

Addressing interoperability in e-health: an Australian approach

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Abstract

This paper describes the use of the ISO ODP family of standards [1][2][3] to address interoperability issues in the Australian e-health environment. The Australian health system has a specific institutional structure and funding model involving a combination of federal, state, territory and local government jurisdictions along with the private sector. This arrangement requires a thorough understanding of legislation, regulation and other policies, as well as governance models and the collaborative nature of healthcare businesses to inform the building of interoperable and sustainable IT systems. The aim is to provide better, safer and more efficient service delivery than what current silo-based approaches deliver. The ODP standards provide a valuable conceptual basis for addressing diversity, richness and evolvability of such a complex system, embracing both human actors and IT systems. The ODP Enterprise Language provides core concepts for describing the organisational context for e-health systems, while the ODP-RM architecture framework allows for the description of various e-health stakeholders' concerns, from organisational, information and technical perspectives. Further value of the standard comes from rigorous conformance and compliance guidelines.

Keywords: *Interoperability, e-Health, ODP Standards.*

1. Introduction

The Australian health system has a specific institutional structure and funding model involving a combination of federal, state, territory and local government jurisdictions along with the private sector. This structure requires a thorough understanding of the policy environment, covering legal, regulatory and other enterprise policies and governance models, as well as of the collaborative nature of

healthcare business, to inform building fit-for-purpose, sustainable and interoperable e-health systems.

In this context, interoperability needs to be understood in broader terms than the traditional technical notion, i.e. in terms of serving the purpose of providing better, safer and more efficient healthcare delivery. This broader context is needed because, in e-health systems:

- there are many actors with different skills and knowledge, collaborating in a team that is setting and respecting a multitude of clinical and administrative policies, while increasingly relying on the capabilities of new technologies; besides, the actors have varying levels of maturity both in terms of new technology adoption and the organisational change needed to support new practices;
- there is an increasing need to support the cross-organisational and cross-jurisdictional nature of healthcare services to ensure continuity and patient-centric healthcare; IT systems can play an important role in facilitating more effective healthcare services in such an environment;
- 'change is the only constant' is a dominant principle, from both the clinical and technological sides, requiring an approach to treating interoperability as a continual state of readiness to embrace new technologies, clinical knowledge and practices, or changes in legislative and social environments.

In general, interoperability is taken to mean 'the ability of a system or process to use information and/or functionality of another system or process by adhering to common standards' [4]. Further, 'system' or 'process' in e-health will often involve humans, so the interoperability must address human and societal issues in the course of using information and functionality from other systems, e.g. the ability to participate in standardised business processes, to understand and use information or results of activities

performed by others, and share findings and knowledge with others. These aspects of interoperability constitute its organisational and information perspectives and they need to be considered alongside the more traditional notion of interoperability referring to technical aspects i.e. capability of machines to exchange data through the exchange of messages. Therefore, interoperability needs to be considered from organisational, information and technical perspectives. Our approach is in line with the recent IEEE direction, which treats interoperability as ‘not so much how machines are working together but how human beings are understanding each other’ [12]. Although this definition is mostly concerned with the information perspective, the organisational perspective introduces structure, policy and process, which drive the need for information that all parties can understand.

One of the key prerequisites for ensuring interoperability across organisational, information and technical perspectives is arriving at a common understanding of key concepts of relevance for these perspectives. Concepts reflect certain topics of interest with certain meanings to the relevant stakeholder, such as:

- concepts of policy, process or role in the organisational perspective; these concepts are of relevance for policy makers, health service providers or health administrators, but also for clinicians and clinical support staff;
- clinical informatics concepts from an information perspective, such as information components for electronic health records, or definition of clinical terms used in various classification or clinical terminology systems; these concepts are of relevance for clinical informatics and clinicians using clinical information systems;
- concepts of service interface, component or message structure from a technical perspective; these concepts are of relevance for those involved in building and managing ITC systems in support of delivery of healthcare services.

