EHRS Blueprint
an interoperable EHR framework
CANADIANS PLACE HIGH VALUE ON QUALITY OF LIFE RELATED TO HEALTH. WE SEE UNIVERSALLY ACCESSIBLE HEALTHCARE AS PART OF OUR NATIONAL VALUES FABRIC – THAT WHICH DEFINES WHO WE ARE AS CANADIANS: WE CARE FOR EACH OTHER’S WELL-BEING INDIVIDUALLY AND COLLECTIVELY. NEXT TO PEOPLE, INFORMATION IS THE SECOND MOST VALUABLE RESOURCE FOR CARING FOR OUR HEALTH. WE TRUST OUR CARE PROVIDERS TO MAKE IMPORTANT CLINICAL DECISIONS ABOUT OUR HEALTH, BASED ON INFORMATION ABOUT OUR CURRENT HEALTH STATUS, OUR PREVIOUS HEALTHCARE AND BEST PRACTICES. WE TRUST HEALTH SYSTEM MANAGERS, POLICY MAKERS, EDUCATORS AND RESEARCHERS TO USE VALID AND RELIABLE INFORMATION TO MAKE OUR HEALTHCARE SYSTEM WORK WELL AT KEEPING US HEALTHY.

To accomplish this availability of health information, wherever in Canada it is needed, requires sharing of information between providers, across care disciplines, across care settings, and across jurisdictional boundaries. With the availability of electronic information systems to collect, manage and transmit this information, it is natural that we look to such systems to be “interoperable”, to work together to support health and healthcare in Canada.
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Canada Health Infoway has been mandated to develop an information and interoperability framework or architecture that will support the development of solutions for sharing critical health and healthcare information across the country, so that the appropriate health information is available for patient care no matter where providers or patients are.

The building blocks include individual electronic health records (EHR), health information management systems in large and small healthcare settings called Point of Service applications (PoS), health information repositories and warehouses, and special service applications that screen and manage health information as it is transmitted from one point to another. These capabilities, combined with a supporting infostructure that connects them all, is called the EHRS.

The Electronic Health Record Solution (EHRS) Blueprint is the framework for the Canadian Electronic Health Record (EHR) solution and it provides the enterprise systems architecture to guide overall development of the whole and the individual parts.

This paper provides an overview of the EHRS Blueprint. Our purpose is to support understanding of the EHRS Blueprint by users of EHR Solutions and by those who are accountable for effectively using information technology for health.
An **EHR** provides each individual in Canada with a secure and private lifetime record of their key health history and care within the health system. The record is available electronically to authorized health providers and the individual anywhere, anytime in support of high quality care. This record is designed to facilitate the sharing of data – across the continuum of care, across healthcare delivery organizations and across geographical areas¹.

The **EHRS Blueprint** provides a comprehensive description of the components necessary for the interoperable EHR and describes, in broad terms, how the components are envisioned to work together. The Blueprint is essentially a conceptual architecture for the interoperable EHR. It gives us the way to get the right information about health and healthcare, to the right people, at the right time in the right format, by creating a robust and extensible framework and standard for sharing health information. It is built to support a broad range of current healthcare processes while being flexible enough to work with improvements and developments in best practice. It is designed to provide communication capability for whatever healthcare processes and practices are deemed most beneficial for individual patients, both within each jurisdiction and nationally.

As a conceptual architecture for the interoperable EHR, the Blueprint provides enough detail to ensure the coherent planning of services across the interoperable EHR.

The conceptual architecture is also technology-neutral. In other words it does not mandate the use of any particular technology, product or vendor service, it simply describes how the solution should work.

### The Need For An Information Solution

Canadians are looking for an affordable healthcare system that responds quickly when needed. The growing and aging population base in Canada continues to increase demands for healthcare services. At the same time, health service delivery costs take up an ever larger proportion of provincial budgets needed to support complex delivery systems while managing a vast number and variety of services, providers, care locations and resources. Information is the lifeblood of an effective healthcare system. Sharing of health information across systems is a critical enabler of a healthcare environment that is responsive and sustainable.

