nehta

Towards an Interoperability Framework

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Health is a diverse community consisting of individual organisations and jurisdictions delivering care through a range of delivery channels. The ICT capabilities of the health sector, from both technical and management perspectives, are diverse. On the path to achieving an electronically connectable environment, the initial requirement is realising a *shared understanding* in delivering the result – E-Health. Across such a diverse community, this is itself an ambitious undertaking.

The national E-Health agenda aligns with the health reform agenda to improve care delivery as it relates to individuals, organisations and jurisdictions. The E-Health agenda needs to be cognisant of the multi-jurisdictional, cross-boundary nature of the health sector, and deal with care delivery imperatives (and therefore clinical communications) that are at and between the various levels of the health sector.

E-Health does not only apply to a health care organisation in isolation but also to the exchange of clinical information on an industry-wide basis. As the scope of E-Health reaches beyond single individuals, organisation, or jurisdictions, so too the requirements for interoperability expand.

Those attempting to accommodate this increase in interoperability, find some of the standards unclear, unaligned, and uncoordinated. Standards are used to varying extents across the health sector, using different implementations and technologies, and inconsistent approaches. In some cases, the implementation of any standards is inhibited due to the existence of products that are not standards-based.

To ensure interoperability a common understanding is necessary and consistent support for a suite of standards is essential. A national approach to interoperability is vital to the E-Health agenda as it drives toward more electronic interconnectivity and contributes to delivering anticipated cost savings and enhanced health delivery opportunities.

To add to the complexity of the industry-wide makeup, on an individual basis, jurisdictions and provider organisations are seeking to build architectures that will deliver to their increasing demands. They are drawing from differing architectural approaches to guide and align a broad range of solution alternatives into a cohesive infrastructure. The hope is that the more modern architectures are able to stimulate service evolution and innovative solution development in a structured and interoperable manner. Many players are choosing a service-driven approach, building upon ICT best practice and preferred vendor solutions.

The 'interoperability' factor when selecting vendor solutions is increasingly difficult to measure without the ability to benchmark products and solutions against common, proven and interoperable standards.

1 Purpose

The Interoperability Framework (IF) documents the approaches, policies, information, and tools that are shared across the health sector to deliver an interoperable E-Health environment. It delivers a single source of guidance on which all parts of the health care community can agree and use as the basis for business and systems integration.

The IF does not replace enterprise approaches delivered by organisations and jurisdictions within health but instead acts as a common toolset to facilitate compatibility. It fills the gap between national standards outcomes and organisational solutions by tying together the multiple layers necessary for interoperability in a consistent manner.

The IF comprises organisational, information, and technical viewpoints that document acceptable E-Health practise. Although it does not directly deliver NEHTA initiatives, it defines the conversation through which compatibility and interconnectivity can take place, both between NEHTA initiatives and the broader health community.

This document is most useful to those defining and implementing the outcomes from the NEHTA Work Program. NEHTA recognises that no single initiative in its Work Program lives in isolation, but instead requires compatibility of approach at multiple levels with the other work within the program. This document defines the context for this crosscutting aspect to the NEHTA initiatives.

2 Introduction

Interoperability is the ability of systems to share information and/or functionality with another system based upon common standards. In comparison, *integration* is the combination of separate systems into a new system functioning as a whole. This is sometimes referred to as a system of systems brought about via interface engines and Enterprise Application Integration (EAI) technologies. Whereas interoperability can be seen as creating a level playing field for predictable and efficient integration, it is in itself insufficient to deliver system integration.

Where integration works well in closed, single jurisdictional and less complex situations, the abstraction of interoperability is better suited to environments that are:

- Multi-jurisdictional,
- Requiring cross-boundary connectivity,
- Complex with emergent behaviour, and
- Open to external inputs and actions.

This should be contrasted to enterprise architecting approaches where a single enterprise can restrict these factors from major influence. An architectural plan is developed to which all collaborating parties are expected to adhere. Standard approaches include the Zachman Framework[1], FEAF[2] (Federal Enterprise Architecture Framework), and TOGAF[3] (The Open Group Architecture Framework).

This paper explores the motivation for an E-Health Interoperability Framework and presents an approach to achieving interoperability across health. We examine approaches taken nationally and internationally to achieve this goal.

3 Challenges

Interoperability introduces new challenges to more traditional ICT architecting approaches. This section defines some of these challenges and later sections will use these challenges to drive requirements analysis and IF delivery.

Interoperability is not solely a technical issue. It requires the diverse drivers and solutions for "joined up" collaboration of ICT systems to be delivered as an interdependent outcome. Within a single organisation, we might expect such a result to be delivered through an Enterprise Architecture but a number of constraints distinguish such a collaborative community from a single organisation.

- A collaborative community is *diverse* in its capabilities, delivery channels, and organisational structures. Diversity provides resilience but also highlights the challenges and potential weaknesses for collaboration.
- *Localisation* of national solutions meets jurisdictional requirements driven from their diversity of environment and approach.

[1] Zachman Institute for Framework Advancement, http://www.zifa.com, June 2005.

[2] Federal Enterprise Architecture, http://www.whitehouse.gov/omb/egov/a-1-fea.html, June 2005.

[3] The Open Group Architecture Forum, http://www.opengroup.org/architecture/, June 2005.

