nehta

Interoperability Framework

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National E-Health Transition Authority

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1 Introduction

1.1 Purpose

This document presents an overview of the NEHTA Interoperability Framework (IF).

The IF is a common reference point that provides guidance to business and IT experts in delivering interoperable e-health systems in Australia - while allowing for the evolutionary and emergent aspects of business, policy and technology. This is achieved through:

- The separation of *organisational*, *information* and *technical* perspectives of e-health to deal with the diversity and complexity of the health environment and facilitate dialogue between the respective stakeholders. Accordingly, the IF is structured in terms of organisational, information and technical components;
- The adoption of a commonly agreed set of *interoperability concepts* and *interoperability patterns*, capturing key aspects in each of these perspectives - based on the existing NEHTA, jurisdiction[1], and international experience; they are not meant to replace existing concepts and patterns but facilitate co-existence of different languages that may be specific to individual e-health domains through a common reference point; and
- A *disciplined approach* in delivering specifications, ensuring conformance of implementations to specifications and applying continual value assessment – to ensure longevity and sustainability.

This document also explains how the IF serves as a basis for establishing the NEHTA Enterprise Architecture, a Compliance, Conformance and Certification Framework, and a Standards Catalogue.

This document follows the rationale, initial findings and principles set forth in "Towards an Interoperability Framework" [NEHTAIF1.8] that provided the motivation and set the scene for the NEHTA Interoperability Framework.

More detailed components of the NEHTA framework are being developed and will be published in 2006, beginning with the organisational IF component and followed by the information and technical IF components.

1.2 Intended Audience

This document is intended for:

- jurisdictional stakeholders, particularly Chief Information Officers and Chief Technology Officers within jurisdictions; and
- the e-health community – specifically strategic planners, clinical informatics experts, business analysts, enterprise architects and solution architects.

1.3 Structure of the document

This document begins with an overview of the IF in Section 2. This is followed by a description of key characteristics of the organisational, information, and technical perspectives of the IF in sections 3, 4 and 5 respectively. Key interoperability concepts and interoperability patterns are described for each.

[1] In Australian health jargon, the term 'jurisdiction' refers to individual State and Territory health entities and their clinician and governance structures

Subsequent sections present areas that are not directly part of the IF but are relevant to NEHTA's IF work. They are provided here for contextual reasons, and as they are developed, they will be packaged in separate documents constituting a family of IF-related documentation.

Section 6 presents Conformance, Compliance and Certification requirements that emanate from the IF and that need to be addressed to ensure interoperability of Australian e-health.

Section 7 describes the Interoperability Framework methodology that links the certification process into part of the development lifecycle, highlighting the need for appropriate requirements, specification, compliance and conformance.

Section 8 outlines NEHTA's intentions towards using the IF for the development of the NEHTA Enterprise Architecture Framework and the NEHTA Enterprise Architecture.

Section 9 introduces the structure associated with the Standards Catalogue.

Finally, Section 10 positions the current status of NEHTA's IF in relation to future developments.

1.4 How to use this document

This document provides an overview of the interoperability concepts and patterns identified and developed as of March 2006. Accordingly, the document:

- presents a high-level description of the communication artefacts in the IF, namely the respective interoperability concepts and patterns; a complete and more formal description of these artefacts will be published in separate accompanying documents;
- is expected to further evolve as new interoperability concepts and patterns are identified through various NEHTA initiatives and jurisdictional projects; note that much of the evolution will be in terms of interoperability patterns as they will document experience from emerging e-health outcomes; and
- provides a reference point for NEHTA and appropriate jurisdictional efforts to ensure comparable business approaches and architectural alignment.

The document consists of five parts.

1. *Interoperability Framework overview.* Outlines the key features of the NEHTA IF.
2. *Compliance, Conformance and Certification overview.* This will be further developed when the certification process is established.
3. *IF Methodology.* An overview of the compliance requirements for Enterprise Architecture methodologies with respect to requirements analysis, architectural specification, and compliance/conformance.
4. *Towards a NEHTA Enterprise Architecture*. Sets the scene and direction for the future NEHTA Enterprise Architecture activity. The outcomes of this activity will be published in a subsequent document later this year.
5. *Standards catalogue structure*. This document describes the standards information to be collected within the standards catalogue to be published by NEHTA. The structure highlights the requirements for compliance that should be included in technical specifications.

This Interoperability Framework can be used as a starting reference point for both existing and new e-health stakeholders in Australia. This includes:

- *Strategic planners* concerned with the enabling role of technology in the delivery of health care services; they should read Sections 1, 2, 3 and 6 of this document;
- *Clinical informatics experts* concerned with the meaning of information and information models representing various clinical artefacts and ontologies; they should read Sections 1, 2, 3, 4 and 6;
- *Business analysts* concerned with capturing business and functional requirements from domain experts and translating them into a form commensurate with the expression of enterprise architectures; they should read sections 1, 2, 3, 4, 5 and 9; and
- *Enterprise architects* and *solution architects*, concerned with developing enterprise architectures or specific solution architectures; they should read all sections of this document.

1.5 Feedback

Feedback on this Interoperability Framework v1.0 is sought from the e-health community and government health jurisdictions. Feedback will be considered by NEHTA and will be incorporated into the next version of the document, which will then be released through NEHTA's website. All comments should be directed to interoperability@nehta.gov.au.

2 Interoperability Framework

Health is a diverse community consisting of individual organisations and jurisdictions delivering care through a range of channels and with varied technical and management information communication technology (ICT) capabilities. On the path to achieving an electronically interoperable environment, the initial requirement is realising a shared understanding in delivering the e-health results [NEHTAIF1.8].

A national approach to interoperability is vital to the Australian e-health agenda as this contributes to delivering anticipated cost savings and enhanced healthcare delivery. Interoperability prepares for the unforseen consequences resulting from the replacement and renewal of health systems as well as changes in business expectation.

2.1 A Shared Understanding

The NEHTA IF aims to develop a shared understanding, to promote compatibility and interconnectivity in Australian e-health. This shared understanding is based on two key features (see Figure 1):

- *interoperability language*[2] for expressing *interoperability concepts*; these concepts describe the common semantics of real-world entities from business, clinical, and IT systems perspectives while leveraging relevant open standards; and
- a set of *interoperability patterns,* introduced as a mechanism for capturing existing issues and observations about commonly occurring phenomena in e-health and reusing[3] them in different contexts (e.g. by different e-health projects).

The value of interoperability patterns is first in identifying the issues that are recognised as possible hindrance to interoperability. In a way, they can serve as a kind of 'check-list' for e-health projects. Another value is in reusing common approaches to addressing these issues to ensure that common (and valuable) principles and interoperability approaches have been preserved and applied across various contexts.

Note that the word ‘pattern’ in interoperability pattern is used in the following sense: 'a way in which something happens, is developed, or is arranged' [Oxford English Dictionary]. Patterns include structural or behavioural relationships between system parts and various constraints that may apply to these relationships. For example, patterns can cover governance, legislative and regulatory issues, value assessment as well as education and change management.

While the interoperability language provides a foundation for shared understanding, the interoperability patterns add further value by capturing common knowledge about the issues that occur when building e-health systems. For example, they enable the capture of common issues encountered by NEHTA and jurisdictional projects, enabling other projects to recognise similar challenges and leverage recognised interoperability

[2] In this document, the term ‘language’ refers to the concepts used to facilitate communication and shared understanding about various dimensions of e-health, but which are defined with sufficient precision to be used for downstream architecture specification and modelling activities.

[3] Note that the IF is mostly concerned with the interoperability patterns, that document common issues and requirements and are reused in this sense, as distinct from solution patterns, that are reused in the sense of being "a solution to a problem in a context", as per Christopher Alexander’s Pattern Language. This will be explained in section 2.3.1.

approaches. Thus the main purpose of identifying interoperability patterns is to reduce duplication.

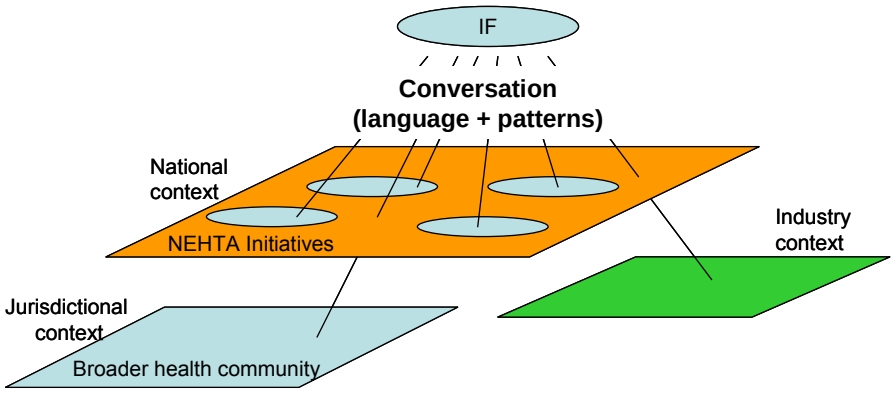

Figure 1: Facilitating a shared understanding through the IF

Figure 1 depicts how the interoperability languages and patterns are applied - first to provide the common conceptual and semantic underpinnings for NEHTA, and then propagated into the broader jurisdictional context. The latter will ensure a shared understanding of organisational, information and technical interoperability concepts as well as interoperability patterns, among different stakeholders in the broader Australian health community - both business and technical stakeholders. Notice that Figure 1 also shows a need for a broader scope of interoperability such as interoperability within an industry context (examples include supply-chain solutions as well as other government sectors such as emergency services or non-government organisations).

Note that the NEHTA IF places importance on the following distinction between interoperability and integration.

Interoperability is taken to mean a continual state of readiness. The key assumption here is that change is the only constant and thus, an approach needs to be developed that prepares all the stakeholders for the previously unforseen consequences. These consequences may be a result of replacement and renewal of health systems or changes in legislative and social environments.

So, when developing future solutions based upon current problem analysis (shown as 'projected' circles into a 'projected future delivery' state in Figure 2), one needs to recognise that the final delivery may not meet changing requirements. These new solution requirements (depicted as red circles in Figure 2) do not match the projected solution deliveries. This is because of the change that is likely to occur over time, be it a technological, business or policy-based issue. In other words, the 'projected future delivery' space is likely to differ from the 'required future solution' space (shown as a box in Figure 2).

Integration is seen as a slice through an interoperability time line, describing a moment in time where systems are interconnected to provide solution delivery.

In summary, interoperability is a necessary precondition to ensure longevity of integration in a changing IT and, more importantly, business environment. Interoperability creates a space for integration solutions that works *with* change rather than against change (see Figure 2).

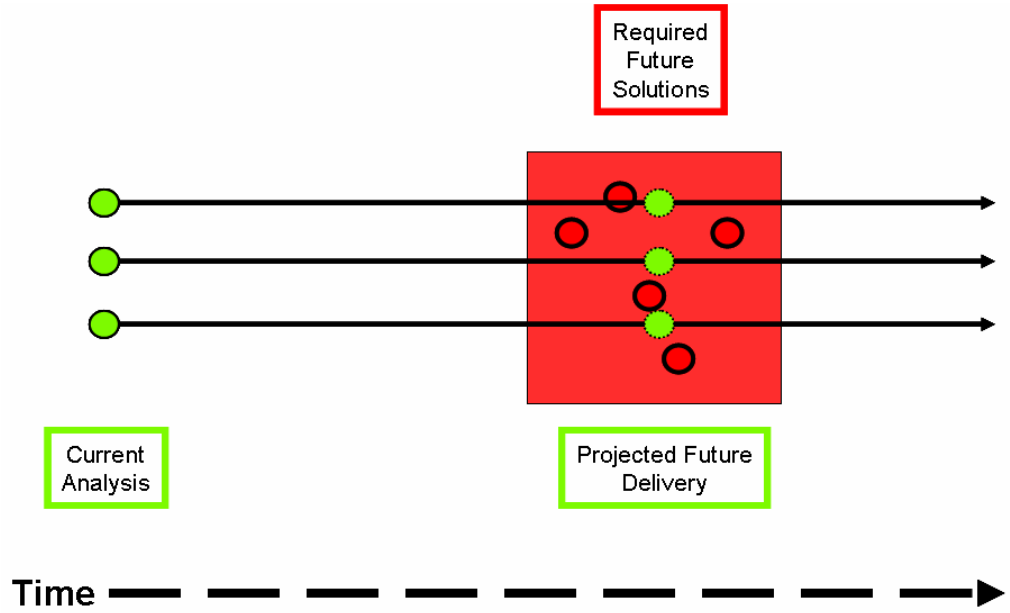

Figure 2: The essence of interoperability - allowing for a changing future

2.2 Structure of the IF

The IF consists of three separate but related interoperability perspectives (see Figure 3):

- The organisational perspective;
- The informational perspective; and
- The technical perspective.

These perspectives are different viewpoints on the one system. A system can be anything of interest, either as a whole, or as composed of its parts. Examples are a particular e-health application such as a health provider index, an e-health 'domain' such as pathology, radiology or clinical terminology, an e-health entity such as a General Practitioner's practice, a hospital, or even the whole e-health system in a region or country. It is important to note that depending on the system in question, the individual component frameworks will be populated to varying degrees of detail as some put a greater emphasis on different delivery aspects. For example, an information model is information intensive while a policy framework is organisational intensive.

