



BC eHealth Conceptual System Architecture

Presented by
the BC eHealth Steering Committee

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Preface

Purpose This document describes, at a conceptual level, the architecture for electronic health (eHealth) for British Columbia. It is part of a pair of documents which guide the development and completion of eHealth capabilities in BC:

The *Strategic Framework* describes the vision, priorities, management processes and development approaches.

The *Conceptual System Architecture* (this document) describes how the parts of the eHealth system fit together, and how they align with the Infoway EHRS blueprint, to deliver the desired services.

Audience The primary audience for this document is those responsible for IM/IT implementation planning in the various agencies responsible for health care in BC, especially the Ministry of Health Services and the health authorities. The purpose of the Conceptual System Architecture, from their perspective, is to help them:

- Identify areas where inter-agency coordination is required to meet the Provincial goals of the eHealth solution;
- Align their own IM/IT Plans with each others' and with the overall Provincial architecture; and
- Identify, in particular, Provincial capabilities that must be developed (or completed) to serve the needs of all of the agencies.

The document will also be used to brief the private sector on the province's plans for eHealth.

Structure This document includes the following chapters:

Introduction	Purpose and scope of document, and introduction to the architecture.
eHealth, EHR and Telehealth	Definitions of eHealth, EHR and Telehealth, and the relationship between the concepts.
eHealth Architecture	Architecture for eHealth, based on EHR and Telehealth requirements.
Current Status	Description of current assets and project status.

Related documents

- BC eHealth Strategic Framework

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1 Introduction

The purpose of the eHealth Conceptual System Architecture is to provide a set of architectural representations of the entire eHealth system. This document is primarily aimed at those responsible for IM/IT planning and implementation within the organizations in the health system. It is intended to help them initiate and steer major projects, to assess those projects' alignment and progress, and to provide broad technical guidance to those projects.

IM/IT architecture should be derived from the structure and processes of the business it is intended to support. Health authority and Ministry IM/IT plans will naturally follow this approach, and this conceptual architecture does the same, focussing specifically on eHealth processes.

We expect that each health authority, and the Ministry, will demonstrate the alignment of their IM/IT plans with this architecture as follows:

1. ***eHealth projects should be classified*** according to the framework presented later in this document (ie as a registry, shared repository, application, common service, or EHR system).
2. IM/IT plans should ***identify what eHealth services are required provincially or by other health authorities*** (ie services which the plans expect other organizations to provide). Each set of related services (eg Drug Profile/ordering) will require collaboration across the health system on the selection and implementation of standards, and on the actual development and implementation of capability. These service expectations should be identified for each project in the IM/IT Plan.
3. IM/IT plans should identify ***what eHealth services will be provided*** by the organization's systems. These services are the counterpart of item 2 above. The entire portfolio of plans will eventually form a coherent network of available services and service expectations.

The architecture is not intended as a detailed blueprint, ready for design and development of information systems. It is in many respects abstract and simplified, in order to provide a comprehensive view that is accessible by executive sponsorship.

2 eHealth, EHR and Telehealth

The Premier's Technology Council relates eHealth, Telehealth and the EHR as follows:

“Before proceeding further, it is important to note that the terms “telehealth” and “e-health” are not synonymous or interchangeable. Although the PTC has not formally defined either term, telehealth is used in the context of videoconferencing and is a subset of e-health. E-Health is a broader term and encompasses all electronic measures associated with health care including the electronic health record.”

A variety of definitions of eHealth have been coined in health literature. For the purpose of this Conceptual System Architecture, the following definition is consistent with the understanding of the Premier's Technology Council:

“e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.” (published in the article What is e-health? J Med Internet Res 2001;3(2):e20)

This definition is broad, and encompasses almost any situation in which health care processes are enhanced through the use of computer technology.

Canada Health Infoway's (CHI's) mandate is to accelerate the development and implementation of Electronic Health Record Solutions (EHRS) within Canada. They define the EHR and the EHRS as follows:

*“An **electronic health record** (EHR) provides each individual in Canada with a secure and private lifetime record of their key health history and care within the health care system. An EHR would be available electronically to authorized health care providers and the individual anywhere, anytime in support of high quality care.”*

*“An **EHR solution** is a combination of people, organizational entities, business processes, systems, technology and standards that interact and exchange clinical data. A network of interoperable EHR solutions—one that links clinics, hospitals, pharmacies, and other points of care—will help enhance quality of care and patient safety, improve Canadian's access to health services, and make the health care system more efficient.”*

(Both of these definitions are included in the CHI EHRS Blueprint, June 2003).

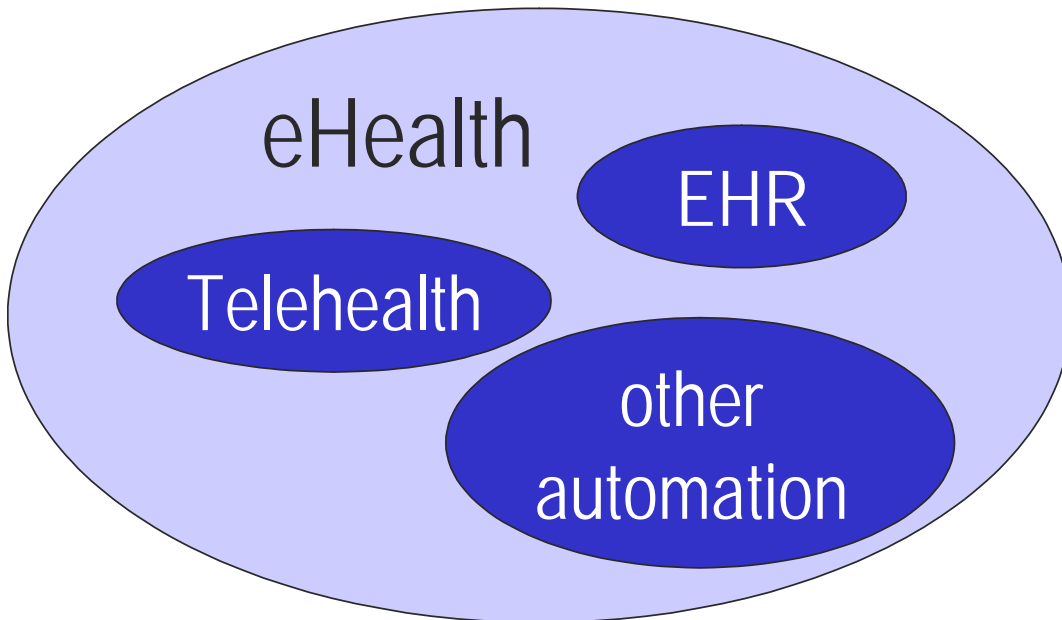
This definition of the EHR focuses on one critical requirement -- the ability to integrate health care data about an individual from different disciplines and domains to provide a single longitudinal record. There are many possible uses of computer technology to provide automation of health-care processes, particularly between agencies, which aren't strictly “EHR-related” according to this definition.

Definitions of Telehealth also abound, and some are broad enough to collide with the above definitions. Canada Health Infoway’s definition of Telehealth is:

“Telehealth is the use of communications and information technology to deliver health care services over large and small distances, including remote and rural areas.”