It was found that the modelling concepts from the ODP standards [1][2][3] have high value in providing such a common understanding because they were developed to support modelling, architecting and building open distributed systems in a technology neutral manner and from various perspectives. In many aspects e-health systems are a special type of open distributed system, and, where needed, the generic concepts of open distributed systems can be extended to support e-health specific related requirements.

This paper is an experience report of using the ODP family of standards to address interoperability issues in the Australian e-health environment, as part of activities carried

out through the National eHealth Transition Authority (NEHTA) [10]. The ODP Enterprise Language provides core concepts for describing the organisational context for e-health systems, while the overall ODP-RM architecture framework allows for the separation of various e-health stakeholders’ concerns into organisational, information and technical perspectives. In addition, the approach of these ISO standards in defining conformance and compliance requirements offers a starting point for developing a sustainable certification programme for Australian e-health.

The next section sets the scene by outlining current state of e-health in Australia, from organisational, information and technical perspectives. Section 3 describes why the ODP standards were used to address interoperability and outlines the approach taken. Section 4 summarises key point from the experience and outlines future issues that need to be addressed.

2. E-health in Australia

This section outlines the specifics of the institutional arrangement of the Australian health sector. This institutional structure is important for the understanding of the complexity of the social, legislative and healthcare contexts in which the IT systems are to be deployed, to ensure sustaining organisational interoperability. This is followed by the description of the current state of information aspects in Australian e-health, as well as the broad set of information requirements needed for information interoperability, enabling a semantically consistent exchange of knowledge among clinical, administrative or research professionals involved in healthcare. The section will also present the current state of technical aspects in Australian e-health and a set of requirements needed to ensure long term connectivity and interworking between IT systems.

2.1 Organisational context

The Australian health system is a combination of the public sector, consisting of federal, state and territory jurisdictions with a network of public hospitals, and the private sector, consisting of general practitioners (GP), private hospitals, pathology labs, pharmacies and other healthcare providers. Federal government provides funding to hospitals and state jurisdictions, and state jurisdictions control allocation of funds to the public health service providers within their own areas. As a result, there are a multitude of policies that govern service provision, depending on the type of provider or the location where the service is delivered. In addition, some policies, such as privacy and consent policies have to be aligned with a broader context, such as federal privacy law, which in turn

includes eleven information privacy principles [5]. These policies, along with the objective of safe and reliable delivery of healthcare, govern provision of healthcare services. They need to be respected in the context of modern healthcare delivery practices, such as patient-centric healthcare, continuity of care principles, and collaborative service delivery.

In order to promote organisational interoperability, this complex institutional structure requires a precise framework for defining roles involved in collaborative service delivery, processes in which they are involved, and policies that apply to them. This dimension of interoperability, as an independent topic has not been addressed in Australian e-health yet, apart from some initial approaches to the specification of business architectures in some jurisdictions.

2.2 Information dimension

The current state of information related aspects of Australian e-health is a result of a significant contribution from health informatics disciplines over many years, especially in the last two decades. A great number of these activities have had a standardisation component, through Standards Australia, in particular through the IT-14 committee. This committee develops standards for Australian health informatics, aligned with and also influencing international e-health developments, such as ISO and HL7 standards. Examples of health informatics standards are electronic health records, messaging and communication, terminology, representation of health concepts, health supply chain, and client and provider identification [6]. The aim has been to support sharing of information across the healthcare sector. Australian health informatics experts have also been involved in other national and international efforts such as HealthConnect [8], the OpenEHR [7] architecture and CEN standards [9].

In spite of the substantial amount of work on a number of health informatics projects and standards, there is a lot of anecdotal evidence of the lack of information interoperability among systems. For example, this is either due to different implementations of the same standards (as is case with multiple versions of HL7 V2 standards), due to different interpretation and understanding of the key concepts in standards, or due to the lack of agreement regarding shared clinical terminology. Further, and in part influenced by some standardisation approaches, there is often a tendency to mix information content and information protocol (e.g. format of messages).