The IF is structured in this way to support the expression of different concerns of the stakeholders in e-health while recognising the inherent complexity of e-health systems. Each of the three IF perspectives have their own set of interoperability language concepts and interoperability patterns. In addition, there are a multitude of relationships and dependencies between the language concepts and patterns across the perspectives (e.g. an organisational concept relates to an information concept). This reflects the fact that the three IF perspectives should always refer to one system and they should be considered together when specifying a system.

This approach to the IF was chosen to address the complexity of e-health systems, resulting from the heterogenous, multi-jurisdictional, multi-domain, cross-boundary, and (increasingly demanded) consumer-centric characteristics of the Australian e-health environment. So, this environment requires addressing not only information and technical interoperability (that has seen much of the effort in the past), but also *organisational* interoperability (see Figure 3). The former deals with the semantics of

information and technical solutions such as a Service-Oriented Architecture [SOA] approach, while the latter deals with the business context.

This breakdown is in line with several national and international interoperability frameworks [AGTIF], [eGIF], [EIF], [EPAN]. Further, the emphasis on organisational issues is supported by a recent IEEE (Institute of Electrical and Electronics Engineers) e-health initiative emphasising the fact that 'interoperability refers not so much to machines working together but human beings understanding each other' [IEEE].

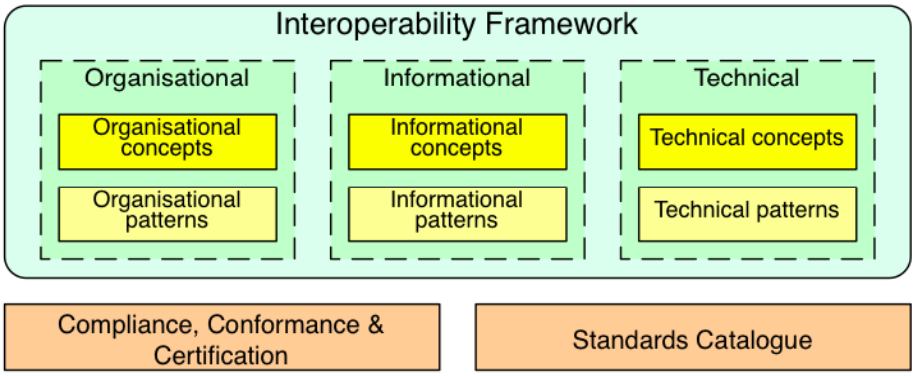

Figure 3: The Interoperability Framework and related components

This figure also shows some related components such as standards catalogue and compliance, conformance and certification framework.

2.3 IF and Enterprise Architectures

The NEHTA IF recognises the co-existence of many jurisdictional e-health efforts in Australia and is not intended to replace or mandate specific enterprise architecture (EA) approaches. Rather, the aim is to provide an overarching interoperability framework that can accommodate existing systems and developments while ensuring alignment and harmonisation of future e-health architecture and systems as appropriate. Examples of such future e-health efforts are individual healthcare identifiers and shared electronic health record systems. This section lists some key commonalities and distinctions between the IF and typical EA themes.

The IF can be seen as a coordinating framework for various jurisdictional Enterprise Architecture Framework (EAF) developments, incorporating similar approaches and a common philosophy – but one that only defines a small set of interoperability concepts and interoperability patterns needed to ensure architectural alignment within NEHTA and more broadly into the e-health community.

The following correspondences can be made between the IF and commonly used EAFs:

- The organisational perspective relates to an EAF's business architecture;
- The informational perspective relates to an EAF's information architecture; and
- The technical perspective relates to an EAF's application and technical architectures.

EAFs are also associated with methodologies that prescribe the steps required to fulfil the requirements of the EAF. These are usually presented separately from the EAF itself. The relationship between the IF methodology and such EAF methodologies is described in section 7.1.

2.3.1 Distinguishing features

One of the distinguishing characteristics of the IF as compared to many EAF approaches is that it provides a more complete set of business concepts compared to Enterprise Architecture Frameworks, providing support for issues such as mutually reliant value assessment. In particular, the e-health requirements stated at the beginning of this section require placing a special emphasis on the concept of business, legal and health-related *policies*. This in turn requires a generic and precise framework for describing how policies relate to business processes, business services, business roles and applications involved in delivering e-health. Such a framework should also recognise and support the implications of possibly multiple sources of policy origin, such as policy conflicts and their need for resolution.

Another unique feature of the IF is a distinction between *interoperability patterns* identified in the IF and the *solution patterns* of relevance for downstream enterprise architecture developments. The IF interoperability patterns specifically reflect the e-health environment in Australia and are captured to flag the existence of commonly occurring structures and arrangements that if not addressed, could provide potential hindrance to interoperability.

The interoperability patterns can serve as a framing mechanism for a number of *solution patterns* that are of relevance for downstream enterprise architecture developments. Note that the word ‘pattern’ in ‘solution patterns’ is used in the sense of: 'something used as a model or guide in making things' [Oxford English Dictionary] as distinct from its use in ‘interoperability pattern’.

The solution patterns can be further categorized into architectural, design and test patterns. For example, they can define some common types of business processes in health such as referrals and apply them to various contexts, e.g. GP to hospital, GP to specialist or even GP to pathologist orders. The purpose of solution patterns is to exploit past knowledge of solution approaches to arrive at solutions faster, using proven techniques.

New patterns, either interoperability or solution patterns, are often discovered while addressing specific problems. They can then be identified as potential candidates to address similar problems in future and documented as appropriate. In this respect, patterns can be regarded as an asset that can be used to facilitate the development and production of models, products and systems.

Therefore, it is the IF concepts and patterns, which when propagated through various EAFs, influence the common understanding and architectural alignment across various e-health architectures. Each jurisdiction is likely to have their own EAF, which is the basis for developing many compliant architectures such as specific solution architectures.

The IF also introduces an overarching methodology supporting a link between business requirements and architectural specification with a certification process enabled through compliance and conformance. This provides clarity to the mutual benefits associated the realisation of standards efforts.

2.3.2 Implications for the NEHTA Enterprise Architecture

NEHTA itself will adopt an enterprise architecture framework that will be compliant with the IF. The NEHTA enterprise architecture framework will be used for the creation of the NEHTA Enterprise Architecture and to guide NEHTA solution architecture development.

The NEHTA EA will define a technical strategy and structure for ICT components within the NEHTA work programme. It will specify business, information and technical architecture components. In addition, NEHTA will adopt and/or develop an EA development methodology that can be used to deliver many infrastructure and solution architectures for NEHTA, according to

the NEHTA EAF. This methodology must be compliant with the IF methodology outlined in section 7.

2.4 Approach to sustainability and evolution

The establishment of an overarching and long lasting interoperability framework for e-health in Australia, initially promoted and adopted by NEHTA, and subsequently by the broader e-health sector, will be achieved through:

- *Encouraging discussions* and setting forth an agreed way of describing interoperability;
- *Documenting* the approaches, policies, patterns, information, technologies and standards, that are shared across the health sector;
- Putting a particular emphasis on a *standards catalogue*, which will be a living artefact that contains a list of currently used and emerging standards, covering all three IF perspectives;
- Establishing an *IF methodology*, as a basis for ensuring economically sustainable and socially relevant outcomes; this allows for a competitive approach to the delivery of interoperable e-health systems and serves as an insurance policy against changes in technologies and business context;
- Adopting an ISO distinction between *compliance* and *conformance,* as highlighted in the ISO/IEC RM-ODP standard [ODP-RM], as part of the IF methodology:
  - Compliance is about checking the extent to which specifications rely on standards as an interoperability mechanism; and
  - Conformance is about checking whether solutions and products satisfy specifications which they claim to implement.
- A *disciplined approach* in applying key phases of the IF methodology (see section 7 for further details), i.e.:
  - Capture of the *requirements* for e-health systems, from all three IF perspectives, with a particular emphasis on using organisational concepts and patterns;
  - Development of a consistent set of *specifications* based on requirements; these in turn will facilitate compatible solutions for the delivery of an interoperable, whole-of-health environment; again, this will be done from all three IF perspectives;
  - Definition of a clear set of *conformance points* in specifications which can be used as a basis for checking the extent to which products and solutions satisfy the NEHTA specifications; these can serve as a basis for subsequent certification of these products; and
  - A *continual value assessment* of the benefits realised. This assessment is needed to monitor the investment and identify points of improvement that may be due to the restructured business processes or new technologies.
- The *proactive engagement* of jurisdictions and other stakeholders to ensure cross-fertilisation and alignment between NEHTA efforts and other developments in Australian e-health.

2.5 Summary

The IF delivers a single source of NEHTA guidance for all of the healthcare community and should be used as the basis for long-term business and systems alignment [NEHTAIF1.8]. The IF is to be seen as a way of aligning various enterprise and solution architecture activities. An important part of the IF is the iterative, incremental and evolutionary methodology distinguishing requirements, specification, conformance and value assessment

phases. The ultimate goal is to facilitate development and continuous evolution of e-health systems to ensure that in the care of patients, all required information for medical decisions and care is correct and available in a timely manner to health professionals.

The following three chapters describe the perspectives of the IF in more detail.

3 Organisational Perspective

The organisational perspective of the IF is addressed in the following Organisational Interoperability Framework (OIF). The OIF addresses the business context as well as legal and policy issues of relevance for understanding, specifying and deploying e-health systems. The OIF allows for the description of business processes, business policies and organisational structures, covering the scope of intra-organisational, inter-organisational and cross-jurisdictional interactions.

3.1 Background

The organisational perspective is becoming more important in response to the increasingly broadening scope of e-health applications involving multiple providers and more direct participation of consumers. NEHTA recognises the importance of organisational interoperability issues and is at the forefront of a number of international e-health initiatives, by placing a special emphasis on this context. A related initiative is the recent CEN251 work on the Health Informatics Service Architecture [HISA]. However, the NEHTA OIF scope addresses further challenges because it includes cross-jurisdictional concerns, requiring a sound approach for describing policies and cross-organisational collaborations, currently beyond the HISA scope.

The OIF is based on the ISO Open Distributed Processing (ODP) standard, specifically the ODP Enterprise Language (ODP-EL). The ODP-EL was chosen because it:

- Provides a small number of generic organisational concepts for describing structural, behavioural and policy concepts. While close to the everyday business jargon, these concepts have a precise meaning, grounded in a number of theoretical and modelling techniques;
- Can be further extended to reflect specific needs of the e-health domain such as policy and privacy concept frameworks, specific health-care roles and processes, as well as other clinical concepts; and
- Has influenced several other industry standards, most notably the Unified Modelling Language (UML) [UML] and Model-Driven-Architecture (MDA) [MDA] in Object Management Group (OMG); in addition the ODP standards have been used in the health domain, e.g. in the ISO Health Informatics Profiling Framework standard [HIPF] and most recently within the Health Informatics Service Architecture [HISA].

3.2 Core concepts

Community is the key OIF concept that provides the context for expressing business structures, business processes and business policies. Although inspired by the everyday use of the word ‘community’, the OIF community has a precise meaning developed to support the capture of requirements and development of unambiguous specifications.

Community is defined as a collection of entities (e.g. individuals, organisations, information systems, resources, or various combination of these), established to meet some objective.

Community is specified in terms of community *roles* and a community *contract.*

The *role* of a community specifies part of community’s structure and behaviour and can be filled by various entities; note that entities have their own life cycle, independent of the community’s life cycle and they can fill the roles of a community, subject to the role-filling (or assignment) policies. Roles

partition community structure and behaviour to reflect specific organisational arrangements. A community authority defines the roles in the community.

A community *contract* is expressed in terms of policies that apply to the entities that fill the community roles and their respective behaviours, e.g. as part of business processes.

A community *policy* constrains behaviour of one or more roles in a community. The purpose of policies is to address uncertainty in the world of imperfect information and thus increase trust among actors involved. For example, well-developed privacy policies in e-health will help to increase trust of individuals in the confidential use and disclosure of health information. Multiple policies can apply to individual roles and there may be circumstances that require dealing with possible conflicts and resolving them. This version of the OIF proposes three core policy types, namely obligations, permissions and prohibitions.

O*bligations* specify a required behaviour.

Permissions specify behaviour that is allowed to occur.

Prohibitions specify behaviour that must not occur.

These policies form the basis for describing other policy types such as delegation, accountability, privacy and consent. In addition, a community can specify violation conditions and possible penalty measures.

The power of explicitly defining policies and linking them to the behaviour of roles in the community lies in the fact that they can be changed during the lifetime of a community or can be tailored to a range of different e-health systems. Policies can be considered to provide choice over basic behaviour specified as part of business processes. This approach ensures a long lasting specification framework, supporting adaptability and evolution of the systems in response to external (or internal) factors.

A *business process* is a structured style of behaviour usually described in terms of the constituent business steps, control of flow and control of data between business steps. So, a business process represents a specific style of behaviour where the focus is on flow of data and control and the roles involved may or may not be identified, depending on circumstances.

So, a community defines a context for defining business processes, structures and policies and can be regarded as a stronger form of UML use case models [UML]. Communities can be related to each other to support hierarchical or peer-to-peer arrangements.