This definition would include the use of teleconferencing or telephone services for consultation and training, but would exclude in-person care delivery supported by computer systems.

The fields of eHealth, Telehealth and the EHR can, therefore, be related conceptually as follows:



“Other automation” includes capabilities that are not specifically related to remote care delivery or to building an integrated longitudinal record (such as electronic ordering, referral or resource scheduling).

3 Existing Capabilities and Strategic Approach

3.1 Existing Capabilities

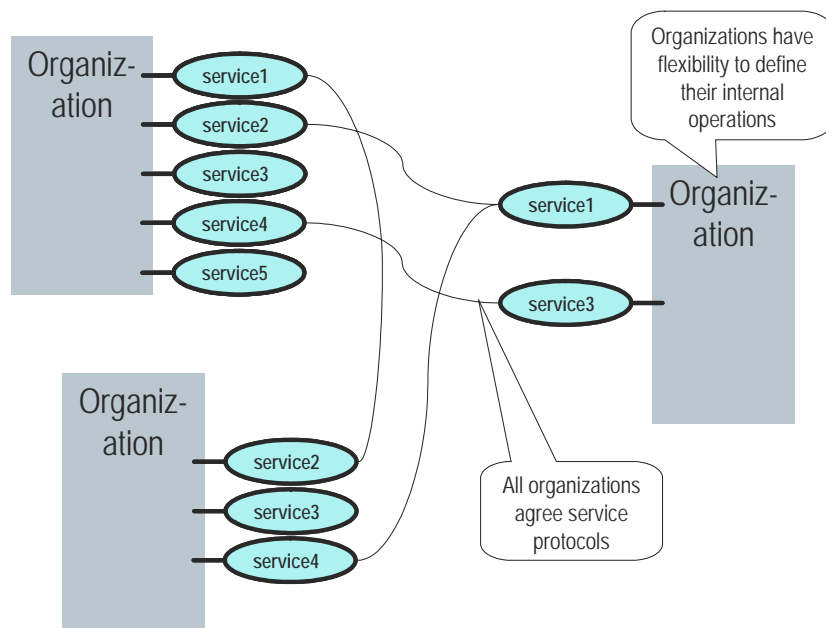
BC already has many of the components required to deliver an overall eHealth capability. This is partly because of the strong business case for certain automation scenarios (such as PharmaNet), and partly because of the coordinated efforts between the health authorities and the ministry in recent years in procuring or developing particular EHR “building blocks”. Because of the size and complexity of the required systems, and the value of the existing assets, the strategic approach of the province is to deliver capability incrementally, incorporating existing systems wherever possible into the architecture.

In some cases, capability will be incorporated by building or buying brand new assets. In other cases, existing systems will be integrated into the architectural framework.

3.2 Service-oriented Approach

Integration of business capabilities across organizational boundaries in a complex system is not a new problem, nor is it peculiar to health care. Complex processes often involve information systems in multiple organizations, where it is not possible to mandate that all organizations’ information systems are developed simultaneously to a single design. A good deal of recent IT standards work, and corresponding technology development, has focussed on integration between organizations in end-to-end business processes. Middleware technologies are big business, and standards committees in many business areas are very active in defining ways for organizations to collaborate.

To allow organizations the autonomy and flexibility they need to take control over their own IM/IT environments, while still enabling inter-organization business, technology architects commonly recommend a *service-oriented* approach. The service-oriented approach allows each agency to do whatever it likes within its own domain. But whenever it collaborates with others in a larger setting, it does so through a number of defined *services*. For each service, the technical mechanism for using the service, the data content and the business rules are all defined and agreed by all participants.

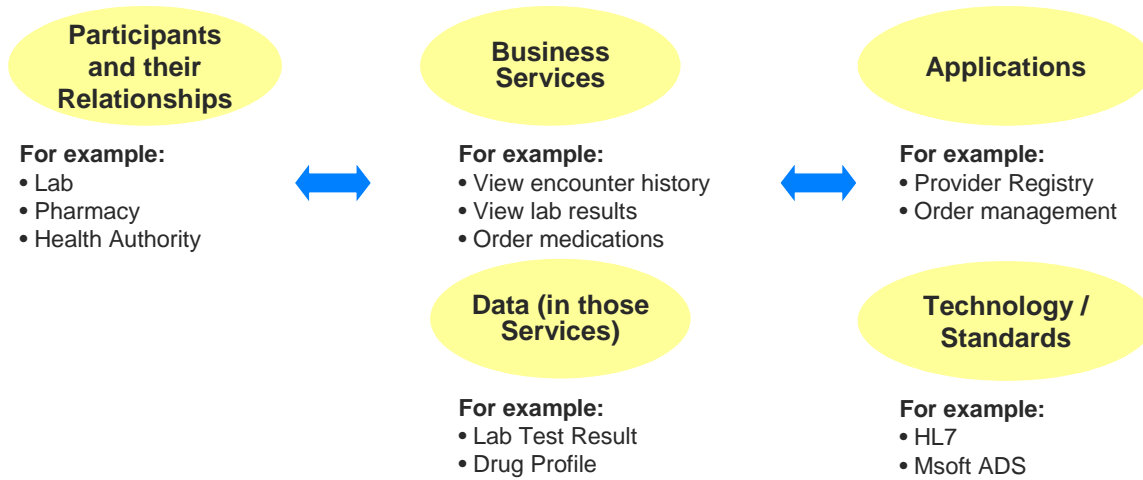


The service-oriented approach is ideal for the development of the eHealth Conceptual System Architecture, because it respects the internal autonomy of each of the participating agencies. This is why Infoway's EHR-S Blueprint takes a service-oriented approach.

This Conceptual System Architecture is therefore a service-oriented analysis. It attempts to identify each of the participants in the provincial health care system and describe their roles and relationships to the rest of the system. The roles and relationships of the participants imply a set of business services that they each must provide to the system as a whole. Each of these services requires detailed definitions of technical protocol, data and business rules, but these aren't included in this architecture, except as general guidance for the system as a whole.

Once the services to be provided have been defined, it's natural to speculate about the kind of applications each organization will need in order to provide those services. The Infoway Blueprint does this in very general terms, as does this architecture.

¹ (Web Services is a commonly-agreed general technical mechanism for invoking services exposed by a computer system. A Web Service consumer doesn't have to know anything about the technical details of how a system realizes the objective -- all it needs to know is that it sends a request in a particular format and the response will be returned in a different, similarly-defined format. Web Services should not be confused with the general view of the World Wide Web - of pages viewed by browsers and served by web servers. Web Services requests are structured documents but they are not necessarily human-readable, or displayable by browsers. In fact, typically, Web Service Consumers are not browsers or user interface programs. Web Services are only called Web Services because they happen to use the same message transmission protocol (HTTP) as is used by the World Wide Web.)



4 eHealth Architecture

4.1 Key Requirements and Constraints

The Conceptual System Architecture is governed by the following important requirements and constraints:

Planning Horizon: The architecture should be realizable within 24-36 months, but should also include the foundation for the implementation of capabilities beyond that time. This means that it must include services that will dominate technical choices, even if they aren't going to be implemented within the stated timeframe.

