An OASIS Case Study

Norwegian e-Health Infrastructure based on XML, ebXML and PKI

Trygdeetaten Case Study

By Pim van der Eijk
For OASIS

OASIS (Organization for the Advancement of Structured Information Standards) is a not-for-profit, international consortium that drives the development, convergence, and adoption of e-business standards. Members themselves set the OASIS technical agenda, using a lightweight, open process expressly designed to promote industry consensus and unite disparate efforts. The consortium produces open standards for Web services, security, e-business, and standardization efforts in the public sector and for application-specific markets. OASIS was founded in 1993. More information can be found on the OASIS website at http://www.oasis-open.org/. OASIS also hosts the ebXML Web site, http://www.ebxml.org/, which serves as the international repository for ebXML-related information, such as case studies, implementations and ongoing specification developments.

The ebXML Messaging Service is an approved OASIS Standard, which enables secure and reliable exchange of business documents between or within organizations. It is a part of the ebXML modular suite of specifications, which is designed to support advanced e-Business integration requirements in applications like e-Commerce, e-Health and e-Government. The OASIS ebXML Messaging Technical Committee, which is responsible for the creation and maintenance of the ebXML Messaging Service specification, was originally formed in 2001. The current production version of the specification is version 2, and was approved in August 2002. Along with three other components of the ebXML framework, this version of the ebXML Messaging Service was approved by the International Standards Organisation as ISO/TS 15000-2 in March 2004. The TC is actively working on the third version of the specification.

The Norwegian National Insurance Administration and Xenos are members of OASIS.

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Executive Summary

The National Insurance Scheme is the cornerstone of the Norwegian welfare system. It provides benefits to the Norwegian population through the national insurance service (*Trygdeetaten*). This service is organized under the management of the National Insurance Administration (NIA).

Norway has had a standardized communications infrastructure for healthcare insurance for over a decade. It supports payments by the NIA of healthcare services provided by its partners, the hospitals, pharmacies and general practitioners' offices in Norway, at an aggregate value of approximately 26 billion Norwegian Kroner (3.2 billion EURO, 3.9 billion USD), or five percent of the Norwegian national government budget.

Two years ago, the National Insurance Administration initiated a project to upgrade the EDI-based communications infrastructure it used to connect to its business partners. Due to the NIA's central role as receiver of records and payment provider, this project has had a major impact. The business case for this project is built on the need for:

- Secure and reliable messaging functionality,
- Better service at the same or lower cost, and
- Faster turnaround in claims processing, due to reduced manual handling.

The project also sought to upgrade the existing infrastructure to:

- Support modern technology and open standards.
- Support a larger number of connected organizations, including general practitioners' offices.
- Enable new services, such as electronic transmission of prescriptions.

A key aspect of the new architecture has been to provide an interface specification based on open standards. One of the core open standards in the new architecture is the ebXML Messaging OASIS Standard, ISO 15000-2. This International Standard provides secure and reliable messaging of arbitrary payloads (EDIFACT, XML and other formats), and supports advanced functionality in areas like routing, monitoring, message identification and correlation.

Today, the new architecture is in production with four applications, and has transported several million ebXML messages corresponding to transactions totaling more than 10 billion Norwegian Kroner (equivalent to 1.2 billion EURO, or 1.5 billion USD).

The decision to standardize on open standards instead of a single, proprietary vendor solution delegates the responsibility to implement the interfaces based on those standards to the various business partners. While this approach requires individual organizations to select a solution that supports the selected standards, it also allows them to select a solution that best meets their (possibly unique) requirements. The use of ebXML Message standard has been a particular success. It provides the advanced functionality required by the National Insurance Administration and its partners, is demonstrably interoperable across the actual deployed systems, and has resulted in a very stable architecture. The National Insurance Administration would certainly recommend it for other sectors that are looking for a reliable messaging solution to handle sensitive information.

Background and Context

The Norwegian Healthcare System

The National Insurance Scheme (*folketrygden*) is the cornerstone of the Norwegian welfare system. It provides a number of benefits to the Norwegian population through the National Insurance Service (*Trygdeetaten*). The National Insurance Service is the largest institution under the Ministry of Labour and Social Inclusion (*Arbeids- og Inkluderingsdepartementet*). It is responsible for the administration of the social security offices and the function utility centers. The national insurance service covers healthcare, old age and disability pensions, and unemployment benefits. Differently from some other countries, there is no private healthcare insurance system in Norway.