To ensure the best possible care to support the best possible health of Canadians, information must be accurate, up-to-date, and accessible whenever those who provide healthcare services need it. Information and communication technologies (ICT) make possible this sharing of patient-centered, care-focused information.

Leaders across Canada are developing a growing consensus on the value of shareable health information using electronic processes. The Romanow Commission Final Report states: “Electronic health records are one of the keys to modernizing the health system and improving access and outcomes for Canadians.” Similarly, the Kirby Senate Committee finds that “Not only can an EHR system greatly improve quality and timeliness in healthcare delivery; it can also enhance healthcare system management, efficiency and accountability.”²

The time has never been better to undertake an initiative of the magnitude envisioned for a Canadian EHRS.

There is a convergence of will, capacity and capability.

The health sector in Canada was one of the first industries to embrace the use of computers and information systems to support administrative, human resource management, financial, and other operational needs. That history of commitment to using electronic information management is now being applied to include clinical information in primary care, long-term care and community-based care. In addition, this clinical information must be integrated in the program-level and overall decision making processes of healthcare administrators and policy makers.

In one sense, we already have EHRs in Canada. In fact, we have a very large number of clinical applications in operation today in hospitals, clinics and physician offices. In the past 20 years, the emergence of systems to support clinical information (CIS) in the areas of radiology (RIS),

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lab orders and results (LIS), and prescription drugs (DIS) has provided increased capabilities to support the clinical needs of providers and their clients/patients, primarily in the acute care sector.

The current state, however, is far from ideal. Having a person’s clinical information located in many different systems is of limited use and takes time to gather at critical moments.

This is the challenge: Information about a person’s healthcare is collected and located in many places and is usually unavailable electronically at the point of care when needed. This challenge has created the impetus for a relatively new concept in the use of information systems to meet our population’s health needs. This concept is an EHR for each person that is available to different healthcare providers and over time. This “interoperable EHR” or iEHR holds information on the health services a person has received, as well as information about their history of diagnostic tests, medications, care plans and health status.

We have learned a lot about information and communications technology generally in the last 30 years. We are now learning how to most effectively use the best of these technologies to provide relevant, timely information for the business of helping Canadians to be healthy.

The Purpose of The EHRS

With this EHRS, Canada is supporting a focus on quality of healthcare through appropriate, securely managed sharing of accurate, reliable PoS information that will support good decision making: by patients themselves, by their care providers, by researchers and educators, by health system administrators and by policy makers.

Such decisions include:

- Family doctors or other primary care providers reviewing their patient’s history and current test results to work out the best therapy for improving health status or caring for a critical health emergency.
- Emergency department clinicians deciding which emergency measures will be effective and safe for a comatose or confused patient.
- Pharmacists using drug profile information to assess the potential adverse reactions of a prescribed medication.
- Educators and health human resource planners determining how to adjust education systems to train the best numbers and kinds of health professionals, developing the best curriculum for current and future needs.
- Although out of the scope of current Infoway investments, a future example could also include clinicians and knowledgeable patients developing and revising guidelines for the best way to deal with diabetes and other chronic diseases.

History of the EHRS Blueprint

Creating a common EHR vision was a top priority for Canada Health Infoway in late 2002. A task group was formed and charged with developing a model for what would be the pan-Canadian EHR. After several months of surveying existing solutions and collecting ideas from healthcare informatics professionals from every province, the group completed and published the first version of the EHRS Blueprint (v1). That document provided the foundation for a conceptual model for pan-Canadian interoperability, complementing the investment programs of Infoway.
Another important consequence of the Blueprint v1 was that it created a common vision and important definitions for the main solution components. This allowed the jurisdictions and Infoway to work together to align EHR initiatives with a common, pan-Canadian architecture, as well as common standards for semantic interoperability.