Support for “EHR” usage: The comprehensive, integrated longitudinal patient record is one of the most significant enablers for improved health care delivery. It is Infoway's prime objective and is an area where much has been achieved.

Interoperability: The architecture must support the integration of work of multiple disciplines, enabling integrated teams to provide care to a single patient, including occasions when the teams are geographically distributed and in different organizations.

Infoway alignment: The architecture must align with the objectives and approach of Canada Health Infoway.

BC Health governance structure: The architecture must support the governance structure of eHealth in BC, in which the health authority is the main focal point for operational delivery of care, and the Ministry of Health Services holds a stewardship role.

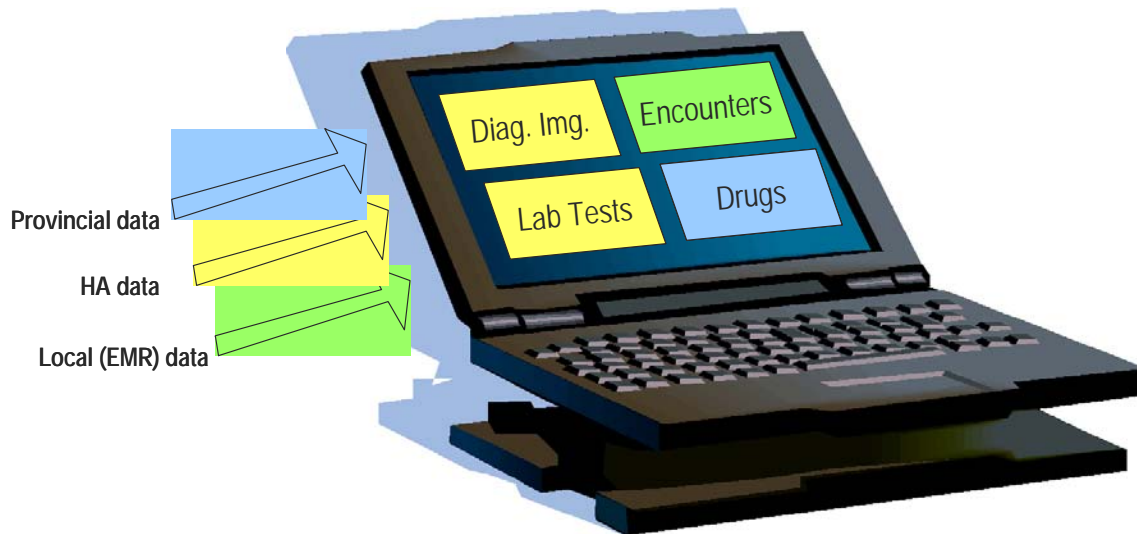
Flexibility: The architecture must be flexible to allow for different business requirements and existing assets in the different participants (especially the health authorities). This requirement, in particular, is what drives the service-oriented approach.

Support for shared procurement opportunities: The architecture must allow for participants in the system to engage in the joint procurement of shared assets.

4.2 EHR Requirements and Architecture

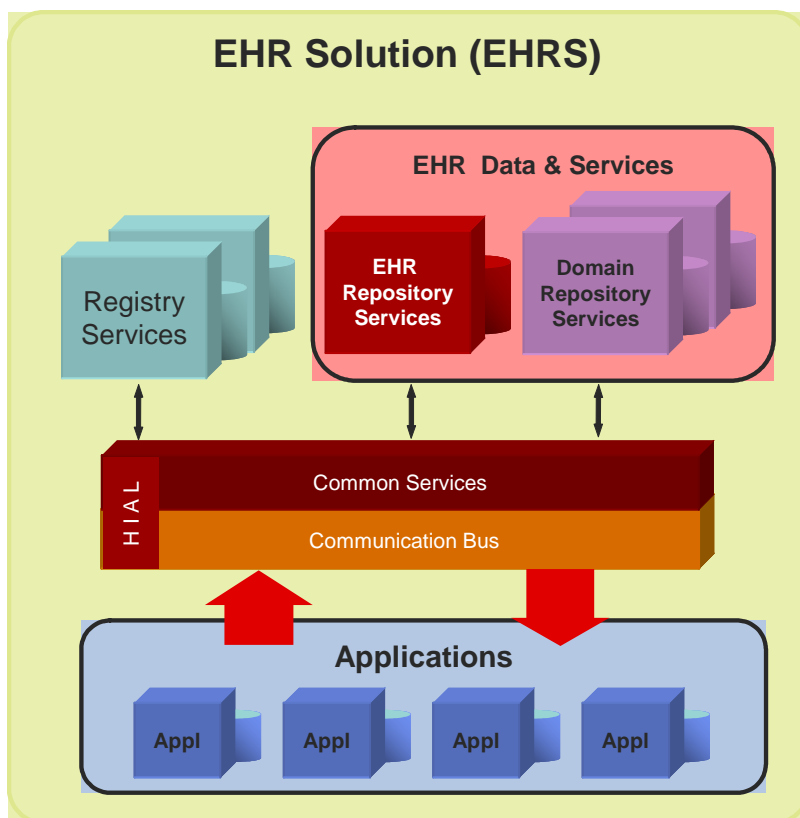
The “EHR” is the subset of eHealth requirements that has recently commanded most attention both from Infoway and from executive sources, because it promises so many benefits in terms of improved patient safety and efficiency of care delivery. At the very least, the eHealth conceptual architecture must support EHR business processes.

A typical usage of the EHR System is the provision to a care provider, in a single viewer application, of an integrated view of a patient's electronic health data. The viewer might be a web portal, or it might be a window in an existing clinical application. Either way, the basic problem to be solved is that this information originates in a variety of settings, some of them provincial, some regional, and some local.



Some of this data (especially lab and pharmacy data) originates in the private sector.