- Communities are *open* to changing membership and require support for a range of predicted, and sometimes unpredictable, events.
- Organisational structures are *complex* but communities are an order of magnitude broader and hence both more complex and evolving.
- Members have community *obligations* but at the same time often strive for organisational goals that may put them in competition with other community members.
- It is often pragmatic and desirable to encourage support for *multiple solution providers* within a community, ensuring competitive market dynamics and evolution. However this also presents an integration challenge for collaboration.
- Many will highlight the *loosely coupled* nature of modern integration environments. The sad fact, however, is that these environments often require external experts to reconstruct the coupling each time a change is required. An open and evolving community cannot operate this way.
- Distributed systems are logically more technically resilient to isolated failure than centralised systems but within a community environment, technical issues can be overshadowed by issues of *provenance and jurisdiction*.
- *Boundaries* are a natural consequence of multiple, independent system design and an integration approach often attempts to hide such conditions through transparency. In a diverse community however, recognition and transition across boundaries is a building block for collaboration. This does not imply cross-boundary integration.
- Technologies and standards are in a constant state of *evolution* as are the requirements for their use. A sustainable response to this evolution is to adopt a dynamic model of standards and technology adoption based upon a combination of pragmatism and idealism.
- Technology changes much faster than information. A *data-driven* approach to interoperability is more sustainable than a connectivity-driven approach in a changing environment.
- *Open Standards* provide an ICT insurance policy against technology changes and possible isolation. It also ensures a level playing field for interoperable solution provision from multiple sources.

The Health sector is the sum of its constituent organisations with a cross-industry component that belongs to the whole. NEHTA's work is delivering the specifications and designs for this cross-industry component, thereby enabling organisations to interoperate in an efficient, affordable, and sustainable environment.

Architecting concepts have been used to deliver interoperability within single organisations but are often aligned to a closed or inward-looking group looking to deliver enterprise efficiency gains. Cross-industry environments require a fresh approach building on the fundamentals of organisational collaboration combining business processes, people, information, and technologies. Communities require a balance between efficiency gains and the delivery of emerging capability amongst diverse and evolving organisations. E-Health interoperability must deliver mechanisms for organisational inter-working from technical, information, and business perspectives but not necessarily prescribe how those mechanisms are used to deliver to emerging requirements.

4 Frameworks, Models, and Architectures

Complexity and evolution are difficult issues for industry-wide solutions. Abstraction and separation of concerns, through various viewpoints, are used to analyse such

environments and hence we see references to various schools of frameworks, models, and architectures for interoperability, integration, and solution design. Two popular approaches for interoperability are Interoperability Frameworks and Interoperability Architectures.

1. An *Interoperability Framework* is a technical *abstraction* defining the standards, policies, and information specifications enabling predictable interconnection and exchange between separate systems.
2. An *Interoperability Architecture* defines a particular *design* for connectivity and exchange based upon the standards, policies, and information specifications provided in a framework. These are often based upon standard approaches such as message-oriented architectures, service-oriented architectures, store and forward, or an information bus.

Industry bodies, de facto standards groups, and vendors have endorsed standards profiles as a common design or architecture. Examples include WS-I Web Services[4], OASIS ebXML[5], OMG CORBA[6], and IETF's AS2[7]. These give pragmatic guides to solving business problems by using a series of standards together to meet the scoped objectives.

More generally we can classify these approaches using a hierarchy of techniques, each progressively providing more concrete steps towards solution delivery (see Figure 1).

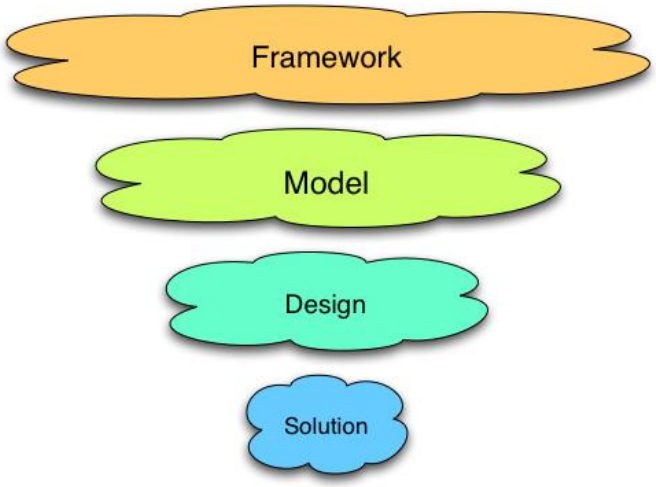

Figure 1: Implementing through a Framework

A *framework* sets broad policy and process guidance providing consistency of approach and ensuring crosscutting between specific functional models is appropriate and informed.

A *model* identifies a particular problem space and defines a technology independent analysis of requirements.

The *design* or architecture maps model requirements into a particular family of solutions based upon standards and technical approaches.

Finally a *solution* manifests a design into a particular vendor software technology, ensuring adherence to designs, models, and frameworks.

[4] Web Service Interoperability Organization, http://www.ws-i.org/, June 2005.

[5] ebXML: Enabling a Global Electronic Market, http://www.ebxml.org, June 2005.

[6] Object management Group, http://www.omg.org, June 2005.

[7] *MIME-based Secure Peer-to-Peer Business Data Interchange Using HTTP, Applicability Statement 2 (AS2)*, http://www.ietf.org/internet-drafts/draft-ietf-ediint-as2-20.txt, December 2004.

