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# ICT ARCHITECTURE AND PROJECT RISK IN INTER-ORGANIZATIONAL SETTINGS

Ole Hanseth
*University of Oslo*

Bendik Bygstad
*Norwegian School of Information Technology*

# ICT ARCHITECTURE AND PROJECT RISK IN INTER-ORGANIZATIONAL HEALTH CARE SETTINGS

Ole Hanseth, Department of Informatics, University of Oslo, Oslo, Norway
  *Ole.Hanseth@ifi.uio.no*

Bendik Bygstad, Norwegian School of Information Technology, Oslo, Norway,
  *Bendik.Bygstad@nith.no*

## Abstract

*This paper investigates the relationship between ICT architectures and project risk, in the context of the development of large inter-organizational systems. Although previous research has identified ICT architecture as a project risk, the focus has been on technical issues. Expanding this perspective, we investigate how technical architectures have bearings on the organization of projects, which may, to a large extent, determine the outcome of large information infrastructure initiatives.*

*Our empirical evidence is ten cases from the health sector, collected over a period of 20 years. Due to space limitations only two cases are presented in this paper. A multi-level analysis allowed us to identify two main architectures; the institutional interface architecture (INA) and the service provider architecture (SPA). Through the careful study of ten cases over a period of 20 years, we present evidence for the high project risk of the INA and the viability of the SPA strategy. We find that the SPA has significant impact not only on the complexity of the technological solutions, but – more importantly – also on the complexity of the projects developing the solutions. The organizational complexity of the SPA based projects, and hence the necessary co-ordination activities, were dramatically reduced, and the success rate of the projects and the benefits for the users similarly increased.*

*Keywords: information infrastructure, architecture, risk*

# 1　Introduction

In the 20th anniversary issue of ISR, Tiwana et al. (2010) argue that there is a need for more research into the co-evolution of design, governance, and environmental dynamics of what they call "platform-centric ecosystems." This paper aims at contributing to this research by addressing the relationship between technological architectures and project risk, in the context of large inter-organizational ICT solutions. In particular the paper addresses the research question: how does the choice of ICT architecture influence on the organization of the development and implementation project, and how do this again influences on project risk?

One excellent context for addressing this research question is the health sector. Building health information infrastructures has proved to be notoriously difficult in most countries, with many large initiatives in trouble (Grenhalgh et al. 2010; Ellingsen and Monteiro 2008; Hanseth et al. 2006). An important explanation of this fact is the overall complexity of the tasks, combined with the complexity of various technologies, in a magnitude that exceeds previous experiences. Such projects often include hundreds of organizations and go on for years or even decades. What kind of ICT architecture and what kind of project organization are appropriate for this challenge? In this longitudinal study we have identified two different architectures:

- The Electronic Data Interchange (EDI) approach, with its architecture which we here call Institutional Interface Architecture (INA)

- The service provider approach with its associated Service Provider Architecture (SPA)

Through the careful study of ten cases over a period of 20 years, we present evidence for the high risk of the INA and the viability of the SPA based solutions. We find that the SPA had significant impact not only on the complexity of the technological solutions, but primarily – and most important – on the organizational complexity of the projects developing the solutions. The organizational complexity of the SPA projects, and hence the coordination activities, were dramatically reduced, and the success rate of the projects and the benefits for the users similarly increased.

Our finding is a cause for concern, because the INA is dominant, and supported by most health authorities and much of the IT professional community. Thus, our aim with this paper is to show how the choice of architecture is crucial for the success of inter-organizational ICT solutions.

# 2　Related research

Research on technological architectures has focused on how to decompose a system into modules so that system flexibility is maximized. This is assumed best achieved through loose coupling among components and strong internal cohesion (Parnas 1972; Henfridsson et al. 2009;). Loose coupling between components, as opposed to tight coupling, means that the inner working of a component can be hidden to other components (i.e. encapsulation Parnas (ibid.)). Loosely coupled components are easier to modify and more available for new relationships in reconfiguration of a modular system.

