4335
Norfolk and Norwich Hospital	1675	1463	916	861	827	572
Earlham Library	81	0	0	0	927	897
City College	11019	9083	3717	0	6719	7270
Grosvenor House	0	0	0	0	1456	1484
Forum Trust	4466	3262	2617	2002	3083	1925
Lancaster House	176	306	123	116	132	138
Broadlands Council	1353	1398	1327	1761	2371	1832
Open Youth Trust	0	0	0	0	2220	2015
Easton College		90	938	405	2293	1908
Hempnall		8	5	4	73	113
Hethersett		86	93	50	92	94
Mulbarton		11	1	2	4	238
New Costessy		9	9	3	87	0
Poringland		18	9	19	0	18
Kerteringham					8	4
SNDL Office					4	5
Surlingham					58	42
0B 6B 37 CB A7						29
0B 6B 37 CB D6						5
0B 6B 37 D5 EE						93

Source: Norfolk Open Link

(South Norfolk hotspots in red)

6.5 Analysis of Results

Fig 6.17: Analysis of Stages one and two connections



An analysis of the results shows that over a six month period, in the eleven sectors of stages one and two were 260 access points were deployed:

1. None of the sectors had more than twelve thousand connections at any time.
2. Despite statistics not being for unique connections, only two locations could boast of over four thousand connections – the university of East Anglia and City College – in February – others were below two thousand five hundred.
3. The 27,080 connections recorded in February on the network actually represent 1,864 unique users.

Table 6.3: Analysis of Inbound and Outbound Internet Connections

Service Sector	Inbound Average Demand (Kbps)	Inbound Peak Demand (Kbps)	Outbound Average Demand (Kbps)	Outbound Peak Demand (Kbps)
County Hall West	44.82	1060	103.13	2710
County Hall East	33.41	1420	211.42	3080
University East Anglia	535	6150	168.26	2240
Norfolk and Norwich Hospital	55.43	3410	11.11	7956.2
Earlham Library	13.74	440.28	41.03	2450
City College	863.65	4720	440.7	2710
Forum Trust	203.04	3500	42.83	2150
Lancaster House	1.1	145.08	3.86	1120
Broadlands Council	19.39	879.09	226.48	3370
Total Demand	1769.58	21724.45	1248.82	27786.2

An analysis of the above data shows

1. A total average inbound broadband Internet demand that is less than 2 Mbps on a 40 Mbps Internet pipe representing less than 5% capacity utilization.
2. The highest average inbound broadband Internet demand is less than 1 Mbps and the lowest 1.1 Kbps
3. A peak inbound broadband Internet demand of 6.15 Mbps on any sector
4. A total peak inbound broadband Internet demand of about 22 Mbps of the 40 Mbps Internet pipe accounting for 55% of capacity utilization.

5. The total average outbound broadband Internet demand is just about 1.25 Mbps representing less than 4% of capacity utilization
6. The total peak outbound broadband Internet demand is about 28 Mbps representing 70% capacity utilization with the hospital sector experiencing the highest outbound traffic.

Other issues of significance

1. The maintenance cost of the network for a year is £300,000 (three hundred thousand pounds)
2. Resource allocation to the project was just two council employees who had to combine their council jobs and managing the project.
3. This resource shortage resulted in the project report not being ready on time.
4. The plans to trial midwives as a form of mobile public sector working was met with scepticism and did not enjoy full commitment due to the reported reluctance to change working patterns over a pilot network
5. There was some success on trial of new applications which saw the trial of a tourist trail application and the BBC trying out new programs delivery on the network
6. The local council was delighted by the positive public relations the network gave to the council but due to State Aid conditions and the maintenance cost of the network there were concerted efforts to find a sustained model to keep the network operational which failed from lack of commercial interest (Carey, 2009).

An overview of the above results shows very poor utilization figures for the network. If the cost of setting up the network is taken into consideration, a less than 5% capacity utilization for a £1.35m pounds network makes abysmal reading.

6.6 Wireless Philadelphia

6.6.1 Background

Philadelphia is one of the cities in commonwealth state of Pennsylvania in the United States of America (US). While it is a historical city, serving as the founding capital for the US between 1790 and 1800, it is also home to a number of Fortune 500 companies amongst whom are Comcast (the cable television and Internet provider), pharmaceutical giants GlaxoSmithKline and has an estimated GDP according to PricewaterhouseCoopers of $312bn in 2005 and $388bn in 2008 (Hawksworth et al, 2005, 2009).

Philadelphia is also home to the second largest number of educational institutions including Temple University, Drexel University, University of Pennsylvania, Thomas Jefferson University, LaSalle University and many more (Wireless Philadelphia, 2004). It is also the sixth most populous city in the US with an estimated population of 1.5 million with 18.4% of families and 22.9% of the population living below the poverty line in 2000; 19.2% of families and 24.2% of the population living below the poverty line from 2005 – 2009 and 12.1% of the population unemployed (US Census Bureau, 2000, 2005-2009).

6.6.2 Reasons for the project

In 2004, in a bid to address the digital divide created by the inability of poor and deprived sections of society from having access to information and benefits available on the Internet, the Philadelphia city council led by the Mayor Mr. John F. Street and Chief Information Officer (CIO) Dianah Neff, laid out their vision for the development of a city-wide wireless WiFi network to provide Internet access to residents of the city. This vision was captioned the 'Wireless Philadelphia Project' and he inaugurated a seventeen-member Executive Committee charged with acting

"as an advocate of wireless community networking" (Lenard, 2005) and developing a city-wide wireless broadband network to achieve the following goals:

- To bridge the digital divide
- To strengthen and enhance the economic development of the city
- To create a digital infrastructure that will transform the city neighbourhoods
- To enhance its reputation as a tourist attraction

The executive committee led by the CIO Dianah Neff was also expected in terms of deliverables to present to the council a business plan, recommendations and a timeline for the completion of the network (Wireless Philadelphia, 2004).

6.6.3 Feasibility Studies

The Executive Committee

The Executive committee sought to achieve the above vision and goals by embarking on feasibility studies to ascertain the viability of the project. The committee sought and obtained specialist help with the appointment of Civitium LLC as the business and technical Consultant to provide guidance on the technical radio frequency (RF) studies and the business recommendations for the project (Wireless Philadelphia, 2004; Breitbart et al, 2007). The committee also sought the assistance of Temple, Drexel and LaSalle Universities for research on business models and marketing strategies to be incorporated into the deliverables (Wireless Philadelphia, 2004). The business plan shows that the data for these studies were obtained from a number of sources which include meetings with community business leaders, well-publicised town hall meetings and focus groups and the Philadelphia School Board (Wireless Philadelphia, 2004; Breitbart et al, 2007, Lenard, 2005). The result of these studies could be summarised as follows:

Stakeholders Analysis

The following stakeholders were identified and focus groups were drawn from 110 individuals representing these groups.

Table 6.4: List of Stakeholders

Government	Residents
Tourists	Business Travellers
Foundations/Funds	Non-Profits
Universities	Schools
Businesses	Agencies/Utilities
Vendors	Healthcare Agencies

Source: Wireless Philadelphia (2004)

A survey of the stakeholders found that 64% of households owned a computer while 62% reported having a wired broadband connection (Wireless Philadelphia, 2004). The focus groups were also reported to have shown an overwhelming support for the wireless initiative with 72% deeming the service as useful, 75% believing they would use the service and a reported majority expressing pride at the prospect of Philadelphia being the first major city to develop a city-wide wireless broadband network (Wireless Philadelphia, 2004). There were also concerns raised on the issue of a training and troubleshooting skills gap; the need to achieve a win-win situation with the private companies currently providing Internet services to the city; the need to ensure the wireless network remains conversant with evolving technology (Wireless Philadelphia, 2004). While there was no consensus on an ideal price, there was a consensus that a variable price structure would be ideal (Wireless Philadelphia, 2004).

Requirement definition

The executive committee in their report identified eight requirements for the new network (Wireless Philadelphia, 2004) namely:

1. Coverage: A city-wide wireless coverage of 135 square miles
2. Low cost access: Service must be cheaper than current broadband offerings
3. Quality of service: No guarantee of bandwidth and availability due to free spectrum
4. Security: The provision of user authentication and secure network transmission, configuration and management
5. Roaming: The ability of subscribers to move without loss of connectivity within the network
6. Longevity: The need to upgrade the network in seven to ten years
7. Value added applications: the capacity to leverage public safety and public works applications on the network in the future
8. Bandwidth: The ability of the network to support an average 1 Mbps bandwidth

Technical Analysis

The executive committee also embarked on a radio frequency (RF) study of the proposed network to assess the technical viability of the project. These studies consisted of a spectral analysis, predictive propagation modelling and physical site surveys consisting of driving and stationary site surveys that examined the signal strength, signal to noise ratios and data rates (Wireless Philadelphia, 2004).

While the study found different services and devices operating in the license free 2.4 GHz spectrum required for the development of the WiFi network, it did not encounter any significant activity that could jeopardise the establishment of the proposed network (Wireless Philadelphia, 2004).

Also, while conceding the need for careful planning on the deployment of network access nodes to achieve appreciable node density and associated signal strength it nevertheless concludes that conditions exist for achieving a 1Mbps service (Wireless Philadelphia, 2004).

Financial analysis

The financial analysis was based on a city-wide network covering 560,500 homes at a 13% penetration rate (Wireless Philadelphia, 2004) while pricing was set across seven broad categories as shown on the table below

Table 6.5: Customer Segmentation

Customer Segment	**Projected Wholesale Rate ($)**	**Existing Competition**	**Target Monthly Retail Price ($)**	**Monthly Price of Competition ($)**
Residential (Fixed & Mobile)	9	Dial-up, Cable, DSL	16-20	10-55
Standard Business	30	ADSL	50-60	120+
Premium Business	100	T1	150	300+
University & Distance Learning	9	Dial-up, Cable, DSL	12-16	
Occasional Use (Mobile)	4.5	T-mobile WiFi,	10/week	10-15/day
Secure Government (Portable)	27.5	CDPD	27.5	40-80
Secure Government (Fixed)	100	T1	100	200+/month

Source: Wireless Philadelphia (2004)

Table 6.6: Financial Projections

	Year 1 ($m)	**Year 2 ($m)**	**Year 3 ($m)**	**Year 4 ($m)**	**Year 5 ($m)**	**Total ($m)**
Turnover	8.2	11.6	12.9	14	14.5	61.2
Operating Costs	5.7	8.1	8.2	8.4	8.3	38.7
EBITDA	2.5	3.5	4.7	5.6	6.2	22.5
Net Profit	-0.9	0.1	1.3	2.1	2.6	5.2
Capital Costs	10	0.2	0.1	0.1	0	10.4
Working Capital Reserve	0	0.1	1.3	1.4	1.4	4.2
Free Cash Flow	-9	2.4	2.8	4.1	4.7	5

Source: Wireless Philadelphia (2004)

Table 6.7: Projected Customer Base

Customer Segment	**Projected Customer Base ('000)**				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Residential (Fixed & Mobile)	77.9	108	117.3	124.3	129.6
Standard Business	0.8	2.1	3.4	4.8	5.3
Premium Business	0.1	0.2	0.3	0.3	0.3
University & Distance Learning	2.6	4.1	6	7.9	8.8
Occasional Use (Mobile)	3.6	3.6	3.6	3.6	3.6
Secure Government (Portable)	0.3	1	1.7	2.4	3
Secure Government (Fixed)	0.1	0.1	0.2	0.2	0.3
Projected Annual Totals	85.4	119.1	132.5	143.5	150.9

Source: Wireless Philadelphia (2004)

The above financial projections by the committee show that they expect the network to break-even within five years while generating five million dollars ($5m) free cash flow that could be utilised in digital inclusion programs and a four million dollars ($4m) reserve for future network upgrade (Wireless Philadelphia, 2004; Breitbart et al, 2007).

Physical and Business Model

It was the recommendation of the executive committee for the establishment of a non-profit corporation to supervise the development of the network to be installed on the street furniture of the council and to carry out the digital inclusion programme (Wireless Philadelphia, 2004). The non-profit organisation was also expected - using a co-operative wholesale model™ (Civitium, 2004) - to outsource to the private sector in a public-private partnership (PPP) the design, construction and maintenance of the network while generating revenue from the bulk sale of access to Internet Service Providers (ISPs) (Wireless Philadelphia, 2004).

6.6.4 Development Plan

Although the Mayor, John Street accepted the recommendations of the executive committee, the implementation of these recommendations differed. While the proposed non-profit was created to oversee the affairs of the wireless network, the adoption of the co-operative wholesale model™ (Civitium, 2004) was jettisoned for that of a private consortium – where the private sector provides the network and the city negotiates favourable conditions for its digitally excluded residents. This was in part brought about by activists like Thomas Lenard who challenged the rationale for the project citing there was no evidence of market failure in the provision of broadband services to the inhabitants of Philadelphia and as such no justification for the involvement of the city council in the development of a wireless broadband network (Lenard, 2005). A charge to which the Dinah Neff, the city CIO responded to that "if you were to ask the local telco, they would say, well, 90% of the city is covered. But if it's as a fee that people can't afford, if they don't have computers and the skills to use them, having it there hasn't helped you overcome your digital divide" (Mohammed, 2005). Lenard also challenged the optimism of the executive committee's report on the grounds that if the conditions were so favourable, why was the private sector not jumping at the opportunity to own such a network (Lenard, 2005). This challenge was taken up by the predominantly dial-up ISP Earthlink PLC, who offered to build out the network for the city of Philadelphia, a proposal that soothed all frayed nerves among city representatives and put paid to the risk of the city being saddled with the ownership of wireless network (Breitbart et al, 2007). In addition to providing the network, Earthlink also agreed to pay the council for using its street furniture to the tune of 5% of customer fees or $1 per subscriber to the non-profit corporation for the provision of digital inclusion activities (Breitbart et al, 2007). Earthlink's actions were also based in part on the ramifications of the US

Supreme court judgement on the Brand X case that gave PSTN and Cable network owners control over what is transmitted over their networks allowing them to restrict competition and access over these networks to other ISPs (Breitbart et al, 2007).