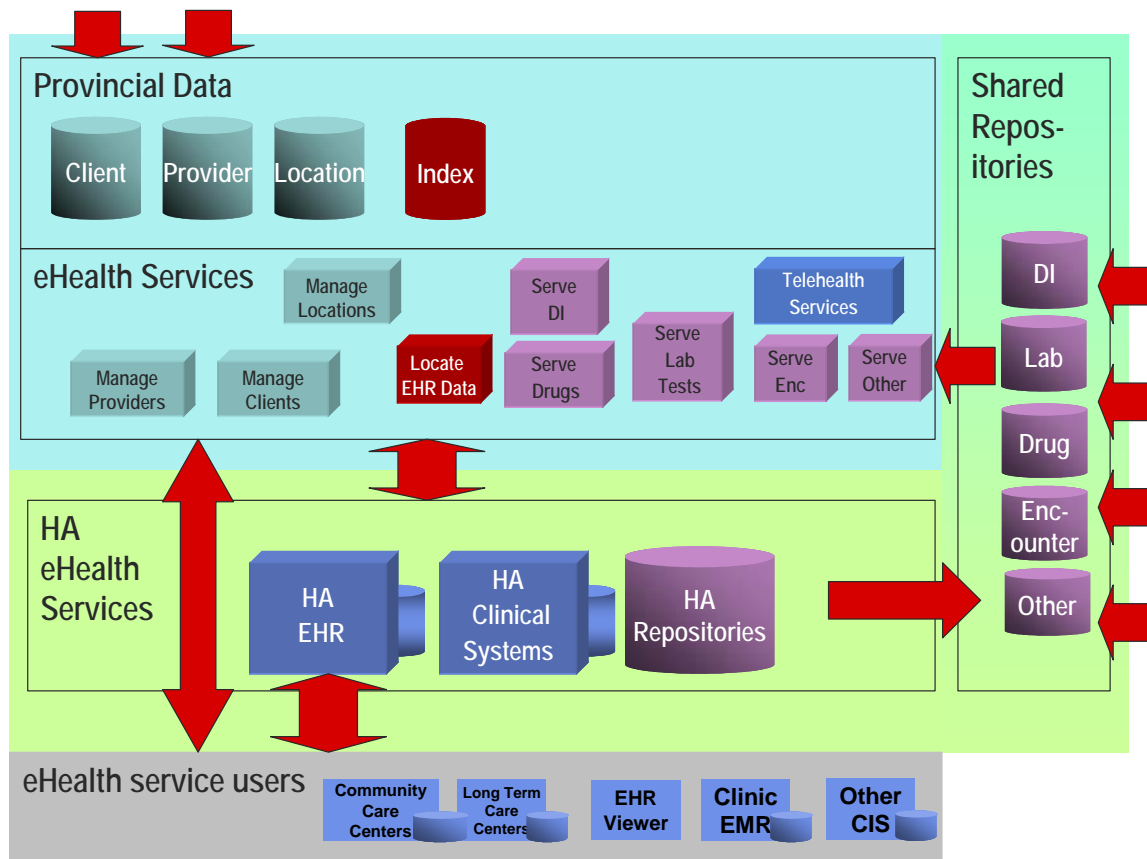
Infoway’s EHRS Blueprint recommends an architectural approach to solving this problem containing the following key features:



- For data sources that might not be available when the data needs to be seen, the information is “pushed” when it is updated, into Domain-specific Repositories, which are accessible when required by applications that need them.

- For all data sources and repositories that will act as sources for the integrated record, an “index” or directory is maintained. As data are pushed into repositories, or stored in clinical systems, a reference to the data is recorded in an EHR Repository or document registry. When an application needs to display an integrated view, it uses the EHR Repository to find the components of the record, and display them.
- All components of the system communicate through a shared network infrastructure, using agreed service protocols. (Infoway calls this the “HIAL -- or Health Information Access Layer”).
- Information is integrated using Registry Services, which allow single patient, provider and location identifiers to be resolved from diverse identifiers used throughout the system.

Infoway’s Blueprint proposes a variety of Implementation Models, which locate the different Repositories, Registries and Clinical Applications at different settings (Provincial, Regional or Local). In BC, the EHR architecture falls into the Provincial/Regional structure as follows:



Health authorities are the focal point of eHealth service delivery. Within their IM/IT plans they provide for clinical systems and domain-specific repositories. Both clinical systems and domain repositories can be considered “feeder” systems for health authority and province-wide eHealth services.

For a collection of strategic topics, health authority feeder systems “push” data into a set of ***shared repositories***. These repositories may be located provincially (eg PharmaNet) or at certain health authorities. In some cases, a few health authorities will collaborate to host a particular repository (eg diagnostic images). In many cases, the shared repository will actually be fed by other agencies (eg pharmacies and private labs).

A set of key ***common data is maintained at a provincial level***. Some of this data is also maintained by outside sources, eg the Colleges and regulating bodies (for provider data) or the pharmacies, among others (for client data).

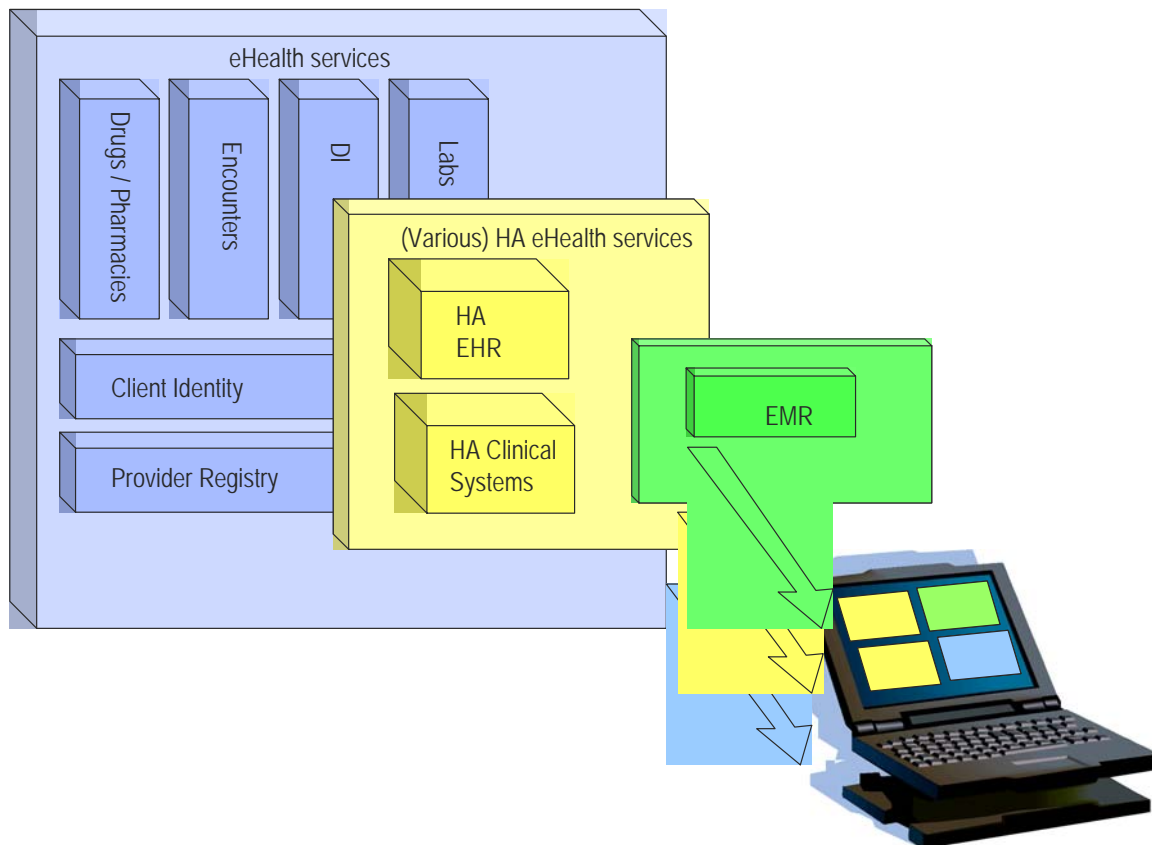
A ***“document index” identifies the location*** of all eHealth objects relating to an individual, indexed by type, and containing links to the specific location of the object (provincial or health authority). Pushing data into domain repositories means also updating the index. For shared repositories, which are actually hosted by health authority clinical systems, publication of an object to the provincial EHR is simply the location of a registry entry in this index.