More recently, Infoway has updated and produced version 2.0 of the EHRS Blueprint. Extending on the original work, the updated architecture provides significantly more detail and range. Additional aspects include a Privacy and Security conceptual architecture and domain models for Public Health and Telehealth. This latest version also includes more information about the various deployment models in use or under consideration across Canada.

Vision of the EHRS Blueprint

The vision that shapes the EHRS Blueprint is as follows: “A high-quality, sustainable and effective Canadian healthcare system supported by an infostructure that provides residents of Canada and their healthcare providers with timely, appropriate and secure access to the right information when and where they enter into the healthcare system. Respect for privacy is fundamental to this vision.”

The EHRS Blueprint is the starting point for the “infostructure” noted above. An infostructure is a shared foundation of hardware, software, and communication technologies with associated architectures that enable an uninterrupted flow of information. The EHRS Blueprint’s purpose is to provide the conceptual framework and working principles for development of shareable electronic health records across the country.

1. It is designed as a reference for strategic planning and healthcare information systems development for provinces, healthcare organizations, provider associations, healthcare professionals, healthcare information solution vendors and for authorities involved in developing privacy and security initiatives.

2. It is designed to support and enable project-specific architecture, design and test phases. Within the context of deployment or development projects, the EHRS Blueprint provides the conceptual view of what needs to be deployed or developed.

3. It has been designed and developed specifically to enable reuse and replication at the architecture level to promote reusability by providing each jurisdiction with a tool to identify a pathway by which it will create, replicate and deploy the different components of an EHR infostructure.

4. It represents a collaborative stated vision of how an EHR infostructure can be created at the jurisdictional level to enable Electronic Health Records across multiple organizations, jurisdictions and provider communities. It forms a base for pan-Canadian EHR standards development initiatives from which Canada can proactively and effectively engage in international health informatics standardization efforts. Different national organizations and provincial standards bodies, that are taking active roles in the definition, development, implementation and evolution of healthcare informatics standards for Canada can use the EHRS Blueprint as a foundation for their discussions, analyses, and decisions.

5. It supports the development of jurisdictional or stakeholder-based education and/or training initiatives related to the design and development of EHR solutions.
To accomplish this, Canadians need a common view of what is possible, a common architectural model for achieving interoperable EHR Solutions, and widespread participation in the vision.

1 A common view and understanding across Canada to coordinate efforts, acting locally for local, national, and global benefit. A common understanding of the desired future state allows for a more coordinated effort across the country where each jurisdiction can act locally while sustaining the objective of a pan-Canadian interoperable set of EHR Solutions.

2 A common architectural model with consistent core standards that ensures overall effectiveness of the information systems used in health services, and that establishes a consistent terminology for facilitating communications between and among different stakeholder groups. The purpose is to achieve availability of necessary and relevant data to anyone authorized to receive it.

3 Participation by all individuals and groups with key vested interest in the EHRS process and outcomes. Much of the discussion on the subject of EHR will occur within jurisdictions, involving governmental agencies, regional health authorities, provider organizations, healthcare professionals and technology vendors. Although those participating in these initiatives will have different perspectives and interests in relation to the EHR, the EHRS Blueprint provides a common framework to better enable stakeholders to express their requirements, align with the overall vision, and to identify and resolve issues.

Value of the EHRS Blueprint

The Blueprint offers service delivery organizations a scalable and extensible framework that allows them to adapt current systems so they can connect to shared information networks and/or readily adopt new and improved systems. Once a Blueprint-based infostructure is implemented, existing information systems capabilities can be increased, augmented, and extended at a pace the organization can afford and manage.

The EHRS Blueprint will facilitate the process of enabling healthcare professionals’ access to patient-centric information and support for clinical decision making. It will provide a framework and support for information sharing between healthcare professionals and providers to inform continuing learning/education. It will form the basis for access to reliable, accurate, longitudinal information needed when conducting research.

For patients, the EHRS Blueprint provides the framework that supports sharing of their health information, improving decision making by providing a more accurate and complete picture of events from all available sources. A goal of the EHRS is to provide access to client/patient data, anytime, anywhere, through an integrated view, to any authorized person. The more complete the informational picture available to the healthcare provider, the better the health decisions, which in turn will result in improved outcomes.