6.6.5 Competition and Industry Rivalry

Another factor that shaped discussions in the deployment of the wireless network and also impacted on future developments in the broadband industry was the action or reaction of the incumbent broadband service provider (Verizon that owns the PSTN and Comcast the operator of the Cable TV network with headquarters in Philadelphia) to the impending entry of the sixth largest city in the US into the broadband industry. The incumbents were incensed at the involvement of the city of Philadelphia in the provision of broadband services and took steps to prevent it. The BBC News statement attributed to Eric Rabe, the Senior Vice President Media relations for Verizon summed up their feelings; "there is a question here about whether the competition is fair when the government has advantages of borrowing money, owning and perhaps giving away real estate access, regulating and taxing us. If you are in a position where you can regulate and tax you competitor, it certainly gives you an advantage. That is a whole fairness question that I think ought to be worked through and thought about" (Handy, 2005).

Verizon launched a lobbying onslaught of more than $3 million dollars against the Philadelphia's wireless broadband plans (while it was still in the feasibility studies phase conducted by the executive committee) in the form of an anti-wireless bill (House bill 30 or Act 183) in the Pennsylvania state house that allowed Pennsylvanian cities and towns to provide broadband services only if the local telecommunications company (in most cases Verizon) has declined interest, effectively giving Verizon a veto power on all future wireless developments

(Penenberg, 2005). The bill also sets aside $140m in subsides to the local exchange telecommunications company (LETC) – which equates to Verizon in Pennsylvania – broken into $100m for complete broadband coverage of the state and a further $40m to an Education Technology Fund (E-fund) for the provision of broadband and connection technology to schools by 2013 (Feld, 2004; POG, 2004)

While Philadelphia city council fought back at the political barriers being erected by Verizon, they only succeeded in obtaining a concession from Verizon that it would not veto their network and as such the Wireless Philadelphia project could continue. This concession did not extend to other Pennsylvanian cities and town that had to obtain 'permission' from the local telecommunications company before developing such plans (Singer, 2004; Breitbart et al, 2007).

Also, while the wireless initiative went through the process of seeking city council approval, Comcast – the largest Cable Television and Internet service provider in the US with headquarters in Philadelphia - played an unofficial consultancy role to city council members, providing technical assessments, critiques on the project and supplying reports on poorly performing wireless projects (Breitbart et al, 2007).

A typical broadband internet connection in Philadelphia when bundled with a mandatory telephone landline costs between $45-60 per month (Handy, 2005). Once it was clear the city's selection of Earthlink to build and manage the wireless network had been ratified by the city council and Earthlink had progressed to the build stage of the network, Verizon offered a $15 per month introductory offer to Philadelphia residents which not only undercut the proposed $16-20 price of the wireless network but also succeeded in mopping up the number of customers who were still on dial-up connections and transferred them unto lengthy broadband

contracts ensuring that when the wireless network would be completed there would be a smaller pool of unattached customers to sign-up for it (Breitbart et al, 2007).

In a wider context, Verizon Communications Incorporated (formed by the merger of Bell Atlantic and GTE corporations) is also reported to have officially spent $147m between 1999 and 2009 on Telecommunications and broadband lobbying activities (Steinle, 2010). Data from the US House of Representatives' Office of the Clerk alone show that between April and June 2010, Verizon led officially declared lobbying activities with an expenditure of $4.5 m, followed by Comcast at $3.8m, AT&T at $3.1m, Microsoft $1.8m, Time Warner Cable 1.4m, Google $1.3m, Yahoo $550,000, Amazon $500,000 and Facebook $60,000 (Lasar, 2010). Comcast also between January 2009 and March 2010 had 78 former government officials drawn from former congressmen/women and their congressional staff, former government antitrust lawyers, former US Federal Communications Commission (FCC) members and their aides registered as lobbyist (Dunbar, 2010). While this practice is not limited to Comcast alone, it has created a form of revolving door that enables former politicians and their aides to be recycled between government and very lucrative positions on Washington area lobbyist firms (Dampier, 2010).

6.6.6 Implementation and Challenges

Earthlink (the service provider selected to own and build out the wireless network) started construction of the ten million dollars network in 2005 after intense negotiations with the Philadelphia City Council which included a agreement by Earthlink to pay the city $740 for ten years per streetlight pole for an estimated 4000-5000 poles with two-third of the estimated payment (about $2m) paid upfront to provide start up funds for the non-profit responsible for carrying out the digital inclusion programmes (Breitbart et al, 2007).

While the network was conceived on the assumption that a node density of 20-25 wireless routers per square mile would deliver the required service speeds and network reliability, the reality proved that a node density of 42-47 wireless routers per square mile – with its corresponding increases in streetlight pole costs – was closer to the mark in order to achieve the stated network requirements (Breitbart et al, 2007; Gustin, 2008).

This resulted in delays forcing Earthlink to reschedule the completion date from July 2006 to 2007, then to November 2007 and again to first quarter 2008. Three years on, after spending $17m ($7m over budget), the network was just 80% complete (Breitbart et al, 2007; Wink, 2009).

The feasibility studies into the wireless network also projected that at a conservative 13% penetration rate of take-up; there would be 77,900 subscribers in the first year increasing to 117,300 in three years (Wireless Philadelphia, 2004). The reality showed that after three years, Earthlink had just **5,942** of a projected **100,000 minimum subscribers** in Philadelphia resulting in a loss of $200,000 monthly in projected revenue (Yao, 2008).

There were also some departures that impacted on the project, Dinah Neff, the CIO of Philadelphia, left the city council to join Civitium LLC as a consultant after negotiating and selecting Earthlink as the service provider (Breitbart et al, 2007; Wink, 2009). The Earthlink CEO Garry Betty, who oversaw the wireless broadband strategy died in January 2007 (Patrizio, 2007) resulting in the appointment of Rolla Huff in June 2007 as the new CEO who sought to reappraise the investment (Breitbart et al, 2007; Yao, 2008, Bangeman, 2008).

6.6.7 Results

The results of the appraisal or strategic review showed that the project was already costing more than the anticipated cost while generating very little income due to low demand which convinced Earthlink to pull out of the wireless broadband market. This pul-out included ending future wireless contracts with the city councils of Houston and San Francisco, laying off 900 of its 1900 wireless broadband workforce, outsourcing its customer and technical services and trying to sell its $17m network in Philadelphia but could not find a buyer (Breitbart et al, 2007; Gustin, 2008, Yao, 2008, Bangeman, 2008).

Earthlink also disclosed that their offer to donate the network free to the city including a cash sum of $1m was rejected by the city council who felt it would cost millions to operate the network (Yao, 2008).

Earthlink transferred ownership of the network to Network Acquisition Company LLC, formed by Philadelphian telecommunications and Internet veterans led by Richard Ransansky, Mark Rupp and Derek Pew on June 12 2008 asking the courts to cap its liabilities at $1m (Wink, 2009).

Network Acquisition on assumption of ownership, made the wireless network free to all who could access it focusing on digital inclusion programmes (Key, 2009) and in the process cancelled the revenue from the 5,942 paying subscribers. This was a strategy that continued until 2010 when Network Acquisition LLC became bankrupt forcing the city of Philadelphia to step-in and buy the assets of the wireless network for $2m, to be converted into a government use only network, to be employed in video surveillance and city applications (MacDonald, 2010).

6.7 Milton Keynes WIMAX Network

6.7.1 Background

The town of Milton Keynes is situated in Milton Keynes borough Council, a unitary authority located in Buckinghamshire UK that is bounded by Northamptonshire and Bedfordshire to the Northwest and Northeast respectively (Mkweb, 2011). It is one to the new British towns formally designated as such on 23 January 1967 (MKBAG, 2003). The new town subsumed a number of old towns such as Bletchley, Wolverton, Strong Stratford and fifteen villages and farmland covering an area of 34 square miles (Mkweb, 2011; MKBAG, 2003).

The city is unique in its design as the only grid square planned city in the UK based on the urban designs of Melvin M Webber (1921-2006) and has an estimated population of 240,990 in 2010 made up of 100,000 houses (MKBAG, 2003; MKI, 2011). This unique grid layout also presented a simple road-side route along which public utilities could be installed and maintained, enabling the effective distribution of gas, water, electricity, telecommunications and the Cable Television network (MKBAG, 2003).

In August 2006, the borough council in conjunction with Freedom 4 (formerly Pipex Wireless, a joint venture between Pipex Communications Plc and Intel Capital, a subsidiary of Intel Corporation) announced plans to deploy a WIMAX broadband network across Milton Keynes (MKBAG, 2007).

6.7.1.1 Reasons for the project

The growth of the Internet, the need for greater bandwidth and the rise of broadband technology was a global phenomenon to which Milton Keynes was not immune. Although broadband had been delivered in most cities of the world via the existing PSTN network as ADSL or through the cable television network using the DOCSIS

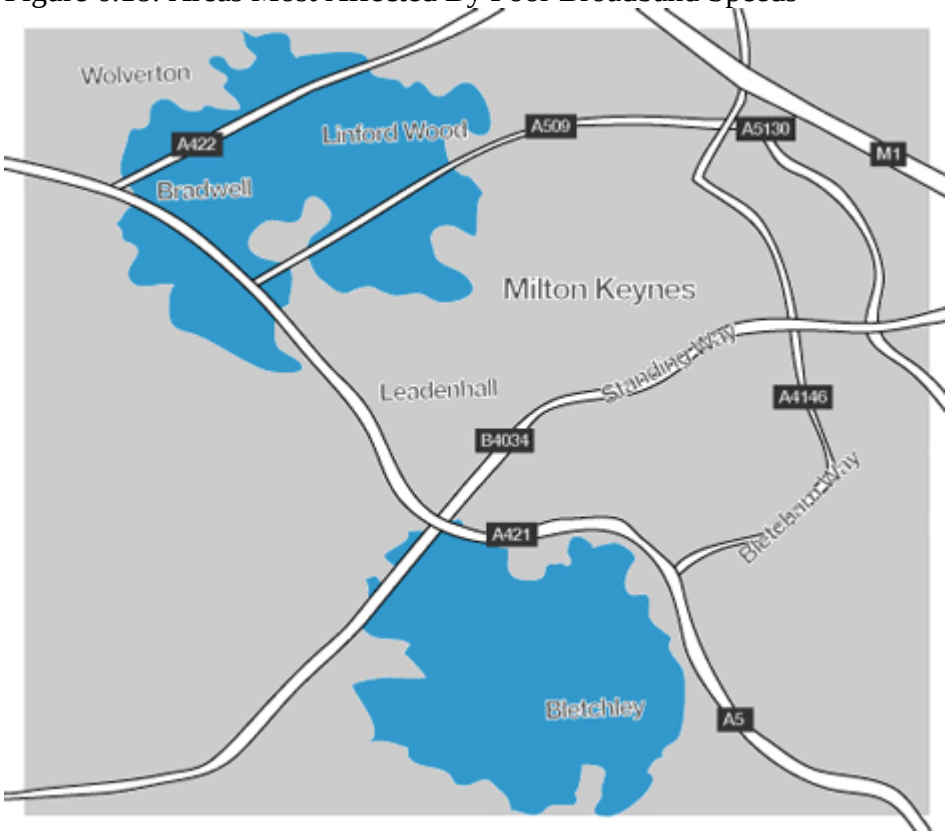
specification, it had peculiar ramifications for Milton Keynes for the following reasons.

In addition to its grid square layout, the new town of Milton Keynes was designed to be serviced by two PSTN exchanges (situated at Fishermead and the Emerson Valley) to cater for its telecommunications needs (MKBAG, 2003). In an era when telecommunications was synonymous with voice calls, the PSTN network designers, British Telecoms (BT) were faced with huge cabling costs due to the fact that the grid square layout of the town meant houses were further apart than in a concentric cluster design resulting in longer distances for telecommunications cables to travel, which when coupled with the design restriction of two PSTN exchanges, meant significantly longer distances between the exchanges and most telephone subscribers (MKBAG, 2003). While this distance posed no problems to a voice only PSTN network, it assumed a significant dimension for a broadband network due to attenuation experienced by subscribers the further they are from the PSTN exchange (Turnbull & Garrett, 2003; Tanenbaum, 2003, MKBAG, 2003).

Also, due to the huge capital outlay of laying a blanket infrastructure for the Milton Keynes, BT decided to substitute cheaper Aluminium cables in place of standard Copper cables for parts of the network. While this was a cost effective substitute for a voice network it was completely inadequate for an ADSL network and limited the maximum broadband bandwidth/speed available to residents to 512 kbps due to the higher degradation of broadband signals on an Aluminium cables when compared to copper cables (Turnbull & Garrett, 2003; MKBAG, 2003).

BT also built the cable television network in Milton Keynes which was not a Hybrid Fibre Coax (HFC) but a Hybrid copper, aluminium and fibre network capable of transmitting only 32 channels and thus restricting broadband speed (MKBAG, 2003).

Figure 6.18: Areas Most Affected By Poor Broadband Speeds



Source: Freedom 4 (2011)

The shaded portions of the above map of Milton Keynes indicate the areas most affected by poor broadband speeds due to the use of Aluminium cablings (Bailey, 2011). These highlighted problems with broadband drove the residents of Milton Keynes to form a community action group in 2003 – the Milton Keynes Broadband Action Group (MKBAG) – tasked with lobbying the public and private sector for a faster broadband and cable television infrastructure in Milton Keynes (MKBAG, 2011).

6.7.2 Feasibility studies

The council responded to the MKBAG campaign by conducting an in-house study to assess ways of solving the broadband problems highlighted. They considered the wireless option and found that while the council owned property and street furniture useful for the deployment of wireless services; they were cash strapped by the capital

costs and technical expertise required for a full scale deployment necessary to solve the broadband problems (Jewell, 2006). They decided on a public private partnership and issued a request for proposal (RFP) tender, advertising their need for a private sector partner while offering access to office accommodation, roof space, financial networking and marketing (Jewell, 2006). This offer was accepted by Pipex communications who signed a strategic telecommunications partnership with the council in February 2006 (Jewell, 2006).