2.3 Technical dimension

Australia has a relatively sophisticated technology base deployed across both public and private sectors. However, it has been afflicted by a number of problems that characterise many other information-intensive industry sectors. This has been recognised in a recent national study which identified a need to provide improvements in the benefits and value that technology, including ICT, delivers to the medical sector [11]. A specific problem is the lack of technical interoperability between IT systems, caused by a vendor driven approach to delivery of IT systems and the lack of an in-depth involvement of purchasers in the specification of systems' functionality. This, along with the existence of competing standards for the same functionality and a silo approach in delivery of IT systems, often results in duplication of data or system functionality, or even lack of correct functionality.

This technology diversity and maturity level again requires a common agreement on key technology concepts and patterns.

2.4 Concluding remarks

The aging Australian population, a shortage of health professionals and an increasing focus on collaborative healthcare, require new national approaches to better realise the value of IT in providing more effective and efficient healthcare delivery, as part of the national health agenda. In early 2006, Australian, State and Territory governments have established the National E-health Transition Authority (NEHTA), to develop better ways of electronically collecting and securely exchanging health information, through [10]:

- improving the quality of healthcare services, by enabling authorised clinicians to access a patient's integrated healthcare information and history, using standardised clinical data formats and terminologies.
- streamlining multi-disciplinary care management, enabling a seamless handover of care by ensuring efficient electronic referrals, including fast, secure mechanisms for directly exchanging important notifications between healthcare providers.
- improving clinical and administrative efficiency, by standardising certain types of healthcare information to be recorded in eHealth systems, uniquely identifying patients, healthcare providers and medical products and reforming the purchasing process for medical products.
- maintaining high standards of patient privacy and information security.

A significant part of the NEHTA agenda is to facilitate a national transition into a more interoperable e-health

environment. This is done by considering e-health through the three separate but related interoperability perspectives introduced earlier, and described in more detail in the following sections, based on the NEHTA Interoperability Framework [13].

3. Looking for a solution to interoperability: the use of ODP standards

There were two main topics in addressing interoperability as part of the NEHTA agenda:

1. Reaching agreements on common interoperability concepts and the way they can be structured and used, namely *interoperability languages* for each of the perspectives
2. Identifying common *interoperability patterns*, introduced as a mechanism for capturing existing issues and observations about commonly occurring phenomena in e-health and reusing them in different contexts (e.g. by different e-health projects)

The NEHTA interoperability framework being developed [13] makes use of the ODP standards to assist in addressing these interoperability problems. Firstly, it applies the ODP viewpoints to support the expression of separation of concerns pertinent to various stakeholders, and then it selects the relevant ODP viewpoint language concepts as a basis for the three interoperability languages. These modelling concepts are also used for the description of key interoperability patterns.

The following subsections discuss the separation of concerns principle and how the relevant ODP viewpoint language concepts were applied across three perspectives in the NEHTA interoperability framework. The use of interoperability patterns is also discussed for each perspective.

3.1 Separation of concerns principle

The distributed, cross-organisational and cross-jurisdictional nature of e-health in Australia, involving many different stakeholders with different concerns constitutes quite a complex system. To deal with the complexity of such a system the interoperability framework adopts the architectural recommendations from the ODP standards, according to which a complex system is best viewed from various perspectives [1][2]. The ODP calls them ‘viewpoints’. This approach was used to structure conversations about interoperability. Thus, the organisational perspective is to be compared to the ODP enterprise viewpoint, the information perspective is to be compared with the ODP information viewpoint and technical perspective is to be compared with the ODP

computational, engineering and technology viewpoints. Note however, that the ODP engineering viewpoint is of less relevance here but might be used in future to address requirements for specific middleware solutions or engineering mechanisms and functions. Similarly, the ODP technology viewpoint is of more relevance when describing implementation choices and thus for the specification of testing requirements.