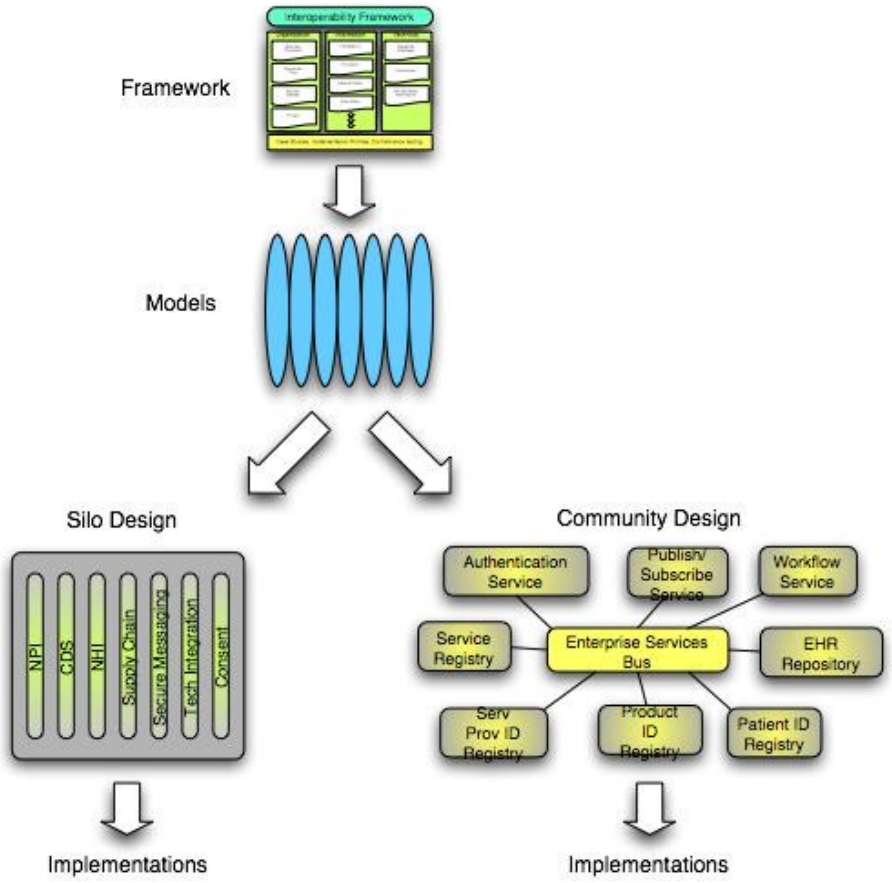

Figure 2: Alternative Design Approaches

Framework-based solutions do not guarantee scalability nor do they necessarily break down traditional silos of connectivity. Figure 2 highlights alternative design approaches to a common set of models. Although it might seem technically obvious to adopt a new, open approach; ingrained business motivations might reinforce existing approaches.

The preferred NEHTA approach is the community architecture where services and service use is expected to evolve over time and the inherent relationship between architectural components requires their solution approach to be considered as a whole rather than as a series of isolated issues. In scaling to national approaches, service evolution and local customisation capabilities are paramount to successful solution adoption.

5 National and International Interoperability Efforts

Interoperability Frameworks are not a new concept. For a number of years, they have been a building block to deliver E-Government outcomes in many countries including Australia. E-Government requirements are a subset of those for interoperable E-Health. Common drivers include the diversity of the community, evolving nature of the participants, and the ever-changing role of technologies and standards.

5.1 Australian Government Technical Interoperability Framework (AGTIF)

The Australian Government Technical Interoperability Framework (AGTIF)[8] was first delivered in 2003 and an update made available in 2004. The work is owned by the Australian Government Information Management Office (AGIMO), formerly known as the National Office for the Information Economy (NOIE). The framework introduces three interoperability aspects:

- Technical,
- Information, and
- Organisation.

The AGTIF is limited to the technical viewpoint and identifies a set of common standards and guidelines for implementation across Australian Federal Agencies. The work provides a classification scheme for standards and in the framework update, a set of case studies describing agency use of standards in the context of delivering solutions.

Further work is currently being undertaken to deliver a National Government Interoperability Framework (NGIF). This framework creates a broader design that will guide and promote interoperation between government jurisdictions covering the three aspects of interoperability, as above.

5.2 e-GIF UK e-Government Interoperability Framework

Often quoted as a seminal work on interoperability at a government level, e-GIF defines the technical policies and specifications governing information flows across government and the public sector in the United Kingdom (UK). Technical specifications are contained within a Technical Standards Catalogue while the policy, management, implementation, and compliance components are part of the main document. e-GIF identifies the use of XML and other mainstream standards as core to information description and integration.

e-GIF provides a pragmatic approach to adopt Internet and World Wide Web specifications where possible including the use of XML and XSL[9] for information schema definition. Policies and specifications are mandatory for all government interchange.

The five main outcomes of the work are the framework itself, the Technical Standards Catalogue, an e-Government Metadata Standard (e-GMS), a centrally agreed information schema repository supported through the GovTalk website[10], and long-term initiative backing through guides, toolkits, working groups, and related activities.

5.3 European Interoperability Framework for Pan-European eGovernment Services

The European Union (EU) has drawn from the Interoperability Framework efforts of France, Germany and the UK to create v1.0 of the European Interoperability Framework[11] in 2004. It supports the delivery of eGovernment services across the EU through the standardisation of information content as well as technical policies and specifications.

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[8] *Australian Government Technical Interoperability Framework*, http://www.agimo.gov.au/publications/2005/04/agtifv2, April 2005.

[9] Extensible Stylesheet Language Family (XSL), http://www.w3.org/Style/XSL, June 2005.