The OIF defines two special types of communities. One type, called *domain*, distinguishes between two kinds of roles, namely the roles of controlled objects and the role of the controlling object. Another special type is called *federation*, allowing peer-to-peer linking of domains. A usual way of facilitating federation is by establishing a service level agreement between the controlling objects of the two domains.

A business service in the OIF is a particular abstraction of behaviour expressing the guarantees of service providers. Typically such guarantees are expressed in terms of service offers which, if accepted by service users (as a requestor for service delivery) form the basis of a service level agreement. The guarantees involve policies that apply to the service providers (a special kind of party) and, if a consumer accepts the service offer, certain policies are also applied to the consumer. This represents formation of a service level agreement or a contract. It is important to note that service delivery also involves benefits that service usage brings to service users and together with the cost of using the service, the value represents a factor in users deciding about different service offers.

The OIF also includes several concepts for accountability as follows.

Party is a special kind of entity which emphases its legal requirements.

Delegation is the action that assigns authority, responsibility or function to others.

Principal is a party that has delegated authority, responsibility or function to another party.

Agent is a party that has been delegated authority, responsibility or function.

Evaluation is an action that assesses the value of something. The value is linked to the notion of quality that in health has the dimensions of safety, effectiveness, patient centeredness, timeliness, equity and efficiency.

3.3 Organisational Patterns

As noted in section 2.3.1 interoperability patterns are a mechanism for capturing existing knowledge and observations about commonly occurring phenomena in e-health. These include structural or behavioural relationships between system parts and various constraints that may apply to these relationships.

From an organisational perspective, four high-level categories of interoperability patterns have so far been identified in NEHTA's initiatives. They are the legislative/regulatory, governance, value assessment, and change management/education patterns, as described below.

Addressing these patterns will promote organisational interoperability and ensure consistency across NEHTA's outcomes (and subsequently outcomes within the broader jurisdictional community).

The organisational patterns are mapped onto the core organisational concepts, introduced in the previous section. This ensures a pragmatic approach to addressing specific problems, while preserving precision (and compatibility) of expression.

Considering the evolutionary character of the NEHTA IF, it is anticipated that new organisational patterns will be identified and documented as they emerge.

3.3.1 Legislative, regulatory and enterprise policy constraints

Legislative and regulatory constraints need to be well understood and addressed for the design of e-health systems, to enable organisational interoperability across health organisation boundaries and between jurisdictions. Examples of such constraints range from different federal, state and territory legislation and policies (and their interplay) to international policies such as for example the US/AU Free Trade Agreement. The impact of these policies needs to be well understood and addressed within e-health systems. In addition, e-health systems should be designed with the expectation that the legislative and regulatory policies are likely to be revised and the e-health systems should be resilient to such changes.

Note that the administrative boundaries above need to be viewed as constructive, as they allow structured interactions between communities. This, along with a policy-based approach to constraining behaviour (coming from legislation and regulation) enables support for various kinds of emergent behaviour and needs to be recognised if an IF is to be sustainable.

This category of patterns captures the key characterising features of national and jurisdictional laws and regulations and positions them in relation to the core OIF concepts. The OIF also gives several examples of e-health systems that need explicit consideration and support for legislative and regulatory constraints.

The key OIF component underpinning the legislative and regulatory issues is a framework for describing policies and processes for managing them. This is because policies represent the rules and norms underlying each of the legislative and regulatory aspects above.

The policy concepts will cover primitive concepts of permissions, obligations and permissions as defined in the core OIF concepts as well as other frequently used policy concepts such as responsibility, liability and consent (derived from the primitive policy concepts) and possibly extended with health-related policies. Thus the policy concepts provide a shared foundation and common understanding of a wide range of legislative and regulatory issues that need to be addressed.

3.3.2 Governance approaches and models

The term 'governance' has a broad meaning and in the OIF it is taken to mean 'the process of public accountability for the way in which an organisation conducts its business and may involve stakeholder representation and structures supporting responsibility, accountability and reporting' [Glossary].

Well-defined and accountable governance structures are needed for e-health systems spanning multiple organisational and jurisdictional boundaries - to support both operational and strategic administration of e-health systems. These will need to be compliant with legislative and regulatory policies that apply to them as prescribed by some authorities. For example, the anticipated future governance of the SNOMED terminology needs to incorporate the strategic administration for that system taking on an overall responsibility for the direction, management and control of its management organisation, while respecting international, federal and state legislation and regulation. However, it will also need to include operational governance such as defining processes and systems for terminology management and editorial control of terminology products as well as governing the development, maintenance, enhancement and production of a health terminology, at global and local levels. The activities of the operational governance bodies need to be overseen by strategic governance.

In terms of organisational concepts, governance models are a special kind of community which is created with the objective of ensuring that the functioning of other structures (typically the controlled sub-communities) are according to the set of rules of that governance community. Examples are corporate governance models, project governance models, enterprise architecture governance and so on.

It is important to note that clear governance structures are necessary but not a sufficient condition for a well functioning organisation. Good governance needs to be complemented with personal leadership qualities, as recently reported in McKinsey study [Oct 2005]. In part, this is also related to the education and change management issues discussed in the section below.

3.3.3 Cost and value assessment

This category of OIF patterns is motivated by the key findings of the Boston Consulting Group [BCG], which identified key benefits and priorities for the national e-health agenda in Australia and recommends a clear business case with quantifiable, clinical or outcomes-based benefits for all e-health initiatives.

The cost and value assessment patterns are not in the form of detailed economic models for evaluating and comparing values of ICT benefits as is typically the subject of specific health economics methods. Rather they list possible approaches that can be further applied by individual initiatives either before or after deploying ICT for health applications.

The initial objective of this pattern is to arrive at approaches to determine shared cost/benefits analysis when developing business cases for NEHTA initiatives, *prior to* the deployment of the systems. This recognises that the lack of a sound cost/benefit proposition will break any chance of information or technical interoperability. It was also recognised that this should not be done in isolation, on a 'silo' basis, but by adopting a shared cost/benefit

approach. This is in line with the recent report by the Productivity Commission [PCReportAug05] after it concluded that the existing 'silo' approach to the assessment might inhibit efficient assessment of emerging inter-dependent technologies.

The Productivity Commission report has also influenced the OIF to provide some guidance on the evaluation of the benefits of the ICT systems *after* they are deployed. This is to address the Commission finding about current inadequate measures of the benefits of ICT applications within the health domain (both in Australia and internationally). One approach for such assessment would be through studies and trials.

The term 'benefits' has been taken to cover a broader set of parameters than financial benefits, and includes for example cost-savings or improved efficiency. However, benefits also need to cover factors such as improvements in healthcare quality and safety (associated for example with the reliable transmission of patent alerts and drug reactions).

The OIF has identified several approaches for assessing the value of initiatives, including the benefits of ICT in e-health. They include:

- *Benefits realisation approach* - a proprietary methodology, developed by the DMR consulting company [BRP];
- The *IOM quality of care* framework, that provides a number of metrics for the measuring of quality of care [IOM];
- *Influence diagrams* - a simple visual representation for identifying and displaying decisions, uncertainties, and objectives, and their mutual influence [InfluenceDiag] - exploited in the recent study which analyses the direct financial benefit of health information exchange interoperability between Australian healthcare providers and stakeholders [Sprivulis];
- *Balanced Scorecard* methodology - enabling a clear definition of key organisational objectives and their measures that go beyond traditional cost-effectiveness measures; and
- *Six Sigma* - has been applied in health domain to improve quality and safety of care and address both clinical and operational issues. [SixSigmaH].

It is anticipated that other emerging cost and value assessment approaches may influence NEHTA recommendations such as a new business case framework being developed by the Commonwealth Government and tested by AGIMO.

The following core organisational concepts can be applied to support a value assessment framework for ICT systems supporting health services:

- The ICT system value is considered where it plays a supporting *role* within a *community* that consists of this role and the roles of various stakeholders involved in delivering healthcare services and which are using this ICT system, directly or indirectly;
- Such an ICT system's *behaviour* is to be abstracted in terms of *services* it provides to other objects filling the corresponding roles in the community and who obtain *value* for using this system; the value, for example, can be considered in terms of increased safety, improved effectiveness and efficiency and timeliness in health service delivery; and
- If an ICT system is also part of *another community* (e.g. a health provider identifier system used within a SEHR community), the services that this system delivers also need to be considered in terms of the *value* the system delivers to the objects in this other community.

The resultant structure could be considered as a *value chain* that points at the linkages between the ICT systems and the communities in which they exist

and to which they deliver benefits; it is possible to then apply any of the value assessment methodologies, e.g. influence diagrams, to such a value chain.

3.3.4 Awareness and change management

Increased awareness and education is needed to inform e-health stakeholders about improved ways of delivering safer and more effective care delivery, by exploiting:

- The benefits of new approaches for the harmonisation of business processes (enabled by new technologies) to deliver collaborative, consumer-centric delivery of services in cross-organisational and cross-jurisdictional environments, while respecting continuity of care and care continuum principles;
- New management approaches that better focus on the needs of consumers, foster team efforts and encourage leaderships; and
- The capabilities of new ICT technologies, paradigms and approaches.

Organisational awareness about the benefits of new business and technology paradigms is an important factor when considering the e-health systems in the context of their *evolutionary* and *emergent* aspects. Organisations such as NEHTA play an important role and complement market factors in increasing awareness and in educating jurisdictions about new business and technology approaches.

Once the benefits of new approaches are recognised, *change management* activities need to be established to deal with the new solution and architecture approaches.

Change management requires a combination of government initiatives and individual leadership to create a momentum for change. The former is about establishing governance structures, processes and policies to ensure controlled and evolutionary adoption of new technologies and management approaches, while the latter is needed to facilitate changes in cultures and mindsets for all involved in e-health – for the benefit of individual consumers, governments, service providers and vendors. However, in implementing changes one needs to take into account risk factors such as those that potentially arise from new licensing mechanisms and operational policies in using emerging open source software.

NEHTA, for example, is established to facilitate an e-health transition within Australia, as part of overall health reform. Consequently, education and change management are high priorities within NEHTA as a way of influencing the community to implement similar approaches.

The organisational IF, through the concept of community and through the policy-controlled techniques for changing the community specification, its structure, behaviour and policies, provides an explicit framework for guiding the process associated with change management. This ‘change management’ community may identify key governance roles for change management, specifying their duties and responsibilities and the business processes to take place.

It is worth noting that business process reengineering has direct implications for change management. By providing a consistent approach to documenting communities and their constituents and behaviour, this may allow reuse of change management strategies across these communities.

3.4 Positioning organisational interoperability patterns and concepts

This section provides a small example to illustrate how organisational concepts can be used to represent several healthcare stakeholders involved in care delivery and how the four organisational interoperability patterns can be positioned in relation to them.

Figure 4 shows a Care Community. It's objective is to provide a context for reliable and safe delivery of healthcare services to the individuals. This community includes the roles of an Individual, single Healthcare Professional and Healthcare Organisation. The last of these roles can be represented as a community in its own right, consisting of a number of Healthcare Professionals.

The figure also shows high-level organisational patterns that, to varying extents, constrain the policies and processes of the Care Community. These patterns can be regarded as high-level communities. For example, state jurisdictions provide their own policies, as does the Federal jurisdiction and these together provide constraints for the functioning of the Care Community. Similarly, the policies and processes of other communities, i.e. Governance, Value Assessment and Education/Change Management communities can be applied to this community. Note that in these three cases these communities may be more tightly related to the Care Community, e.g. by having a common role specification between them.

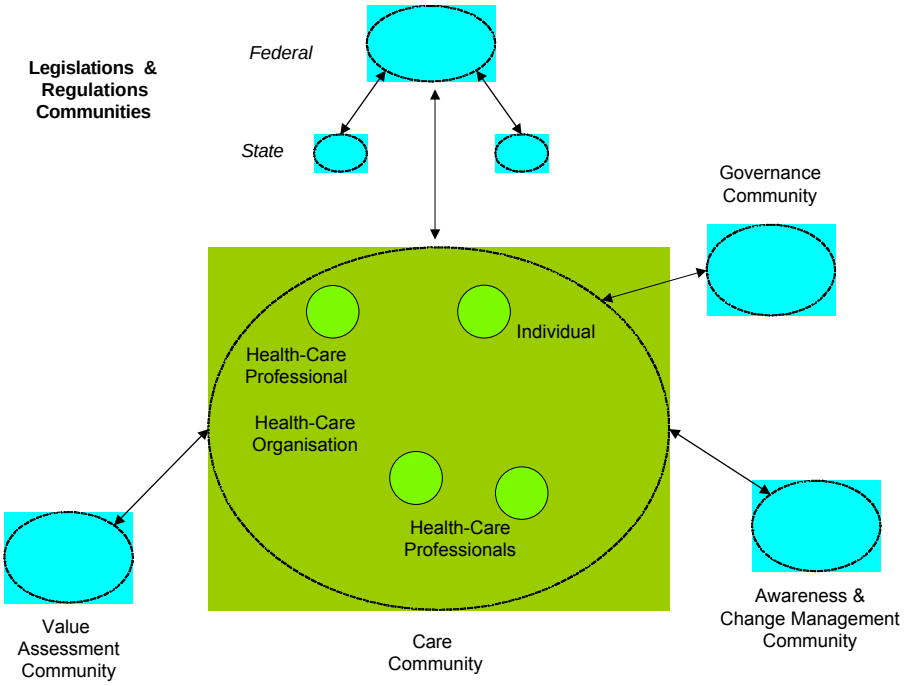

Figure 4: Care community – use of organisational concepts and patterns

4 Information Perspective

The information perspective of the IF is addressed in the following Information Interoperability Framework (IIF). The IIF addresses the semantics of information of relevance for understanding, specifying and deploying e-health systems. The IIF allows for the description of key information components and their relationships. It is not meant to replace or introduce a new information model but rather facilitate the co-existence of different information modelling approaches through a common reference point.