Traditionally, research on technological architectures has focused on the internal architecture of one software system. More recently, as the number of system has been growing and their integration has increased, much attention has been directed towards architectures specifying the relations between individual solutions. This research has directed much of its focus towards Service Oriented Architectures (Vassiliadis et al. 2006), where the modular structure consists of services. The implementation of SOA may vary, from simple ASP solutions, to Web services, and further to more complex SOAs with Enterprise Software Bus middleware (Rosen et al. 2008). An example is Tiwana and Konsynski (2010), who found solid evidence for the widely held view that a modular architecture makes alignment of ICT solutions and business strategy easier to achieve.

The literature reviewed above focuses mainly on projects and solutions located within one single organization. The e-health solutions discussed in this paper are different in the sense that each single solution will be shared by virtually all health care institutions in Norway and a large number of independent software suppliers and other actors are involved in the development of the solutions. Such large scale solutions raise a host of new challenges when it comes to both ICT architecture and the management of development activates. These challenges are addressed within a growing body of research – to which the research presented here belongs – conceptualizing these large scale solutions Information Infrastructures (II) (see for instance (Ciborra et al. 2000; Edwards et al. 2007; Hanseth et al. 1996; Star and Ruhleder 1996; Tilson et al. 2010). Most of the II research has aimed at exploring the complexity of IIs and the impact of this complexity on the design, management and evolution of IIs. A few articles address design strategies or methodologies (Hanseth and Lyytinen 2010).

A somewhat similar field is e-business networks. In the e-business research it is often distinguished between two basic types of e-business architectures (Chaffey, 2008). The first is a solution with one dominant actor, who will define the architecture and often also implement it, the typical examples being vendors such as Amazon and Apple. The second type is a supply chain with several companies on equal terms, communicating from their own separate system, often with EDI messages or web services (Chaffey, 2008). The risks of these architectures, however, are not systematically discussed, except for a general warning of the need for good contracts.

In response to the unresolved challenges of failed IT development project, the discipline of risk management was introduced as a key approach in IT project management (Boehm 1991). The IT project risk literature is extensive. At the top of the risk lists, researchers have identified top management commitment, user participation/commitment and incomplete/unstable requirements (Bannerman 2008; De Bakker et al. 2009; Keil et al. 1998). A standard IT project management text book, such as Cadle and Yeates, offers a full chapter on risk management, emphasizing the need for a systematic identification, assessment and mitigation of project risks (Cadle and Yeates 2008). The identified types of risk are commercial, relationship, requirements, planning/resource, technical and subcontract risk, with the focus mainly on management interventions.

In a longitudinal study in the health care sector Sicotte and Paré (2010) identified several risks, such as political, technical, management and usability risks, and found that the risk factors were closely intertwined. They also found that risk interdependence evolved dynamically over time, with a snowball effect that rendered a change of path progressively more difficult (Sicotte and Paré 2010). Although the project management literature has been increasingly preoccupied with risk management, most research is related to management issues, as the examples above illustrate. Architectural issues are relatively superficially treated. In a similar way the literature on technological architectures concentrates mostly on how to achieve the required technological flexibility, and does not address risk.

One reasonable assumption from this review would be that sound architectural principles, in particular modularity, will decrease project risk. We do not contest this view, but as we will show in our cases, this is not as simple as it sounds. In practice, modularity may be implemented in very different ways, with different outcomes. We will discuss this in detail in the next section, where we assess two paradigms for inter-organizational solutions.

# 3 Two ICT architectures

In this section we present the two different basic architectures found in the cases analysed.

## 3.1 The Interface Architecture (INA)

What we call the Institutional Interface Architecture (INA) is closely linked to the well established *EDI paradigm*. This paradigm offers a framework for electronic communication between organizations that emerged in the early 70-ies. It takes as it starting point the information flow