Patients can also benefit from not necessarily having to travel away from home to consult specialists or specialized services. When information about the patient is available electronically through the EHRS to specialists or to specialized services in other locations, decisions about care can be made from a distance. The services prescribed by these specialists can then be provided by primary care providers or others where the patient is. This reduces trauma to the patient, time needed to start treatment, the effort required to build a paper medical record to transport with the patient, and costs and inconvenience to everyone involved.

An example of an area in which shared electronic health records make a concrete difference to quality and safety of care is the medication errors that occur in hospitals. A study conducted in the United States in 1998 showed that, after implementing a computerized order entry system, rates of serious medication errors fell by 88%. Based on results of a Canadian study, we know that at least 7.5% of hospital admissions, or 185,000 of almost 2.5 million annual hospital admissions in Canada, were associated with an AE (adverse event or harm resulting from inappropriate medications) and close to 70,000 of these are potentially preventable. The Blueprint enterprise architecture provides a mechanism to share drug information along with electronic prescriptions capability that will help to significantly reduce errors not only in the hospital setting, but also in the community.
THE EHRS BLUEPRINT HAS BEEN DESIGNED TO ACHIEVE THE VISION and to accomplish the overall purpose of communicating critical health-related information available for safe, timely, health-promoting decision making by healthcare providers, patients, administrators and governing bodies. The EHRS Blueprint describes how the EHR of each individual patient is created and managed from a business and system perspective and how and where interoperability would be created.
Possible Methods for Sharing EHR Information

The primary purpose of the EHRS is to allow sharing of clinically-relevant data in support of healthcare and services anywhere in Canada.

Four possible methods of sharing EHR information across systems were considered in developing the Blueprint for EHR Infostructure:

1. Single database or the “Big Database in the Sky” where data from all PoS applications are stored in the same data store and all users can pull data from that store.

2. Data broadcast to all, or a logical subset of systems. This would involve replication of data from one system to all other relevant or participating systems, and every PoS would hold the same kind of information in similar formats. Direct connection would occur between each PoS and all other participating systems.

3. A single index/locator service, or the “Big Index in the Sky”, where an EHR Index or locator service holds links to all PoS applications where information resides. Each PoS system interfaces to other systems.

4. Use of a shared reference information source that is populated with clinically relevant data by the various PoS systems. Other PoS systems or viewers reference it, and pull needed data from it. This reference source remains external to the operation of each PoS, so does not directly “touch” the PoS.

The last method was chosen to form the basis of the EHRS for many reasons: It protects both PoS application performance and core data by removing the impact of other systems “reaching in” to retrieve data; it requires the lowest number of direct interfaces, dramatically reducing the overall costs of integration; it requires standards to be applied to all data exchanged with the EHRS, improving the consistency and usability of that data; it allows for the re-use or leveraging of legacy systems; and, overall, it is the most cost-effective.

Each jurisdiction will have its own electronic health record solution (EHRS) shaped according to its needs and characteristics. Each will have the same overall enterprise architecture as depicted in the EHRS Blueprint, which allows for flexibility of application using common health information standards.

**Figure 1**
The EHR Solution Concept

The EHR Infostructure is made up of:

- Registry systems to manage and provide the information required to uniquely identify the actors and resources in the EHR. These identified elements include the name of the patient/client (including a unique identifier), the provider of care, the location of care, the end users of applications and the terminologies used to describe diseases, acts or other clinically relevant information. Registries which hold patient/client consent information are part of the EHRI as well.
An EHR Infostructure (EHRi) is a collection of common and reusable components in support of a diverse set of health information management applications. It consists of software solutions, data definitions and messaging standards for the EHR.

- EHRi Domain Repositories that manage and persist (maintain over time and applications) subsets of clinical data pertinent to the clinical picture of a patient or client. A diagnostic imaging PACS solution, where digital diagnostic images are held in an information repository, is an example of a Domain Repository.