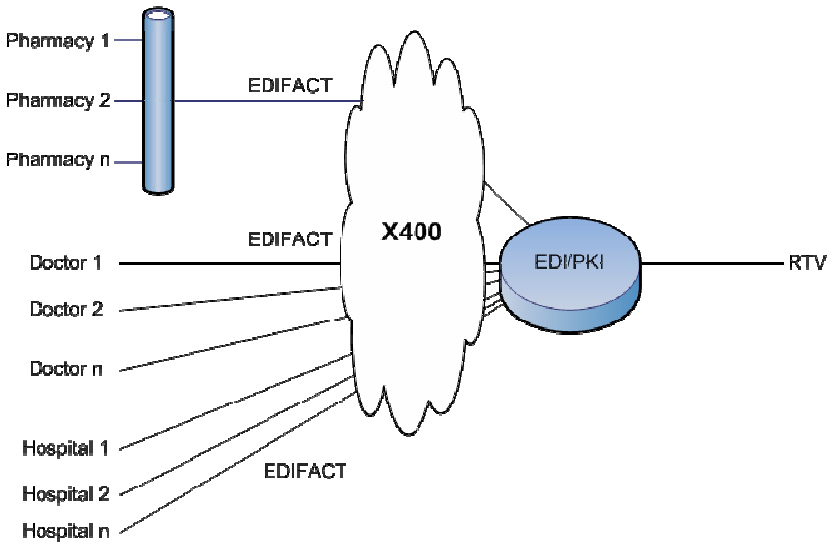
Norway has a population of only four and a half million people and is sparsely populated. It is therefore obvious that the responsibility for the Norwegian health service has historically been decentralized and operated through the nineteen counties (*fylker*) and 435 municipalities, each responsible for its part of the health service. In its present form, the healthcare system is the result of a reform which took place three years ago. Where previously the nineteen counties were directly owners of the 80 hospitals in the country, all hospitals are currently owned by the central government. With the exception of some private laboratories, all hospitals in Norway are therefore state-owned. This healthcare reform also created five larger regional healthcare service organizations that are responsible for healthcare service in each of five larger regions of Norway. All pharmacies are privately owned, except for pharmacies in hospitals, which are owned by the hospitals and therefore indirectly owned by the central government.

The national insurance service is organized under the management of a central directorate, the National Insurance Administration (NIA or *Rikstrygdeverket*), which runs its operations through its regional and municipal bodies. The NIA has overall authority over the Service and has the power to issue detailed regulations and general recommendation concerning the application of social insurance law. The National Insurance Administration is directly subject to the authority of the Ministry of Labour and Social Inclusion. On average, the National Insurance Service budget accounts for a third of the Norwegian national government budget. In recent years, this amounts to 260 billion Norwegian Kroner (equivalent to 32 billion EURO, 39 billion US Dollar).

The e-Health infrastructure discussed in this case study supports payments by the National Insurance Administration of healthcare services provided by the 80 hospitals, 550 pharmacies and 1850 general practitioners' offices in Norway worth ten percent of this amount, or approximately 26 billion Norwegian Kroner (3.2 billion EURO, 3.9 USD).

Legacy EDI System

Norway has had a standardized communications infrastructure for healthcare insurance for over a decade. This infrastructure was based on EDIFACT messages and used the X.400 message protocol. It also made use of a proprietary Public Key Infrastructure (PKI). The overall architecture of this system is displayed in the following diagram.



Architecture of the legacy infrastructure based on EDIFACT, X.400 and proprietary PKI

The existing infrastructure covered communication between all pharmacies and hospitals and the National Insurance Administration. The existing system is in high volume use between GPs and hospitals for the transfer of medical results from the hospital to the general practioners' EPJ (Electronic Patient Journal) systems. The system also connects each hospital directly to the National Insurance Administration. Although there were some diskette-based solutions, there was no networked electronic communication between general practitioners' offices and the NIA. As a result of this, claims processing was still very much paper-based, time-consuming and labour-intensive.