[10] *Setting Standards for Seamless Electronic Government*, http://www.govtalk.gov.uk, June 2005.

[11] *European Interoperability Framework for pan-European eGovernment Services*, http://europa.eu.int/idabc/en/document/3761, version 1.0, 2004.

The framework is an enabler for pan-European interoperability rather than delivering interoperability. It highlights the complexity of cross-border interactions through the principles of accessibility, multi-lingualism, security, privacy, subsidiarity, use of open standards, assessment of open source software, and use of multi-lateral solutions.

Three dimensions of interoperability are described; organisational, semantic, and technical interoperability. These viewpoints address common eGovernment services and their underlying business processes, specification and publication of information elements and dictionaries, and open standards for technical interoperability of both front- and back-office services.

Understandably multi-lingual and cross-boundary issues are highlighted with objectives to improve effectiveness of solutions through new service opportunities, efficiency of provision, flexibility of channel delivery, and transparency of service access.

5.4 UK NHS National Programme for IT (NPfIT)

The UK Health sector has come together under a National Programme for IT[12] (NPfIT) leveraging off the work of the e-GIF. Now known as Connecting for Health (CfH), this is a centralised approach to IT interoperability enacting an interoperability architecture based upon specific health delivery points such as Care Records. Since the NHS is the predominant health provider in the UK, a centralised and architected solution is possible but it still remains to be seen whether the centralised approach can meet the broad set of expectations in the community. The £6.2 billion IT health infrastructure projects are being centrally directed but locally provided within England.

The integration technology for the effort is based upon a reliable underlying IT infrastructure for sharing of the Care Records. The Transaction and Messaging Service (TMS) is part of an Enterprise Architecture and implements a large-scale Web Services-based rollout delivering connectivity to the national Spine. Responsibility for this architecture lies with the Central Design Authority and Technology Office. Again, this centralised architecture is possible through the shared e-GIF background and the dominant role of the NHS in health provision to the English.

5.5 Canada Health Infoway

Infoway[13] was constructed to foster and accelerate the development and adoption of electronic health information systems with compatible standards and communications technologies on a pan-Canadian basis. Their mandate is driven through the deputy ministers of health for the federal, provincial, and territorial governments of Canada. As well as supporting the organisation issues of moving the agenda forward, they are also looking to a national solutions architecture for an Electronic Health Record (EHR) Solution (EHRS).

The proposed architecture is described in the "EHRS Blueprint, an Interoperable EHR Framework"[14]. It describes business and technical considerations and approaches for the development and implementation of a pan-Canadian EHRS. This Enterprise Architecture includes a service-oriented approach to community collaboration along with a series of registries providing standard services. An open source pilot of this architecture has been completed as IRIS[15] (Infoway Reference Implementation Suite) utilising open source

[12] National Programme for IT in the NHS, http://www.connectingforhealth.nhs.uk, June 2005.

[13] Canada Health Infoway, http://www.infoway-inforoute.ca, June 2005.

[14] EHR Solution Blueprint, http://www.infoway-inforoute.ca/investments/portfolio.php?lang=en#EHRSolutionBlueprint, June 2005.

[15] Infoway Reference Implementation Suite, http://sourceforge.net/projects/crrs, June 2005.

technologies such as Tomcat[16] for Java Servlets, the MySql[17] database, JBoss[18] Java application server, and Apache[19] Web Server.

No explicit interoperability framework exists for Infoway although there is a standards collaboration group and nationally, the Treasury Board of Canada provides the Treasury Board Standards (TBIT) that mandate information and technology standards for use across the federal government of Canada.

5.6 US DHHS Health Information Architecture

The United States (US) Department of Health and Human Services (DHHS) Office of the National Coordinator for Health Information Technology[20] (ONCHIT) has initiated an Request for Proposals (RFP) process for the development of up to six prototypes for a Nationwide Health Information Network Architecture. Late in 2004, a Request for Information (RFI) for health interoperability identified key requirements including the provision of a decentralised architecture built upon Internet technologies, open standards, and shared policies. However it was also noted that many non-technical issues were important including bridging the private and public health providers, providing central leadership, certification and compliance to agreed standards, and addressing privacy concerns as well as other legal issues between state jurisdictions. The prototypes are to be utilised in a simulated health environment including up to 100 health personnel running through various health scenarios. Completion of the 12-month prototype implementations and testing will deliver within the 500-day goal set in April 2004.

5.7 Summary

An Interoperability Framework is an enabler for systems working together. It provides the shared vision and rules for instigating coordinated change to support complex, emerging interactions between organisations or individuals. The publication of interoperability guides and ensuing engagement with all levels of health is critical to success.

Technical, information, and organisational viewpoints differentiate issues relevant to interoperability. Key aspects of these technical components include the use of open standards, a service-oriented approach to system design, and the adoption of Internet technologies to ensure access to the latest in technology advances. The standards catalogue identifies common technical building blocks for system interaction. Technical issues must be equally balanced with shared information specifications and policies aligning organisational business processes.

6 Interoperability Framework Approach

The broad nature of an Interoperability Framework brings together organisational, information, and technical aspects relating to the delivery of interoperability across health (see Figure 3). This breakdown of viewpoints has been adopted by AGIMO's AGTIF and the European Interoperability Framework. It is also compatible with other approaches such as eGIF.

[16] Apache Tomcat, http://jakarta.apache.org/tomcat, June 2005.

[17] *MySQL: The World's Most Popular Open Source Database*, http://www.mysql.com, June 2005.