- The Shared Health Record repository that holds basic information on health encounters and health service events, and the clinical observations associated with those events.

- A set of Longitudinal Record Services to coordinate accesses to patient-centric information and updates to that information across domains and applications. It also manages metadata to help locate data across multiple domains and registries.

- Standardized common services and communication services to sustain the interoperability of the different components within the infostructure, as well as to sustain interoperability and a high degree of abstraction between the EHR infostructure and the PoS applications.

- Standardized information, message structures and business transactions to support the exchange of information in and out of the EHRi.

- An EHR viewer as a generic presentation application allowing end-users to access, search and view relevant and authorized clinical data about clients. The viewer provides a single seamless view of all available, relevant healthcare information on a patient regardless of its source.
Creating “Share-ability” or an Interoperable EHR

Below is a high-level depiction of the architecture that will support local solution development within a framework of sharing critical information that is generated at multiple points, locations and jurisdictions.

This model shows how sharing will be made possible while maintaining the rights and responsibilities for healthcare and standards among jurisdictions and professionals:

- Each jurisdiction will have its own EHRS, with some large jurisdictions having a number of regional EHR solutions that work together.
- The information systems that support information management and sharing are distributed across the jurisdictions.
- The characteristics of the clinical information databases are determined by national standards.
- All of the various databases and applications are connected to the EHRI so that information can flow wherever it is needed. At the same time, it flows through services that ensure that the information is managed securely and confidentially according to all current principles, standards and requirements.
- There is a federated set of EHR databases specific to pan-Canadian issues (i.e., Public Health Surveillance).
- There is a message-oriented model of communication.
- When full interoperability is achieved at the jurisdiction levels, using the principles of the EHRS Blueprint, the ability to find and access EHR data anywhere in the country will be a reality.
Architectural Principles Of The EHR

The EHRs Blueprint defines a set of principles upon which the architecture of the interoperable electronic health record (iEHR) is based. These principles range from assumptions about what constitutes the EHR, through expressions of the basic things that must be true in any implementation of the Blueprint in order for each infostructure to have a consistent interface with PoS applications and to be able to interoperate with each other.

For example, the following architectural principles exist concerning the concept of the EHR in the Blueprint:

- The EHR has a common definition across Canada.
- The EHR Infostructure is authoritative as a source of data for PoS applications and their end-users.
- The EHR Infostructure is a client/patient centric data repository designed to share clinically relevant data.
- EHR Infostructure information is composed of data replicated from PoS applications into coordinated EHR data domains.
- It will be evident to the end user when the EHR is the source of some of the clinical data they are viewing.
- Information contained in the EHR data repositories includes all clinically relevant data, maximizing completeness, timeliness and accuracy of access to data across time and across the continuum of care for any client/patient.
- For end users, the result is perceived as a single source of all relevant clinical information operating seamlessly and invisibly across all components – a black-box with a set of supported transactions. The EHR Infostructure is seen as a gateway which any PoS application can use to contribute to or access data for a particular client/patient.

In addition, the Blueprint elaborates on the principles of designing, building, and implementing the infostructure necessary for the interoperable EHR, including the following:

- The Blueprint defines the infostructure as a controlled environment in which privacy and security policies and other clinical information rules and policies can be applied.
- The infostructure may be implemented at any jurisdictional level, which allows for a high level of flexibility and configuration concerning local and provincial needs.
- The infostructure uses a Services Oriented Architecture, an approach that provides needed information so that the appropriate granularity, flexibility and reusability are enabled throughout the different layers of functionality described in the architecture.
- Application of a messaging mechanism in compliance with pan-Canadian EHR standards to ensure unambiguous, uniform understanding of the data.
- Design and use of EHR data domain repositories to enable reuse and continued return on investment (ROI) on existing or upcoming jurisdiction level solutions.
- The EHR Infostructure combines the capabilities of a network of interconnected EHR Solutions to insure the availability of accurate and complete health records to any authorized user in Canada.
- There is no single “home” for the client’s electronic health record. Each EHRI is responsible for holding and orchestrating access to EHR data for every client who has received health services in the jurisdiction the EHRI serves. If a client/patient has, over time, received services in four different jurisdictions, then its single virtual EHR actually exists in four different jurisdictions.
- Internal identifiers are required within an EHR Infostructure to allow for or all participating systems to easily access data. These internal identifiers which allow tracking and supplying of appropriate information to the right end user are never exposed to PoS applications.
- The EHRs supports both Canadian official languages – French and English.
These principles allow for a variety of jurisdiction-specific EHR solutions to suit each jurisdiction’s needs and characteristics. At the same time, health information needs to be shared in response to clear need. As each jurisdiction begins to develop or implement EHR solutions, it is very important that they base their specific decisions on these principles and architectural characteristics. A consistent application of these principles in realizing EHR solutions is critical to achieving interoperability on a pan-Canadian basis.

Key Elements Of The EHRS Blueprint

PoS Applications

These are the software programs or information systems being used at the points of service, providing critical healthcare information to inform clinical decision making (Fig. 3, p 15). This may be the Electronic Medical Record (EMR) in a physician’s office or primary care clinic, the information system in a hospital emergency department, or the system in the local pharmacy—among many others. At the Point of Service, the healthcare provider using the application wants to access information about the client/patient such as their health history or current condition that they or others have captured. The user of the system at this point will want to be able to access such information seamlessly—quickly and easily using only one operation—even when that information may come from many different systems.

The desired end result of the application of the EHRS Blueprint is to have information available for health-related decisions in one view regardless of the source of the information (system, location, time).

PoS systems are responsible for most, if not all, collection of the clinical data that will eventually form the EHR of a patient. These are not silos of clinical information but collection and sharing points. These are critical elements in the EHRS as they represent the primary point of value—that is, where all of the information gathered and managed throughout the EHRS fulfills its primary purpose of supporting healthy decisions, at the interaction point between the patient and healthcare provider.

Fundamental principles used in the design of the EHRS, that apply here, include:

- The highly specialized and functional applications clinicians use or will use on a daily basis will continue to be managed, changed and designed in processes led by clinicians. The object is to capture key clinical data from these for the EHR and to integrate relevant EHR data for use in these applications.

- The architecture leverages the prior investment (clinical knowledge, technology and capital) in clinical applications. Existing applications that are effective are accommodated or adapted for continued use within the architecture. Much wisdom has been imbedded in these applications and must be used.

Note that each PoS is assumed to have its data stored locally (as represented by the data cylinder inside each box) and that they do not communicate directly with each other; they communicate via the Health Information Access Layer (HIAL) where information will be verified for correct patient identity and appropriately anonymized depending on the intended use, the location and provider identification added where appropriate, and the identity of the requester checked for authorized use.

Each site is basically considered a stand-alone instance of a clinical application, so that it can maintain information relevant to the practice setting, without that information being part of the EHR that is accessible through the infostructure. Information that is pushed to the EHR for sharing is a duplicate version, not the original.

For example, a physician may want to keep notes about local services provided or details of questions used in the patient interview that are not necessary for the shareable EHR.

The Shared Data: EHR Repositories

Each PoS application that supports care in a clinical
setting only contains some of the range of healthcare information on a patient. There is some information that will enhance clinical decision making for a patient that is not available from these applications; rather, it is available from other systems. This information, sometimes from diagnostic services, sometimes from larger systems like Public Health services, must also be available at the point of care. To ensure the availability of this kind of clinical information, the Blueprint includes a small number of EHR domain repositories, usually associated with a province or jurisdiction; each containing a significant subset of the overall EHR data available for sharing with other domain repositories and jurisdictions.

The Blueprint has identified four logical clinical domain repositories (Fig. 4, p 16).