4.1 Background

This is the first version of the IIF and is based upon the initial findings presented in NEHTA's "Towards an Interoperability Framework" [NEHTAIF1.8]. The next version of the IIF will be further expanded to reflect jurisdictional consultation and further work on NEHTA initiatives and various international health informatics initiatives, including open standards such as HL7 [HL7] and SNOMED [SNOMED].

The IIF links the organisational perspective on interoperability to the technical perspective. Relevant informational standards will be documented in the NEHTA Standards Catalogue (see Section 9).

4.2 Core concepts

An *information component* is the key IIF concept. This represents an element of information that corresponds to some concept in the real world, e.g. demographic information about an individual.

An information component can be:

- a simple, *foundation component* (based on standard data types, e.g. integer, string, date or quantity); or
- a more *complex structure* that consists of a set of information components such as contact details for an individual, or even Electronic Health Records (EHR).

A *relationship* between information components expresses some dependencies or associations between things in the real world that they represent. A special kind of relationship is a composition of several information components into complex structures as mentioned before. Another kind of relationship expresses *mappings* between different information components. These mappings can, for example, be used to assign semantic relationships between concepts or terms from different clinical term sets.

A *constraint* represents restrictions or rules that can apply to other information components such as a valid range of numbers representing blood pressure.

A *constrained structure* is a complex structure to which some restrictions or rules apply.

An *archetype* is a specific instance of a constrained structure, modelling clinical or other domain specific concept by defining the structure and business rules of the concept [ISO/TC 215]. Archetypes may define simple compound concepts such as 'blood pressure' or 'address', or more complex compound concepts such as 'family history' or 'microbiology result'.

A *value domain* is another use of constraint. A value domain constrains data elements to a set of specific permissible values, e.g. severity can be restricted to be one of 'mild', 'disabling' or 'life threatening'. Another value domain constraint is the recommended use of concepts from a terminology, e.g. Snomed CT.

Finally, an *information model* will consist of a number of information components, to which various types of constraints can be applied and which are related to each other through a multitude of relationships. Examples of such information models are models for pathology, medications, immunisations/registries and discharge/referrals.

4.3 Information Patterns

Information interoperability patterns are used to capture some common characteristics of information that are identified in various health informatics applications, both within NEHTA and jurisdictional efforts, and reused across them.

The information patterns will facilitate a shared understanding about important information concerns and approaches and ensure consistency of NEHTA outcomes and subsequent alignment within the broader jurisdictional community. The information patterns are described using the core information concepts, introduced in the previous section.

Five high-level categories of information patterns have been identified by NEHTA, as listed below. Considering the evolutionary nature of the NEHTA IF, it is anticipated that new patterns will be identified and documented as they emerge.

4.3.1 Information rights

This interoperability pattern refers to the recognition that there may be complex circumstances associated with the creation, access to, use and modification of information, in particular personal and clinical information about individuals or sensitive information about some medications or other medical products. This results from the many different parties that may interact with information components during their lifecycle and that information may be stored at various resources owned by many other parties.

A central concept underlying the existence of multiple parties and their involvement in the information life cycle is that of *rights* associated with relevant information and corresponding obligations.

Information rights are not as simple as “ownership of information”, but need to consider a number of different rights surrounding the lifecycle of information, including:

- Copyright;
- Moral Rights;
- Exclusivity;
- Access and Distribution rights;
- Modification rights; and/or
- Transferability of rights.

An example of such a pattern is a “data custodian” for an EHR Service where the custodian:

- Does not hold the copyright or the moral rights (as the creator / author of the information does);
- Does not have exclusive access to the information, as it may be shared with other people;
- Does not have the right to modify the information;
- Has the right to allow authorised third parties to access and redistribute the information, subject to appropriate permissions;
- Can under certain circumstances (e.g. termination of the EHR Service), transfer its rights to another EHR Service;
- has obligations to protect information; and

- may have rights to charge for information access (directly or indirectly).

Further, in this case, the individual:

- has rights to obtain access to their information based on freedom of information or privacy legislation.

This pattern is closely related to the OIF. For instance, in organisational terms, the concept of a right typically involves two core policy concepts, i.e. permission and obligation. Permissions typically apply to the subject who is, for example, entitled to access or modify information. Obligations typically apply to other parties who need to ensure that a subject's rights are not violated, e.g. obligations of a custodian of electronic health records to deliver the required information to the subject.

4.3.2 Temporal dependencies

This pattern captures the importance of considering the temporal dependence of information. Examples are:

- *Limited time-validity* of information, e.g. the expiration of referrals after 6 months from their issue; note that in some cases captured information may need to be kept indefinitely as it includes information about significant event occurrences. Examples could be genetic information, blood type, or allergies.
- *Decreasing relevance of information* (containing for example diagnosis results) with respect to time, e.g. CT results may be obsolete after one year, as symptoms may occur in the mean time; at the extreme end, some information has no significance at all, e.g. information about localised infection that has been cured or a broken toe that has healed or the review of CT.

This aspect may have direct implications from a technical perspective, as the time expiration can be a trigger for some activity, e.g. sending reminders that a regular check needs to be performed. It may also have a close relationship with the organisational framework as some of the temporal constraints on information are defined as policies stated in the OIF.

4.3.3 Information quality

This pattern emphasises the need to consider various aspects of information that reflects its fitness for use. This includes:

- *Accuracy* - how well information represents a real-world value or thing for a particular purpose, e.g. how accurate is blood pressure information taken from a home BP monitor against that taken by a GP. Note that in this example a home monitor may not be as accurate as that measured by a clinician but it may have the level of accuracy required for the purpose for which it is intended. Another example may be whether the blood-test information about John Smith is referring to that of John Smith, living at the Gold Coast, Hedges Av.
- *Accessibility* - the precision with which access control policies are specified (e.g. only those who have rights to access information are permitted to do so) and the ease with which information can be accessed.
- *Relevance* – information is only relevant within a particular context requiring identification of such contexts.
- *Ease of understanding* – information should be written to suit the context, intention and audience to enable ease of understanding; for example, there is often a significant barrier between the understanding available to a consumer and that perceived by a medical professional.
- *Consistency of representation* – as information propagates across many systems, it can be transposed between representations by various

messaging and integration hubs, losing a consistent representation and making future comparison and merging difficult.

4.3.4 Scope of application

This group of interoperability patterns captures the multiple uses applied to one piece of e-health information, e.g. clinical, statistical/epidemiological, or financial and consequently by the various roles involved in these uses.

For example, during and after an inpatient episode the following information may need to be used or collected:

- For *clinical* purposes, throughout the process of health service delivery, health-care professionals can collect some information as part of diagnostic phase. They may require access to other information (e.g. from the evidence-based knowledge repository) while they also create other clinical information, such as following a recommended care plan including the corresponding medications to be used.
- For *financial* purposes, hospital administrators need to create billing information, such as the cost associated with the hospital stay but also the cost of health-delivery services. This information is to be used for billing and claims but also for checking budget compliance.
- For *statistical/epidemiological* purposes, there may be requirements for the collection of statistical information about that individual and the care they received, e.g. information about the type of disease and how it is linked with the age, gender and demographics data of an individual. This information may be needed (or in some cases required) by various government agencies or other organisations for research purposes such as determining trends in populations or population health planning such as primary care policies and incentives.

These different scopes of application can lead to multiple perspectives on information. These need to be correlated to ensure alignment with their meaning. It is important to note that some information can be used for multiple purposes, e.g. certain evidence-based information can be used for both clinical and also statistical purposes.

In general, the OIF concepts and patterns can be used as a guiding mechanism in understanding the nature of information regarding its purpose and scope of application. In this respect, information needs to be considered in the context of one or several organisational concepts and patterns, such as:

- Business processes where it is created or consumed;
- Business policies determining permissions, rights, obligations and consent constraints regarding information access and creation; and
- Relevant organisational patterns such as legislative, governance and policy patterns that may determine the scope of application.

4.3.5 Information transformation

This pattern captures the commonly occurring requirement that information often needs transformation from one form to another as it propagates through a health community.

One such pattern category is of importance for message transformation, as different systems require semantic or syntactic changes during the exchange process. Such a transformation engine is often a critical integration component within jurisdictional systems as many message formats are used by many different applications and organisations.

Another category is more relevant to the transformation from machine-readable forms to human-readable forms. The former being more suited for automated processing while the later supports human integration into organisational processes. Technologies such as XML have often been chosen

as an intermediate form that can be automatically rendered into a visible form through a standard template or parsed within systems based on a standard and predictable format.

5 Technical Perspective

The technical perspective of the IF is addressed in the following Technical Interoperability Framework (TIF). The TIF provides a framework for specifying functionality to be delivered by the technologies employed within e-health applications - but oriented to a business purpose, as documented by the organisational concepts and patterns. The TIF provides a set of concepts and technical interoperability patterns which serve as a common denominator for a number of specific technical solutions that can be employed in e-health systems today or into the future. The TIF concepts and patterns are general in nature to ensure a common understanding of technical concepts in the long term. The TIF is not meant to replace or introduce new architecture models but rather facilitate the co-existence of different technical modelling approaches through common reference points.

5.1 Background

The TIF specifies elements of a technical infrastructure. Component architectures have driven infrastructure delivery through the functional capability of software components. The approach is technology-centric (but independent of any specific technology choices) and allows for the composition of components to deliver higher-order function. We see a similar methodology in low-level programming languages utilising software libraries to meet more complex solution requirements. The glue between components, however, is still based upon primitive, technically oriented software components.

Services[4] are more closely aligned to business functionality rather than technical functionality and provider a coarser grain of capability delivery. Through this business alignment, policy issues such as security, reliability and other quality aspects can be described with more business relevance than if directly applied to primitive software components.

Figure 5 graphically describes the relationship between basic ICT infrastructure, the abstraction to business services, a composition capability to support business processes and orchestration, and ultimate access through service delivery channels. These support service provisioning, access, use and operational issues, as part of delivering business value to the end-users.

While software components reflect the capabilities of underlying technologies, the services should reflect functionalities required by the business context including the contained business logic. From the implementation perspective, services can represent a subset of component functionality interpreted in a way to reflect business needs. This is based upon a generic principle of separation, similar to separation between computational and engineering concepts adopted by the ISO ODP standards. This approach is also in line with the key tenet of a specific TIF interoperability pattern (the Service-Oriented Architecture (SOA) paradigm described below) – defining services as a unit of business functionality.

Further, the functionality of a service is specified in terms of a service interface that reflects the business context. Note that this does not preclude implementing SOA using an Application Programming Interface (API), a client-server architecture or a three-tier architecture. The key characteristic of an SOA service is that, regardless of its implementation, it is specified in terms of a business need, not programming terms.

[4] The concept of ‘service’ in this section refers to services in a technical sense – to be provided by some ICT system; they are a distinct but related concept to that of ‘business service’ introduced in the OIF section.

Finally, services can be composed into even coarser units to better support automation of certain service relationships needed, for example, to support business processes and collaborations. Examples of some specific ways of composing services are process flow, orchestration and coordination. There are a number of interoperability patterns that can be used to characterise specific styles of composing components and services, as well as their dependencies, and these are described at the end of this section.

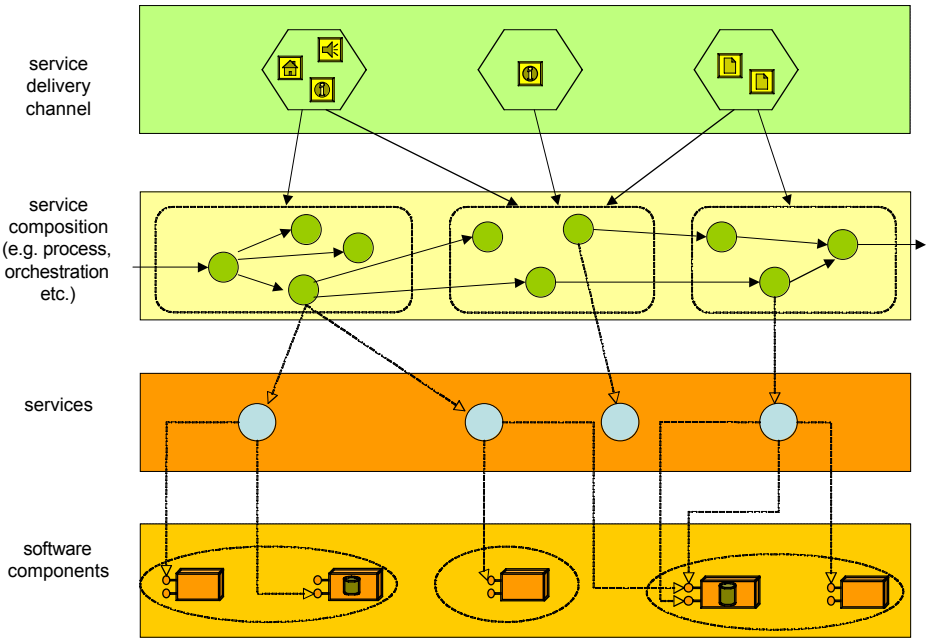

Figure 5: Relating business process to software components

This version of the TIF has taken into account NEHTA's work to date in technical architectures including Secure Messaging and more general technical principals and approaches from the ICT industry. The next version will be expanded to reflect jurisdictional consultation and further progress by NEHTA.