As shown in the diagram, there is no direct connection between individual pharmacies and the NIA. There is central hub, NAF Data, which connects to all pharmacies using a pharmaceutical computer network. This central system is connected, using EDIFACT batch file upload via X400, to the NIA systems.

The Norwegian e-Health Infrastructure

Two years ago, the National Insurance Administration initiated a project to upgrade the communications infrastructure it used to connect to its business partners: the pharmacies, hospitals and general practitioners' offices. Due to its central role as a receiver of records and payment provider, this project has had a major impact.

Business Requirements

While the existing EDI system already provided a number of benefits, there were both business and technical reasons for initiating a major overhaul of the e-Health communications infrastructure. The main benefits the new system was set out to provide were the following:

- ***Security*** of messages is very important due to the sensitive nature of information exchanged in an e-Health context:
  - Clear and unambiguous ***authentication*** of the identity of the sender of a message must occur.
  - The ***integrity*** of a message should be preserved in transit between sender and recipient.
  - The ***confidentiality*** of privacy-sensitive information about individuals must be respected.
  - The infrastructure should provide ***non-repudiation*** to ensure that a sender cannot deny having sent a particular message, and that a receiver cannot deny having received it.
- Message transport should be ***reliable*** and make sure messages are delivered once and only once, in an auditable way.
- Efficiency of the administrative processes should be improved to enable the healthcare system to provide ***better service*** at the same or lower cost.
- ***Reduction of manual handling*** is not just important for cost efficiency reasons; it also allows messages to be processed faster and therefore payments to be provided sooner and more accurately.

Technology Context

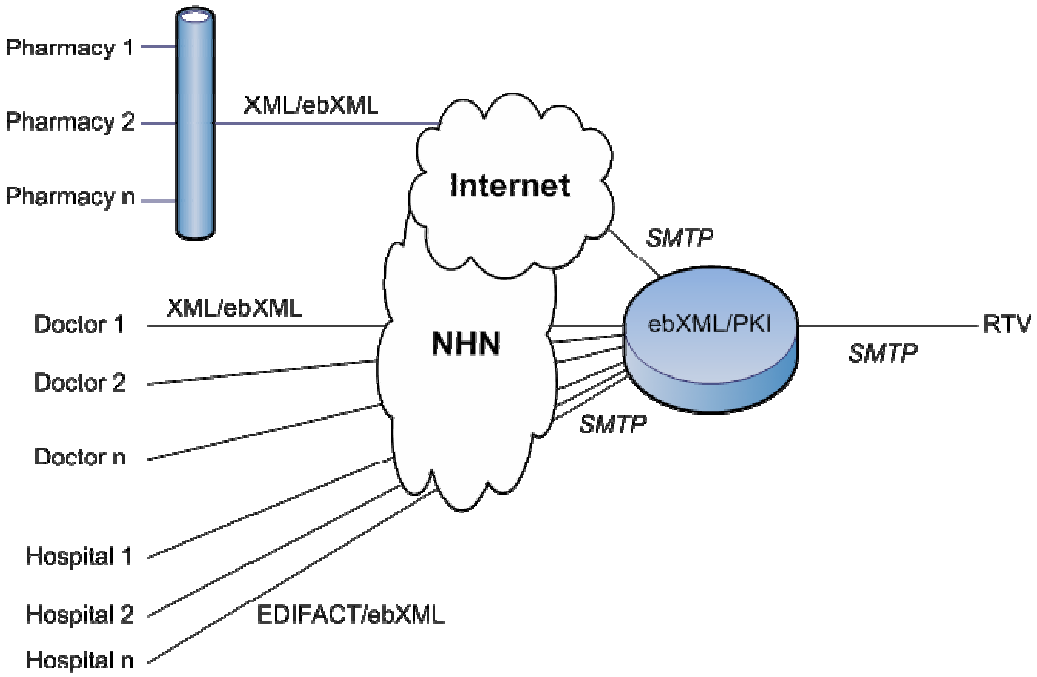
The project was also started in the context of technology and standards changes at the National Insurance Administration:

- A migration from mainframes to less expensive UNIX-based platforms and more manageable, scalable Java-based application servers.
- Introduction of a secure messaging-based system for enterprise application integration at the NIA.
- A migration to industry-standard Public Key Infrastructure (***PKI***).
- A strategy to build solutions on ***open standards*** and to prefer commercially available, off-the-shelf products from market leaders over proprietary or custom-built solutions.