[18] JBoss Enterprise Middleware System (JEMS), http://www.jboss.org/products/index, June 2005.

[19] The Apache Software Foundation, http://www.apache.org, June 2005.

[20] Office of the National Coordinator for Health Information Technology (ONCHIT), http://www.os.dhhs.gov/healthit, June 2005.

Integration and interoperability are distinct concepts. Integration environments connect interfaces between heterogeneous systems using interconnection technologies. They create a "joined up" world of components coupled through ICT technology. On the other hand, interoperability is a state of readiness for organisational and technical compatibility leading to integration outcomes. Interoperability requires common approaches to organisational processes, information content, and technical solutions. Integration works in the small but falters at the enterprise level and beyond. Walker et al.[21] define four levels of health care information sharing:

- Level 1: Non-electronic data exchange using postal mail, telephone, etc.
- Level 2: Machine transportable data limited to non-electronic manipulation. Examples include fax, scanned documents, portable data format.
- Level 3: Machine organised data that requires manual translation between incompatible vocabularies, proprietary data formats, or unstructured content.
- Level 4: Machine interpretable data transmission utilising structured messages from standardised and coded vocabularies.

Interoperability is enabled via electronic connectivity at level 2 but only reaches automated interconnection at level 4 where semantic interoperability is supported. It is only through the combination of connectivity and shared understanding that interoperability can be achieved.

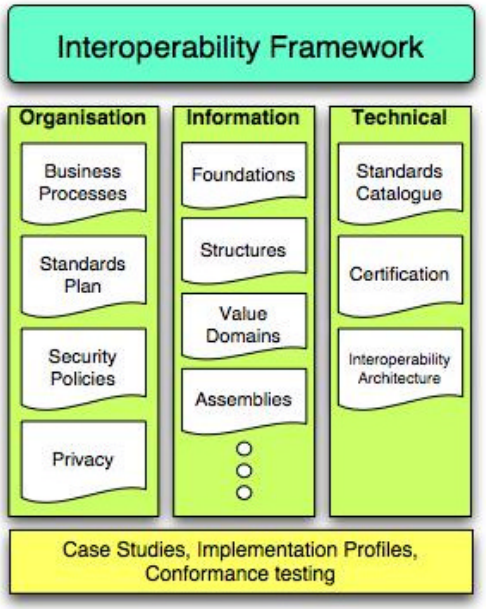

Figure 3: An Interoperability Framework

6.1 Interoperability Principles

Collaboration across diverse communities requires a balance between common patterns of use based around open standards along with localisation to meet jurisdictional and sector requirements. The pan-European Interoperability Framework provides a compelling set of Interoperability Principles with this ideal in mind. These reflect well into requirements for the Australian health sector:

[21] Walker et al., "The Value of Health Care Information Exchange and Interoperability", 19 January 2005.

- Design of systems should encourage *accessibility* by all parts of health regardless of capability or alternative technology choices. Multiple channels of delivery should enable clients and providers to interact through seamed but compatible collaborations,
- Information transfer must occur within the agreed context of a *security framework* based upon appropriate security policies to mitigate the perceived risk within different parts of health. This should include identification, authentication, non-repudiation, and confidentiality,
- Interoperability policies and solutions must provide for *personal privacy* requirements as specified through privacy legislation,
- The IF is designed to bring together multiple organisations/jurisdictions through common understanding and standards use. The *subsidiarity* principle ensures nothing should be done by a larger and more complex organisation that can be done as well and as cost effectively by a smaller and simpler organisation,
- *Open standards*[22] based upon low-cost access, published availability, and unconstrained use which encourage collaboration and interoperability. Open Source[23] solutions often form part of this standards community through their publicly available specifications available in code form, and
- Collaborative arrangements based upon bi-lateral agreements provide interoperable solutions but constrain the scalability of results. *Multi-lateral* approaches ensure agreement on standards common to a community enabling continual reuse of the solution.

6.2 Organisational Interoperability

Interoperability does not occur without organisational support for appropriate business collaboration models based upon sound financial, policy, and governance processes. These provide a sustainable environment in which interoperable solutions can be created, deployed, and managed. The Organisational Interoperability component of the IF will provide a shared policy and process framework across the E-Health interoperability agenda covering each NEHTA initiative.

Business Processes

Coordinated business interactions require a common understanding of business function even though alternative delivery mechanisms and channels may be employed. Key to coordination is the transition of organisational boundaries including bridging multiple jurisdictional processes and policies. For example, collaborative procurement processes require a consistency between procurement functions across organisations enabling shared points of technical interaction.

Financial Analysis

A shared economic model supporting the interoperability outcomes is essential to a scalable and sustainable interoperability solution. It builds a basis on which independent parties can collaboratively work toward interoperable outcomes. Individual interoperability deliverables are difficult to analyse on a cost/benefit basis in isolation and instead must be evaluated based on a shared cost/benefit model taking into account their co-dependent relationships. This part of the framework will define a standard approach to component

[22] Open Standards are publicly available specifications for achieving a specific task. See http://www.csrstds.com/openstds.html.

[23] The origins of Open Source Software (OSS) are publicly accessible in part or in whole. See http://en.wikipedia.org/wiki/Open_source.

analysis. For example, infrastructural components such as a PKI environment deliver their benefit enabling other services rather than as an endpoint of service delivery themselves.