5.2 Core concepts

Software component – this is a software entity that makes one or more functions available to other components; some of these functions or their composite structures can be used to support implementation of services.

Service – this concept is used to specify functionality of relevance for business; typically a service will implement the corresponding business logic and can make use of one of more components; a service can also encapsulate existing applications.

Service composition – a way of establishing a behavioural relationship between several services, including various constraints on them, with the aim to support a more complex business activity such as a business process or business collaboration; there are various technical ways of composing services, such as orchestration, choreography.

Action – represents something that happens; for example a communication between two parties is considered an action as well as communication between two objects; there may be more than one object or party involved in an action, as the examples indicate.

Event – represents the observed occurrence of an action in the real world, either as a result of actions of components or other actors (defined in the OIF) or from the environment external to them; a special kind of event is temporally driven, such as through time expiration.

Message – a unit of communication, between software components, including those components that involve direct interaction with end-users.

Interaction – a set of related actions, which occur at two or more software components or two or more services and which describe some cause-effect relationship between their behaviours.

5.3 Technical Patterns

Technical interoperability patterns capture some commonly occurring, existing or emerging, structures, approaches and technical characteristics identified to be of importance for many enterprise systems. These patterns encompass service delivery channels, styles of component interactions, technical quality aspects and architectural styles.

Some of these patterns have been identified through NEHTA's initiatives. In addition, the technical interoperability patterns will also need to include other types of interoperability patterns that capture broader knowledge of emerging technology trends such as event-driven architecture approaches. As with other IF components, the aim is to document the TIF interoperability patterns to support reuse across NEHTA initiatives and broader e-health applications.

The technical interoperability patterns will facilitate a shared understanding of important technical concerns and approaches and ensure consistency of NEHTA outcomes and subsequent alignment within the broader e-health community. The technical patterns are described using the core technical concepts, introduced in the previous section.

Several TIF interoperability patterns have been identified so far; they are described below.

5.3.1 Service delivery channels

This family of patterns capture the different types of service delivery channels reflecting specific technology options. These options include:

- physical media (paper, x-ray film etc);
- electronic physical media (DVD, USB key or other token technology);
- connected interfaces (e.g. portal); and
- disconnected interfaces (e.g. local application).

Depending on the nature of the technology or business function in question, these service delivery channels can make use of one or more of the composition structures, services or low-level technical components. For example, a terminology service delivery can employ DVD technology or be delivered interactively through web-based portals.

Each channel has its own resource characteristics that may constrain the end-user experience. For example physical media represent a very different interaction paradigm than an online experience. It restricts the immediacy of updates and requires the delivery of physical media as opposed to online service access.

Portal interfaces are a popular lightweight service access point utilising a web browser to provide ubiquitous access from a variety of platforms and locations. Such mechanisms have the potential to cover similar functionality to local applications but may restrict the breadth of the user experience depending on limitations in browser technology and interoperability.

5.3.2 Style of component interactions

These patterns capture the distinctive way software components can interact, including the following:

- *Request/reply*: where there is single request and a causally dependent reply;

- *Directed messaging (or one-way messaging)*: where independent messages are sent to a nominated recipient with no expectation of a reply to the sender;
- *Publish/subscribe*: where independent events or messages are published by one application and received by zero or more (possibly anonymous) subscribers with no expectation of a reply to the publisher (i.e. undirected messaging);
- *Continuous flow* (or streaming): where an ordered sequence of messages is published by one application and directed to one or more downstream recipients; e.g. video e-health applications such as tele-medicine; and
- *Complex interactions*: combinations of the preceding interaction styles with dependencies between the various component interactions.

Each of these patterns has their own technical characteristics that in turn make them better suited for specific situations in support of e-health applications.

5.3.3 Technical quality

This group of patterns captures the quality aspects of the TIF concepts, namely the service delivery channels, composite service structures, services and components, and their interactions. Typically quality is expressed in terms of some measures of various aspects of a TIF concept such as a service or service delivery channel. The aim is to express some value delivered to other components/services or the end-users.

Examples of such aspects are:

- *Rate of information transfer*. A measure of the information exchange capability of system components. "Broadband quality" is often used as a benchmark for consumer access while industry is assumed to provide higher transfer rates.
- *Latency*. Information exchange latency refers to channel delay. The transfer rate may be high but slower latency can affect streamed communication including voice and video.
- *Probability of failure*. Failure can occur in different parts of a system including communication, storage, and processing. In many situations it is difficult to identify the exact point of failure but an overall quality measure of failure enables qualitative.

5.3.4 Technical architecture styles

This category of interoperability patterns captures various approaches to combining and composing software components and their interactions, as previously described, into more complex structures for delivery of solutions. These approaches are characterised by different rules and constraints that guide such grouping, referred to as architecture styles.

Examples of such architectural styles are Service-Oriented Architectures (including older client-server architectures), Message-Oriented Middleware and Event-Driven Architectures (including Business Activity Monitoring specialisations).

Note that a specific e-health system may be built based on the application of one such architecture style or by combining several architectural styles in a consistent manner. For example, a Service-Oriented Architecture style is more relevant to the relationship between business solutions and underlying technical delivery while Event-Driven Architectures are more closely aligned to a technical perspective.

5.3.4.1 Service Oriented Architecture (SOA)

The basic tenet of SOA is a specification of technical services that have a close link to business structures and processes and can be reused across several business application areas. The focus here is on identifying business units of functionality and capturing them in a manner independent of technical platforms or programming languages available or in use.

This SOA approach requires a looser coupling of applications and a higher degree of technical abstraction than has been the case in the past, in the client-server architectures for example. The focus of the client-server architecture was on identifying building blocks as well, but these building blocks were limited by the structuring applied and that closely reflected a technology-driven (and not business-driven) view on applications.

An SOA approach requires significant cultural change in the mindset of analysts, designers, and programmers, who must start designing and building systems in terms of services that reflect business functionality needs, rather than worrying about the characteristics of available technical platforms.

An example of specific technology that satisfies the key characteristics of SOA is the Web Services (WS) stack. At present, many foundation technologies from the stack can be used to start providing SOA functionality, such as SOAP, WSDL and WS-Security. However, it is important to note that WS is subject of many ongoing development efforts and their full compatibility with the SOA is anticipated to occur within next 3-5 years. In particular, one of the key impediments to the full SOA capability is policy-based management and control [Burton]. In spite of this, SOA is the best approach and most scalable architecture style today and WS's represent their best technical implementation approach.

Note that recent developments in SOA places more emphasis on the importance of policies. These (technical) policies define constraints and capabilities of a system or technical service. Similarly, the concept of business policy defined in the OIF is also considered as a constraint, but applied to the behaviour of individuals or organisations. This similarity between the organisational and technical concept of policy will facilitate clear mapping between the two views on policies and subsequently between the business and technical views on services.

5.3.4.2 Message Oriented Middleware

Message Oriented Middleware (MOM) provides a reliable form of directed messaging or publish/subscribe. One or more messaging hubs offer persistence and reliability allowing a message receiver to be inactive when a message is sent. The message is later consumed when the receiver becomes active again.

In traditional MOM, messages are addressed to their recipients usually indirectly through a message queue. This allows the sender and receiver to be loosely coupled, as they do not need to synchronise to communicate.

Direct addressing through recipient-named message queues may be less suitable for wide-area, large-scale systems and so it may be advantageous to decouple message sources and sinks with respect to naming, so they may be mutually anonymous to each other. This is often called a publish-subscribe mechanism although this name is more usually associated with Event-Driven Architectures (see Section 5.3.4.3). Sources "publish" to the entire network and interested sinks "subscribe" to messages. The network then only forwards messages if there is at least one subscriber waiting on that message queue.

MOM has a larger share of the market than Object-Oriented Middleware, being used for database access in large business applications. An example of MOM is IBM's MQseries (reliable, MOM service) [IEEE Distributed Systems Online]

5.3.4.3 Event-Driven Architectures

The key focus of the Event-Driven Architecture (EDA) is on events, either because they may trigger some application behaviour or because one or more events together can signify some important occurrence of business value. EDA do not typically support a queuing metaphor as provided with MOM. Event generators publish event content and the event infrastructure will forward such content on to those event consumers who have indicated a need for that type of content. Event subscriptions tend to be content-based, providing an expression of interest over the entire event content. In contrast, MOM usually address message content to named message queues either representing subjects of interest or individual recipients.

Events are a more primitive level of behaviour than services while signifying an asynchronous character of behaviour. In contrast, SOA generally involves bi-directional request/response communications between an invoking and an invoked service. Both of these architecture styles will be needed for future enterprise systems.

EDA covers a number of areas, including:

- Event-driven processes which have capability to react to external events, rather than to be driven by traditional local control and data flows; and
- Event correlation and abstraction, and other relationships between events such as causality, membership, and timing; these are needed to represent complex event patterns that may be used as part of event data mining, to identify cause and effect between certain actions, useful for example in detecting fraudulent and illegal actions.

Business Activity Monitoring is a recent extension to EDA. It defines a particular use of event-driven processing to facilitate run-time monitoring of certain processes, activities, or people involved in business collaborations. This architecture style is, for example, employed in checking regulatory compliance such as Sarbanes-Oxley and HIPAA policies (United States).

5.4 Summary

An overview of the key interoperability concepts and patterns presented in previous sections is shown in Figure 6. Technical interoperability is sometimes regarded as the most important interoperability outcome if one approaches interoperability from an integration perspective, however this is not a correct interpretation of the IF motivation nor contribution. It is only as a complete set of interrelated perspectives that the IF value is realised.

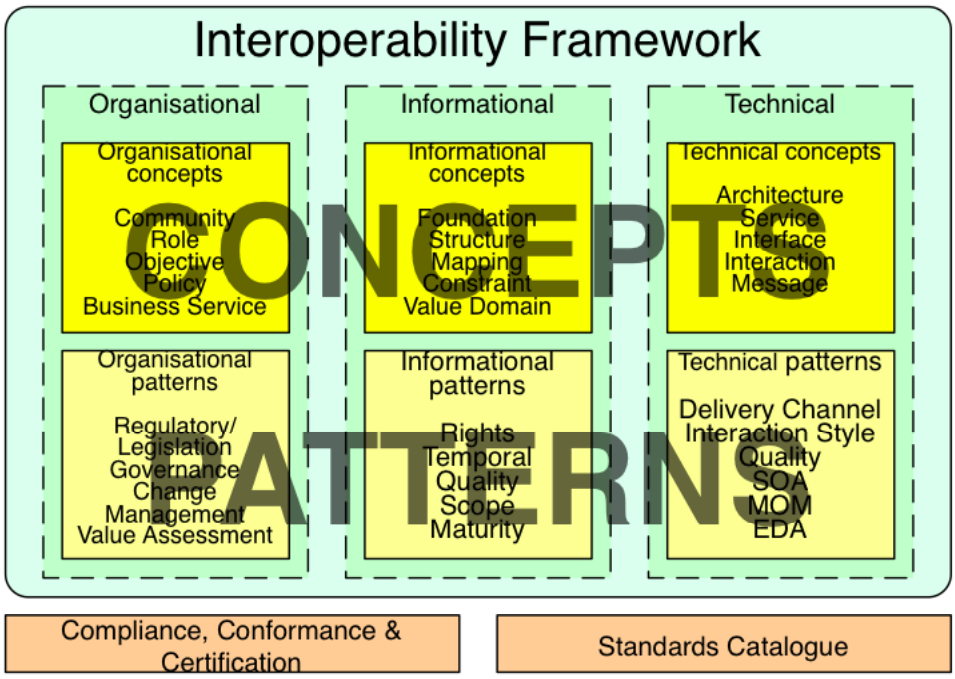

Figure 6: The NEHTA IF - key concepts and patterns

6 Towards Compliance, Conformance and Certification

Standards and specifications are important elements in delivering an interoperable future. They support the separation of implementation from specification[5] allowing for component replacement and system evolution. Specifications are developed from (business and/or functional) specifications. They are expected to have a longer life relative to their implementations, as they are independent of rapidly evolving IT technologies. They create an environment in which technical integration can occur for a predictable and fixed cost even though the elements for integration may not be known beforehand. A standard is a more generally adopted specification but generally provides a similar level of direction.

In isolation, standards and specifications provide guidance for interoperability but it is only through some form of measured adherence to these standards and specifications that the benefits will be realised. NEHTA's approach to express such adherence is through the use of two separate principles, namely compliance and conformance principles, following the ISO recommendations [ODP-RM], see Figure 7.