between organizations. From the very beginning the paradigm has aimed at replacing paper based communication structures with computer based communication – the paradigm example being exchange of orders and invoices. This paradigm can then, in principle at least, easily be adapted to the health care sector to support the electronic exchange of information usually exchanged on paper forms like those being focused in the projects reported here.
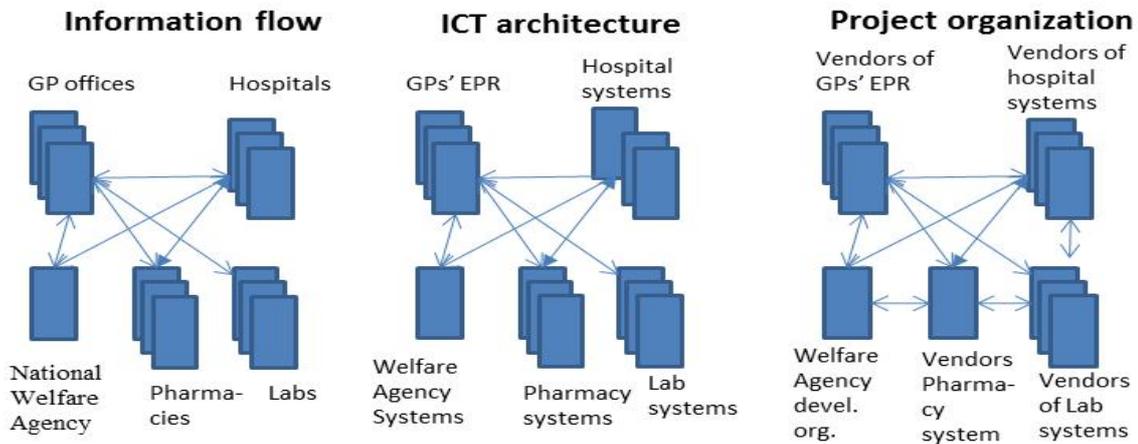


*Figure 1. The EDI paradigm and the AC/INA*

Taking existing paper forms as the starting point, the focus of the paradigm has been on defining electronic standards, in terms of EDI messages, equivalent of the (semi-standardized) paper forms. An II enabling electronic exchange of the actual information is, then, assumed to be established by *extending the applications* containing the actual information so that they can send and receive the messages representing this information as illustrated in fig. 1 below. For this reason we see the architecture of the overall II as *application centric*. This way of building IIs also implies that the EDI paradigm is based on a technological architecture that *mirrors exactly the organizational structure created by the information flow between the organizations involved*, i.e. the interfaces between the main modules of the II are the same as the interfaces between the institutions involved in the information exchange as illustrated by fig. 2 below. Combing these two aspects of the architecture we name it Application Centric Institutional Interface Architecture, AC/INA, or INA for short.

For many e-business solutions the EDI paradigm has been successful (Turban et al. 2006). But not for all – representatives from the oil industry are saying that EDI is inappropriate in the supply chain in their sector due to the high number of suppliers and a low number of transactions between oil companies and most of their suppliers. In their view, EDI works well in supply chains with a lower number of suppliers and a high volume of transactions between each of them. In the health sector the EDI paradigm has had a modest success. This claim will be substantiated later in this paper. Reaching agreement about standards' specification among the stakeholders has been difficult. And coordinating the implementation of the standards so that the information can be exchanged correctly has been challenging (Hanseth et al. 2006).

## 3.2 The Service Provider Architecture (SPA)

The main difference between INA (figure 2) and the second architecture we have identified in our empirical material is that in the latter case all information exchange is taken care of by one separate system and not as an extension of the application as illustrated in fig. 1 above. This means that in the INA there is a tight coupling between each application and the module handling the information exchange for this particular application and a loose coupling between the various modules handling the information for the various applications. In the SPA this is opposite: a loose coupling between the