- Migration from X.400 to a less expensive, ***Internet Protocol***-based National Health Network (NHN) in Norway.
- The emergence of Extensible Markup Language (***XML***) as new standard message format and format for electronic business documents.

New Architecture

The architecture of the new infrastructure was designed to meet the business requirements in the emerging technical context. An overview of the architecture is provided in the following diagram.



New architecture of the Norwegian e-Health Infrastructure

In the new architecture, general practitioners' offices are connected to the NIA and other organizations in the Norwegian healthcare using the National Health Network. This is one of the key differences from the existing architecture, where this communication is still very much paper-based. Unlike hospitals and pharmacies (which use company or "server" certificates), messages sent by general practitioners will be signed using the personal private key of the individual general practitioner. Sensitive messages sent to them will similarly be encrypted using their public key. The infrastructure provides on-line verification of signatures and also checks for revocation of certificates, using the standard Lightweight Directory Access Protocol (LDAP).

Pharmacies remain connected using the existing interfaces and protocols to the national pharmacy system. However, this national pharmacy hub, acting as a kind of gateway, now connects using ebXML Messaging over the SMTP transport protocol over Internet Protocol to the NIA. The existing connections from hospitals to the NIA will continue to use the EDIFACT message format for existing message types.

Open Standards

The architecture for the Norwegian e-Health infrastructure is based on ***open standard*** transport protocols and message formats. Each partner is (and remains) responsible for being able to send and receive messages according to the standard interfaces, and for the selection of the software products and services to develop and provide these interfaces. The NIA has worked with its partners in the selection of these standards. The joint decision has been to use XML formats for new message types, while EDIFACT will continue to be used for existing production systems.

One of the benefits of using transport protocols and message formats based on open standards is that a single solution is not mandated to each business partner. A key advantage of the use of XML is that it allows for better message specification and automatic ***message validation*** and therefore eases error detection and testing.

Another difference with the existing situation is that ***ebXML Messaging*** will be used as message transport protocol. The next section will explain what ebXML is, and what functionality the ebXML Message Service provides. EbXML Messaging will be used to transport both EDIFACT payloads (for existing connections) and XML payloads (for new message types). While X.400 connections will continue to be used for some existing connections, these will gradually migrate to the use of ebXML Messages.

KITH, the Norwegian Centre for Informatics in Health and Social Care, is responsible for development of healthcare IT standards in Norway and also maintains the relation to European and international standards organizations in the healthcare domain. KITH has developed the XML schemas for the new message types and publishes them on its Web site. KITH has also recommended the use of ebXML Messaging.

The ebXML framework for e-business

The ebXML initiative started in 1999 as a joint initiative between ***OASIS***, the international, not-for-profit consortium that drives the development, convergence, and adoption of e-business standards, and ***UN/CEFACT***, the United Nations Centre for Trade Facilitation and Electronic Business. Its original goal was to develop a modular, yet complete electronic business framework to enable the development of a single global electronic marketplace. Today, the ebXML framework consists of:

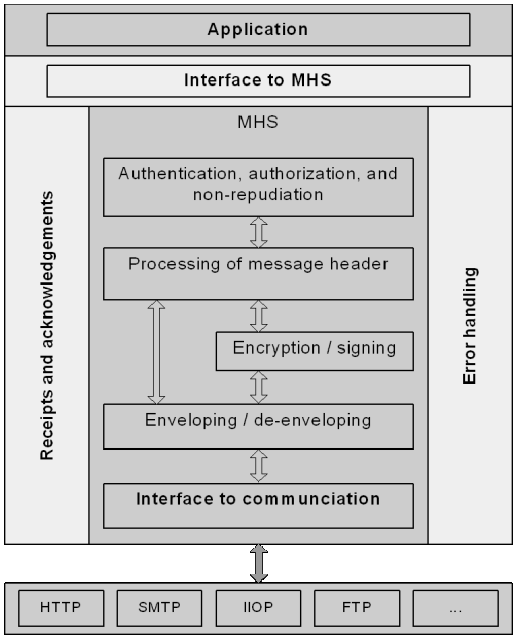
- A series of technical infrastructure specifications, which continue to be developed and maintained within OASIS:
  - The ebXML Collaboration Protocol Profiles and Agreements (CPP/A) specification, which can be used to define how two trading partners engage in electronic business collaborations through the exchange of electronic messages.
  - The ***ebXML Messaging*** Service specification, discussed in the next section.
  - The ebXML Registry specification, encompassing a Registry Information Model and a set of registry services
  - The ebXML Business Process specification, which provides a representation language for business processes, activities, and collaboration used for business collaboration.
- A specification for business information, developed by UN/CEFACT.
  - The ebXML Core Components specification definition.