3.2 Organisational context

The ODP Enterprise Language concepts and structuring rules [3], especially the community modelling concept, were found to provide a precise and flexible framework for describing a combination of the organisational context and the positioning of ITC systems in the delivery of e-health services. “Community” is used as an overarching concept for the definition of organisational roles, processes and policies. This concept has been valuable in defining the scope of policies that can apply to healthcare and the actors involved, and it has also provided useful insights in gathering business requirements. Further, the community concept allows the description of a hierarchical and federated arrangement between communities, allowing the identification of organisational boundaries and relationships between them. In addition to the enterprise language concepts of community, role, policy, process, contract, domain and federation, it was valuable to refine the general concept of service, introduced in part 2 of the ODP-RM [1], from the enterprise viewpoint.

So, *business service* is defined as a particular abstraction of behaviour expressing the guarantees of service providers, 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 in the enterprise language) and, if a consumer accepts the service offer, certain policies are also applied to the consumer. It is important to note that business service delivery also provides a basis for identifying benefits that service usage brings to service users. When coupled with the service cost, service users can determine the relative value of alternative service offers to inform their choice of service provider.

In addition, the Interoperability Framework has, so far, identified four high-level categories of interoperability patterns. These are the legislative/regulatory, governance, value assessment and change management/education patterns. The organisational patterns are mapped onto the core organisational concepts introduced from the ODP Enterprise Language. This ensures a pragmatic approach to addressing specific problems, while preserving precision (and compatibility) of expression. Considering the

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

3.3 Information perspective

The diversity of the approaches and domain groups involved in health informatics standards has resulted in a certain level of semantic inconsistency between information concepts. Our experience suggests that the current state of affairs requires an approach that would unify various existing information modelling approaches through a common reference point identifying the core information concepts and their relationships. These core information concepts constitute a modelling language that can be used to describe a number of clinical information concepts related to clinical terminologies, event summaries, and electronic health records. Note that many information models can be produced using the core clinical information concepts but they do not stand alone, and must be interpreted in the context of one or more business services, stated in the organisational perspective.

The information perspective in this version of the Interoperability Framework is based on a subset of ODP information viewpoint modelling concepts, namely the concept of information objects, and invariant and static schemas. Dynamic schema concepts and a more comprehensive set of clinical modelling concepts, based on various clinical informatics results, will be proposed in the next version. However, the current version of the information interoperability component does not provide a clear separation between two aspects of information - the *representation form* of clinical information and the *meaning* of information, reflected by the interpretation of information. The ODP guidelines can provide starting point for this separation. It is also important to make a distinction between the requirements for electronic representation and processing of electronic data, from the requirement to support interpretation by clinicians, for clinical purposes. Although electronic data and electronic processing can facilitate some simple inference approaches, as in clinical terminologies or decision support systems, certain forms of information will always be processed by clinicians. This is an important issue to take into account when implementing clinical information processing systems, to make allowance for information to be represented in both structured and unstructured forms, for use by both IT systems and humans.

Finally, the information perspective introduces several categories of information patterns to facilitate a shared understanding about important information concerns and approaches and ensure consistency of NEHTA outcomes and subsequent alignment within the broader jurisdictional

community [13]. These information patterns are described using the core information concepts, mentioned above.

Five high-level categories of information patterns have been identified so far. These are information rights, temporal dependencies, information quality, and the scope of application and information transformation. Considering the evolutionary nature of the NEHTA Interoperability Framework, it is anticipated that new patterns will be identified and documented as they emerge.

3.4 Technical perspective

In terms of the technical perspective, several ODP concepts from [1][2] were used as a basis for deriving a core of a technical interoperability language, in particular because of ODP's technology independent approach and its applicability to an open distributed environment. Examples are the ODP concepts of action, behaviour, service (as a technical abstraction) and interaction. The technical perspective also includes a limited number of other technical concepts, derived from these concepts, but based on current e-health applications, such as the concept of message. The subsequent versions of the interoperability framework are expected to incorporate some new concepts, which will, in part, be driven by the needs of the relevant stakeholders.