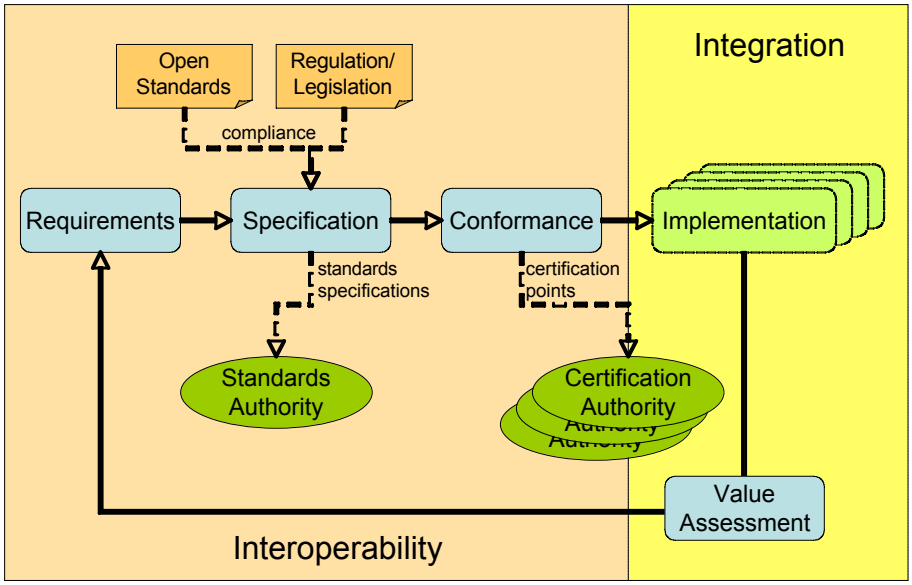

Figure 7: Role of Conformance and Compliance in Interoperability

The specification is a solution design without presupposing the implementation technology but instead allowing for choice in the eventual implementation. These specifications are of significant value in the interoperability process. In order to interoperate with other specifications, they should *comply* with openly available standards and define *certification points* through which *conformance* to the specification can be tested (see Figure 7).

[5] Occasionally implementation details and requirements may exist within architectural specifications but these situations are an exception rather than the norm and should be noted as exceptional cases.

6.1 Compliance

One standard or specification is *compliant* with another standard or specification if all propositions true in the initial standard are also true in the complying standard. For example, the Web Services security specifications must be compliant with Web Service messaging (SOAP).

It is certainly possible to develop new specifications with no compliance to existing standards or specifications. However this is not the desired outcome. Existing standards or specifications should be referenced and adopted wherever possible to allow for maximal potential for interoperability. Where no standard is chosen, there is little chance of two independent specifications sharing common approaches and thus enabling use of common infrastructure.

Compliance also includes statements that describe how specifications need to satisfy possible legislative or regulatory constraints or requirements as shown in Figure 7.

Compliance is an issue for all NEHTA specifications as well as any other specification referencing NEHTA specifications.

6.2 Conformance

The aim of most specifications should be to serve as a basis for implementing a system that satisfies its specifications. When implemented, a system will need to be checked to determine how it satisfies the specification. This is done by observing the system's behaviour and comparing it to the specification, and is referred to as *conformance* to the specification.

A conformance statement identifies *conformance points* within a specification and the behaviour that must be satisfied at these points. The truth of a statement in an implementation can only be determined by testing and is based on a mapping from terms on the specification to observable aspects in the implementation. We can classify these conformance statements into programmatic interfaces, user perception, system interworking, and media exchange.

All NEHTA technical solutions will be required to conform to the specifications whether those implementations are provided through NEHTA or from external software vendors.

6.3 Certification Process

Conformance points can be specified at different viewpoints within the Interoperability Framework. For example, ISO 9000 is concerned with the organisational processes associated with quality rather than the technical implementations of the processes. In each case, the certification process is associated with a certification community (as per the organisational concept of community in section 3.2) consisting of a certifier role conducting the certification process, the artefact being tested for certification, the owner of the specification, and the owner of the artefact.

The certifier role in the certification process can be played by a number of parties:

- Organisations or individuals can *self-certify* solutions based upon their own interpretation of the conformance criteria. This is a low cost, scalable solution to certification but provides little guarantee of a common certification outcome.
- A *national certification organisation* could be developed which supports all conformance statement types across organisational, information, and technical viewpoints. This is not a minor undertaking but does create the strongest guarantee of common conformance. The UK health reform work has followed this model by developed a large

testing facility but their solution to e-health is based around common implementations, not common specifications.

- Several *existing conformance organisations* already exist within Australia. These include the Australia Healthcare Messaging Laboratory and organisations associated with Standards Australia. These organisations provide a low-cost entry point into conformance and distribute the load associated with such work.

It is also possible to migrate through alternative conformance approaches, beginning with self-certification through selected certification organisations. The start of this process begins with the implementation-independent specifications and associated conformance criteria.

Further detail on the certification process will be provided in a forthcoming document on compliance, conformance, and certification to be released in mid-2006.

7 Interoperability Framework Methodology

The Interoperability Framework requires a consistent high-level methodology to guide the initial phases of the solution delivery process, ensuring that future interoperability is achieved. This is not a replacement for an Enterprise Architecture Framework methodology but should instead be viewed as a compliance requirement for an EAF methodology. This section positions the IF methodology and outlines its requirements.

7.1 Comparing the IF methodology with an EAF methodology

The IF methodology is a high-level development methodology that reflects the transitionary and evolutionary spirit of NEHTA's contribution to the long-term interoperability of Australian e-health. As a result, the IF methodology has been developed to ensure vendor and technology independence, open standards compatibility and the sustainable delivery of architecture specifications and subsequent IT system implementations.

The main aims of the IF methodology are to provide:

- a systematic and consistent way of delivering specifications based on a set of requirements;
- a disciplined and unambiguous approach in expressing compliance and conformance criteria (as described in section 6);
- an iterative and incremental way of developing specifications, according to a pre-defined project plan; and
- agility in terms of dynamic responses to external triggers including value assessment approaches.

In a similar way, as the IF represents a higher-level of abstraction than EA frameworks so the IF methodology represents a 'higher-level' methodology than many EA methodologies.

7.2 IF Methodology

Technical outputs that define or create an ICT capability are required to follow a standard IF methodology including requirements analysis, architectural specification, and compliance/conformance identification phases (see Figure 8) before choosing specific solution design, implementation delivery, and value assessment options (see Figure 7). Each phase comprises organisational, information, and technical concepts and patterns.

- *Requirements* capture and analysis is used to scope a business problem and (as Figure 8 depicts) the majority of requirements are going to be expressed in terms of organisational concepts and patterns. For example, the identification of key communities, statements of their objectives and the constituent business processes, roles and policies. In addition, the key information components, supporting the organisational requirements will need to be identified, along with the key IIF patterns. There may also be technical requirements such as the use of an SOA style.
- An *Architectural Specification* will describe the contribution a deliverable makes and relationships it requires to other technical system components. Depending on the system being described, architecture specifications will consist of varying degrees of organisational, information and technical specifications. Each of these specifications will be done in a sufficient detail for the subsequent implementation phase. For example, an organisational specification will

include a more detailed description of business processes than what is identified at the requirements phase. It will also include a detailed information model and technical architecture. The technical architecture must be independent of technology and provider choice and present an architectural foundation based upon service principles including provision of reusable business services and separation of interface from implementation.

A Service Relationship Statement must describe the service interfaces that are provided to other NEHTA services and those service interfaces that are required by the deliverables. The required service interfaces will also be part of the Compliance Statement.

A *Compliance Statement* detailing all NEHTA, national, and international standards/specifications that are being utilised by the deliverables. This includes both those used within the deliverable and those with which the deliverables interoperate. It is strongly advised that all efforts be undertaken to be compliant with obviously relevant Australian Standards where possible and if not, a non-compliance statement should be provided.

- A *Conformance Specification* accompanying the Architectural Specification will identify a set of conformance points enabling certification of implementations against the Architectural Specification.

Conformance with the NEHTA IF methodology requires adoption of the concepts and patterns associated with the three interoperability perspectives as well as delivery of a set of documents detailing adherence to the methodology requirements.

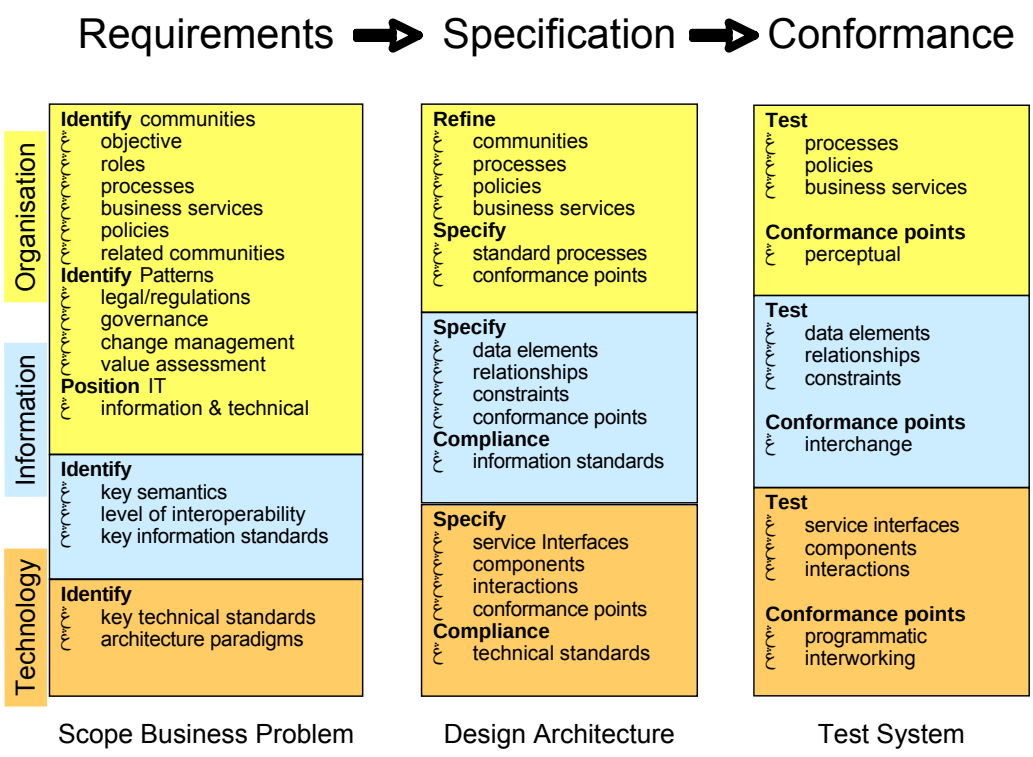

Figure 8: NEHTA standard IF methodology for requirements, specification and conformance

Note that the IF methodology also includes the value assessment phase (not shown in Figure 8). This phase is key in providing a business justification for a solution before the development process starts. A post-release assessment determines the value of the system in use and possibly determines points of possible incremental improvement.

8 Towards a NEHTA Enterprise Architecture

The Interoperability Framework defines a language of concepts and patterns across three perspectives that enable cross-enterprise architecture cohesion. Each jurisdiction has or is likely to adopt an Enterprise Architecture Framework (EAF) that will lead to different enterprise architecture and toolset choices. The IF works across this diversity of approaches to align conversations through the organisational, information, and technical perspectives. It is through the shared understanding and adoption of common interoperability concepts and patterns between the IF and individual EAFs, that this conversation can be achieved.

NEHTA must also choose an appropriate EAF to use in its creation of interoperable e-health infrastructure services for Australia. Figure 9 depicts the co-existence of State and Territory, Federal, private sector, and NEHTA approaches to enterprise architectures (EA) and highlights the degree to which all contribute to a national e-health environment. The NEHTA EA provides a coherent architecture for NEHTA services and is not a replacement for jurisdictional architectures. It provides a foundation for interoperability across the NEHTA services and may be reflected on by jurisdictions as being a potential approach to their own enterprise architecting issues. It should be noted that the IF is not a replacement for EAF's but instead creates cohesion between their approaches through the aforementioned concept and patterns.

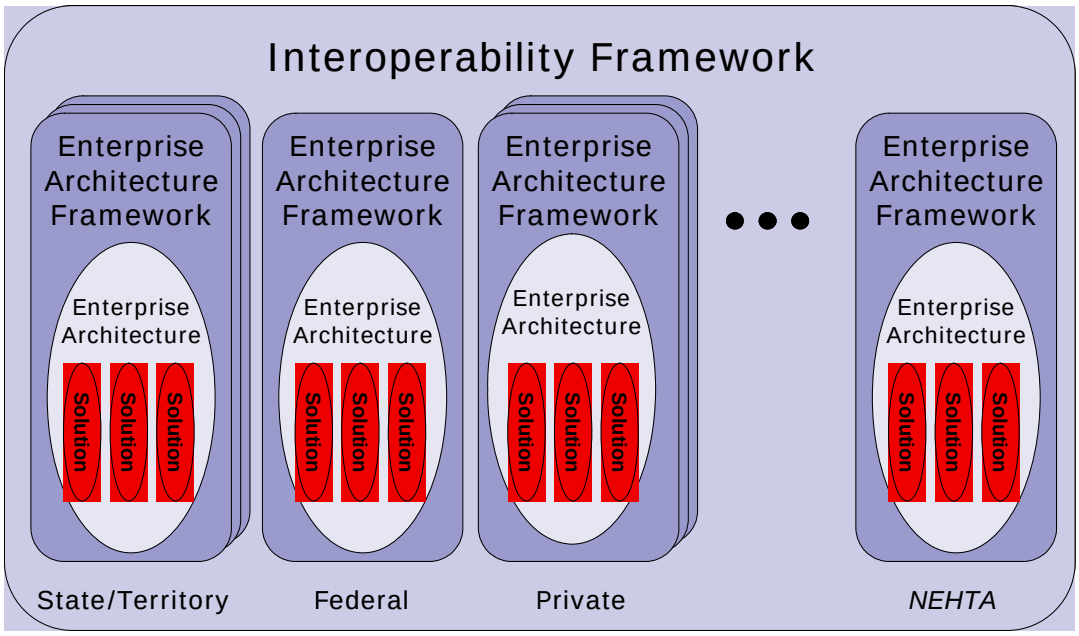

Figure 9: The Interoperability Framework as a family of enterprise architectures

It is expected that new contributors to the national e-health community will emerge and others will leave. Each will follow their own EAF approach but by mapping to the IF concepts and patterns, they equip themselves for future interoperability and subsequent integration.