Privacy, Policy, and other Legislative Issues

Privacy, anti-competitive issues, and other legislative barriers may restrict the perceived ability to interoperate through common semantic (information) and technical infrastructure. The legislative analysis will define a shared basis on which both state and federal legislation impacts the delivery of an interoperable E-Health solution. For example, perceptions of privacy and consent issues have been inhibitors for collaborative E-Health outcomes and impact on NEHTA initiatives such as Secure Messaging and EHR sharing.

Governance

The national approach to E-Health interoperability governance requires appropriate stakeholder engagement to gain trust in and ownership of the outcomes but also requires an independence of leadership seen as equitable to the industry. Specific areas of interoperability such as clinical data standards will require more specific engagement. The E-Health interoperability governance model will identify the common governance issues and provide an appropriate community breakdown to gain engagement on specific interoperability issues.

Standards Plan

The National E-Health Standards Plan is part of the standards implementation initiative. The initiative is to provide support and resources as necessary to enable the consistent and interoperable implementation of NEHTA specifications and standards. Support for standards implementation can take shape in many ways. NEHTA considers that Standards Implementation needs to be approached from aspects of:

- Interaction with existing standards organisations – locally and internationally;
- Interaction with industry including jurisdictions, international equivalents and vendor community;
- Providing a resource centre that supports the implementation of NEHTA specifications.

The *National E-Health Standards Plan* defines a national approach to interaction with standards organisations within Australia and internationally. This plan will provide an analysis of the activities required to support uptake of NEHTA specifications and provide guidance regarding the adoption and uptake of the specifications and recommendations resulting from NEHTA's work.

6.3 Information Interoperability

Many integration approaches concentrate on the delivery of connectivity technologies to enable system interoperation. This approach is subject to technology and solution changes as new standards and technologies permeate the market. The semantics of information (as opposed to their syntactical representation) provide a more concrete proposition on which to base evolutionary, collaborative interactions.

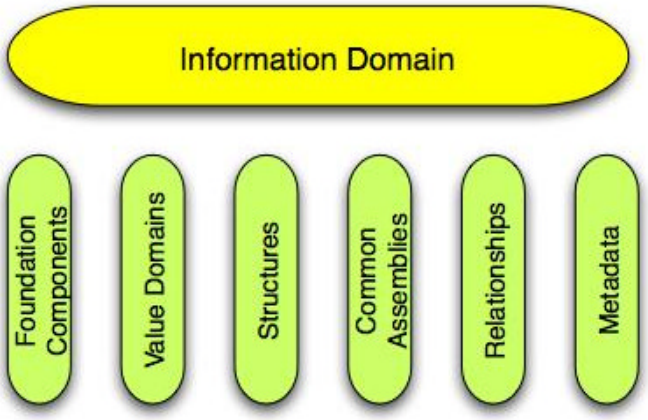

Figure 4: Information Interoperability and the Information Domain

Agreement on shared semantic understanding is the basis for all communication and is informed from an agreed national E-Health Information Domain. Significant national and international efforts have been applied to health informatics. Those in Australia include but are not limited to Health Level 7[24] (HL7), Standards Australia IT-014 committee[25], Health Informatics Society of Australia[26] (HISA), Australian Health Information Council[27] (AHIC), National Centre for Classification in Health[28] (NCCH), and the Australian Institute for Health and Welfare[29] (AIHW).

Much work is overlapping and in some cases complementary information specifications are misaligned. Even within a single standards organisation such as HL7, multiple versions of version 2 of the HL7 standards are still in use within Australia while an international effort is underway to migrate to the newer version 3 specifications which are yet to be completed but do represent a significant enhancement to their information model through the Reference Information Model (RIM), all interchangeable through XML.

Information specifications provide shared building blocks for semantic (information) interchange including (see Figure 4):

- Foundation Components

  Basic data elements and types are the foundation for any information model. International efforts through both ISO TC 215[30] and CEN TC/251[31] are underway to define these clinical and business elements.

- Value Domains

  Standardised terms and their synonyms allow exchange of clinical information for many purposes including clinical care, administration,

[24] Health Level 7 (HL7), http://www.hl7.org, August 2005.

[25] Standards Australia IT-014, https://committees.standards.org.au/COMMITTEES/IT-014/, August 2005.

[26] Health Informatics Society of Australia (HISA), http://www.hisa.org.au, August 2005.

[27] Australian Health Information Council (AHIC), http://www.ahic.org.au, August 2005.

[28] National Centre for Classification in Health (NCCH), http://www3.fhs.usyd.edu.au/ncch/index.htm, August 2005.

[29] Australian Institute for Health and Welfare, http://www.aihw.gov.au/, August 2005.

[30] International Standards Organisation (ISO) Health Informatics Technical Committee (TC) 215, http://www.iso.org/iso/en/stdsdevelopment/tc/tclist/TechnicalCommitteeDetailPage.TechnicalCommitteeDetail?COMMID=4720, August 2005.

[31] European Standardization of Health Informatics, http://www.centc251.org/, August 2005.

regulatory oversight, and fiscal management. Terminologies, vocabularies, dictionaries, code-sets, catalogues, and classifications allow common clinical understanding. NEHTA's Clinical Information and Clinical Terminologies initiatives are building upon existing work by HL7 and Standards Australia as well as international efforts including SNOMED CT to deliver specifications within this space.

- Structures

  Foundation elements and value domains are brought together to form more complex structures including data structures/groups, schemas, and archetypes. These mechanisms must enable complex elements to be combined and separated.

- Common Assemblies

  The application of structured information mechanisms leads to common assemblies providing templates, priority message content, event summaries, and electronic health records (EHR). Much international effort is being put to defining both the structure, content, and constraints associated with EHRs.