6.7.3 Development Plan

Pipex communications Plc proposed to build a wireless WIMAX network in Milton Keynes to solve the broadband problems. Pipex was uniquely placed to make this offer because they had obtained ownership of two 84 MHz blocks of spectrum in the 3.6-4.2 GHz band through company acquisitions and a further 220 MHz in the 28 GHz vital for deploying a WIMAX network (Baker, 2010). Pipex communications formed a new joint venture with Intel Capital (Intel corporation subsidiary) called Pipex wireless in April 2006 and in the process received £25 million pounds from Intel for the development the WIMAX network (MKBAG, 2007).

6.7.4 Implementation and Challenges

In October 2006, Pipex wireless announced plans to commence a trial network starting in December 2006 for a period of six months to "evaluate radio performance, range, bandwidth and network operations" (MKBAG, 2007). This said network including roof-top infrastructure was to be built and operated by Ericsson while the base stations and customer equipments were to be supplied by Airspan (MKBAG, 2007). The plan was to use five base stations to trial about 500 residential and business users, using between 2-10 Mbps broadband speed for free in return for their feedback (MKBAG, 2007).

The service achieved symmetrical indoor broadband speeds of 5 Mbps with no line of sight at a range of 1.2km from the base station and outdoor broadband speeds of 10 Mbps down, 9 Mbps up at a range of 1.2km; 6 Mbps down, 4 Mbps up at a range of 6km from the base station (MKBAG, 2007). The trial could not obtain its sample size of 500 users, by July 2007 (at the end of the six months trial), there were only 154 WIMAX trial users of which 60% said they could sign-up for the service if reasonably priced while 33% said they would definitely recommend it to a friend (MKBAG, 2007).

The trial also identified some technical deficiencies of the network. WIMAX signals were found to be susceptible to interference from trees which were capable of blocking its signals. This was compounded by the fact that despite the low power emitted by WIMAX base stations, their installation and location are subject to the same regulations that govern the installation and location of 3G mobile transmitters with far greater emissions (Bailey, 2011; Kennedy, 2006) this made it difficult to increase the base station density needed to obtain an appreciable quality of service (Baker, 2010).

In September 2007, the Milton Keynes council approved the setting up of a wholly owned limited liability company – Connect MK limited – to start operations in November 2007, to partner Pipex wireless (now Freedom 4) in the resale of commercial WIMAX broadband offering which was formally launched in December 2007 (Freedom 4, 2007). Five other resellers or sales partners were also engaged which were Mirus-IT solutions, Ripwire, Konnex Networks, Communicate Better and Vialtus Solutions (Freedom 4, 2011).

Another challenged that Freedom 4 faced was that its spectrum licence was a point-to-multipoint fixed wireless licence restricting it from offering mobile broadband

services such as data cards and dongles because unlike WiFi, WIMAX receivers were not inbuilt into devices. This meant they were restricted to residential and business customers with a fixed location only and could not offer the 'mobile' selling point of a wireless network to their customers (Baker, 2010).

6.7.5 Competition and Industry Rivalry

In January 2007, just one month after Freedom 4 announced plans for a six months trial offering of WIMAX in Milton Keynes, BT made a take-over bid of £450 million for Freedom 4 which was rejected by its board who at the time were oblivious to the technical difficulties that lay ahead in making their network fully mobile (Baker, 2010). Also, while Freedom 4 was having problem making their network truly mobile, same could not be said of 3G operators who were quietly leveraging their services into the data industry by offering wireless dongles and data cards on pay-as-you-go as well as on monthly contracts for in some cases as little as £10 per month (Baker, 2010). Although OFCOM, granted Freedom 4 a variation in November 2009 to offer dongles and data cards, their failure to auction the 2.6 GHz band in 2008 (after an announcement of intent) due to political and legal pressure from the 3G operators led by O2 and T-Mobile (OFCOM, 2008; Baker, 2010) meant Freedom 4 could not lay their hands on a spectrum that would have boosted their signal propagation and reduced costs especially at a time when WIMAX was ready and the 3G operators were hamstrung to bid for the spectrum or susceptible to anti-competition accusations due to LTE or Next generation mobile technology (the two technologies that can use the spectrum) not being ready. The current OFCOM plans to auction the 800 MHz and 2.6 GHz spectrum in 2012 (Bratby, 2011) plays right into the hands of the 3G operators who not only have deeper pockets to outbid smaller WIMAX operators like Freedom 4 but will also have technical justification

as LTE would be ready for deployment. LTE trials were conducted in December 2010 at the Preseli Mountains in Wales by Arquiva and Alcatel-Lucent on the proposed 800 MHz spectrum in anticipation of the said auction by OFCOM (Saran, 2010)

6.7.6 Results

The end result of these problems was that Freedom 4 could not achieve their projected demand of 85 customers per base station (425 for the 5 base stations) required to break-even operationally (Middleton, 2010). One of the resellers speaking under a condition of anonymity stated that in the first year, they signed up less than 100 customers and after three years, they still had less than a thousand. These challenges led Pipex Communications Plc (now known as Daisy Group) in to a strategic rethink that cumulated in their exit of the WIMAX industry in June 2010; divesting their assets by selling the spectrum licence to its only WIMAX competitor UK broadband for £12.5 million and the closure of Freedom 4 (Middleton, 2010; Yirrel, 2010). This was a move they reported would save £800,000 a year on licensing fees and an additional £1 million a year in cash from Freedom 4's closure (Middleton, 2010; Yirrel, 2010).

6.8 Conclusion

This chapter presented the results of the exploratory study into Norfolk Open Link, a wireless mesh WiFi network developed in Norfolk County council. The study has presented the rationale for the project, its design and the corresponding implementation. The results for the network utilization have also been presented and it shows a number of interesting factors for the sectors under review.

- None of the eleven sectors that make up stages one and two had more than twelve thousand connections at any time within the six months under review.

- Despite the recorded connections not being for unique connections (i.e. recording multiple connection by one user), only two locations could boast of over four thousand connections – the university of East Anglia and City College – in February 2007 – others were below two thousand five hundred.
- The 27,080 connections recorded in February 2007 on the network actually represent 1,864 unique users.
- A total average inbound broadband Internet demand that is less than 2 Mbps on a 40 Mbps Internet pipe representing less than 5% capacity utilization.
- A peak inbound broadband Internet demand of 6.15 Mbps on any sector
- The total average outbound broadband Internet demand is just about 1.25 Mbps representing less than 4% of capacity utilization

The above findings from this exploratory study provide answers on how this pilot network has fared. While the onus of the subsequent chapters would be to examine why the results were as observed, the secondary case studies of Wireless Philadelphia and Milton Keynes WIMAX network have been introduced to buttress the discussion.

Chapter Seven

Analysis and Discussions

7 Introduction

This chapter will present an analysis and discussion of the public access industry as a means of investigating the research problems identified in the exploratory study and hypothesis proposed in the chapter five. In line with the objectives of the Total Technology program, an analytical approach would be adopted. These analysis and discussions would conclude the chapter.

7.1 Problem Solving One

Secondary Research Question: why is wireless broadband technology not the dominant design for public access industry?

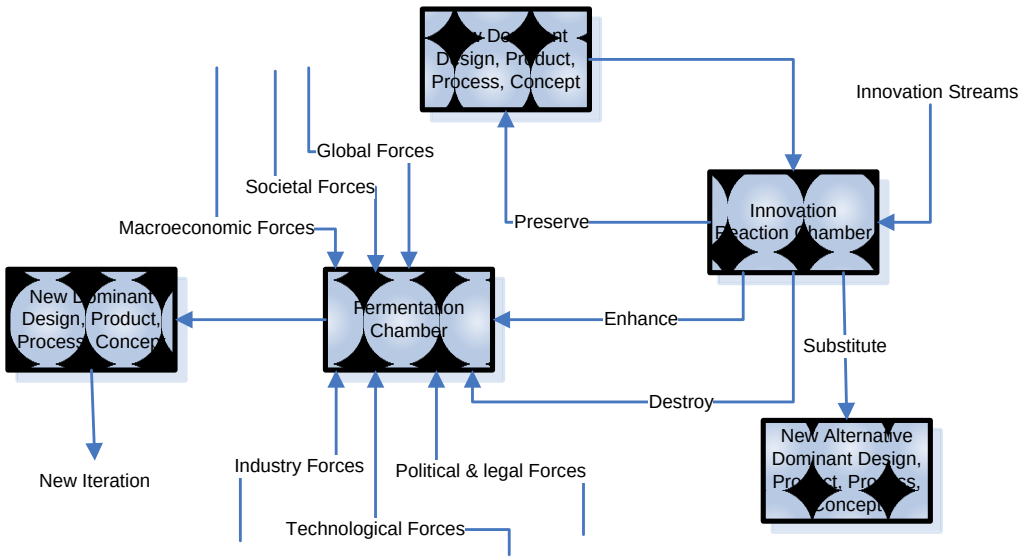
Hypothesis:

The innovation strategy for introducing wireless broadband technology is faulty in its choice of industry

The hypothesis and its testing were guided by the following:

Reference is made to the technology cycle developed in Section 3.5.3.1 reproduced below for clarity.

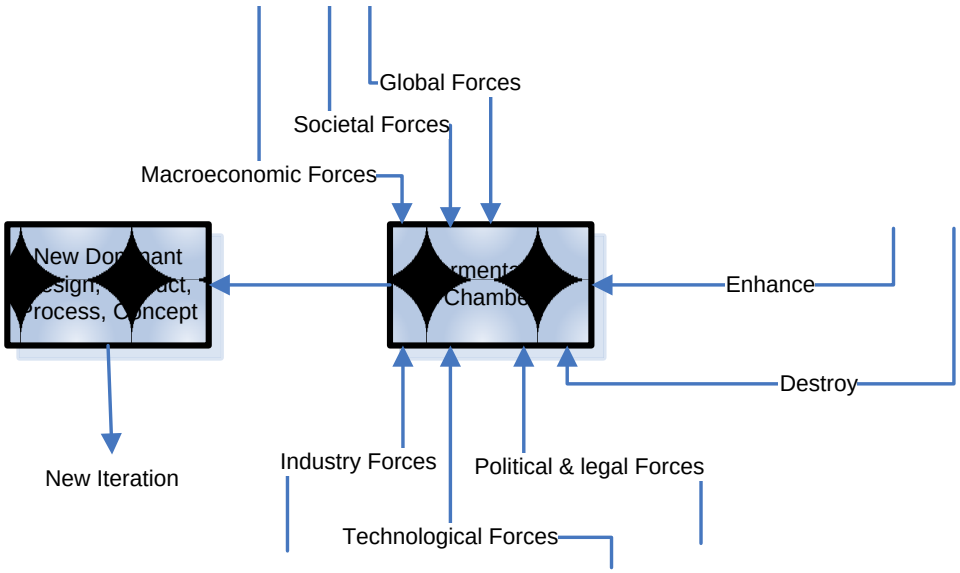
Fig 7.1: Technology cycle



It was stated that the fermentation chamber is impacted by external forces which in conjunction with Foster's S-curve dictate the dominant design.

Fig 7.2 Fermentation Chamber

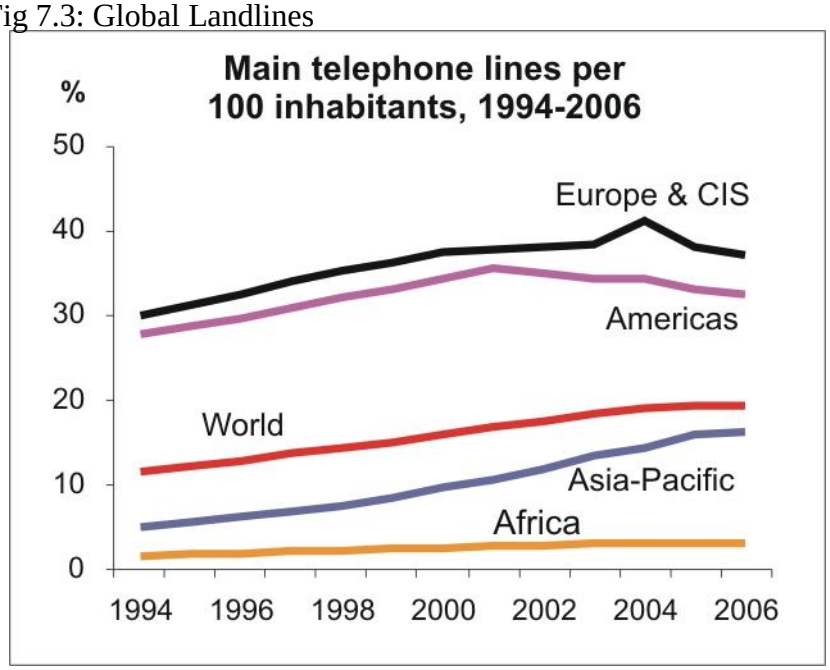
The forces acting on the fermentation chamber as shown below



Global forces

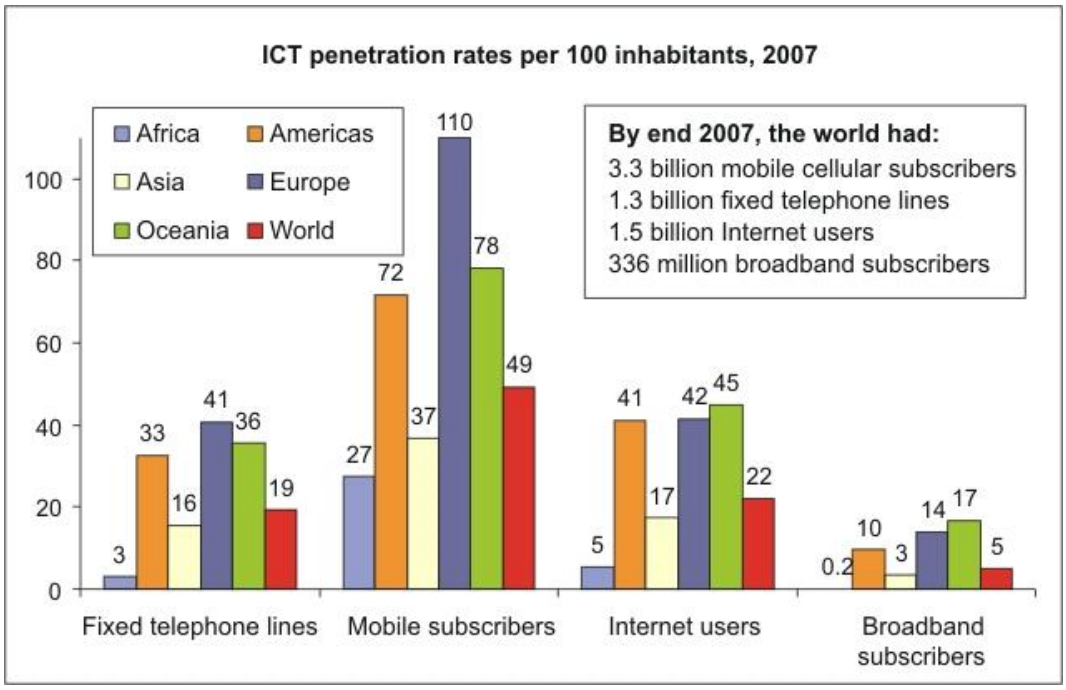
There is a global move towards the adoption of wireless technology precipitated by the growth of mobile phones worldwide. The ITU report on global ICT development trends show global penetration of landline phones in fig 7.3 below