In March 2004, these five technical specifications have been published as five parts of the International Standard, ISO 15000.

While originally designed to support electronic business, ebXML is really a generic framework for collaboration between organizations. It is equally suited to e-Government and e-Health integration as it is for e-Commerce.

The ebXML Messaging Service

The ebXML Message service is a powerful, robust, secure general purpose message protocol. Architecturally, it fits between a business application or middleware and lower-level Internet protocols, providing business-oriented additional functionality. This is illustrated in the following diagram:

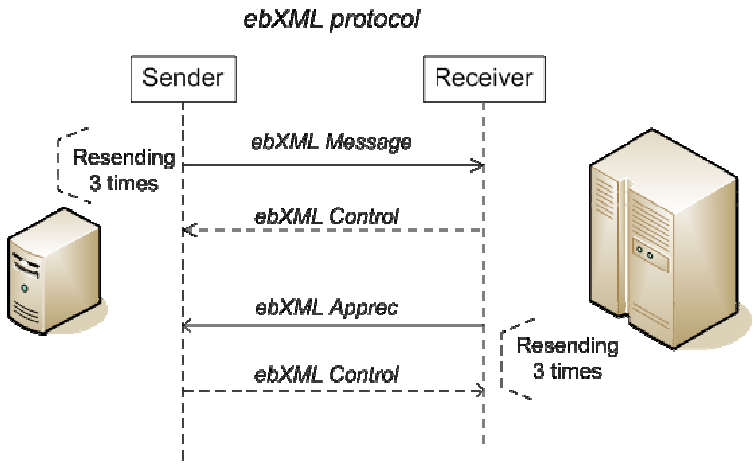


ebXML Message Service Handler

Specifically, the ebXML Messaging Service offers the following benefits:

- It provides the ***security features*** (authentication, integrity, confidentially and non-repudiation) mentioned in the discussion on Business Requirements, page 7, through the use of XML digital signatures and XML encryption, in conjunction with a Public Key Infrastructure (PKI). In messages sent from general practitioners, the digital signature used to sign the ebXML message is the personal certificate.
- It can be used over various lower-level transport protocols. In the Norwegian e-Health network, ebXML Messages use ***SMTP*** as the underlying Internet message transport protocol. Other ebXML applications use HTTP, often layered over Transport Layer Security (SSL/TLS).

- It provides a ***reliable messaging*** protocol based on receipt acknowledgments and a retry mechanism. This prevents loss of messages in the messaging system. In the Norwegian e-Health network, messages are resent up to three times, and can therefore recover from accidental loss at the lower (SMTP) message transport level.



The ebXML Reliable Messaging Protocol

The ebXML Message Service also has the following benefits:

- It has an enhanced set of ***message identification*** and ***correlation*** message header fields, useful to support long-running, asynchronous transactions.
- It enables ***routing*** based on envelope information (even for encrypted payloads).
- It supports tracing and ***monitoring*** of message traffic.
- It can be used in conjunction with other parts of the ebXML framework, in particular ebXML Collaboration Protocol Agreements, to easily specify (partner-specific) message service ***configuration***.
- It can be used to transport payload in ***any format***. This means the Norwegian e-Health infrastructure can use it both for new transactions (XML business documents) and existing transactions (EDIFACT messages).

In the Norwegian National Health Network, the use of ebXML Messaging is part of the interface specifications. For connectivity, it is up to the sender and the receiver to implement the ebXML Messaging Service standard in a proper way. There is no requirement to use a particular software implementation, as long as the implementations are ***interoperable***.

Xenos terminalONE

The ebXML Message service provided by the National Insurance Administration is arguably one of the critical components. It is built using a commercial product, Xenos terminalONE.