One aspect of the NEHTA Enterprise Architecture is the technical viewpoint ensuring cohesion between the specifications and solutions produced through the NEHTA work programme. This section introduces the technical perspective of what will be a larger body of work to deliver the NEHTA Enterprise Architecture including coherent organisational, information, and technical approaches.

8.1 Principles

The wider health community as in the past put significant effort into messaging as the basis for e-health connectivity. This has a number of weaknesses as it scales to accommodate interrelated yet distinct e-health community roles. Recent advances in ICT thinking have migrated to a services abstraction as the basis for interconnectivity. Noted weaknesses include managing the relationships between messages and facilitating an abstraction between the specification and implementation of e-health solutions. Such abstractions are a basis in architecting for change.

NEHTA has chosen to adopt a Service-Oriented Architecture (SOA) approach as part of its enterprise architecture. This approach works effectively in the inter-jurisdictional, cross-sector (public/private) environment that characterises e-health. As described in the Technical Perspectives section on patterns, it is particularly aligned with a business-focussed delivery paradigm enabling organisations to interoperate in an emergent and evolutionary environment.

The NEHTA enterprise architecture is based upon a number of principles. These principles encompass the motivation for following an open approach to standards, specifications, and subsequent implementation, and:

- Provide *architectural leadership* to those implementing solutions;
- Create an *environment* that cultivates future interoperability;
- Sustain *multiple implementation approaches* and *multiple owners* of those implementations;
- Utilise the *Interoperability Framework* concepts and patterns to underpin a shared approach; and
- Adopt a *Service-Oriented Architecture* based upon reusable services and separation of delivery channel from underlying business services.

NEHTA aims to both promote and produce solutions through service deployment that are enabled for an interoperable future where they may be re-factored, redeployed, or even removed from use. These architectural principles guide the solution creation process to ensure we are architecting for the future and, more importantly, architecting for change. This is an example of the education/change management pattern described in Section 3.3.4.

8.2 The Service Architecture

NEHTA will make a significant contribution towards transitioning e-health to an interoperable future where new solutions will be created for problems we may not have yet recognised. Some service solutions will be generated in local communities, others by jurisdictions, and some will be provided nationally. These parts must all co-exist and interoperate without disenfranchising parties contributing to a national e-health future.

Services will be provided in different forms by different parts of the community as changes occur in the understanding and ownership of e-health issues. For example, it is likely, and desirable, that local communities and jurisdictions work with new technology approaches that, over time, may manifest themselves as national approaches or services.

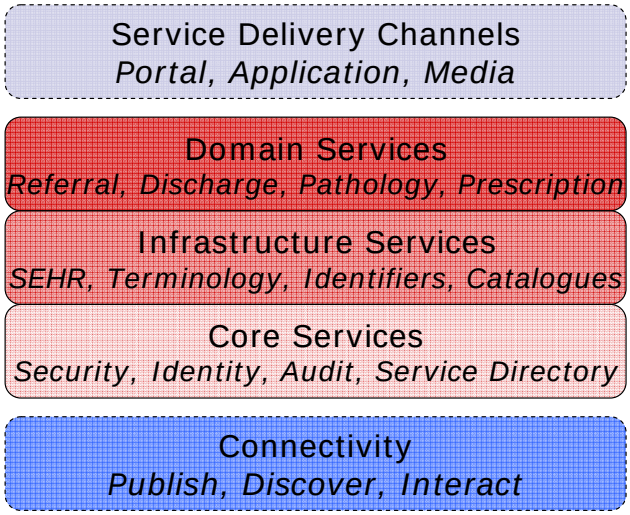

Figure 10: Layers of the NEHTA enterprise architecture

Distributed systems have taught us that a sedimentary effect occurs within infrastructure over time. What was once an application component becomes part of the infrastructure as it permeates the environment.

NEHTA has a role to create an environment conducive to the adoption of these infrastructure services. Some shared services will be local in extent, extracting service contributions from Patient Administration System (PAS) and Clinical Information System (CIS) systems and repackaging them as reusable service components available to the organisation and potentially beyond. Other service elements leverage national approaches and solutions.

The NEHTA infrastructure describes a set of services and connectivity approaches required to deliver the technical capabilities of the NEHTA Enterprise Architecture. The components of the NEHTA infrastructure have been dissected into service delivery channels, shared services, foundation services, and connectivity mechanisms as summarised in Figure 10 and outlined below. This identifies the role different infrastructure components play in supporting the variety of e-health outcomes.

- *Service delivery channels* provide the layer through which end users interact with systems. They range from shared portal technology to specific applications and media technologies such as DVD and written forms. Each channel carries ownership of some business logic but relies upon infrastructure components to deliver end user solutions.
- *Domain services* encompass services of relevance for specific health domains such as pathology, radiology, hospitals and general practice.
- An *infrastructure service* is used by one or more domain services for a common purpose. For example this might be access to a shared repository such as a medicines or national product catalogue, a national clinical terminology or identifier, or shared EHRs.
- *Core services* are a more basic element of the environment required for meaningful operation of infrastructure services and domain services. This includes mechanisms such as security, identity management, and service directory.
- *Connectivity* includes support for the publication, discovery, and interaction of services. Key to such connectivity is the standard protocols for connectivity.

Over time we would expect some change in status between different elements of this layering. In particular, the transition of shared services through to foundation services as parts of the infrastructure become more essential than optional. No governance or implementation ownership is presumed through these layers. In fact it is likely that multiple delivery alternatives will be

employed across all layers as many parties deploy to meet the architectural requirements in regional, jurisdictional, and national communities.

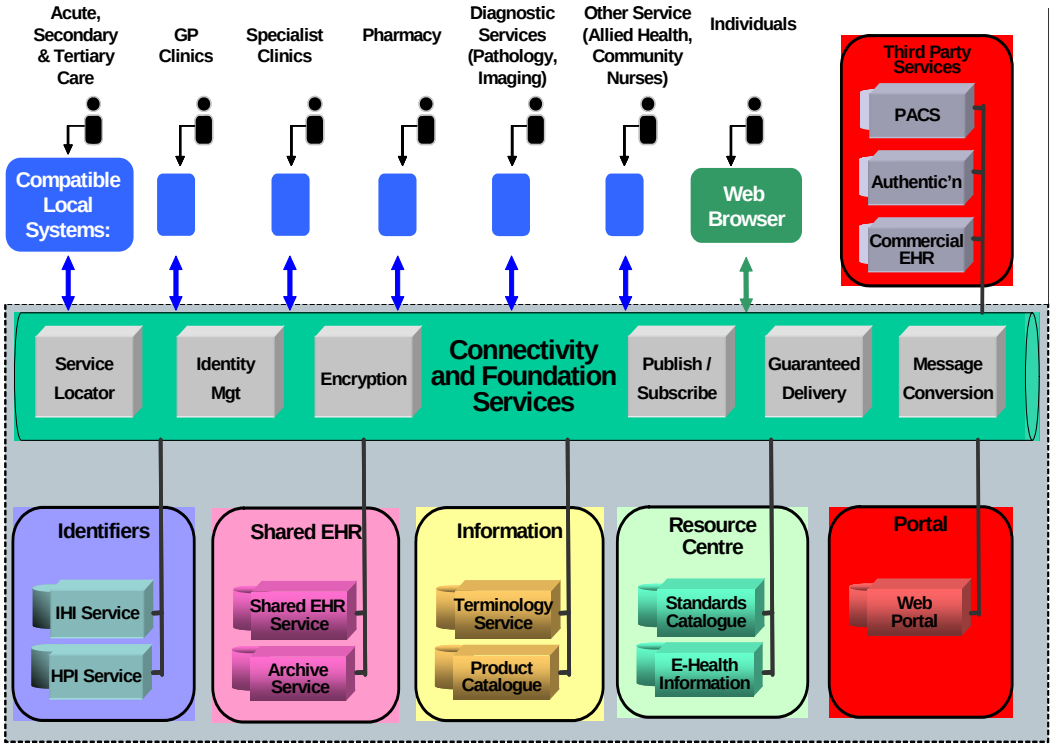

Figure 11: NEHTA initiative delivery within the NEHTA enterprise architecture

A service-based view of the NEHTA enterprise architecture is shown in Figure 11. It depicts the broader e-health community working through the connectivity and foundation services (represented by the box framed by a dashed line) to access many of the shared resources within the NEHTA work programme. NEHTA specifications determine how these services will interact but do not imply NEHTA ownership or operation of their implementation. Some, such as the connectivity environment have no single implementation but rather are the result of orchestrated implementation of a single specification by many parties. Other services such as a product directory may have a single national instance or may have multiple jurisdictional instances. Each, however, will be conformant to a single national specification.

The Service-Oriented Architecture approach can deliver direct business value by making business drivers the conduit for technical outcomes rather than driving business outcomes from technical solutions. It uses the concept of a service interface as part of the service specification to separate an implementation from the agreement that service makes with those using that service.

Such service agreements are not only of relevance to the infrastructure but also form part of the software relationship through to clinical care systems. Figure 12 on the following page describes the relationship between clinical care systems accessing shared national services in turn relying on foundation services. Each element in the picture requires a services specification whether it is the interface specification for user authentication or the interface to a GP clinic.

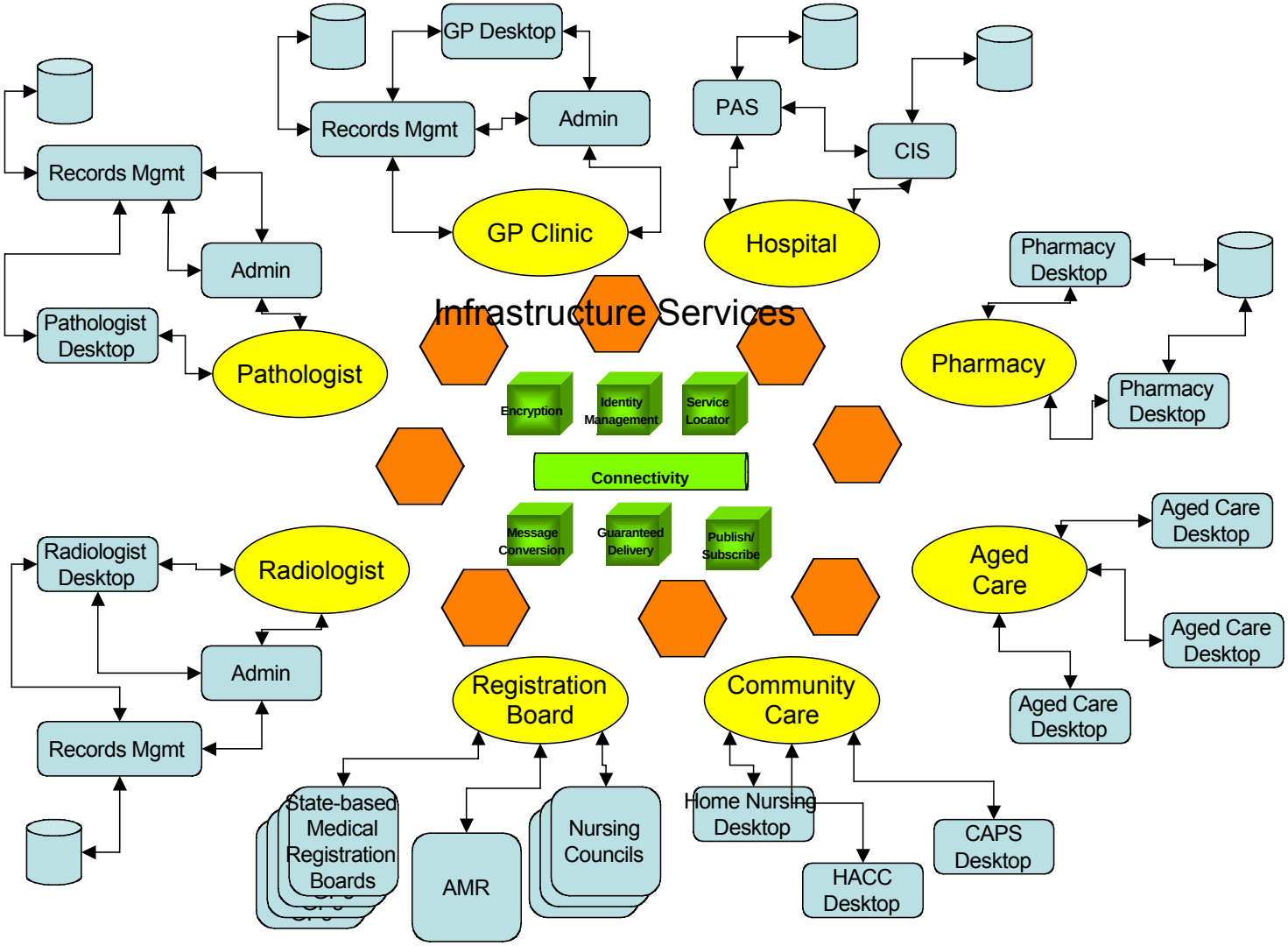

Figure 12: Service use from infrastructure to service delivery channel

Since services are the building block of SOA approaches, it is essential to agree upon a standard set of foundation service specifications as well as shared service specifications from which e-health solutions can be delivered. NEHTA is developing these service specifications as part of the initiative deliverables. In addition, international efforts are underway to standardise service specifications through HL7 and the OMG. These efforts will bring together the vendor community with the various national e-health initiatives as well as jurisdictional and community outcomes.