Fig 7.3: Global Landlines



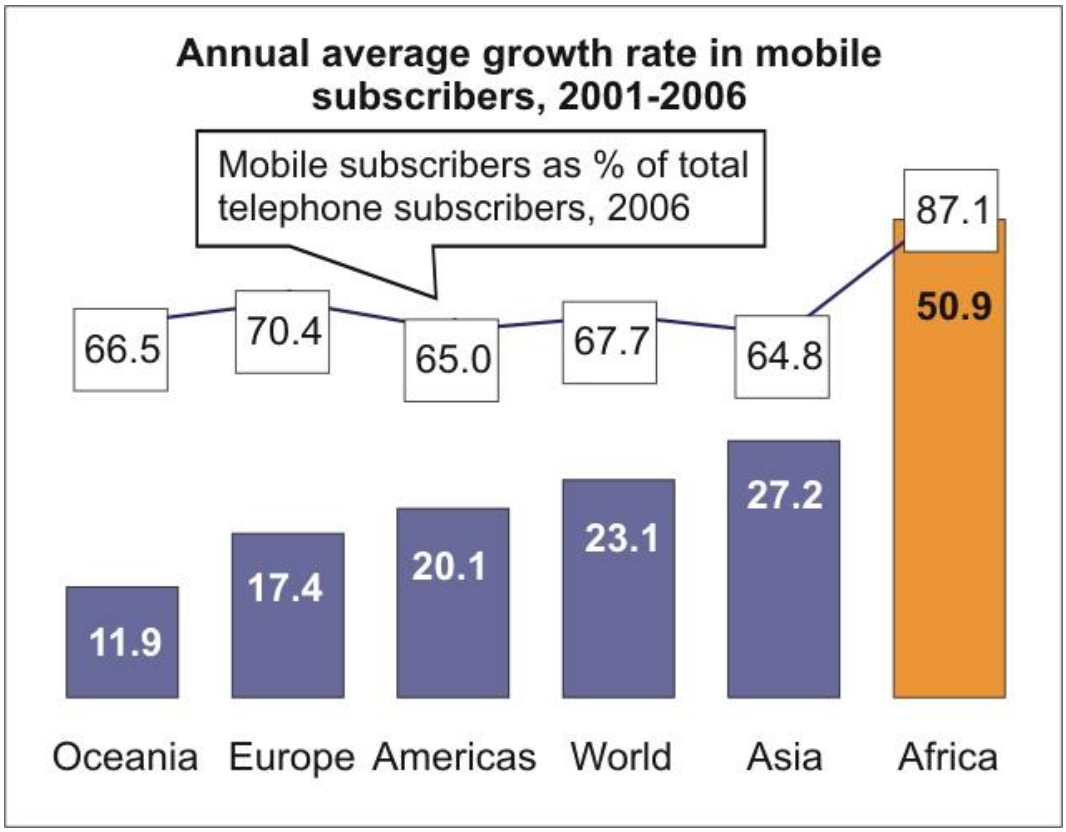
Source: ITU, 2008

Fig 7.4: Global ICT Penetration



Source: ITU, 2008

Fig 7.5: Global Mobile Penetration growth rates



Source: ITU, 2008

While landline growth worldwide is almost flat out, Fig 7.4 and Fig 7.5 show some very interesting growth rates for mobile technology worldwide which indicates a global acceptance of mobile technology. Steinbock (2003) also acknowledges that there have been successive waves of wireless innovations which were accelerated by globalisation demonstrated by the global standards in wireless technologies. Drawing on the above trends, an assessment the globalisation is aiding wireless technology is made.

Political & Legal forces

Wireless broadband technologies operate in the free 2.4 GHz spectrum band and are not under any restrictions save the guideline that wireless access points do not have power ratings above 100mW. Norfolk Open Link is being implemented by the council also gives credence to the fact government is open to their introduction. While political lobbying by the leading wired broadband operators in the Digital Britain/economy act is acknowledged the fact it has not been implemented mitigates this as the source of the anomaly.

Macroeconomic forces

The sub-prime crisis and the attendant global recession of mid 2008 is also been discounted as a significant factor because the network began operations before the recession. Its effects are also being discounted because wireless is the cheaper technology than its wired competitor (in the form of fibre optics) and as such is supposed to have a stronger case during a recession

Societal forces

The societal forces could be examined from the point of demographics which shows that there is a digital divide (ITU, 2008). The statistics from Figures 7.3-5 show how mobile technology has been employed in bridging the telecommunication divide in terms of mobile phones. It is expected that wireless technology would also play a

significant part in bridging the digital divide and enable the growth of the Internet. The main environmental issue on the use of wireless technology were from health scares due to exposure to radio frequency (RF) radiation. This was dealt with by the world health organisation in their fact sheet 193. In terms of aesthetics, wireless access points were designed to blend with the street furniture. From the foregoing, societal forces could not be responsible for the wireless is not the dominant design.

Industry forces

The industry forces of competition cannot be ascertained by empirical methods since they can't account of competition (Narayanan & O'Connor, 2010). They would be evaluated by strategic analysis.

Technological forces

Globalisation aided the development of a universal standard resulting in the emergence of 802.11x which defines WiFi as the industry standard. The emergence of an industry standard is supposed to herald a new dominant design and usher in a period of incremental innovation which resulted in the development of 802.11a, 802.11b, 802.11g and the recent release of 802.11n wireless standards.

SWOT ANALYSIS

STRENGTHS	**OPPORTUNITIES**
Low set up cost	Internet Access
Flexibility	Wireless CCTV
Mobility	Automated meter reading
Convenience	Traffic and train signal networks
WEAKNESS	**THREATS**
Bandwidth	Wired broadband technologies
Signal interference	Mobile phone broadband

From the above analysis, the hypothesis would be tested on two of the forces acting on the fermentation chamber. They are the Industry and technological forces.

The hypothesis would also be being tested using strategic analysis and as a control two other industries (the public safety and public works) where wireless broadband technologies find application would be included.

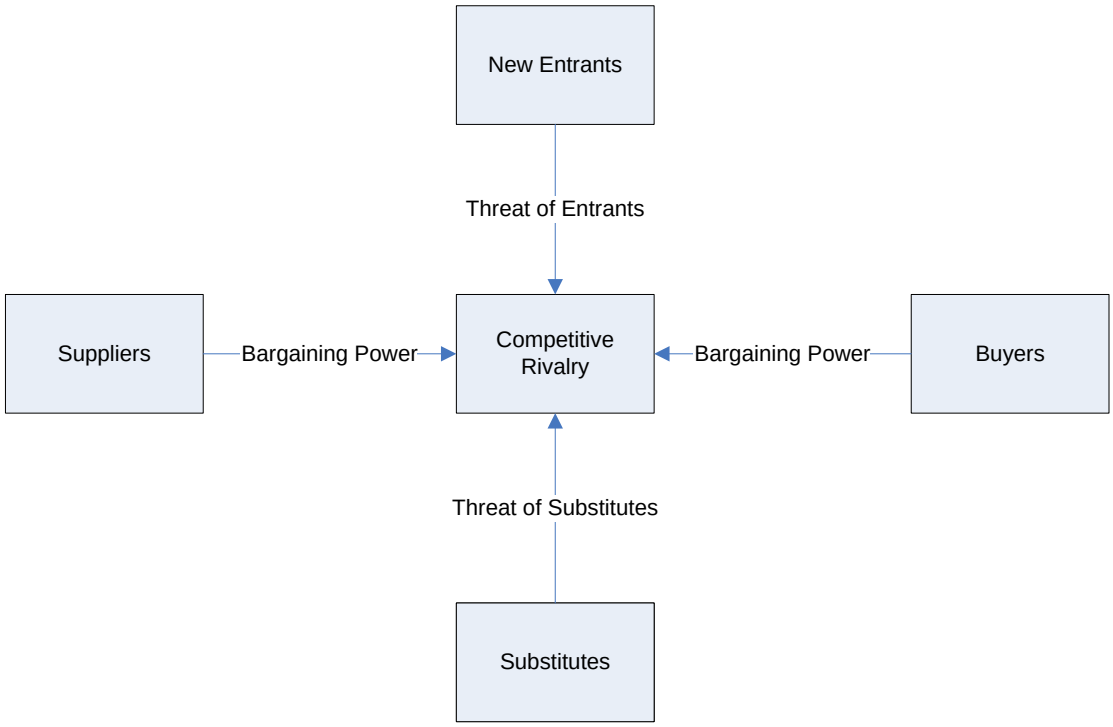
The point is also being made that the goal of the analysis is to ascertain if the right industry choices have being made in the innovation strategy

7.1.1 Test 1:

Are the industry forces of competition in favour of the technology?

This would be investigated using Porter's five forces model and the framework from Grant (2005). Details of the framework and results are shown in Appendix 3.

Fig 7.6: Five Forces Model



Source Porter, (1985)

Table 7.1: Industry Analysis for Public Access Industry

	Forces	Rating
1	Power of Customers	High
2	Power of Suppliers	Low
3	Threat of New Entrants	Low
4	Industry Rivalry	High
5	Threat of Substitutes	High

- In any industry, competition negates profits and as such having three of the five industry forces high show it is a competitive industry with high industry rivalry that is not very conducive for introducing a new innovation.
- A competitive industry does not preclude the potential for profits; it has to be weighed in conjunction with other factors such as the power of customers which shows it is high. This indicates that customers wield considerable bargaining power thus reducing the attractiveness of the industry.
- If the high threat of substitutes is taken into consideration, the attractiveness of this industry starts to dwindle.
- While the it is good news on the threat of new entrants being low due to the capital outlay required to participate in the industry the fact that most of the customers in the industry would already be locked into yearly broadband contracts introduces some constraints or switching costs that do not support the cannibalisation efforts of wireless broadband technology on wired broadband solutions. This fact also make it difficult for wireless broadband technologies to find the niche of customers that will pay for the cost of

providing the network while wireless broadband technologies evolve into the dominant broadband technology

In line with the above analysis, an assessment could be made that the Public Access industry though may be profitable is not a favourable industry to easily break into due to competition.

Table 7.2: Industry Analysis for Public Safety Industry

	Forces	Rating
1	Power of Customers	Moderate
2	Power of Suppliers	High
3	Threat of New Entrants	Low
4	Industry Rivalry	Moderate
5	Threat of Substitutes	Low

- The analysis for the public safety industry shows one of the five forces of competition is high, two are moderate and last two low. These are the characteristics of an industry where high profits could be made.
- The threat of new entrants is low while Industry rivalry is moderate indicating the prospect for an eventual entrant the chance to survive.
- The power of customers is also moderate indicating the possibility of niche customers that could pay for the cost of setting up the network or differentiation while the technology is being refined through further enhancing innovations to enable it become the dominant technology.
- It is also worthwhile to note that the threat of substitutes is low enabling the technology to thrive.
- The power of suppliers is high making it a very profitable industry for a supplier to be in.

In line with the above analysis, an assessment could be made that the Public Safety industry is profitable and a favourable industry to launch a new innovation while it is being enhanced to maturity.

Table 7.3: Industry Analysis for Public Works Industry

	Forces	Rating
1	Power of Customers	Moderate
2	Power of Suppliers	Moderate
3	Threat of New Entrants	Low
4	Industry Rivalry	Moderate
5	Threat of Substitutes	Low

- The analysis of the Public Works industry shows that none of the forces are high. Three of the forces are moderate while the remaining two are low. These results indicate the characteristics of a profitable industry where competition borders on being moderate to low.
- The profile of an oligopolistic market which is mostly true of the public works industry. The power of customers is moderate which indicates they may be agreeable to a technology that could reduce their costs and increase their profits.
- The power of suppliers is also moderate since the market borders on monopoly to oligopoly. Win – win solutions and co-operation sells more since suppliers can't dictate too much.
- The threat of new entrants is low, the industry rivalry is moderate and the threat of substitutes is also low. The prospect of finding opportunities for a trial run leading to adoption in the industry is promising.

In line with the above analysis, an assessment could be made that the Public Works industry is profitable and a favourable industry to introduce wireless technology.

7.1.2 Test 2:

Is the technology a match with the industry drivers?

Table 7.4: Industry Technology Fit

Industry	**Industry Drivers**	**Strengths**		**Weakness**	
		Wired	**Wireless**	**Wired**	**Wireless**
Public Access	Bandwidth	√			√
Public Safety	Mobility, Flexibility		√	√	
Public Works	Cost & Time Savings		√	√	

The public access industry is driven by bandwidth. The initial offering was dial-up and there was a time when a 56kbps access was considered the ultimate connection. Today, 2 Mbps is considered as base as was proposed in the Digital Britain/Economy act. The table above shows that presently, bandwidth is not one of the strengths of wireless technology. As in the review of networking media, copper cables (UTP) can boast of over 100 Mbps (CAT 5e) while fibre optic cables range between 100 Mbps to 1 Gbps. The 802.11g wireless standard specifies 54 Mbps while there has been some commercial offering of 108 Mbps, it has not been standardized currently presenting bandwidth as a weakness in wireless technology. The push for FTTH, FTTL and FTTC by the wired industry leaders (been adopted in the Digital Britain/Economy act) have all acted to reinforce the position of wired broadband technologies as the dominant design. It is expected that when the new enhancing standard 802.11n which specifies 600 Mbps comes fully on stream it would act to transform bandwidth from a weakness into a strength for wireless broadband technology. While wireless might not attain the bandwidths offered by fibre optic cables, if it could offer a bandwidth that can support current requirements and retain

spare capacity for future bandwidth demand, its low deployment cost compared to wired broadband could just make the difference in convincing the sceptics to embrace it.