applications and the communication system and a tight coupling between the various communication modules. For this reason we say that this architecture is *Communication System Centric.*
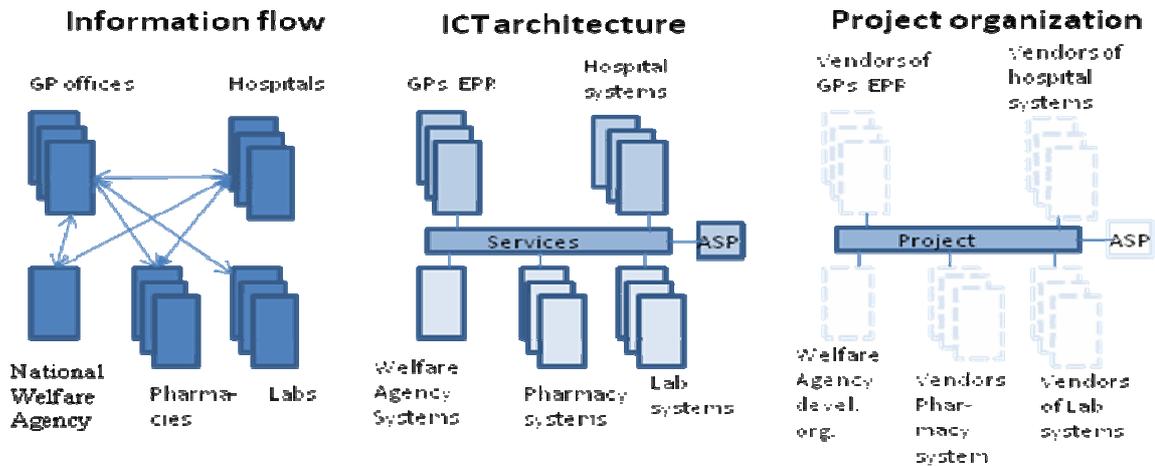


*Figure 2.        The Service Provider Approach and the SPA*

There is also another difference between these two architectures. In the INA communication is assumed to be symmetric – the individual applications are sending and receiving messages between each other. Applications integrated according to the SPA are integrated according to an asymmetric pattern where the II is established to enable some organizations to deliver their services to others in a more efficient way. And the communication system is more tightly integrated to the systems of the service providers than those of the service consumers. In many cases, the SPA based IIs are offering the services providers' services to the users in the service consumer organizations directly and not through their existing applications. For this reason we say that this architecture is also a *Service Provider oriented Architecture.*

## 3.3      Message Oriented and Service Oriented Architectures

The EDI paradigm has been closely linked to what is usually called Message Oriented Architecture (MOA) since the communication is based on message passing, usually implemented by sending the messages by means of an email service. Widely experienced limitations of MOA based solutions contributed to the development and increasing popularity of Service Oriented Architectures (SOA). SOA based solution have mostly been developed by using Web Services or SOAP implementations.
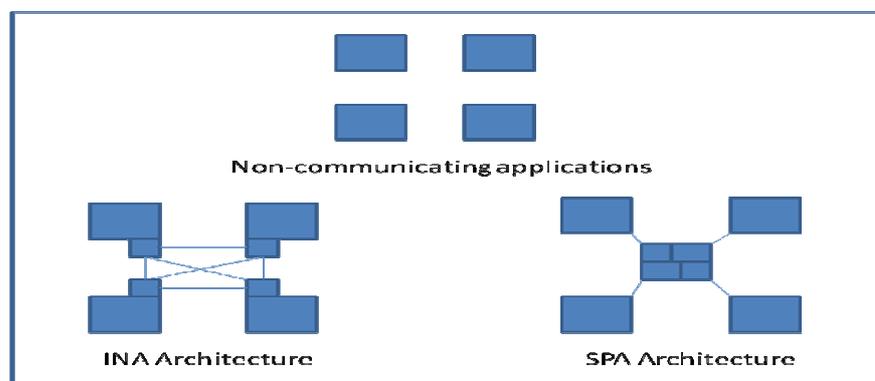


*Figure 3.  INA and SPA*

In our cases the INA IIs are mostly based on message transmission my means of email. But not strictly so. The early INA IIs were all implemented as MOA solutions using email. But later on messages

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were transferred based on underlying SOA technologies. And several of the SPA IIs were also primarily based on underlying MOA communicaiton services. So we think it is important to point out that INA and the SPA are independent of underlying communication services. INA and SPA are two different ways of *decomposing* an II, i.e. which modules it is split into, at the overall level, while MOA and SOA are two different ways of defining the *interfaces*, or the interactions, between the communicating modules (see figure 3).

# 4 Method

The empirical material reported in this study was collected more or less continuously for a period of over 20 years, in the Norwegian health sector. Our research has been guided by a strong interest to understand the development of large information infrastructures, at different levels, as they evolve over time. Studying these large socio-technical structures over time is challenging, because of the complexity of the domain; the number of actors and initiatives is large, and the projects often last for several years. The significance of ICT architecture has been prominent, as they play a crucial role at different levels.