The PoS applications are responsible for pushing (or publishing) data that is to be shared into an EHR Data Repository. PoS systems that contribute in this way are also known as “EHR Source Systems.” The EHR repository is then responsible for receiving this information and storing it in its local database until the moment when this data will be needed by another authorized user.

A simplified view of how this model works can be seen in Figure 5 (p 16). Here the PoS applications act as both the sources and users of the EHR data stored in the four domain repositories located at the jurisdictional level above. All exchange of information is done using standards-based interfaces defined in EHR Interoperability Profiles.

Q: What are Interoperability Profiles?

The EHRs Blueprint provides high level design requirements for the EHRi and interoperable EHR solutions in the form of Interoperability Profiles that:

- Are normative and specify the interfaces between PoS applications and the EHRi
- Are derived from detailed use-cases (“The Life of the Lamberts”) to provide traceability between EHRi system functions and clinical business requirements
- Include descriptions of the types of service requests that will be made to an EHRi
- Include descriptions of the data to be exchanged by referring to data views of the data model
- Assume service calls where message requests and responses are carried between the PoS applications and the EHRi

These profiles are made up of messages using standard message definitions, such as DICOM and HL7. Those messages are further supported by data standards, including reference terminologies such as SNOMED CT and classification systems such as ICD10-CA. These interfaces carry the patient’s data between the EHR infrastructure and the PoS applications.

6 “The Life of the Lamberts” describes a mythical Canadian family that has many of the typical clinical incidents that can occur. These clinical incidents form the basis of storyboards and descriptions of information interactions that are then translated into needed EHR services.
Figure 4
EHRI Data Repositories

Figure 5
PoS Systems Sharing EHR Data

Figure 6
Registry Services

Figure 7
Longitudinal Record Services
Correctly Identifying Patients/Clients, Service Providers, and Service Locations: Registry Services

To be useful and trustworthy to the clinical end user, the information the clinician gets from the IEHR must be accurate and reliable.

As an example, a primary care physician needs to know that the laboratory test results shown in the EHR has the same normal range and means the same thing no matter what lab the results come from and no matter what equipment was used to generate the results. This means that the data and language used to describe the data must be normalized through the application of common standards or ways of showing the data.

In addition, clinicians need to be sure that the information they are seeing from the EHR relates to the person they are dealing with and not someone else.

The Blueprint includes repositories called registries (Fig. 6, p 16) for identifiers of key attributes, in particular the patient, provider, location, user and clinical terminologies, to ensure that the right clinician or user accesses and provides the right information on the right person in relation to the right location. This will ensure that the end user has valid, reliable and understandable information to make safe and health-enhancing decisions.

The Whole View: Longitudinal Record Services

To be useful to clinicians in making clinical decisions we have to bring together all the data for a given patient, from whatever source holds that information, effectively creating the perception of a single longitudinal record.

Even after resolving a unique identifier for the patient, the presence of multiple repositories, each holding some part of the EHR data, presents a challenge with respect to retrieving this information efficiently.

As part of this service oriented architecture, on which the EHRS Blueprint is based, there is a set of services called the Longitudinal Record Services (LRS) (Fig. 7, p 16).

These will perform the functions of collecting and bringing together information from registries, repositories and other sources; normalizing it for common understanding; recording instances of use; and managing other relevant information on behalf of the PoS systems. The LRS has the necessary knowledge about the EHR data in the EHRS to respond quickly to any PoS request.

The Glue that Binds: Health Information Access Layer (HIAL)

The connection of possibly hundreds of PoS with multiple repositories and registries could be a logistical nightmare.

The HIAL can be seen as the Canadian healthcare version of what the industry sometimes calls an “Electronic
Services Bus” (ESB). Its job is to act as a gateway – the critical sharing point – making it possible for information in different languages and forms to be shared with the full range of EHRs. It provides a single standardized way for PoS applications to connect to the EHR infrastructure, regardless of how a particular jurisdiction has partitioned EHR information domains and services.

Because its functions are similar to those in other industries, it can leverage some of the technology that has been developed for other industries and environments.