In line with the above analysis an assessment could be made that the drivers for the public access industry are currently not a match for wireless broadband but there are efforts to convert this weakness to strength.

7.1.3 Inference

Test one presented in 7.1.1 sought to answer the question:

Are the industry forces of competition in favour of the technology?

The results from test 1 show that the Public Access industry is a competitive industry with high industry rivalry. It concluded that an assessment could be made that the Public Access industry though may be profitable is not a favourable industry for the technology due to competition.

Test two presented in 7.1.2 sought to answer the question

Is the technology a match with the industry drivers?

This test showed bandwidth as the main driver for the public access industry not mobility and as such a 'strength' for wired technologies that currently possesses higher bandwidths. It was also noted that wireless was not too far behind in rectifying this weakness.

The combination of both tests shows why wireless broadband technologies cannot presently be the dominant design in the public access industry. The competition in the industry is hostile to its introduction while the main driver of the industry is still a weakness for wireless technology.

The following secondary case studies will further illustrate the above analysis.

Wireless Philadelphia

The secondary case study on Wireless Philadelphia presented in section 6.6 chronicles the development of a city-wide WiFi network in the city of Philadelphia. Despite the stated noble aims for its development, the efforts ended in failure – a failure that presents real life illustrations of analytical alleged competition in action.

With the advent of Philadelphia city council into the wireless broadband market, Verizon started a media campaign alleging 'unfair' competition while committing over $3 million dollars to lobbying for an 'anti wireless bill' that barred all cities in Pennsylvania from competing in the broadband industry. This bill effectively created an entry barrier protecting the dominance of wired broadband from the threat of wireless broadband. It is also ironic that while 80% of Philadelphia was wirelessly covered with a cost of $17 million dollars, the house bill 30 made provision for a $140 million dollars subsidy for the deployment of wired broadband.

Before the Wireless Philadelphia project, a typical broadband package bundled with a mandatory landline costs between $45-60 per month, just as the network construction started, Verizon issued an introductory offer for broadband at $15 per month undercutting the proposed $16-20 per month price of the wireless network neutralising the cost advantage of the new network. This action also mopped up the ready pool of dial-up customers that could have signed up for the wireless network by tying them on to lengthy broadband contracts that would ensure that there is reduced demand and some difficulty in switching from wired to wireless technology.

This reduced demand was manifested in the number of customer after three years which stood at 5,942 of an estimated 117,300 resulting in significant losses of $200,000 monthly for EarthLink the wireless broadband provider. These are losses that led to EarthLink reassessing their wireless strategy and choosing to pull out of

the wireless broadband industry and in the process sacking 900 employees. These are actions that could not be said to encourage the replacement wired broadband by wireless technology.

The transfer of Wireless Philadelphia to a non-profit network solely focussed on bridging the digital divide also ended in failure or was not sustainable due to an absence of an established revenue stream.

The practical deployment of the wireless network also showed that apart from the weakness in bandwidth, WiFi also requires a significant node density to avoid the occurrence of 'dead spots' on the network resulting in increased costs.

It is interesting also to note that in Wireless Philadelphia, three universities contributed to the assessment of the viability of the project (Temple, La Salle and Drexel Universities) (Wireless Philadelphia, 2004) but as the business plan revealed most of their efforts were directed towards obtaining user and stakeholder opinions through focus groups and neglected the forces of industry competition whose effects have produced far reaching consequences presented in the these discussions.

Milton Keynes WIMAX

The secondary case study on a WIMAX network in Milton Keynes presented in section 6.7 also chronicles the development of a wireless network on a howbeit different technology. While the reasons for the project stem from the shortcomings of BT in their substitution of Aluminium for Copper as the networking cable in their bid to reduce development costs, this created a window of opportunity for wireless broadband technologies that WIMAX sought to fill. This is a position acknowledged by BT in its attempted acquisition of Freedom 4 for £450 million pounds. The inability of wired broadband technologies to compete in Milton Keynes sets up a classic stage for competition between new wireless technologies. While the

differences in technology between WiFi and WIMAX negates grounds for a direct comparison in terms of technical difficulties, WIMAX deployment also requires an increased concentration due to the easy attenuation of WIMAX signals from the base stations which in turn translates to increased deployment costs. The lure of mobility and flexibility offered by wireless broadband was nullified by the point to multi-point licensing restriction. These were the twin challenges faced by WIMAX in Milton Keynes that was exploited by their 3G competitors. Freedom 4 needed a variation to their license to allow them to make a mobile offering to their customers and a spectrum (2.6 GHz) that would reduce the WIMAX signal attenuation that was costing them dearly in deployment cost. Freedom 4 succeeded in securing the former but failed in obtaining the latter due to the political and legal pressures exerted by the 3G operators led by O2 and T-Mobile in 2008 who while acknowledging the superior data capabilities of WIMAX over 3G had an eye on the future development of LTE, a new innovation in mobile communications that would boost their entry into the wireless broadband industry. The 3G operators have more financial power due to their established position in the mobile voice industry enabling them to leverage their capabilities and compete in the mobile data industry. The WIMAX operator Freedom 4 on the other hand is just starting to introduce an innovation and is already being hamstrung by the power of the competition in delaying the bidding on the vital 2.6 GHz spectrum to such a time as when LTE would be ready for deployment – a time when the financial muscle of the 3G operators would certainly tip the spectrum auctioning scales in their favour.

In both secondary case studies, these innovations have been thrown to the ‘sharks’ where Verizon’s annual budget on lobbying alone is more than 80% of the cost of Wireless Philadelphia. It could be speculated that there has been an over reliance on

the voice of the customer. While the voice of the customer is an important tool in evaluating the perceptions of a service or product; it is not the defining component of an innovation strategy. **Survival first** is the defining component in any innovation strategy. This is evident in market pull and technology push scenarios where in the former, market pull forces in essence only supply that customer or segment of customers that are prepared to pay for the survival of the innovation while in the latter, technology push tries to seek out the customer or segment of customers that will pay for the survival of the innovation.

The critical objective of any innovation strategy is to find customers that are prepared to pay for the survival of the innovation and this is the defining difference between successful and unsuccessful innovations.

Another important information is the data from the office of national statistics which states that 95% of the UK population have broadband connections. This implies that 95% of citizens in the UK already have a broadband contract (which is well known to be for twelve months). So anyone developing a wireless broadband network is only building the network for the 5% customer base that are yet to secure a broadband contract while they wait on the 95% to end their contracts and switch. This is based on the assumption that the lure of mobility will drive them from their existing contracts and not taking into consideration that the industry driver for public access is bandwidth not mobility; the strength of wireless technology they are basing their assumption on. This amounts to competing on a weak foot and expecting to win.

It is therefore reasonable that the network utilization figures for Norfolk Open Link be less than 5% which corresponds to the percentage of citizens without broadband access.

It is the function of the innovation strategy to identify these risks and take appropriate action to mitigate their effects to ensure the survival of the innovation hence the hypothesis that the innovation strategy is faulty which has been shown to be true.

7.2 Problem Solving Two

Primary Research Problem: How wireless broadband technology can become the dominant design in the public access industry

The analysis from Section 7.1 on "why wireless broadband technology is not the dominant design in the public access industry" revealed the issues mitigating against its growth of in the form of competition and poor fit with industry drivers. The analysis also presented the strengths and weakness of wireless technology in the public access industry. There is also another issue of interest which can be obtained from the industry analysis; this has to do with the industry rivalry.

Broadband access is not the primary industry of the major wired broadband providers. It is a secondary industry to them and as such represent secondary revenue streams to top-up their primary revenue streams. This presents a very interesting dynamics to the industry because it means all the wired broadband providers could deliver wired broadband access **free** if they wanted to or so desired.

This in essence means the real question facing wireless broadband providers is

How do you compete in a broadband industry where the cost of production for your competition is almost ZERO?

The truth in this statement is exemplified by the decisions of Talk Talk™ to provide broadband free to its customers. This is also the case with SKY broadband™ who provide free access. While it could be argued that competition is a component of

every industry, the innovation strategy to launch wireless broadband technologies primarily as a public access technology instead of a secondary revenue stream as other industry players is inadequate. The strategy did not acknowledge the industry dynamics and overestimated the importance of wireless technology to the public access industry just as Motorolla's Iridium™ project overestimated the importance of satellite phones to the business community. In both cases, IT IS NOT THE TECHNOLOGY THAT FAILED BUT HOW IT IS PRESENTED.

Marketers in the field of commerce have understood this fact and take the issue of industry options seriously. It could be speculated that this was part of the reasons that inform the re-launch of Lucozade™ from a convalescing drink to an everyday energy drink for sports people.

An additional requirement for crafting technical innovation strategies is the need for the innovation to survive and be nurtured into dominance which is not required in a marketing strategy.

This requires a new innovation strategy to level the field.

7.2.1 Proposed Innovation Strategy

The table 7.5 below shows a comparison of the industry forces of competition and for reasons of convenience table 7.4 would be reproduced below.

Industry	**Industry Drivers**	**Strengths**		**Weakness**	
		Wired	**Wireless**	**Wired**	**Wireless**
Public Access	Bandwidth	√			√
Public Safety	Mobility, Flexibility		√	√	
Public Works	Cost & Time Savings		√	√	

Table 7.5: Industry comparison

	Forces	Public Access	Public Safety	Public Works
1	Power of Customers	High	Moderate	Moderate
2	Power of Suppliers	Low	High	Moderate
3	Threat of New Entrants	Low	Low	Low
4	Industry Rivalry	High	Moderate	Moderate
5	Threat of Substitutes	High	Low	Low

Table 7.6: Weighted Suitability Analysis

Industry	Customers	Suppliers	New Entrants	Rivalry	Substitutes	Aggregate competition
Public Access	25	-25	-25	25	10	10
Public Safety	-5	25	-35	5	-10	-20
Public Works	5	5	-25	5	-10	-20

An examination of table 7.4 indicates the need to work on increasing the bandwidth of wireless technology (802.11n) coupled with the results from the previous questions, it would be logical to designate public access as a future industry. This assessment is also supported by table 7.6, a weighted suitability analysis that shows the public access industry as the least suitable industry. It does not however present a clear cut choice between the public safety and public works industries.

Scenario one: Council development

The industry for a local council to start will be the public works industry.

Reasons:

- If the council is providing the public works, it will result in cost reductions and efficiency savings that can be passed on to other sectors.
- If public works are being performed by the private sector, such a mutually beneficial proposition to cut their cost would be welcomed as well as secures WHO WILL PAY FOR THE NETWORK, ensuring the survival of the investment.
- It also ensures that the technology has a platform to survive on while it is being tweaked and enhanced to eliminate teething problems.
- Due to the spread of public works, the wireless network could be easily leveraged into the public safety arena, allowing the council to have safer streets or public access industry were the network will now be on same footing as other industry players and can offer broadband access for free if they so chose.

Scenario two: Private Sector Development,

This is the point where short term and long term visions and plans come into play. The financial resources available to fund the undertaking also play a deciding factor in the choices.

- For an operator with limited funds, the public safety industry would be ideal. The industry forces show that the power of suppliers is high. This power could translate into lucrative Short Term profits which can pay for the network while it is being enhanced and tweaked and could also fund future expansion into the public works industry or public access industry where the operator will now be on same footing with the incumbent industry players.

- For an operator with considerate funds, the public works industry would be an ideal starting point with the long term plans of leveraging the network into the public safety and public access industry where as in the former case, they will be on the same standing with other industry players who could offer broadband access for free if they choose to.

Opportunities in the public safety industry include

- Close Circuit Television (CCTV)
- Wireless sensor networks (that can be adapted detect high noise levels, drug farms, bomb making chemicals)
- Parking cameras
- Speed cameras

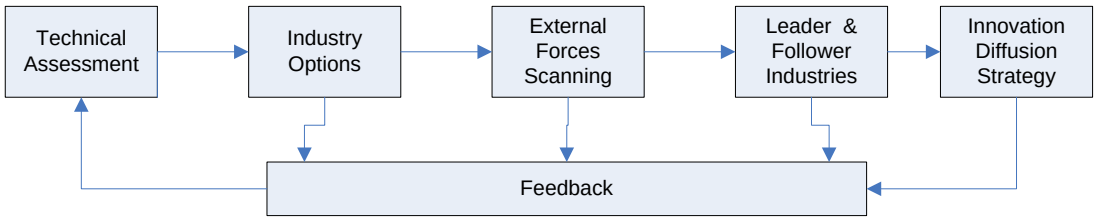
Opportunities in public works include

- Automated meter reading (electricity, water, gas)
- Road traffic lights controls and Railway network signals
- Bus network real time information, local information terminals

7.3 Strategic Innovation Model

In developing this conceptual model, reference is made to the technology cycle developed in Section 3.5.3.1.

Fig 7.7: Strategic Innovation Model



Stage one:

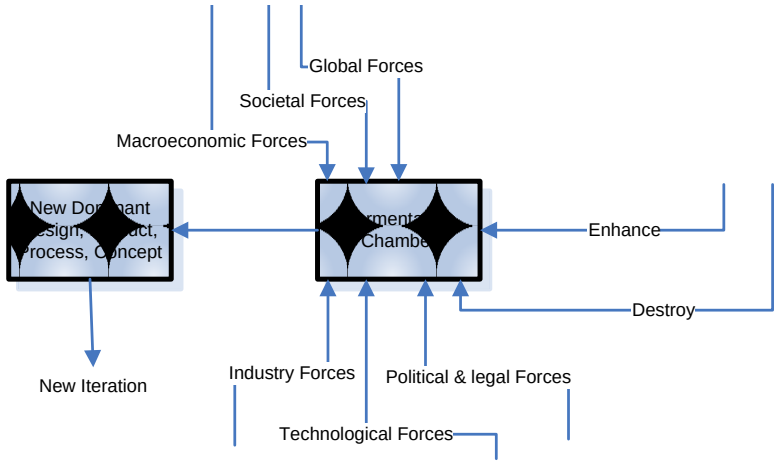
The identification of the technical strengths and weakness of the innovation, allowing the deficiencies to be enhanced as it iterates with the dominant design in the fermentation chamber

Stage two:

The generation of alternative industries or segments that the innovation could be viable

Stage three:

The evaluation of the external forces acting on the innovation and the dominant design it seeks to replace in the different industries with a view of mitigating their effects. These are the same external forces acting on the fermentation chamber.