Our research approach has been a multilevel case study (Pettigrew, 1985; Miles and Huberman 1994). Specific projects have been studied in detail over time, and were documented extensively. At higher levels regional and national initiatives (with international links) have been followed, and we have been particularly interested to investigate the dynamics between different levels, where, needless to say, standards and architectures has been a focal issue.

The cases were chosen on a combination of systematic and pragmatic reasons, i.e. we have selected some key central national initiatives, and researched interesting local and regional projects that were available. The most important source has been interviews with informants in different roles; doctors and nurses, line managers, IT professionals, staff users and high-level bureaucrats. Literally hundreds of reports has been collected and analyzed. At several occasions, solutions have been demonstrated, and we have observed systems in use in many situations. An overview of the cases is shown in Table 1 below.

Each case has been analyzed separately, focusing on the role of ICT architecture in the development project. Then the full portfolio of cases has been analyzed in two dimensions (Pettigrew 1985):

| Project | Period | architecture | Overall results |
|---|---|---|---|
| National pilot project for electronic Prescriptions (ePrescription 1) | 1993-96 | INA | Terminated in 1996 |
| Regional project for electronic patient record solution (The Elin project) | 2004-07 | INA | Some success, slow diffusion |
| Regional project for integrated patient record solution. (Elin-K) | 2005-09 | INA | Terminated in 2009 |
| National project for electronic prescriptions (ePrescription 2) | 2004-11 | INA | On-going, but challenged |
| National private network for medical lab tests (Dr. Fürst's Medical Laboratory) | 1987-2011 | SPA | Successful |
| Edimed | 1989-1996 | SPA | Successful |
| Northern Norwegian Health Network | 1997-2003 | SPA | Successful |
| Well/DIPS Interactor | 2006-2011 | SPA | Successful |
| The Blue Fox Project | 2005-08 | SPA | Successful |
| The Prescription Register | 2003 | SPA | Successful |

*Table 1.       Projects*

First a temporal analysis was done, focusing on the development over time. This analysis documented the trajectories of projects, but also of the various discourses in the sector. For example, the forward chaining of events served to explain intentions of stakeholders, while backwards chaining of events served to explain outcomes. Overall, the temporal analysis helped to understand the dynamics of the architecture approaches.

Then a comprehensive analysis was conducted, comparing the architectures and the outcome of the different cases. A central part of the analysis was the role of architecture in designing and implementing the solution. For example, the differences between ePrescription 2 and the Blue Fox project revealed significant differences regarding the role of architecture, in projects that had many similarities in goals and objectives. These differences served as input to identifying the effects of different architectures.

# 5 Cases: Developing IIs for Health Care in Norway

Due to space limitations we have chosen to present two of the ten projects in the Norwegian health care sector shown in table 1. The two project are ePrescription (with an INA architecture) and the National private network for lab tests ("Fürst") building on a SPA approach. We describe how these projects have unfolded, and then zoom in on the role of the technological architectures chosen, before we assess the interplay of architecture and project organization.