- Relationships

  Transformation between messages, information elements, and terminologies allows different systems to interact through common transformations.

- Metadata

  Standards for the classification of information itself are captured through metadata. The archivist and librarian communities have developed a rich set of metadata standards including Dublin Core[32]. The Australian Government has standardized upon the AGLS Metadata Standard[33] which is based upon Dublin Core.

Specification of these elements require significant work to both align existing national and international approaches as well as qualifying optional features making existing solutions too flexible. An information specification must also include the appropriate format for serialization into health messages as these structures are exchanged between health care parties.

Publication and dissemination of the national E-Health Information Domain is a requirement for the wider health sector as well as the NEHTA Work Program needing to reference and use information components. These will need an agreed standard for publication including a standard language such as XML and XML Schemas[34]. The Information Domain must provide information model principles, policies, and artefacts for use.

6.4 Technical Interoperability

Connectivity of systems for information exchange and service use requires compatible technical solutions. We base these solutions on open standards providing a level playing field for competitive provision of technical solutions.

Technical Interoperability is concerned with the specification of technical standards enabling solution delivery. Three major outcomes are relevant to this work:

[32] Dublin Core Metadata Initiative (DCMI), http://dublincore.org/, August 2005.

[33] AGLS Metadata Standard, http://www.naa.gov.au/recordkeeping/gov_online/agls/summary.html, August 2005.

[34] W3C recommendation describing the structure of an XML document.

- Interoperability architecture,
- Standards catalogue, and
- Certification processes.

Recommended standards and shared national services imply an architectural approach to their access and provision. The architectural design will describe this approach and position NEHTA service specifications such as national registries and catalogues. It will include basic service components, their interaction, and other infrastructural building blocks enabling solution delivery for E-Health across the nation.

Common approaches to meeting such requirements include a Service-Oriented Architecture or an Enterprise Services Bus (see Figure 5). This is not prescriptive for intra-organisational use but rather descriptive of the national design approach taken to standards adoption and service provision at the national level.

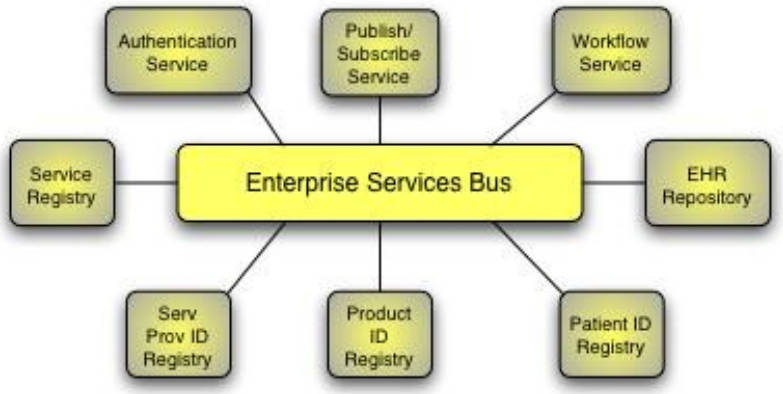

Figure 5: Interoperability Architecture

Service-Oriented Architectures (SOA) describes family of design approaches providing policies, practices and frameworks enabling application functionality to be provided and consumed as sets of services. In this context, services are logical, business-level work units that are independently developed, programmatically accessible, and adhere to an open standards–based specification. SOA encapsulates both design and run-time philosophies. The family of services should be evolvable throughout the system lifecycle allowing new functionality to be introduced and deprecated services transformed or removed without a need to recreate many system functions. Run-time support implies an ability to discover services at run-time enabling dynamic integration of components at a business level. This provides support for more advanced service interconnection features including workflow, rapid application development, and business activity monitoring.

The Enterprise Services Bus (ESB) approach is one type of SOA. It is an evolution from experience with Enterprise Application Integration (EAI) where a set of adaptors integrate diverse technologies through an integration hub. The heterogeneous nature of integration in many cases led to unsustainable complexity growth in EAI enterprise situations. EAI environments often became large, inflexible, and hard to manage. ESB is an alternative approach to system design that creates a network of collaborating business-level services, supported by a lightweight, distributed software layer. The loosely coupled service interfaces are independently enabled according to open, common interface standards.

Some SOA designs are now being based upon event-based information delivery. Service requests are routed to destinations based upon their content and it is the infrastructure that makes the decision as to the most appropriate destination. This creates an extremely loosely coupled binding between client and server allowing system transformation with a minimum of impact. This publish-subscribe mechanism requires new services to advertise

their capabilities and become more agent-like in their self-awareness and self-management.

SOA's have been demonstrated to provide more scalable, evolutionary architectures for dynamic enterprise environments where heterogeneous technologies and emerging business functions require an agility often lacking in traditional architecting approaches. NEHTA is developing a series of service offerings such as the medical product directory that will be logically presented as business level E-Health services. These services will be accessed and provided in accordance with SOA principles allowing for distributed system evolution, dynamic service discovery, and business-level interoperability.

Standards Catalogue

The catalogue lists relevant E-Health-related standards and documents their status and use. Since standards emerge, evolve, and cease their relevance, the catalogue is a living document requiring regular update. It also attempts to capture the lifecycle of standards creation and adoption by referencing the currency of standards. Typical information captured includes:

- Name,
- Overview,
- Version,
- Custodian,
- Usage (currency),
- References to use, and
- Categorisation.
- Certification Process

Standards-based interoperability requires additional steps to ensure adherence to standards leads to integrated solutions. "Paper-based" standards do not guarantee integrated solutions as there is always a degree of interpretation available to those implementing a standards-based solution. This latitude is often the stumbling block between conceptual and practical connectivity.