Xenos terminalONE is an end-to-end, standards-based transaction gateway solution that expedites business transactions over the Internet and across disparate platforms. It is

developed and maintained by Xenos, a Canadian solution provider company with offices in North America and Europe.

Xenos terminalONE transport is a J2EE software component that enables reliable and secure end-to-end exchange of data over the Internet. It provides a full ebXML Messaging 2.0 implementation, including support for the reliable messaging and security modules. Public Key Infrastructure can be used both at the SSL/TLS transport level, to provide client and server authentication, and at the message content level.

For per-partner configuration, the software uses the Collaboration Protocol Agreements (CPA) mechanism. This mechanism is also defined in the ebXML framework and allows interoperability across ebXML implementations.

The terminalONE transport module can be used as a standalone component in a J2EE application server, or in conjunction with terminalONE transform (an any-to-any data transformation engine) or terminalONE traffic (which intelligently routes transactions to the right back office system based on the type of data or a wide variety of other parameters).

Current Status and Outlook

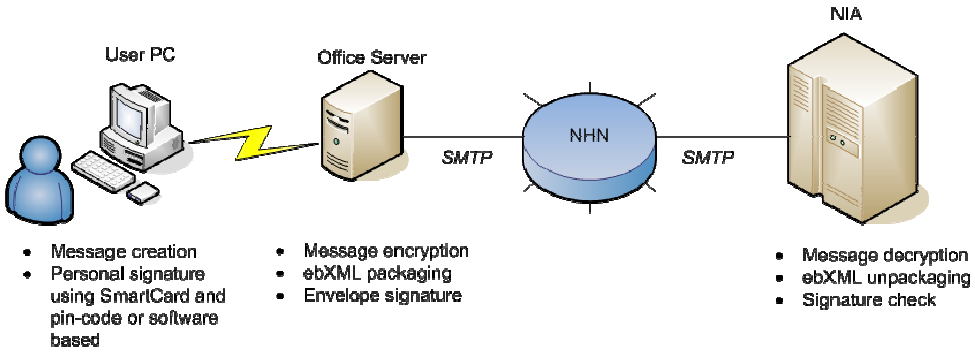
The Norwegian e-Health infrastructure has been under development and deployment for two years. This section reviews the current status of the initiative and current plans.

Today's Applications

At present, four applications are using the new architecture:

- ***Medical certificate***. Currently, 900 general practitioners at 350 offices (out of a total of 1850 offices) are using this application, covering access to 20% out of a total of 3.5 million medical records. The expectation is that this will double in 2006, as more and more suppliers of software to general practitioners add ebXML Messaging capabilities to their products, thus enabling their customers to connect to the e-Health infrastructure.
- ***Requests for payment*** from general practitioners to the NIA. This is currently used by 500 doctors at 200 offices.
- ***Requests for payment*** from pharmacies to the NIA. All pharmacies in Norway are using this application, and transactions totaling 10 billion Norwegian Kroner (equivalent to 1.2 billion EURO, or 1.5 billion USD) annually are transacted using this application.
- The ***EHIC*** (European Health Insurance Card) is a European standard card format for European Union, European Economic Area or Swiss nationals traveling or staying temporarily in another EU/EEA country or Switzerland, indicating they are entitled to receive medical care should they become ill or have an accident. The order process between the NIA and the card producer uses ebXML Messaging. Currently, two million cards have been produced using this application.

The following diagram illustrates the connectivity between general practitioners' offices and the National Insurance Administration, using ebXML messaging over SMTP using the National Health Network.



Future Applications

The current focus of the e-Health infrastructure is to increase the use of the services, by:

- Increasing the number of business partners connected to the NHN and capable of sending and receiving ebXML messages,

- Adding additional services that use the infrastructure.
- Migrating existing services that use EDIFACT on X.400 to use ebXML over SMTP. These will not migrate to XML but will retain EDIFACT as the payload document format.

The next big project is electronic transmission of ***prescriptions***. This will generate 17 million messages per year. The initial development work has started, and initial pilot testing will take place in 2007. This new application is of particular interest as it leverages a lot of infrastructure already built to support the services that are in production today:

- It will use the ebXML connections in the general practitioners' offices to transmit prescriptions to a new national prescription database.
- These messages will be signed using the personal certificate of the prescribing doctor, like the medical record service operates today.