## 5.1 INA Project: ePrescription

The hegemony of the EDI approach dates back to the late 1980s, when international standards for data exchange were introduced. Norwegian authorities, in most sectors, including health, were early adopters of EDIFACT thinking and solutions. Since 1990 there has been a whole series of INA based development projects. We illustrate the challenges related to the NA architecture by presenting one typical example: the ePrescription project which is a large project with generous funding from the Norwegian Parliament, strong political backing from political as well as administrative levels, and with strong commitments and support from a large number of actors.
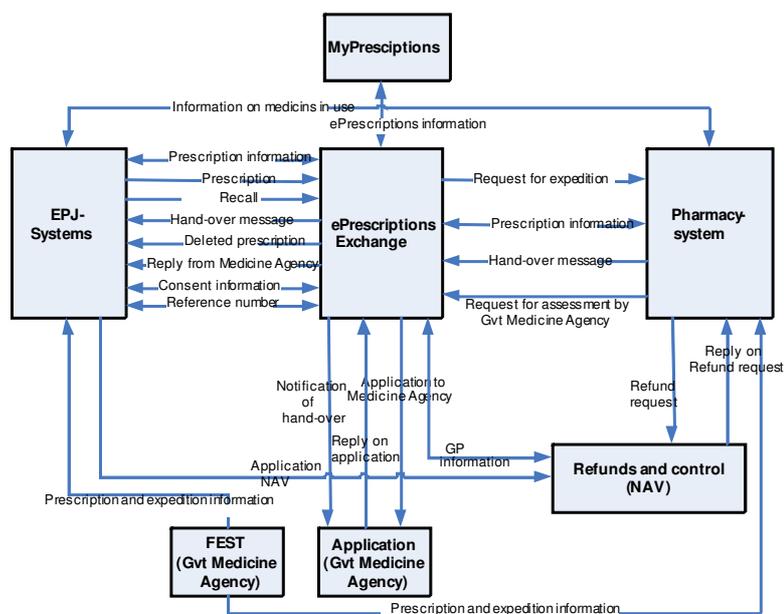


*Figure 4. The ePrescription solution: Main components*

The ePrescription project was established in 2005 with direct funding from the parliament of about 40 million Euros from the Norwegian Parliament during six years – from 2005 up to 2010. By the end of 2010 around 60 million Euros has been spent on the project. During 2006 several detailed requirements specifications and architectural document were written, specifying an ambitious, fully integrated solution. The Prescription Exchange was designed to handle 300 million transactions per year. This reflected that, in the designed solution, each prescription would generate approx. 11 transactions, from a national volume of around 27 mill prescription per year. As illustrated in figure 4, the architectural solution was based 31 different (standardized) messages being sent to the Prescription Exchange, which would perform various controls, before distributing them to other actors.

The top requirements specification of The Directorate of Health emphasized that the various actors were responsible for "their" modules, with a central database, the Prescription Exchange, as the key one. The project was organized in sub-projects reflecting each institution that was included in the service and five subprojects were established. The six main EPR vendors (3 GP and 3 hospital systems) were invited into one of the sub projects in 2006; each had to make their of version of a quite complex piece of software with exactly the same functionality.

The three suppliers of EPR systems for hospitals were too busy to participate. Another issue was that the suppliers of the hospital EPRs demanded more specific requirement specifications before they were willing to develop anything. Eventually, only the biggest vendor within the GP market agreed to develop a pilot version of electronic prescription.

In May 2008 the first pilot implementation was inaugurated by the Minister of Health. It was carried out in a village in the eastern part of the country, and included the GPs and the local pharmacy. It turned out to be a minor disaster, and after four months a crisis was declared. The main reason for the problems was not the ePrescription solution, but that the new version of the EPJ system was unstable. Somewhat unreasonably, the ePrescription project got the blame in an angry press.

The main technical solution was tested and accepted during 2009, while waiting for the vendors to complete and test their new versions. Pilot roll-out project were conducted in 2010, and contracts for large scale operations were signed. The pilots were reported to be successful, but new challenges have emerged. For instance, it seems to be the case that more or less all GPs need to upgrade their ICT infrastructure - PCs, network bandwidth, and even printers – to be able to run the solution.

At the same time, other challenges surfaced. While the primary health care system (the GP level, administrated by municipalities) issues 70% of the prescription, the rest is issued by hospitals. These are organized in four health regions, as separate state companies. In the autumn 2009 it became clear that the IT managers in the health regions had made very little preparations for integrating hospital EPRs (which are different from the GPs) with ePrescription solution. Moreover, they raised comprehensive objections to the architecture of the solution.

The situation facing the ePrescription program in 2011, then, was a challenging one. First, the late schedule of the key vendors made the stated goals of adoption unreachable. While the EPR systems were expected to be ready in 2010 – they were not. The full scale solution for the pharmacies might be as late as 2012. And the hospitals signalled that they might be ready (to start) in 2013. This obviously does not mean that the ePrescription solution will be fully implemented nationally by 2013.Even though the project is extremely generously funded and well managed (according to traditional project management recommendations), the technological complexity combined with the number of autonomous actors involved and the interdependencies between them caused by the technological architecture chosen just make the project unmanageable. We will now contrast the INA based projects with one that has adopted a different architecture.