Stage four

An evaluation of a lead and/or follower industry or segment for an innovation which should at a minimum be an industry or segment that can pay to sustain the cost of providing the innovation. Core to this design is the principle of leader and follower industries or segments.

Stage five

This stage involves the development of diffusion strategies to commercialise the innovation within the selected leader industry or segment. This strategies include licensing, alliances, outsourcing, joint ventures, partnerships, franchises and direct commercialisation.

Stage six

This is the review stage that enables the strategy to be tweaked.

Where Logic of Concept has worked

The Internet was developed in the 1960s, and it was not until the early 1990s that it became a commercial success. Computer networking survived because there was a defence industry that was willing to support its existence. This was taken up by the NSF who funded it until it was sold to the industry consortium. This funding allowed the innovation to survive and evolve into what we have today. It survived long enough for Tim Berners-Lee to develop HTTP.

British Telecoms (BT) did not start out as an Internet Service Provider (ISP). It was a PSTN operator providing voice communications services. It did an assessment of its technical capabilities and realised they were relevant in the internet industry resulting in the development of Internet services (dial-up and broadband).

Amazon.com started in 1994 as a conceptual innovation to sell books via the Internet. They survived the dot.com era after losses of $1.4bn in 2001 by transforming from a specialty retailer to an multi-purpose retailer restructuring their offering to include third party items from other retailers like Toys “R” Us to generate additional funds which enabled it to survive (Frey & Cook, 2004).

7.4 Conclusion

This chapter presented the analysis and discussions arising from the technology management problems identified in the exploratory study.

The chapter sought answers to 'why wireless broadband technologies are not the dominant design in the public access industry'. It investigated the hypothesis of a faulty innovation strategy using strategic analysis found on questions of industry favourability that an assessment could be made that the Public Access industry though profitable is not a favourable industry to easily break into due to competition.

There was also an examination of the fit between the public access industry drivers, the strengths and weakness of wireless technology. The examination found that an assessment could be made that the drivers for the public access industry are currently not a match for wireless broadband but there are efforts to convert this weakness to strength.

The chapter also sought answers to the question of how wireless technology could become the dominant design in the public access industry. The public safety and public works industries were presented as possible candidates for the successful primary launch of wireless broadband technology with a public access industry launch recommended as secondary. Analysis were made, different scenarios presented and a strategic innovation model was also presented.

Chapter Eight

Conclusion

8 Introduction

This is the final chapter of this thesis and it presents a précis of the previous chapters, a summary of the contributions of this study and its recommendations

8.1 Conclusion

This thesis is an exploratory study into the development of digital societies and it examined public sector modernisation and innovation from a technology management perspective in its introduction of wireless technology. The study is interested in:

1. Understanding how the innovation is being implemented
2. Identifying technology management problems from the implementation
3. Investigate why the problems arose
4. Proffering solutions to the observed problems

1.

The study found that innovations in the public sector were being implemented through the concept of modernisation. The modernisation agenda it advocates played out as an innovation strategy to propel the adoption of new technologies into public sector service delivery and society in general. It is a strategy that precipitated the launch of two process innovations E-government and more recently Digital Britain. E-government was focussed on the creation of innovative government processes that have enabled joined-up working between government agencies and organisations while Digital Britain is focussed on the creation of new societal infrastructure to reflect the realities of the digital age.

The study found that public sector modernisation as a concept draws its origins from a mixture of sociological, political and economic theory and their offshoots in the form of New Public Management Theory. The role of technological innovations in the categorization of societies was acknowledged by the need to present a new classification based on the impact of digital technology to reflect the present realities. The study also identified modernisation as the driving force behind the trial of wireless technologies in the delivery of government services by Norfolk County Council which culminated in Norfolk Open Link – a free public Internet access network. The reasons for the project, its design and implementation were presented as well as network utilization results.

One of the contributions of this thesis to the innovation discussion is that the influence of political theory or ideology and sociology has been understated in the studies of innovation management in the public sector. A foray into the conundrum it presents shows a tripartite relationship in spite of the intrigues of strategic management because they define the 'corporate strategy' of the public sector.

2.

The review of networking literature pointed to the creative destruction of wired networking technology by its wireless counterpart and the emergence of wireless technology as the dominant technology but the network utilization figures of the Norfolk Open Link were at odds with this view. The results showed a less than 5% utilization of a free wireless Internet network. This contradicted the literature and as such was identified as a technology management problem.

3.

An analytical investigation to ascertain why wireless broadband technology was not the dominant design in the public access industry was carried out. The hypothesis of a faulty innovation strategy was investigated and the results showed that:

- The public access industry is competitive with high industry rivalry
- The customers in this industry wield considerable bargaining power
- The industry suffers from a high threat of substitutes
- The customers in the industry are locked into yearly contracts which acts as a constraint to switching from an existing provider
- The yearly contracts also make it difficult to find customers to pay for the cost of setting up a wireless network to enable it evolve into a dominant design
- The public access industry is driven by bandwidth which compared to wired technologies (1 Gbps or more) is not presently a strength of wireless technologies. It generally operates as a 54 Mbps with improvement to 600 Mbps expected
- The office of national statistics reports that 95% of the UK population have broadband connections. This implies that 95% of citizens in the UK already have a broadband contract (which is well known to be for twelve months). So anyone developing a wireless broadband network is only building the network for the 5% customer base that are yet to secure a broadband contract while they wait on the 95% to end their contracts and switch.
- It was therefore reasonable that the network utilization figures for Norfolk Open Link be less than 5% which corresponds to the percentage of citizens without broadband access.

- It is the function of the innovation strategy to identify these risks and take appropriate action to mitigate their effects to ensure the survival of the innovation hence the hypothesis that the innovation strategy is faulty which has been shown to be true.

Triangulation was provided by two secondary case studies from the Wireless Philadelphia project and the deployment of WIMAX in Milton Keynes. Wireless Philadelphia was a networking project that three universities contributed to the assessment of its viability but ended in bankruptcy because they neglected the forces of industry competition and concentrated on opinions and focus groups. It is a failure that presented in both cases real life illustrations of analyzed competition in action. It saw the entry of Philadelphia city council into the wireless broadband market and Verizon (the wired broadband provider) committing over $3 million dollars to lobbying for an 'anti wireless bill' that barred all cities in Pennsylvania from competing in the broadband industry. This bill effectively created an entry barrier protecting the dominance of wired broadband from the threat of wireless broadband. It is also ironic that while 80% of Philadelphia was wirelessly covered with a cost of $17 million dollars, the house bill 30 made provision for a $140 million dollars subsidy for the deployment of wired broadband.

Also, before the Wireless Philadelphia project, a typical broadband package bundled with a mandatory landline costs between $45-60 per month, just as the network construction started, Verizon issued an introductory offer for broadband at $15 per month undercutting the proposed $16-20 per month price of the wireless network neutralising the cost advantage of the new network. This action also mopped up the ready pool of dial-up customers that could have signed up for the wireless network

by tying them on to lengthy broadband contracts that would ensure that there is reduced demand and some difficulty in switching from wired to wireless technology.

This reduced demand was manifested in the number of customer after three years which stood at 5,942 of an estimated 117,300 resulting in significant losses of $200,000 monthly for EarthLink the wireless broadband provider. These are losses that led to EarthLink (Philadelphia's wireless provider) to reassess their wireless strategy and opt to pull out of the wireless broadband industry and in the process sack 900 employees. These are actions that could not be said to encourage the replacement wired broadband by wireless technology.

It could be speculated that there had been an over reliance on the voice of the customer which though an important tool in evaluating the perceptions of a service or product; it is not the defining component of an innovation strategy. **Survival first** is the defining component in any innovation strategy. This is evident in market pull and technology push scenarios where in the former, market pull forces in essence only supply that customer or segment of customers that are prepared to pay for the survival of the innovation while in the latter, technology push tries to seek out the customer or segment of customers that will pay for the survival of the innovation.

The critical objective of any innovation strategy is to find customers that are prepared to pay for the survival of the innovation and this is the defining difference between successful and unsuccessful innovations.

4.

The study also sought answers on how wireless technology could become the dominant design in the public access industry. It was identified that broadband access was not the primary industry of the major wired broadband providers. It is a secondary industry to them and as such represents secondary revenue streams to top-

up their primary revenue streams. This presented very interesting dynamics to the industry because it meant all the wired broadband providers could deliver wired broadband access **free** if they wanted to or so desired. This in essence meant the real question facing wireless broadband providers is

How do you compete in a broadband industry where the production cost of your competition is almost ZERO?

The public safety and public works industries were presented as possible candidates for the successful primary launch of wireless broadband technology with a public access industry launch recommended as secondary. Analysis were made, different scenarios presented and a strategic innovation model was also presented.

Also emanating from this study is the idea that challenges the common axiom and points to survival not necessity as the mother of all inventions. History is littered with stories of individuals and organisations that were victims of necessity or lack (food, funds etc.) resulting in their demise whilst those that innovated survived. The will to survive produces inventors and innovators. A will not to accept the odds, to hope against hope, paves a way which is recognised as innovation.

An examination of the preceding discussions contained in 1-4 above reveal that the aims and objectives of the study to investigate the introduction of wireless technology in the public sector were achieved.

8.2 Contributions

A new classification of societies presented in section 2.7

The three dimensions of innovations was presented in section 3.4.3

An alternative technology cycle presented in section 3.5.3.1

A strategic innovation model presented in section 7.3

8.3 Recommendations

The recommendation for councils and government is to introduce wireless technologies into the public works or public safety industry first before leveraging into the public access industry. The key should be an industry that can pay for the cost of setting up the network.

- It also ensures that the technology has a platform to survive on while it is being tweaked and enhanced to eliminate teething problems.
- Due to the spread of public works, the wireless network could be easily leveraged into the public safety arena, allowing the council to have safer streets or public access industry were the network will now be on same footing as other industry players and can offer broadband access for free if they so chose.
- Wireless networks are excellent public relations tools

Private Sector Development,

- For an operator with limited funds, the public safety industry would be ideal. They could achieve lucrative Short Term profits which can pay for the network while it is being enhanced and tweaked and could also fund future expansion into the public works industry or public access industry where the operator will now be on same footing with the incumbent industry players.
- For an operator with considerable funds, the public works industry would be an ideal starting point with the long term plans of leveraging the network into the public safety and public access industry where as in the former case, they will be on the same standing with other industry players who could offer broadband access for free if they choose to.

Opportunities in the public safety industry include

- Close Circuit Television (CCTV)

- Wireless sensor networks (that can be adapted to detect high noise levels, drug farms, bomb making chemicals)
- Parking cameras
- Speed cameras

Opportunities in public works include

- Automated meter reading (electricity, water, gas)
- Road traffic lights controls
- Bus network real time information, local information terminals

Proposed publications

The following paper titles are proposed for publication to disseminate the results of this study:

1. Modernisation and the digital revolution: evolution of societies
2. The third dimension of innovation
3. Towards a revised technology cycle
4. Creating successful innovation strategies
5. Developing successful city-wide wireless broadband networks

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Appendix 1

Norfolk Open Link – Wireless Project

Final Project Case Study

1. Introduction

'Broadband networks will be as critical to the twenty-first century as roads, canals and transcontinental railways were to the nineteenth century and the interstate highway and basic telecommunications were to the twentieth.'

FCC Commissioner, Michael Copps, August 2003

Running from July 2006, Norfolk Open Link was a £1.1 million two-year project fully funded by the East of England Development Agency (EEDA) to evaluate the potential of mobile technology in the area. Of particular interest was how Open Link would affect the economic development of Norfolk and the region's ability to delivery public sector services.

The pilot project provided a wireless network which covered a large area of Norwich city centre including a 4km radius from County Hall and stretching to key sites in the east and west of the city such as Broadland Business Park, University of East Anglia (UEA), Norwich Science Park and Norfolk and Norwich University Hospital. The Open Link project was later extended to include around 20 rural locations in South Norfolk.

Over its two year operating period, the Open Link Project provided an invaluable opportunity for public sector to study just how the application of wireless technology would benefit the people of Norwich and Norfolk in general and the public and private sectors in particular.

2. Original Project Aims & Objectives

The original aim of the Norfolk Open Link project was to evaluate the potential requirement for mobile technology in Norwich and Norfolk.

2.1 Aims for the public sector

To identify how public sector organisations such as health, education, social services, police, fire service and public transport could benefit from using wireless-based technology in the delivery of services.

No single organisation could realistically pilot a project of this size, so the aim was to encourage greater collaboration and enable public sector organisations to assess the feasibility of using 'joint funded, shared infrastructure' projects in the future.

The Norfolk Open Link project would also provide more opportunities for remote working with staff able to access work systems when away from the office.

2.2 Aims for the private sector

To enable small and medium-sized businesses within the Norfolk Open Link area to use wireless enabled laptops, personal digital assistants (PDA) and mobile phones to

access the internet. This, in turn, would increase the awareness of wireless technology and encourage private sector investment in this area.

For the local economy, increased awareness of the technology leads to a realisation of its potential; advertising on websites, giving customers the option of buying online and encouraging staff to work from home. So increasing productivity and profit.

2.3 Aims for the general public

During the pilot period, to provide free and open public internet access allowing people to go online using wireless enabled laptops, personal digital assistants (PDA) and mobile phones anywhere within the areas where the service is available.

3. Project Implementation & Operation

Whilst the project received its funding from East of England Development Agency, it was managed by Norfolk County Council who worked closely with leads from other public sector organisations as well as business and political representatives. The design, deployment and operation of the network during the pilot was managed by Synetrix, a company specialising in this field, who were awarded the work following a competitive tender process.

It was not possible due to legal and commercial limitations to use the project as a commercial service and therefore no charges were made to access and use the service. Project funding covered the operation of the service during the life of the project.