Previous IT standards work has utilized a common implementation to precisely describe solution semantics[35]. Unfortunately this leads to stagnation in development of the standard allowing more flexible standards approaches to meet changing market expectations[36]. An alternative approach has been to utilize a more flexible paper-based standard but facilitate interoperability through the testing and certification of different implementations. This allows the market to compete on standards implementation yet maintain a commonality that supports interoperability. Such testing facilities can be through "connectathons" or more formal compliance processes. NEHTA must position compliance and certification processes such as these to support standards uptake.

In order to certify use of standards, implementation profiles are required that describe interoperability requirements within a particular delivery channel. They prescribe a set of actors, processes, and standards to an extent that enables formal certification development for that particular profile. Much work has gone into developing such descriptions in the Integrated Health Enterprise[37] (IHE).

[35] OpenGroup's Distributed Computing Environment (DCE) provided an implementation as the primary standard reference.

[36] Many would note the move from OpenGroup DCE to the Object Management Group's (OMG) CORBA as being driven by this phenomenon.

[37] Integrating the Healthcare Enterprise, http://www.ihe.net, June 2005.

7 Implementation Support - Case Studies and Guidelines

Tracking and promoting good practice is a cross-community engagement instrument for spreading knowledge about interoperable solution development based upon the IF. It fosters the development of pilot implementations and promotes solutions through recognition of common requirements and infrastructure. The IF provides a common reference for description of alternative solutions and spans the three IF viewpoints

Case studies are the companion to implementation profiles. They describe solution implementations highlighting the organisational, information, and technical interoperability aspects of the outcome. This allows others seeking similar solutions a standard approach to evaluation and thus enables cross-community leverage and learning.

8 The Interoperability Framework and the NEHTA Work Program

NEHTA undertakes a broad range of initiatives created from E-Health requirements. These work items are specified as isolated problem spaces but are often co-dependent with other NEHTA initiatives. Figure 6 positions the 2005/06 NEHTA initiatives within the IF highlighting those that are essentially technical in nature through to the framework itself.

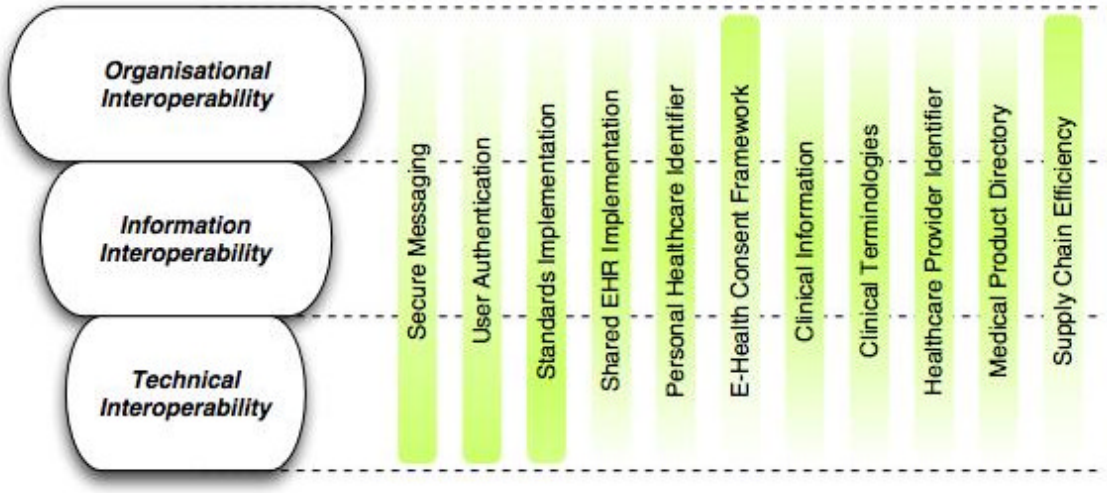

Figure 6: NEHTA Initiatives and the Interoperability Framework

Each layer of the framework creates a focus for collaborative discussion and creation of a cross-initiative NEHTA position. All initiatives have multiple viewpoints covering more than one interoperability layer. For example, Supply Chain Efficiency requires business process alignment at the *organisational level*, the creation of a shared catalogue with common terminologies at the *information level*, and interconnectivity standards at a *technical level*.

9 Next Steps

The IF is an opportunity to align the NEHTA Work Program ensuring that cross-cutting initiatives share common direction and outcomes. While it is likely jurisdictions will continue to provide work items based upon isolated problem components, NEHTA must align these objectives to a broader E-Health design, creating consistency of approach and efficiency gains through interoperable results.

The *Interoperability Framework* initiative creates the framework structure and governs it's evolution along with the interoperability layers it encompasses. It creates a separation of concerns amongst the framework layers and brings together expert panels to align and guide the layers.

- *Organisational Interoperability* creates cohesion amongst approaches to governance, finance, legislation, and business processes.
- *Information Interoperability* owns the family of information building blocks from basic data type elements through to terminologies.
- *Technical Interoperability* combines all aspects of standards along with the broad architectural approach linking e-health services and information.

Many NEHTA initiatives will bring together aspects across many interoperability perspectives. It is not the intent to dissect initiatives into separate work components but instead to create forums where crosscutting can be recognised and guided to maximise reuse and commonality of approach.