Access to all of these data is provided through a set of standardized services. These services provide access to resources in shared repositories, or in health authority applications. (For query access, these will likely be Web Services. For most online services, the data standard for the service is likely to be HL7.) In this representation of the eHealth architecture, the services are separated from the repositories for the simple reason that some of the repositories are already in place, and the required work is to expose the data through a standard service interface.

Data are integrated into health authority clinical systems or EHR systems, including EHR viewers, for use in the health authority and by external care providers. It’s important that the data integration happens through the use of the standard services already defined, and not by indiscriminate bulk replication.

A ***“HIAL” exists both within each health authority***, supporting its own internal integration, ***and amongst all participants*** in the province. This infrastructure component provides basic messaging capability, but also a number of other common services such as federated authentication and authorization, message queuing and workflow, and administration.

This architecture allows the assembly of the EHR viewer (the integrated view) using services exposed at the local, regional and provincial settings:



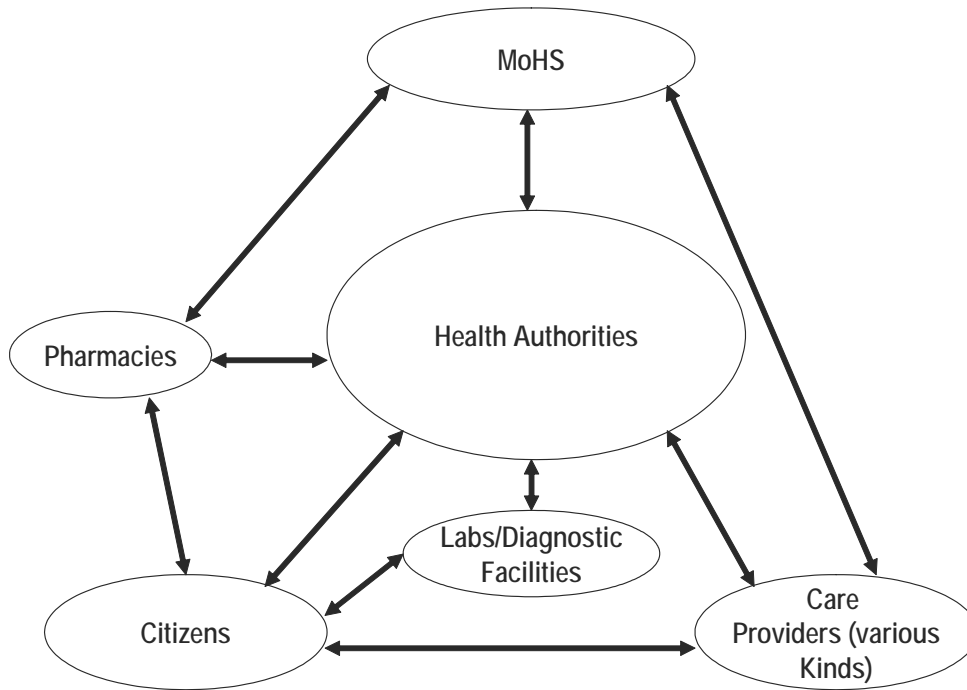
Although the EHR usage is not the only component of the eHealth architecture, it is one of the most important and urgent ones. Furthermore, it requires an approach to integration, and procurement of basic infrastructure, which is required to support all features of eHealth. Thus, if the province can build the EHR architecture, it can likely be extended to support all eHealth scenarios.

This conceptual architecture aligns with the Infoway EHRS Blueprint as follows:

- It relies on shared (domain) repositories for important EHR topics;
- EHR services provide indexing of data in repositories, for assembly when required;
- All data holdings are exposed as services, with assembly of services for care providers, to deliver functionality;
- Service interfaces are based on standard protocols;
- The architecture requires the development of service infrastructure to support provincial and regional service delivery and integration

4.3 Participants, Roles and Relationships

The overall health system in British Columbia is complex, and most of the participants have a wide range of inter-relationships with each other. The major participants in the health system, their key roles and their main relationships to the other participants are described in the following diagram and table:



Participant	Role	Main Relationships	Concerning
Ministry of Health Services	Stewardship of the Health System	Health Authorities	Finance, overall performance measures
		All participants	Best practices and guidelines
	Administration of Health Benefits	Citizens, Care Providers, Health Authorities	Benefits and Eligibility, Claims and Payments
	Stewardship of Provincial eHealth services	Most other participants in the system	Client Identity Management, Provider data management, Location data management, Electronic Health Record management, Pharmacy business processes
Health Authorities	Delivery of eHealth services to care providers	Care Providers	eHealth data and services, particularly including EHR, scheduling of resources and referral
		Ministry of Health Services	Provincial eHealth services, such as Registration and Drug Profiles
	Delivery of eHealth services to other HAs	Other HAs	eHealth data and services, particularly including EHR, scheduling of resources and referral
	Provision of care	Citizens	Health care information
		Laboratories	Diagnostic orders and results
		Pharmacies	Medication orders
Care Providers	Provision of care	Citizens	Health care information

Note: “Care Providers” includes individual care providers such as physicians, and also contracted care providers such as home support and community care providers.

The intent of this diagram and table is to illustrate the pivotal role of health authorities in delivering eHealth Services to the system either directly or through Care Providers.

The diagram and table hide a number of complexities, including:

- the special role of the PHSA;
- the roles and relationships of supplementary practitioners, dentists, and the Ambulance Service;
- the location of participants in the private sector (private laboratories and community pharmacies).