4. Technology

The implementation of NOL involved the design and implementation of the largest community wireless network in the UK at the time. Developments in wireless technology made it possible to create a coverage of over 15 square km, this involved the deployment of just over 260 wireless 'access points' fitted on lamp columns and other street furniture. To deliver effective communication between these access points and the 40mb project internet pipe, the service was configured in 11 separate sectors. This gave a level of resilience and also allowed the project to operate in a number of physical environments e.g. built up areas, residential areas, business parks, campus, etc. User access was tested on a range of devices including desktop computers, laptop computers, PDA, wi-fi handsets and information to assist users to get the most from using the service was published on the project web site.

A support line was also provided for those users who needed additional support in configuring their equipment to connect with NOL.

5. Project Findings

Workshops and interviews with users during the life of the NOL project identified a number of areas of generic benefits associated with the availability of wireless broadband, these included:

- Support for mobile working thereby increasing personal productivity and reducing some employment costs (e.g. office space)
- Promoting tourism and local business for example virtual tourist trails and

similar applications which are able to 'push' location specific digital content to user devices

• Student access to college/university on-line resources from outside campus which is where majority of students live

• Opportunity for people to experience benefits of accessing internet who aren't able to use fixed broadband connection and therefore may be socially excluded (e.g. temporary residents, low waged, unsuitable credit status, students)

5.1 General Public Findings

At the end of the project various exercises were carried out to gauge the impact the Norfolk Open Link project had made on the public and private sectors and general population of the region. This included a combination of telephone interviews, a survey of 218 people (151 Open Link existing users and 67 non-users) and a workshop bringing together a variety of public sector organisations based in Norfolk.

Two distinct groups of users were identified:

• Those who use Norfolk Open Link as a free alternative to subscribing
• Those who need mobile access to the internet for personal or business reasons.

Overall, the findings demonstrated that there was a real requirement for wireless, mobile technology in Norwich and Norfolk. Open Link was viewed positively with respondents who used the service reporting that it improved their productivity. In fact, 62% reported they had gained between 1 and 2 hours productivity a week. They also reported that such a facility made Norwich a more attractive place to live with 88% stating a preference to live, work or study in a city with such a service. This aligned with findings from other national surveys which reported that access to broadband was considered by many to be an essential pre-requisite and should be viewed as a basic utility similar to water, gas or electric.

The research also looked into how willing users would be to pay for such a service. Around 40% stated that they would be likely to subscribe to a fee-based service to 'some' extent, a 'great' extent or a 'very great' extent.

During early months there were approx 16,000 connections per month but this grew to a monthly average of 42,000 connections to the NOL service with many users feeling that it meet their needs and going on to use it on regular basis. A significant number of users also went on to use commercial wireless services such as wifi hot spots at hotels, coffee shops etc (i.e. there was a growth in demand for the service during the pilot as well as an increase in commercially available wireless services) this lead to a conclusion that the project stimulated overall demand for broadband over life of project.

By the end of the project in 2008 there was an increase in the availability and number of consumer devices which had wi-fi capability as well a growing demand for wireless 'zones' outside the home where these could be used. During the project, Channel 5's Gadget Show visited Norfolk to test Norfolk Open Link network with

various equipment and subsequently launched a campaign using the NOL project as the basis for all cities campaigning to achieve wireless coverage.
Whilst no empirical data was collected on those individuals or businesses who had benefited in some way from the project (e.g. number of low income households who were able to benefit from savings through using internet to buy various goods and services, number of businesses who used network to implement more flexible working practices, number of residents who used the project to get practical experience of using internet and then went on to buy commercial broadband service), there was much anecdotal evidence to support the claims that the project had delivered tangible benefits as well as identifying potential demand and requirements

5.2 Public sector findings

Public sector organisations in Norfolk are experiencing a growth in the number of mobile or field-based staff, leading to the need for a clear strategy on coverage. The need for a common platform across all public sector applications also emerged; another indication of the trend towards multi-functional front line staff. Free access in public buildings such as hospitals, city halls and libraries would also provide a medium to deliver messages on, say, health and safety or fire prevention to the general public.
Project also identified many practical benefits to using wireless to support communications and evolving work processes associated with delivering local authority activities. A key finding from experiences at other local authorities was the importance of the local authority role in collating demand and campaigning for improved broadband access (wired and wireless) for residents and local businesses often as part of regeneration initiatives.

5.3 Private sector findings

Although recognising the development and operation of wireless networks and wireless services as offering genuine commercial opportunities, further work would be required to develop a business model which will deliver real, tangible financial benefits before private sector would be ready to invest in wireless projects.

Such a business model would need to reflect requirements for ubiquitous coverage and the development of partnerships with other service providers to ensure seamless roaming over its infrastructure. Another finding was that it was unlikely that the levels of demand would support multiple providers. Concerns over privacy and security would also need to be addressed.

5.4 Technology lessons learnt

Much of the technology used in the delivery of the project was innovative at the time and valuable experience was gained during the project on the practicalities of deploying and maintaining wireless services in a variety of environmental situations and weather conditions. A number of technical changes and upgrades were implemented during the project to improve services. Regular meetings and presentations enabled the project to share its findings with other interested parties.

6. Conclusion

The Norfolk Openlink Project was successful as measured against its original objectives. It was also regarded as successful in other areas, for example actual usage was much greater than expected, the profile of the service was very positive and people liked it. There was also some disappointment that the service was not continued in some form and the promotion of serious debate on the role of the public sector in the delivery of wireless services. There was also an indirect benefit to the profile of Norwich/Norfolk due to high level of positive local, national and international interest and coverage which was assessed as much greater than that which could usually be achieved with similar funded projects targeted at promoting Norwich and Norfolk.

7. The Future

The project finished in mid 2008 with the closure of the wireless service and associated web site and support line.

Experiences from the project have been shared with both public and private sector organisations through various meetings, events and presentations and continue to shape the development of other wireless city initiatives

Attempts were made to find commercial organisations interested in continuing to use the existing equipment to deliver a commercial service but given the development and changes in wireless technology, much of the equipment was not suitable for re-use and was therefore decommissioned. However since the end of the project there has been interest from a number of commercial communication companies in establishing and marketing various broadband services including wifi in the Norwich area.

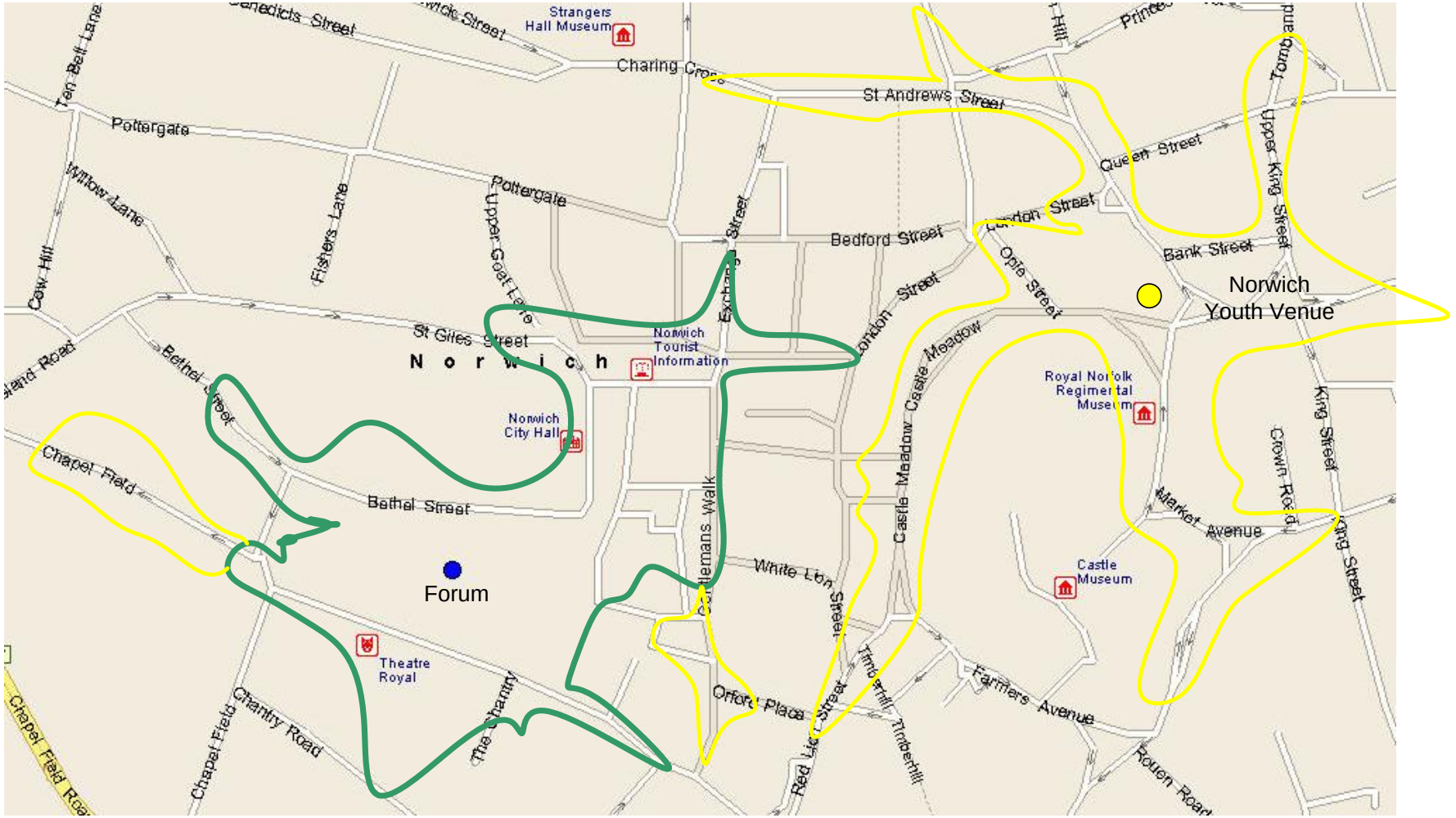
There will continue to be a role for the public sector through organisations such as Shaping Norfolk's Future and EEDA in collating demand and promoting broadband availability to support economic activity.

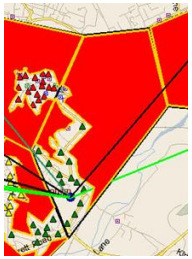
Further information

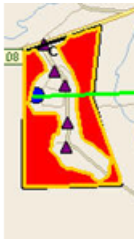
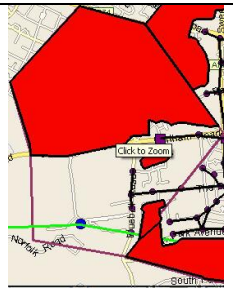
Please contact Ann Carey (ann.carey@norfolk.gov.uk) at Norfolk County Council if you require any further information.

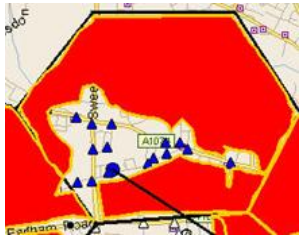
Appendix 2

Detailed city Centre coverage (as at 20.3.06)

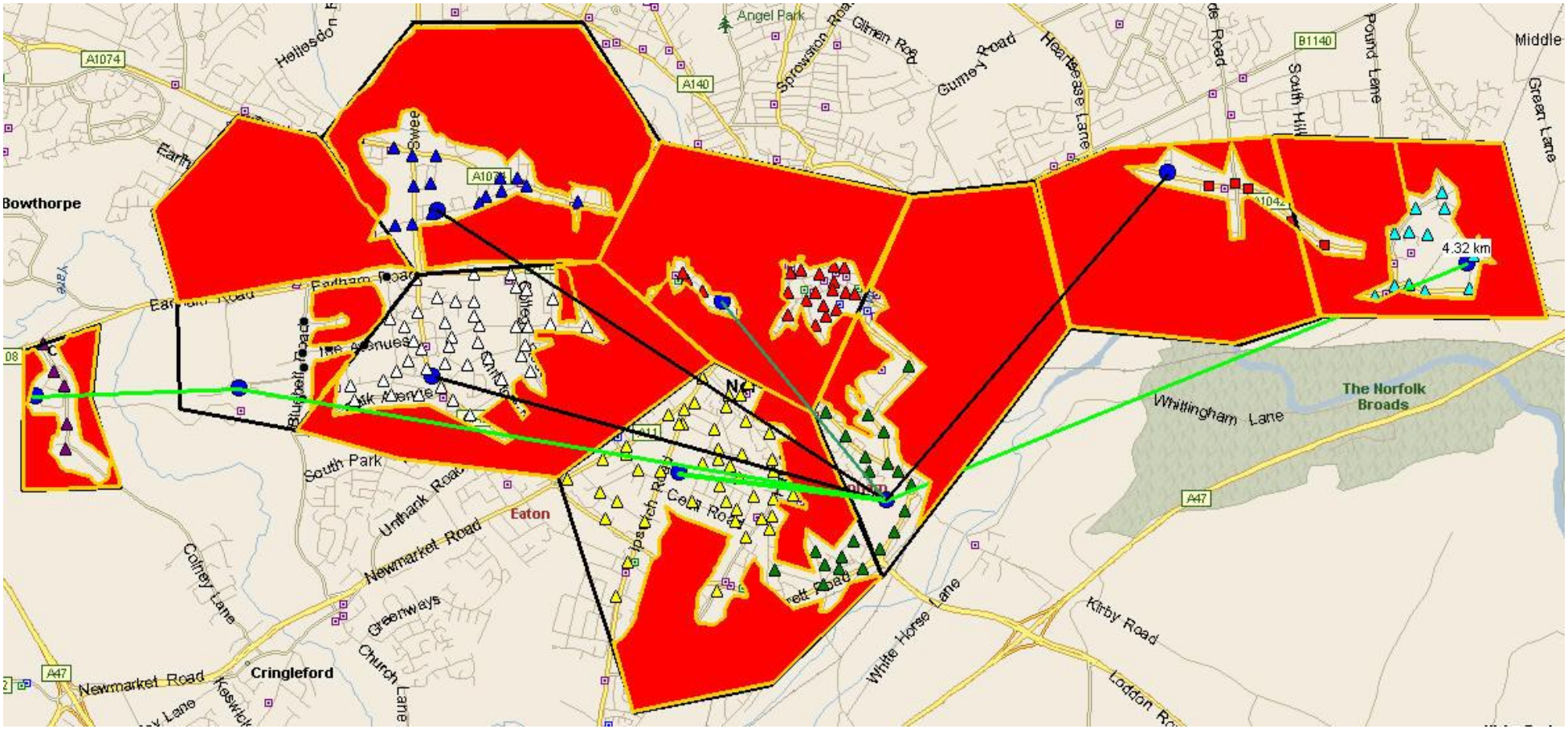


Phase 1 Deployment	*Deployment Issues*	*Potential Solutions*
	**City Centre Sector** Main problems in city centre are lack of street furniture and layout of city. Priority is to increase coverage in Gentleman's Walk area. A number of lamp columns in the Prince of Wales/ Rose Lane area are unavailable due to the fact that they are already being used for Xmas decorations; this limits access into city.	1. Additional columns have been found in near forum to increase coverage. Site survey is being re-checked to see if range can be extended. Especially towards pedestrian areas. 2. Commercial companies approached to host access points including Chapelfield and Castle Malls, Jarrolds, and Norwich Youth Venue. 3. Alternative back haul sites including Charles House and commercial companies are being approached. 4. May Gurney advising on street furniture
	**NCC Sector** Backhaul location on south side of sector. Access into north of sector only up Carrow road /Koblenz Avenue Eastern pact of sector taken up by building sites and football ground. No Access to northern half of sector due to hop count from County Hall.	1. Put backhaul link into Broadland district council and extend into east of sector down the Thorpe road and Telegraph Lane east. 2. Establish alternative backhaul location at Charles House and extend into riverside area and east along Thorpe road. 3. Use mesh extenders to increase coverage distance from particular AP locations around shopping centre and residential developments