Further, the ODP concepts accommodate various architectural styles such as service-oriented or event-oriented architectures, which were considered as special kinds of technical interoperability patterns. The value of these emerging architecture styles in an e-health environment is in driving a shift towards a focus on business functionality, allowing purchasers to better specify the expectations of the IT systems, reflecting their business needs, rather to purchase only that which is available in the market. Note however, that the SOA alone is not sufficient to ensure technical interoperability. What is required is strong governance for architecture developments to ensure a continuum between requirements of healthcare business and information and technology dimensions. Thus, it is the combination of the technical solutions and organisational patterns such as change management, education, awareness and governance mechanisms that will ensure the longevity, sustainability and realisation of the true benefits from the e-Health systems. Other technical patterns are technical quality, service delivery channels and style of component interactions [13].

4. Discussion and Conclusions

This paper presents an experience report on using the ODP family of standards to address interoperability problems in

the Australian e-health environment. The starting point was to use the ODP viewpoint philosophy to provide a structured way of addressing concerns of different stakeholders' involved in e-health, including clinicians, policy makers, administrative personnel and architects and builders of ICT systems. This separation of concerns was achieved by adopting three different perspectives on e-health systems, namely the organisational, information and technical perspectives.

Further, the ODP standards were used as a basis for identifying a minimum set of the respective interoperability language concepts. In particular, the ODP Enterprise Language has been found to be a good fit for the organisational perspective of the interoperability framework. This is because of the expressive power of the ODP community concept to describe cross-organisational and cross-jurisdictional nature of healthcare delivery, to represent various governance structures, as well as to facilitate identifying value chains between ICT systems and communities in which they exist and to which they deliver benefits. To the best of author's knowledge the use of such an overarching concept represents a novel approach in the Australian e-health sector. It is worth noting that an initial feedback has identified a need to provide a better support for certain management concepts, e.g. the statements of mission and vision as well as the concept of quality. The organisational perspective has adopted the approach taken from health sector according to which quality has the dimensions of safety, effectiveness, patient centeredness, timeliness, equity and efficiency [13]. The current version of the Interoperability Framework includes a limited set of information and technical interoperability languages, based on the ODP information and computation concepts provided in [1][2]. They are introduced to provide a common reference point for existing approaches, e.g. information modelling and to some extent technical concepts. These languages, as well as the organisational interoperability language, are expected to be extended in the next versions of the Interoperability Framework, based on the input from various stakeholders [13]. Finally, the novelty of the Interoperability Framework is the provision for a number of interoperability patterns, which are described in terms of the respective interoperability languages.

It is the combination of the interoperability concepts and interoperability patterns that provides a powerful union, making the optimal use of standards yet retaining a pragmatic and expressive framework. Although the sets of both interoperability concepts and patterns are expected to grow, the patterns space is likely to be more active, reflecting the intent to capture an evolving set of common clinical, management and technical approaches in the health sector.

The interoperability framework can serve as a foundation for producing downstream enterprise architectures, according to the enterprise architecture framework of choice. It is believed that if the respective enterprise architecture frameworks are compliant with the interoperability framework, this will in turn ensure consistency for the modelling languages used for the individual enterprise architectures produced according to the architecture framework guidance. This is applicable at the national level or in the context of individual jurisdictions. Note that the definition of compliance, is based on the ODP guidelines provided in [1][2]; thus 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 or specification [13].

Compliance with the interoperability framework is necessary to ensure interoperability. A further mechanism is needed however to assess the level of conformance of the systems that claim that they implement the architecture specifications or open standards. Again, the ODP standards provide a clear framework for specifying conformance expectations, consisting of the identification of several types of conformance points [1]. These conformance points can be considered in the context of the three interoperability perspectives.

In summary, it is the combination of a disciplined approach to the development of specifications (satisfying the respective set of requirements), a rigorous approach to the conformance verification and a sound governance framework (both organisational and IT systems), that will provide assurances that the future e-health systems be interoperable. However, this is going to be an incremental process, with various mechanisms used to facilitate transition. One such mechanism is the establishment of an approach to checking maturity of organisations towards adopting interoperability concepts and patterns. This is one aspect of near-term development plans.

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