Even though the TIF describes multiple architectural patterns, foremost for the NEHTA EA is an SOA-based approach. It is envisioned that NEHTA will also require adoption of an event-based model for asynchronous information delivery in future. As demonstrated needs arise and expertise increases, this will be added to the NEHTA Enterprise Architecture.

8.3 NEHTA Alignment

NEHTA has a very active programme of work specifying, and sometimes implementing, various aspects of the NEHTA Enterprise Architecture building blocks used to deliver an interoperable e-health environment. It is not only critical to deliver the right services into this environment but also to align the process of delivery to ensure a flexible and agile result is achieved.

NEHTA shall therefore ensure that:

- All initiatives undertaken by NEHTA are in compliance with the NEHTA EA and Interoperability Framework Methodology;
- Proposals for new services and components are considered in the context of the NEHTA EA; and
- NEHTA's architectural specifications are consistent with the Interoperability Framework and NEHTA EA.

8.4 Connectivity Implementation – Web Services

Service-Oriented Architectures are a design style that increases organisational flexibility and agility through reusable, shared services implementing autonomous business and technical functions. SOA is more than a technical implementation, as it also requires a change in all aspects of ICT analysis, specification, and design, including change in the mindset and approach of business and software experts.

The Web Services Framework (WSF) is the most applicable approach to the implementation stage in an SOA but it should be noted that the WSF is also in an evolutionary state. Sufficient market adoption and standardisation exists to drive forward with SOA projects such as that being undertaken by NEHTA and ongoing standardisation efforts in the WSF will lead to impact areas such as policy management and administration.

Web Services were originally designed as the programmatic companion to web page access through web browsers. However this has not been the trajectory of use since its inception. Many have used Web Services to implement integration strategies by leveraging the ubiquitous and relatively simple Web Services support provided through most technology platforms. These integration approaches are in the most part not SOA implementations but rather tightly coupled integration solutions that leverage a more ubiquitously shared connectivity technology than was previously available.

Web Services as an SOA platform requires a translation of the design features of an SOA approach into the Web Services platform. In particular this imposes a higher-level business granularity on services beyond the programming-level, client/server approach that is often seen in Web Services used as an integration platform. The service definitions are designed to be reusable through eventual assembly into and with other service elements to meet existing and emergent delivery requirements.

A Web Services infrastructure by its nature is a distributed entity with the basic communication capability delivered through each service implementation according to an agreed set of standards. Services are deployed through Web Service platforms enabling the creation and deployment of services.

Further information on NEHTA's approach to Web Services is contained in NEHTA's publications Towards a Secure Messaging Environment and Web Services profile (reference).

9 Standards Catalogue

The NEHTA Standards Catalogue will draw from work completed by the Australian Government Information Management Office (AGIMO) in their Australian Government Technical Interoperability Framework version 2 [AGITF]. This collection of standards is to identify a set of nominated standards providing essential guidance and building blocks for the delivery of NEHTA outcomes.

Standards are relevant across the entire NEHTA work programme and provide both validation with external expert groups as well as a rigour to the outcomes generated by NEHTA as they enter the standards communities. The Standards Catalogue will be a living document reflecting the emergent outcomes of the NEHTA initiatives and deliver those standards in current use. The catalogue will also document the lifecycle of these standards as they newly enter community uptake or are on a decline in usage.

Steps in generating this catalogue include identifying:

- a conceptual model to classify standards for search and retrieval;
- standards selection criteria; and
- information to be collected about the standards.

The Standards Catalogue will be published by NEHTA as a separate document but the following serves as a first cut at the structure for this Catalogue.

9.1 Conceptual Model

Standards are relevant to the three Interoperability Framework viewpoints and a conceptual model based on these perspectives will allow users of the Standards Catalogue to discover standards relevant to their needs. An appropriate category reference will be included in the standards information stored within the Catalogue.

The conceptual model will be populated as standards are added to the Catalogue. Initially it will only include a reference to the IF viewpoints. No single conceptual model will satisfy all those seeking standards but the Catalogue will include some category classifications as included in the AGIMO's Australian Government Technical Interoperability Framework (AGTIF) [AGTIF].

- *Security*, e.g. PKI, X.509, SAML;
- *Interconnection*, e.g. HTTP, FTP, SOAP, WSDL;
- *Data Exchange*, e.g. RSS, X.400, XML;
- *Discovery*, e.g. LDAP, X.500, UDDI;
- *Presentation*, e.g. HTML, RTF, PDF;
- *Metadata for Process and Data Description*, e.g. BPEL4WS, UML; and
- *Naming*, e.g. URI, WS-Naming.

9.2 Selection Criteria

Standards in the catalogue will either currently be in use or under consideration for use by NEHTA. The catalogue will include both de facto and de jure standards coming from national and international standards bodies including proprietary, business, and more openly developed standards.

NEHTA is aligned to the adoption of open standards. These standards should require no royalty payments, be openly published, allow extension, promote reusability, and reduce the risk of technical lock-in and high switching costs. Open standards will be selected where possible but when significant market or

technical issues predicate alternative selection, we will adopt the standards deemed most relevant and useful to the community.

9.3 Standards Information

Each standard will include the following information

- *Name & Version:* The common name and most recent version under use for a given standard;
- *Classification:* The relevant IF perspective and category of application;
- *Rights Model:* “Open” for freely available standards; “Proprietary” for standards whose use is controlled by a commercial organisation; “Commercial” for standards that require payment for use; and “Government” indicating the item is a public sector resource;
- *Overview:* A brief definition or description of the standard;
- *Initiatives:* The initiatives employing this standard;
- *Status:* The current status of the standard. “Deprecated”, “Fading”, “Current”, or “Emerging” indicating the status of the item within a usage lifecycle. “Deprecated” standards are no longer in common use and have been superseded by newer standards or approaches. “Fading” refers to standards that, while still used, are receiving less support or are being superseded. “Emerging” refers to standards that do not currently have widespread use, but which are expected to receive more usage in future. “Current” refers to standards that have strong and ongoing support at this point in time;
- *Last Updated:* Date at which this standards entry was last updated;
- *Reference:* A URL referring to definitive information relating to the item; and
- *Comment:* Any further comments that may be pertinent to the item or its use.

10 Next steps

There are several steps to be undertaken in completing subsequent versions of the Interoperability Framework. This section highlights these next steps.

10.1 Further Development and Consolidation

NEHTA will generate detailed information and technical interoperability components to complement the detailed OIF already completed. These will be completed as NEHTA's work in the various initiatives becomes more advanced. In addition, the relevant international health informatics initiatives such as HL7 [HL7] and SNOMED [SNOMED] will be leveraged.

NEHTA will seek detailed feedback from these international initiatives and the jurisdictional community about the existing interoperability concepts and interoperability patterns and extending or refining both of these according to the specific needs of NEHTA. These needs may be in part driven by the specific requirements of e-health stakeholders with whom NEHTA liaises.

10.2 Interoperability Maturity Model

It may be useful for organisations to assess the extent to which they have applied the concept of interoperability; one approach to such an assessment is proposed below for discussion. This is based upon the CobiT Capability Maturity Model[6] developed and promoted by the IT Governance Institute, under the auspices of the ISACA[7]. This approach categorises the adoption of interoperability approaches and principles according to the following levels of engagement:

0. *Non-Existent*. Lack of awareness about interoperability.
1. *Initial.* An awareness that the issue of interoperability exists and needs to be addressed. There is no coordinated approach to interoperability but instead ad-hoc approaches are applied on a case-by-case basis. This level can be achieved through a general understanding of NEHTA's interoperability objectives and work program.
2. *Repeatable.* Interoperability approaches and principles have been adopted by individuals but are the responsibility of the individual and not proactively coordinated through training and communication. There is a reliance on the work and knowledge of individuals.
3. *Defined.* Approaches and principles are documented and are communicated and documented. This level can be achieved though participation in workshops describing concepts and patterns for each of the interoperability components and the NEHTA IF methodology life cycle. This includes:
    a. Formalisation of business, information and technical *requirements* using the appropriate set of IF concepts and patterns. It is expected that the majority of requirements will come from the OIF perspective. This is because they provide an explicit framework for relating policies, processes and structural organisational aspects, while allowing definition of hierarchical and federated structures.
    b. Derivation of *specifications* from the set of requirements, structured in terms of the organisational, informational and

[6] CobiT: Control Objectives for Information and related Technology.

[7] SACA: International Security Audit and Control Association. See http://www.isaca.org and http://www.ITgovernance.org

technical components using the respective concepts and patterns. Note that each organisation can use their own notation for expressing the specifications but it is anticipated that in most cases UML notation will be sufficient.

c. Addressing the *conformance* and *compliance* aspects of the specifications in association with the specification. The specifications will need to clearly identify conformance points where testing needs to be performed and compliance points to demonstrate the use of appropriate open standards or the use of specification fragments from other e-health initiatives, where needed.

4. *Managed.* Interoperability approaches and outcomes are monitored and measured for compliance with the NEHTA IF methodology lifecycle.
5. *Optimised*. This is the most mature level of engagement with interoperability and requires a continuous feedback process to the IF. A refined level of best practise is continually reassessed providing improved interoperability quality and effectiveness.

Note that the "Towards an Interoperability Framework" document [NEHTAIF1.8] identified four levels of health care sharing, ranging from non-electronic data exchange to the machine interpretable data transmission utilising standardised structured messages [Walker]. These represent various levels of maturity needed to support different levels of automation in e-health. Interoperability only reaches automated interconnection at the fourth level where semantic interoperability is supported. However, full interoperability can only be achieved through the automated interconnection and shared understanding. In particular, the latter involves shared understanding of the organisational concepts.

Table 1: Summary of Interoperability Maturity

Level of Maturity	Description
Non-existent	No exposure to IF concepts, patterns, or methodology.
Initial	Recognition of interoperability issues and the need to address them.
Repeatable	Individuals utilise interoperability concepts, patterns, and methodology through individual initiative.
Defined	Organisation-wide adoption of interoperability processes through documentation and training.
Managed	Compliance to the IF and methodology are monitored and measured. Action is taken where compliance is not achieved.
Optimized	Organisational feedback into the IF concepts, patterns, and methodology to ensure a process of continuous improvement and effectiveness.

10.3 Mapping to an Enterprise Architecture Framework

Mapping between Enterprise Architecture Framework (EAF) approaches and the Interoperability Framework will provide readers of the IF with an understanding on how the IF can influence this work. This mapping will be included in the next version of the IF.

10.4 Guidelines and Profiles

An awareness and education programme within and beyond NEHTA through the publication of guidelines and profiles will enable broader take-up of the Interoperability Framework. These publications will guide and document the application of the IF within NEHTA and within jurisdictional interoperability and enterprise architecture projects, as appropriate.

10.5 Feedback

NEHTA has in place a process to consult with jurisdictional groups to discuss the application of the Interoperability Framework to their work, including jurisdictional enterprise architectures. In particular NEHTA seeks feedback from jurisdiction on this current IF and the concepts and patterns relevant to their own experiences in the context of cross-enterprise architecture requirements for the IF.

NEHTA will also engage with the standards community on this work to see that interoperability approaches become part of the health standards work plan for Australia.

Feedback will be considered by NEHTA and will be incorporated into the next version of the document, which will then be released through NEHTA's website. All comments should be directed to interoperability@nehta.gov.au.

11 References

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12 Glossary

CIS	Clinical Information System
EA	Enterprise Architecture
EAF	Enterprise Architecture Framework
EDA	Event-Driven Architecture
ICT	Information and Communications technology
IF	Interoperability Framework
IIF	Information Interoperability Framework
ISO	International Standards Organisation
IT	Information Technology
MOM	Message-Oriented Middleware
NEA	NEHTA Enterprise Architecture
OIF	Organisational Interoperability Framework
OMG	Object Management Group
PAS	Patient Administration System
RM-ODP	Reference Model for Open Distributed Processing
SOA	Service-Oriented Architecture
TIF	Technical Interoperability Framework
UML	Unified Modelling Language
WSF	Web Services Framework