The mechanism used at pharmacies to retrieve prescription from the new prescription database will also be based on ebXML Messages.

A growing number of connections also create a growing number of trading relations, or Collaboration Protocol Agreements in ebXML terminology. There is no centralized management of CPAs and, today, each new or modified CPA imposes some manual processing at the National Insurance Administration. Work is ongoing and close to completion to automate CPA formation as a self-service application, generating a CPA from information submitted by a partner wishing to connect to a service at NIA. This will increase the efficiency of the overall solution, as it reduces management time and costs.

Interoperability and Open Standards

From the outset, the Norwegian e-Health infrastructure has been firmly based on the principle of using open standards:

- ebXML Messaging, the International Standard for secure and reliable messaging.
- EDIFACT and XML for the definition of business document types.
- Internet Protocol for the National Health Network

The use of open standards has been a strategic choice that has worked well for the project. This principle explicitly leaves the responsibility of implementing these standards with the individual business partners. Organizations make an agreement to communicate and then are individually responsible for the implementation of the agreement. It does not impose a single software solution on an entire community, but allows individual business partners to select a solution that conforms to the standard, but also meets each individual organization's (possibly unique) requirements.

At the National Insurance Administration, the choice of ebXML Messaging as the messaging standard is not being regretted. The interoperability of the Xenos terminalONE deployed at the core of the network at National Insurance Administration and the messaging systems of the business partners has been quite successful. While any project this size and involving critical business messages requires extensive testing, the system is now in production, is very stable and delivers secure and reliable message capabilities to the connected organizations in the Norwegian healthcare system. The National Insurance Administration would certainly recommend ebXML Messaging for other sectors looking for reliable messaging to handle sensitive information.

As other projects of similar scope and nature have found, the real challenges in deploying and extending the Norwegian e-Health infrastructure are not technical, but related to the organizational complexity of connecting large numbers of partners that use a diversity of enterprise and legacy systems, but are required to converge on a common interface.

Further Reading

The international Web site for the Ministry of Labour and Social Inclusion in Norway is at http://odin.dep.no/aid/english/bn.html. The main entry point for the Norwegian National Insurance Service (NIA) on the public Internet is http://www.trygdeetaten.no/. The web page at http://www.dep.no/odin/english/norway/social/032005-990494/dok-bn.html provides an overview of Norway's social security and healthcare service. A selection of health-related public web sites in Norway is at http://www.norway.no/tema/health.asp.

The OASIS web site is http://www.oasis-open.org/. The various technical committees and their public documents and email archives can be accessed through this site.

The main portal for the ebXML specifications and information about its use, adoption by end users, and implementation in software and services is http://www.ebxml.org/. This includes descriptions of, or references to, case studies. Another e-Health case study using ebXML Messaging is the UK project http://www.ebxml.org/case_studies/NHS-ebMSG-casestudy-041206.pdf, "Connecting for Health".

The ebXML Messaging specification (ebMS) version 2 is available from OASIS or ISO:

- http://www.oasis-open.org/committees/ebxml-msg/documents/ebMS_v2_0.pdf
- http://www.iso.org/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=39973

The ebXML Configuration Protocol Profile and Agreement specification (CPPA) is available from OASIS or ISO:

- http://www.oasis-open.org/committees/ebxml-cppa/documents/ebcpp-2.0.pdf
- http://www.iso.org/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=39972

The latest information and documents from the Technical Committee responsible for ongoing work on the ebXML messaging service specification are available at http://www.oasis-open.org/committees/ebxml-msg/. This includes (drafts of) future versions of the ebXML Messaging specification.

The NIA uses the ***Xenos terminalONE*** product to provide ebXML Messaging functionality. More information on this product is available at http://www.xenos.com/products/terminalone.htm.

KITH, the Norwegian Centre for Informatics in Health and Social Care, is responsible for development of healthcare IT standards in Norway. Its web site is http://www.kith.no/.

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The production of this white paper was supported by Xenos, providers of the terminalONE product used by the National Insurance Administration to provide ebXML Messaging functionality, in accordance with the OASIS Case Study Guidelines (http://www.oasis-open.org/casestudies/guidelines.php).