## 5.2     SPA Project: Fürst

While the initiatives or efforts we have classified under the label "SPA projects" are different in many ways, they have some important features in common. One of these is the fact that the architecture the solutions are based on is different from the INA. None of the projects, however, are based on architectures that were well defined or well established within the ICT field.

The development of solutions for electronic information exchange between health care institutions in Norway started when a private lab, Dr. Fürst's Medicine Laboratory (Fürst) in Oslo, developed a system for lab report transmission to general practitioners (GPs) in 1987. The system was very simple - the development time was only three weeks for one person. The interest of Fürst was simply to make a profit by attracting new customers. It was assumed that the system would help GPs save much time otherwise spent on manual registering lab reports, and that the GPs would find this attractive. Each GP received on average approximately 20 reports a day, which took quite some time to register manually in their medical record system. The system proved to be a commercial success and brought Fürst many new GP customers. Its success made the potential benefits of this kind of solutions clear to many actors within health care. And many other labs, privately as well as publicly owned, developed and adopted similar solutions quickly not to lose out in the competition with Fürst.

When Fürst's solution for lab report transfer was successfully adopted by the lab's customers, Fürst wanted to extend the scope of electronic services offered. Fürst started the development of a pilot solution in 1992 together with one of the vendors of EPR systems for GPs. The solution was tested in a pilot implementation in a GP office in 1993. The experience of the pilot users did not create much enthusiasm; one reason was obviously that the overall usability of the solution was rather poor, but also that the GPs saw no immediate benefits. Fürst concluded that a successful solution would have to offer the GPs some added value.

After some time Fürst came up with the idea of offering the GPs the possibility of ordering new tests of a specimen after the results of those ordered first were available. Usually a GP orders several tests of the same specimen. Often, which combination of tests that is most relevant cannot be decided until the results of some of the analysis are seen. Accordingly, it would make sense to order some tests, look at the results and then decide on which additional analysis that is relevant. When both orders and results were transmitted electronically, this possibility could become reality.  And Fürst started developing such a service by extending its lab report service which was based on the simple but enabling ICT architecture. In this solution the lab service includes a client module on the GPs PC, leaving the EPR system almost unaffected. The communication between the client module and the lab system was designed and controlled by Fürst. The client module has some communication with the EPR system; it retrieves some patient information, and returns some basic lab test information. This is done through rather primitive mechanisms. What is significant in this SPA solution is that it (i) ensured tight and easy communication between GP and lab and (ii) that it does not require any changes in the EPR system.

Fürst used the standard messages for orders and reports. But these covered only a small part of the information exchange between the client module running in the GPs' computers and the server module running inside the lab. The rest of the information was exchanged using proprietary formats and protocols. Just as important as the messages exchanged between the GPs' computers and the lab is the very simple interface between Fürst's client software and the EPR systems.

After some pilot testing of the solution, Fürst concluded that the interactive solution required broadband networks and decided to wait until this was more broadly available – and cheaper. So real life testing started again around year 2000. Then the planning of the establishment of the Norwegian Health Care Network, which should offer broadband connections to all health care institutions, started, and Fürst decided to postpone deployment of the solution until this network was in operation. So in 2003 Fürst and the pilot users of the interactive ordering service became the first users of this national broadband service. The interactive ordering solution has increasingly got a reputation for being a

useful tool and the growth in number of users has accelerated. The number of users had by Nov 2010 increased to about 3.500, i.e. more than 50% of Fürst's customers.

The important difference between this solution and the INA solutions is, as far as this article is concerned, the fact that the architecture made it possible for a very simple project organization, inside one formal organization or company, to develop the whole solution. Further, the development organization could do so without almost any coordination or cooperation with other organizations or companies. Another important difference is that this combination of ICT architecture and development organization made it simple to extend the range of services offered to the users (i.e. GPs) through an experimental and evolutionary innovation and development process which again led to a situation where users were offered a broad range of services they highly appreciate beyond just sending orders and receiving reports, i.e. the interactive ordering service.