Phase 1 Deployment	*Deployment Issues*	*Potential Solutions*
	**City College Sector** Good overall coverage Southern area coverage reduced by sports playing fields.	1. Find alternative backhaul site in southern part of sector to increase coverage. 2. Investigate mesh extenders in area. 3. Eastern edge of sector connected to NCC Sector Mesh to increase coverage.
	**Norfolk & Norwich hospital sub Sector** Good coverage no major problems Full coverage across site and up to Watton road	No extra work needed
	**UEA Sector** Good coverage can be achieved on the UEA campus subject to agreement with English Heritage to site columns on listed buildings. Access off site is not as good due to the distance from the backhaul site to the main roads.	1. Investigate alternative backhaul site in University village area. 2. Investigate mesh extenders 3. Establish agreement with English heritage

Phase 2 Deployment	*Deployment Issues*	*Potential Solutions*
	**Earlham Library Sector** Good overall coverage limited by trees and area layout	1. Examine if city college sector can be extended into this area to increase coverage. 2. Examine use of Mesh extenders.
	**Julian Hospital Sector** South side of sector limited by cemetery whilst north side has river and waster ground	1. Revisit site survey to examine deployment 2. Investigate alternative backhaul site in north-east of sector

Phase 2 Deployment	*Deployment Issues*	*Potential Solutions*
	**St Williams Way Sector** All non St Williams Way lamp columns are owned by parish council and are of concrete construction. No agreement with PC and advised by May Gurney to steer clear of these columns	1. Move sector backhaul down to Broadland District council. Coverage will be mainly along Yarmouth/Thorpe road and side roads. Also access up Harvey Lane and Telegraph lane east. Broadland District Council has agreed to this move.
	**Thorpe Business Park Sector** Coverage is generally good for this sector but there is a limit to the number of lamp columns available for use. In addition NPS' landlords require £1500 to put the hosting agreement into place.	1. Look at alternative street furniture with May Gurney to increase coverage. 2. Work with NPS to reducing backhaul hosting costs.


Angel Park
A1074
A140
B1140
Bowthorpe
Fakenham Road
Blubbell Road
The Avenues
South Park
Eaton
Newmarket Road
Colney Lane
Greenways
Church Lane
Cringleford
A47
Ipswich Road
Celtic Road
Whittingham Lane
The Norfolk Broads
White Horse Lane
Kirby Road
Pound Lane
Great Lane
Gurney Road
Heartsease Lane
4.32 km

Appendix 3

APPENDIX 3.1: PUBLIC ACCESS INDUSTRY

Bargaining Power of Customers is high if:

The Council is price sensitive, as when:	
Cost of installing Wireless Mesh Networks is high relative to total Public access Industry cost.	**TRUE**
It finds it difficult to differentiate Wireless Mesh Networks.	**FALSE**
It faces stiff competition for their Wireless Mesh Networks.	**TRUE**
Bargaining power:	
Size and concentration Customers is high relative to Wireless Network providers.	**TRUE**
Customers have low switching costs.	**TRUE**
Customers are well-informed.	**TRUE**
Customers have the ability to integrate backwards.	**FALSE**

The above scanning indicates that the bargaining power of customers is high.

Also, if True is weighted +5 and false -5 then effective weight of force is +25

Bargaining Power of Suppliers is high if:

The Public access Industry is not price sensitive, as when: The cost of supplied Wireless Mesh Networks is low relative to total Public access Industry cost.	**FALSE**
Wireless network providers' and Wireless Mesh Networks are easy to differentiate.	**TRUE**
The Public access industry is not facing stiff competition for its Wireless Mesh Networks.	**FALSE**
Wireless network providers bargaining power is high, as when: Size and concentration of Wireless Network providers is high relative to the Public access Industry.	**FALSE**
Public access industry has high switching costs.	**FALSE**
The industry is not well-informed.	**FALSE**
Providers have the ability to integrate forward.	**TRUE**

The above scanning indicates that the bargaining power of suppliers is low.

Also, if True is weighted +5 and false -5 then effective weight of force is -25

Threat of Potential Entrants is increased if:

There is few any economies of scale.	**FALSE**
There is not a strong learning curve effect.	**FALSE**
Minimal capital is required for entry into Public access Industry.	**FALSE**
It is difficult to differentiate wireless mesh networks.	**FALSE**
Distribution channels are easy accessed.	**TRUE**
Entry into the market is free from government and legal barriers.	**TRUE**
Mild retaliation expected from established producers.	**FALSE**

The above scanning indicates that the threat of new entrant is low.

Also, if True is weighted +5 and false -5 then effective weight of force is -25

Rivalry within the Public Access Industry is high if:

There is low concentration, in number and size, of competing firms within the Public Access Industry.	**FALSE**
Diversity of competitors within the Public access Industry.	**TRUE**
The wireless network industry experiences slow growth.	**TRUE**
Fixed costs are relatively high.	**TRUE**
Added capacity comes in large increments.	**FALSE**
Differentiation between products within the Public access Industry is low.	**TRUE**
High exit barriers from the Public access Industry.	**TRUE**

The above scanning indicates that rivalry is high in the industry.

Also, if True is weighted +5 and false -5 then effective weight of force is +25

Threat of Substitutes is high if:

Buyers are likely to easily substitute.	**TRUE**
The price performance within the Public access Industry is relatively commendable.	**TRUE**
Low degree differentiation.	**FALSE**
The possibility that Wireless Mesh Networks could find new markets as substitute for some other product cannot be denied.	**TRUE**

The above scanning indicates that the threat of substitutes is high.

Also, if True is weighted +5 and false -5 then effective weight of force is +10

A summary of the industry forces shows that

1. Power of Customer high
2. Power of Supplier low
3. Threat of New entrant low
4. Industry Rivalry high
5. Threat of Substitutes high

The above shows that in the public access industry which includes broadband Internet, it would be more difficult for wireless technology to be a sustained success in this industry.

The scanning of an alternative industry would be recommended like the public safety industry

APPENDIX 3.2: **PUBLIC SAFETY INDUSTRY**

Bargaining Power of Customer is high if:

The Customer is price sensitive, if when: Cost of installing Wireless Mesh Networks is high relative to total Public safety Industry cost.	**FALSE**
It finds it difficult to differentiate Wireless Mesh Networks.	**FALSE**
It faces stiff competition for their Wireless Mesh Networks.	**FALSE**
Bargaining power: Size and concentration of Local Government Councils is high relative to Wireless Network providers.	**TRUE**
Councils have low switching costs.	**TRUE**
Councils are well-informed.	**TRUE**
Councils have the ability to integrate backwards.	**FALSE**

The above scanning indicates that the bargaining power of customers is moderate.

Also, if True is weighted +5 and false -5 then effective weight of force is -5

Bargaining Power of Suppliers (Wireless Network providers) is high if:

The Public Safety Industry is not price sensitive, as when: Cost of supplied Wireless Mesh Networks is low relative to total Public safety Industry cost	**TRUE**
Wireless network providers' Wireless Mesh Networks are easy to differentiate	**TRUE**
The Public safety industry is not facing stiff competition for its Wireless Mesh Networks	**TRUE**
Wireless network providers bargaining power is high, as when: Size and concentration of suppliers is high relative to the Public safety Industry	**TRUE**
Public safety industry has high switching costs	**FALSE**
The industry is not well-informed	**FALSE**
Providers have the ability to integrate forward	**TRUE**

The above scanning indicates that the bargaining power of suppliers is high.

Also, if True is weighted +5 and false -5 then effective weight of force is +25

Threat of Potential Entrants is increased if:

Hardly any economies of scale	**FALSE**
A weak learning curve effect	**FALSE**
Minimal capital is required for entry into Public safety Industry	**FALSE**
Product differentiation is a difficult	**FALSE**
Distribution channels are easy accessed	**FALSE**
Entry into the market is free from government and legal barriers	**FALSE**
little retaliation expected from established producers.	**FALSE**

The above scanning indicates that the threat of new entrants is low.

Also, if True is weighted +5 and false -5 then effective weight of force is -35

Rivalry within the Public Access Industry is high if:

Low concentration in number and size of competing firms within the wireless network industry.	**TRUE**
Diversity of competitors within the Public safety Industry	**TRUE**
The Public Safety industry is in slow growth.	**FALSE**
Fixed costs are relatively high	**TRUE**
Added capacity comes in large increments	**FALSE**
Differentiation between products within the Public safety Industry is low	**FALSE**
High exit barriers from the Public safety Industry	**TRUE**

The above scanning indicates that industry rivalry is moderate.

Also, if True is weighted +5 and false -5 then effective weight of force is +5

Threat of Substitutes is high if:

Buyers are likely to easily substitute	**FALSE**
The price performance within the Public safety Industry is relatively commendable	**FALSE**
Low degree differentiation	**FALSE**
The possibility that Wireless Mesh Networks could find new markets as substitute for some other product cannot be denied.	**TRUE**

The above scanning indicates that the threat of substitutes is low.

Also, if True is weighted +5 and false -5 then effective weight of force is -10

1. Power of Customer Moderate
2. Power of Supplier High
3. Threat of New entrant low
4. Industry Rivalry Moderate
5. Threat of Substitutes low

The above scanning shows that the public safety industry would presently offer a more sustained success for the introduction of wireless technology

APPENDIX 3.3: **PUBLIC WORKS INDUSTRY**

Bargaining Power of Customer is high if:

The Customer is price sensitive, if when: Cost of installing Wireless Networks is high relative to total cost.	**TRUE**
It is hard to differentiate product.	**FALSE**
It faces stiff competition for their Wireless Mesh Networks.	**FALSE**
Bargaining power: Size and concentration of Local Government Councils is high relative to Wireless Network providers.	**TRUE**
Councils have low switching costs.	**FALSE**
Councils are well-informed.	**TRUE**
Councils have the ability to integrate backwards.	**TRUE**

The above scanning indicates that the bargaining power of customers is moderate.

Also, if True is weighted +5 and false -5 then effective weight of force is +5

Bargaining Power of Suppliers is high if:

The Industry is not price sensitive, as when: Cost of supplied Wireless Mesh Networks is low relative to total Public safety Industry cost	**FALSE**
Wireless network providers' Wireless Mesh Networks are easy to differentiate	**TRUE**
The Public Works industry is not facing stiff competition for its Wireless Mesh Networks	**FALSE**
Wireless network providers bargaining power is high, as when: Size and concentration of suppliers is high relative to the Public safety Industry	**TRUE**
Public Works industry has high switching costs	**TRUE**
The industry is not well-informed	**FALSE**
Providers have the ability to integrate forward	**TRUE**

The above scanning indicates that the bargaining power of suppliers is moderate.

Also, if True is weighted +5 and false -5 then effective weight of force is +5

Threat of Potential Entrants is increased if:

Hardly any economies of scale	**FALSE**
A weak learning curve effect	**TRUE**
Minimal capital is required for entry into Public safety Industry	**FALSE**
Product differentiation is a difficult	**FALSE**
Distribution channels are easy accessed	**FALSE**
Entry into the market is free from government and legal barriers	**FALSE**
little retaliation expected from established producers.	**FALSE**

The above scanning indicates that the threat of new entrants is low.

Also, if True is weighted +5 and false -5 then effective weight of force is -30

Rivalry within the Public Works Industry is high if:

Low concentration in number and size of competing firms within the wireless network industry.	**TRUE**
Diversity of competitors within the Public works Industry	**TRUE**
The Public works industry is in slow growth.	**FALSE**
Fixed costs are relatively high	**TRUE**
Added capacity comes in large increments	**FALSE**
Differentiation between products within the Public works Industry is low	**FALSE**
High exit barriers from the Public works Industry	**TRUE**

The above scanning indicates that industry rivalry is moderate.

Also, if True is weighted +5 and false -5 then effective weight of force is +5

Threat of Substitutes is high if:

Buyers are likely to easily substitute	**FALSE**
The price performance within the Public works Industry is relatively commendable	**FALSE**
Low degree differentiation	**FALSE**
The possibility that Wireless Mesh Networks could find new markets as substitute for some other product cannot be denied.	**TRUE**

The above scanning indicates that the threat of substitutes is low.

Also, if True is weighted +5 and false -5 then effective weight of force is -10

1. Power of Customer Moderate
2. Power of Supplier High
3. Threat of New entrant low
4. Industry Rivalry Moderate
5. Threat of Substitutes low

The above scanning shows that the public safety industry would presently offer a more sustained success for the introduction of wireless technology