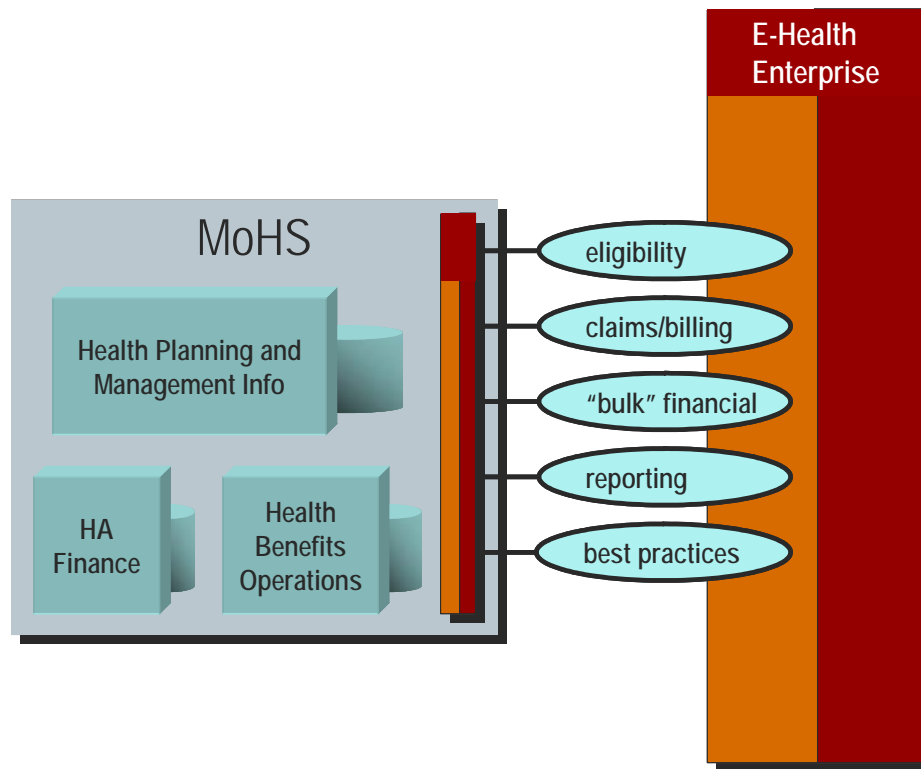
4.4 Inter-agency Services

The roles and relationships described above imply the business services, which each participating agency should be providing. This section describes the key services to be provided by the Ministry of Health Services and the health authorities, and it identifies the applications that are likely to be required to support them. Note that the purpose of the architecture is to be definitive about the services, but to allow flexibility of implementation within each participant's domain.

In the diagrams in the following section, the colour coding is intended to align with that in Infoway's Blueprint; pale blue for registries, lavender for domain repositories, powder blue for applications, and red for EHR repositories and services.

4.4.1 Ministry of Health Services - Steward/Governor of the Health System

In its role as the Steward and Governor of the health system in British Columbia, the Ministry of Health Services must provide a collection of business services as follows:



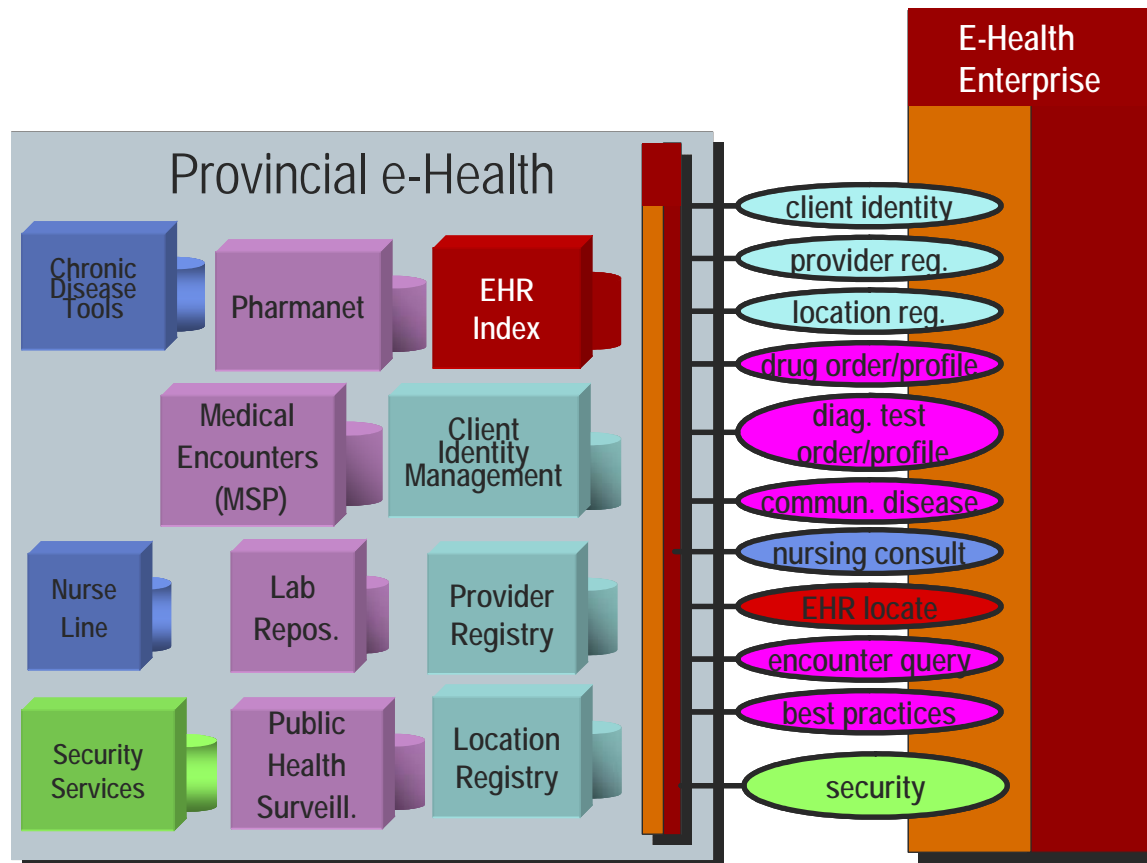
Eligibility: The Ministry is responsible for management of health benefits, and therefore informs the rest of the system about individuals' eligibility for publicly funded care. This service is currently provided through HNWeb and HNI transactions.

Claims/Billing: The Ministry provides a claims/billing/payment service, because of its role in administering Health Benefits. This service is currently provided through Teleplan4.

Bulk Financial: The Ministry provides bulk payments to health authorities.

Reporting: The Ministry collects detailed information supporting analysis of performance and usage of the health system. A variety of data collection mechanisms are in use.

Ministry of Health Services: - Steward of provincial eHealth services.



Client, Provider and Location Registry: The Ministry provides registration and query capability for clients and providers.

Drug order/profile: The Ministry currently provides a domain repository of dispensed medications, and will soon provide an electronic ordering capability.

Diagnostic Test order/profile: The Ministry currently has no role in this domain. However, the Provincial Laboratory Coordination Office is responsible for the provincial coordination and provision of laboratory services.

Communicable Disease: The Ministry will support the aggregation of information about communicable diseases, province-wide surveillance and the generation of alerts.

Nursing Consult: The Ministry currently operates the BC NurseLine, which provide nursing consultation services via the telephone.

EHR Locate: In order to support assembly of a province-wide EHR, an EHR Locate service will be required at a provincial level.