In addition to this case we have identified four other initiatives that have developed solutions based on the same architectural principles as the Fürst solution. And all projects have developed very successful solutions and with very small resources compared to the ePrescription project.

Are there alternative explanations of the outcome of the cases, for instance user participation or project management? Or were the INA projects generally larger and more complex than the SPA projects, and thus unreasonable to compare? These are important issues. It is true that the INA projects generally were larger. Our view, however, is that *the INA projects were larger because of the chosen architecture,* rather than because the problem to be solved was larger. The key point is that the choice of ICT architecture greatly influences on the size and complexity of the project. Regarding user participation and project management we do not find any significant differences among the projects.

# 6 Concluding discussion

Discussing the INA and SPA approach, we will focus on three key issues; the ICT architecture, the project organization and the associated risk. We summarize our argument in table 2.

As our case studies showed, all the INA projects were problematic. They all suffered from various problems associated to complexity; the large number of involved actors, the heterogeneity of technical solutions, and the many dependencies that created postponements and friction when schedules were not kept. The key to these problems are illustrated in figure 4. The chosen ICT architecture was (as usual in EDI solutions) based on the data flow between the involved organizations. This led to a relatively complex ICT architecture, with a large number of messages flowing between a large number of systems, which means that many local applications must be modified in order to produce and receive messages. In practice, each vendor has to develop their own client modules of the solution.

|  | INA approach | SPA approach |
|---|---|---|
| ICT architecture | Many applications, sending messages to each other | Single application, distributed to clients |
| Project organization | Co-ordinated teams in many organizations | Single team, within one organization |
| Overall risk | High | Medium to low |

*Table 2.        Comparing the two approaches*

Further, the INA solution implies a project organization with participants from all involved actors, usually organized as a number of sub-projects, with a central coordinating actor. As observed by van der Aalst (2009) this increases the challenge of co-ordination. The coordinating actor cannot usually instruct the other participants (since they represent independent organizations), but will have to maneuver with compromises and politics. This combination of technical and organizational complexity increases significantly the risk of postponements and even failure, as shown in the cases.

The SPA projects, although different in type and scope, were all successful. Our analysis shows that the overall reason was the chosen ICT architecture. This architecture did not reflect the information flow between the numerous organizations, but it was based on a solution from one application service provider, which greatly simplifies the solution. In the SPA based solutions the important interfaces within the overall solution are the interfaces between the communication solution and the applications - not the interfaces between the different modules of the communication system that are running within different organizations. In the SPA architecture there is a tight coupling between the different components of the communication system and weak coupling between the communication system and the applications, while the INA based solutions are based on tight coupling between the applications and the communication system (i.e. the module running within the same institution) and loose coupling between the modules within the communication system.

The most crucial aspect of the SPA based solutions, in the context of this paper, is the fact the architecture of the communication solution allows the complete solution to be developed by one single project team within one single formal organization. Only minor development work needs to be done by other organizations like application vendors. In more general terms, the important aspect of the SPA architecture is the fact that the complexity of the development organization becomes dramatically reduced compared to those of the INA based solutions.

Summing-up the increased risks of the INA approach compared to the SPA approach:
- A more complex technical solution, with a higher technical risk
- A more complex project, with very challenging co-ordination
- Higher costs, because the vendors will all have to develop their own client solutions
- Higher implementation risk, because the INA solution requires that all actors start at the same time. Such "big bang" strategy is more risky than an incremental approach as the SPA allows for.

We believe that these findings have bearing both for the field of management of inter-organizational projects, and for the growing area of health information infrastructures. Further research should investigate these issues in other settings.

Are there alternative explanations of the outcome of the cases, for instance user participation or project management? Or were the INA projects generally larger and more complex than the SPA projects, and thus unreasonable to compare? These are important questions. It is true that the INA projects generally were larger. Our view, however, is that *the INA projects were larger because of the chosen architecture,* rather than because the problem to be solved was larger. The key point is that the choice of ICT architecture greatly influences on the size and complexity of the project. Regarding user participation and project management we do not find any significant differences among the projects. For instance, the ePrescription project was managed in an excellent way according to normal standards. The problem was, however, that the choice of architecture generated an organizational complexity making it more or less unmanageable.

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