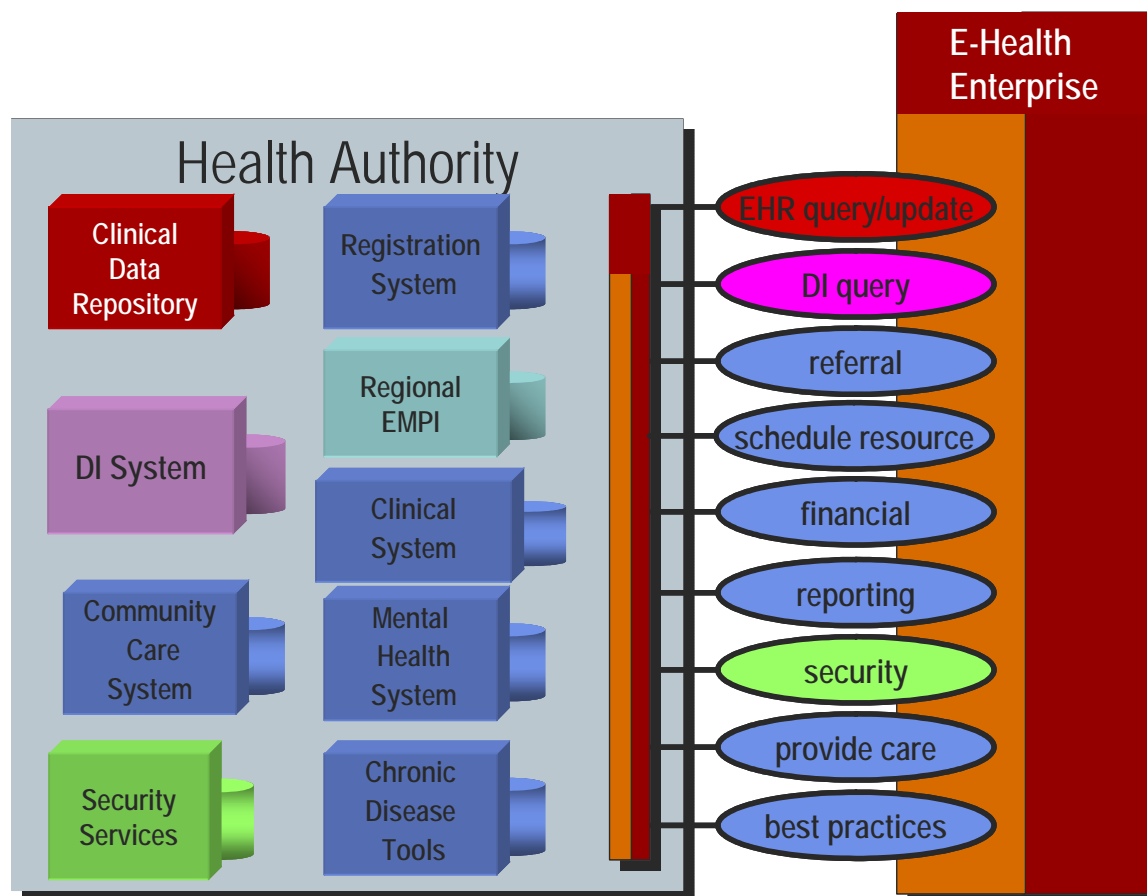
Encounter Query: Likewise, in order to support assembly of a province-wide EHR, a provincial query service for medical encounters will be required.

Best Practices: The Ministry currently publishes best practices and clinical guidelines, along with other less formal health-related information, through the Web and the BC HealthGuide.

Security: All of these services must be adequately secured. Strictly speaking, security is a “common service” provided not by each participant, but by the infrastructure. However, each participant needs to provide services to authenticate and authorize each other’s users, and to administer that authentication and authorization.

4.4.2 Health Authority

The health authorities in the province all have differing dominant requirements and existing assets. PHSA in particular has a special role, in that it predominantly provides common services to other health authorities, and has no citizens “of its own”. But an example health authority will provide the following capabilities to the rest of the system:



(Note that the “applications” are intended to be illustrative).

EHR query/update: This service allows another health authority or a care provider to execute queries on EHR data served by the health authority. For care providers served by the health authority, this service includes the “EHR Viewer”. Eventually, authorized care providers may also be able to update EHR data held by the health authority.

DI Query: This service is a special case of the EHR Query service, intending to support retrieval of diagnostic images from the authority’s diagnostic image repository.

Referral: This service allows a care provider or another health authority to achieve referral of a case to a resource or care provider served by the health authority. This service is being piloted in BC in the e-MS Project.

Schedule Resource: This service allows a care provider or another health authority to schedule usage of a resource. This service is particularly aimed at supporting the use of Telehealth facilities, but also includes scheduling other assets and appointments.

Financial: This service is intended to support financial relationships between health authorities, and between health authorities and care providers (not only individuals, but also contracted agencies). It includes contract management, invoicing and payment.

Reporting: Just as health authorities report to the Ministry of Health Services, contracted agencies and individuals report to the health authorities.

Provide Care: This service seems a little out-of-place, since the focus of care provision is predominantly the health authority. However, there are situations where a health authority will provide care through some electronic means (eg a Telehealth consultation), so it's quite legitimate to identify it as an eHealth business service.

Best Practices: The health authority will provide best practice and related health information to its major related participants (mostly care providers and citizens).

Security: The health authority will provide the capability for care providers, citizens and other health authorities to authenticate themselves and be authorized for access to services and resources.

4.5 Data Holdings

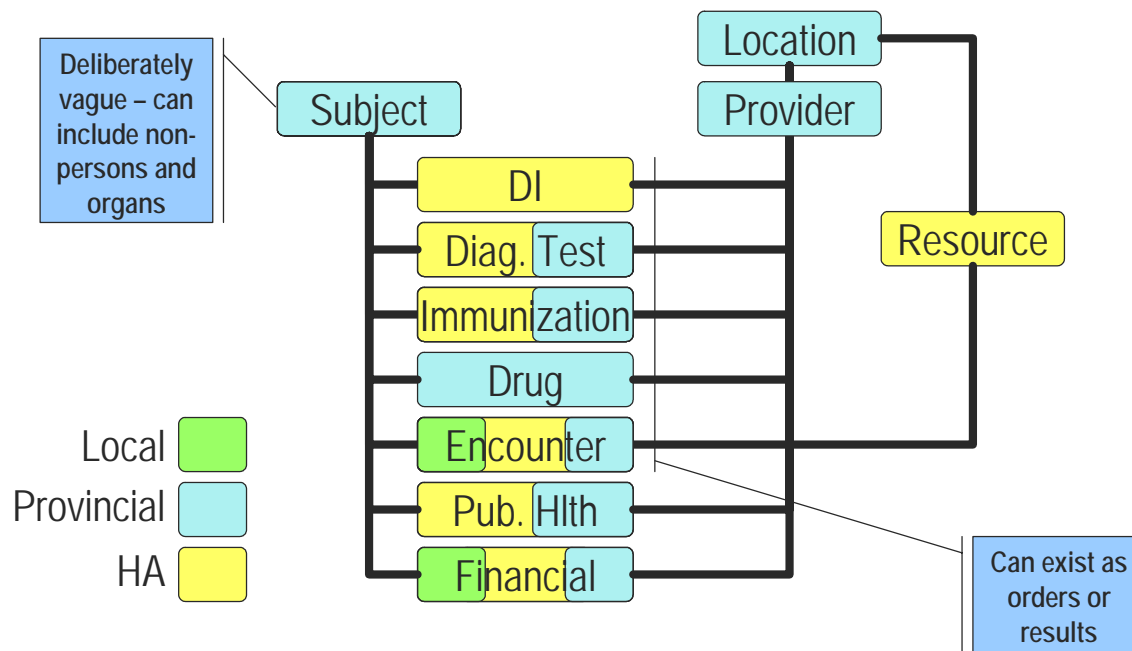
The purpose of a data-oriented view of the Conceptual System Architecture is to identify and define the major items of data *that must be shared between the participants*. This definition is required because, otherwise, service interfaces provided by different organizations cannot be relied upon to achieve the same ends, and interoperability is lost.

Most conceptual architectures contain a data model to express this set of consistent definitions. For health care, there is no need to develop a data model from scratch. There have been many prior efforts to define data, the most popular of which is the HL7 Reference Information Model.

In practice, the province will initiate efforts to build (or buy) the services and capabilities outlined above one by one. For each set of services, standards will be chosen, for our participants to expose those services to the enterprise. These standards will not only be technical standards, they will also define business rules for interactions, and data. For example, for client identity services, the HL7 Version 3 messaging standards supporting Patient Administration have been selected. For diagnostic image transfer, the province will likely standardize on DICOM.

The data models supporting the standards, likely to be chosen, are detailed and comprehensive, and are "overkill" for a conceptual architecture.

Nevertheless, there is some utility in showing a Data Model in the Conceptual System Architecture. It provides an overview of the data holdings that may be used to settle on strategic conclusions about placement (Regional/Provincial/Local). The following conceptual model makes an attempt at this placement:



This data model describes the contents of the Electronic Health Record as a collection of data items all associated with a subject (the citizen). Each item may also be associated with a provider, a location and some resource. Furthermore, each item can be a record of an event, or an order for something to happen. The colour coding in the above diagram attempts to allocate primary responsibility for holding the data item for the purpose of sharing within the eHealth Conceptual System Architecture. Some of the data items identified in this model originate in the private sector (particularly diagnostic test results and drugs dispensed).

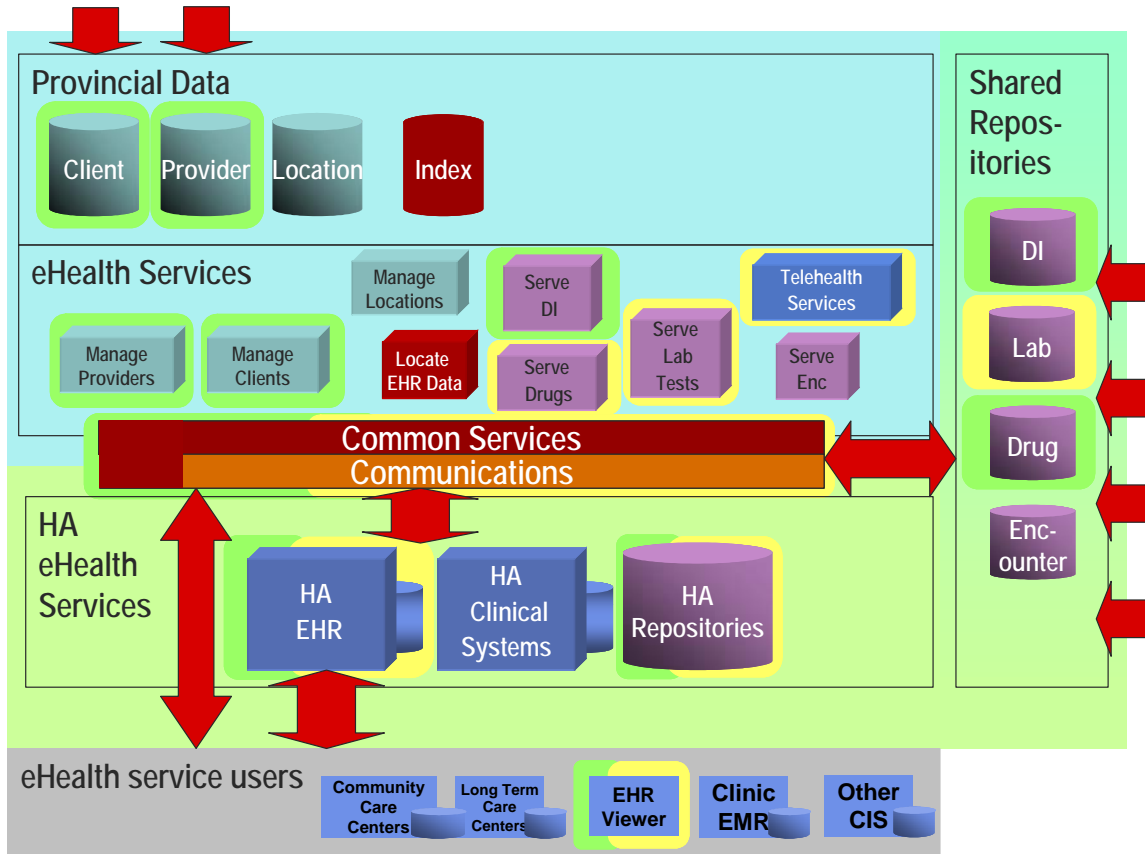
4.6 Service Infrastructure

The treatment of the Conceptual System Architecture in this section has predominantly focussed on business services and data. The purpose of this focus is to identify the key business services as a way of judging the alignment of IM/IT plans and the portfolio of project initiatives. However, none of these services may be integrated to support any eHealth usage scenario without some key items of infrastructure. These items are:

- Network services, including reliable high-speed TCP/IP connections for data, and corresponding capabilities for voice and video transmission (to support Telehealth applications).
- Secure, reliable messaging services, promising the reliable delivery of private, secure transmissions.
- Common user authentication and authorization services, allowing users to be authenticated by one of the participants, and for their permissions to be transferred with them as they use resources throughout the system.
- Group collaboration services, including secure email and file transfer, web conferencing and distribution.

5 Current Status

The efforts of the Ministry and the health authorities over the past few years have resulted in the development of a number of “building blocks” supporting, in particular, the delivery of EHR capabilities. Referring to the EHR Architecture in section 4.2, the delivery status of the components is as follows:



In the diagram above, components surrounded by a green border, are either in place or under development. Components surrounded by a yellow border are in planning. Some components are in a “mixed” state because of regional variation, or an incremental approach to delivery. Projects receiving or expecting Canada Health Infoway support are identified.

Provincial Data		
Client	Client Registry in place, EMPI services under development	✓
Provider	Provider Registry Service in place	✓
Location	To be planned	✓
Index	To be planned	✓
eHealth Services		
Manage Providers	HL7 Provider Services under development	✓
Manage Clients	HL7 Client Services under development	✓
Manage Locations	To be planned	✓
Locate EHR Data	To be planned	✓
Serve DI	Provincial DI Grid under development	✓
Serve Drugs	PharmaNet services planned	✓
Serve Lab Tests	Planning under way	✓
Serve Encounters	To be planned	✓
Telehealth Services	Planning under way	✓
Shared Repositories		
DI	Regional DI installations under development, some complete	✓
Lab	Planning under way	✓
Drug	PharmaNet complete	
Encounter	To be planned	✓
Common and Communication Services		
Authentication and Authorization	Common authentication and authorization based on federated model designed and in implementation.	✓
Network	Common secure network in place.	
Broker Services (messaging, routing, workflow, transformation)	Broker standard in place, procurement under way.	✓

In addition, planning is under way for the Provincial implementation of Public Health Surveillance capabilities.

Each of the health authorities has their own plans for implementing EHR Systems, clinical systems and domain repositories. From a provincial perspective, the major missing pieces are a provincial system for access to lab results, a common approach to an encounter repository, and the overall EHR index service.