The level of complexity and requirement for privacy and security of individual health information, however, surpasses that of any other industry, resulting in different sets of terminologies, concepts and information standards, including the use of HL7 v3.

This is unique to healthcare and requires that existing solutions be customized to meet the pan-Canadian EHR standards. The idea of having a single point of access and integration for each jurisdiction’s EHR infrastructure is the principle behind the HIAL (Fig. 8). The HIAL provides a highly scalable and extensible platform for connecting the many PoS applications with the various EHR components.

Figure 8
The Health Information Access Layer (HIAL)

JURISDICTIONAL INFOSTRUCTURE

POINTER OF SERVICE
The HIAL is made up of services, service roles, information models and messaging standards required for the exchange of EHR data and the execution of interoperability profiles between EHR services.

The Common Window – EHR Viewer

So far, there has been an implicit assumption that all user interaction with the EHRi will be performed through a PoS system, such as a CIS or EMR.

But, what if the user does not have a PoS or what if their PoS is not capable of providing a window into the EHR?

This is where the EHR Viewer comes to the rescue. Figure 9 shows the complete view into the EHRs Architecture as shown on the lower right-hand corner as a new green box representing the EHR Viewer. Note that the EHR Viewer is included along with the other PoS applications, but it is distinguished by the fact that it does not rely on a local data store (i.e., the cylinder representing a local data store as shown with the other PoS systems), but must obtain all its information from the EHR.

The EHR Viewer is expected to be used in supporting real time day-to-day care delivery activities for different types of caregivers.
EHRI SERVICES: ENABLING THE EHR INFOSTRUCTURES TO WORK TOGETHER

SERVICES WITHIN THE EHRI FIND, RETRIEVE, RESHAPE, AUTHENTICATE AND TRANSMIT INFORMATION from the various repositories or source systems, when it is called for by an authorized user, and display seamlessly the appropriate clinical information to that authorized user.
Communication Services Within the HIAL

The first point of interaction between a PoS system and the HIAL is with the Communication Services. These services provide the very basic connectivity capabilities needed to support interaction with the PoS applications.

<table>
<thead>
<tr>
<th>SERVICE TYPE</th>
<th>DESCRIPTION</th>
<th>SERVICE COMPONENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol Services</td>
<td>Deal with the network, transport and application level protocols. These services will support pluggable modules to support various protocols</td>
<td>• Application Protocol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Network Protocol</td>
</tr>
<tr>
<td>Messaging Services</td>
<td>Handle the message after the application and network protocol wrappers have been removed; including, parsing, serialization, encryption and decryption, encoding and decoding, transformation and routing</td>
<td>• Transformation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Encryption/Decryption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Parser</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Routing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Encoding/Decoding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Serialization</td>
</tr>
</tbody>
</table>

**Figure 10**
Communications Services in the HIAL
Common Services in the HIAL

As noted, an essential role of the HIAL is to provide a collection of services between the other EHR components:

- Acting as the “gatekeeper to the EHR,” it provides extensive security services for all components. These services were originally described by the EHRS Privacy and Security Conceptual Architecture and incorporated into the EHRS Blueprint, version 2.0. There are 10 named services, including Identity Management (with the Provider Registry), access control, encryption/decryption and others.

- It provides privacy services, establishing rules set by the patient and existing policies/legislation for governing how EHR data is to be protected and shared.

- It provides complete configuration information about how EHR services have been deployed and can be accessed.

- It supports the low-level communication between the EHR services, other EHRS Business Services and PoS applications.

**Figure 11**
HIAL Common Services
<table>
<thead>
<tr>
<th>Service Type</th>
<th>Description</th>
<th>Service Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration Services</td>
<td>Manage the integration, message brokering and service catalogue functions</td>
<td>• Service Catalogue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Broker</td>
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<td></td>
<td></td>
<td>• Mapping</td>
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<td></td>
<td></td>
<td>• Queuing</td>
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<tr>
<td>Interoperability Services</td>
<td>Handle resolution functions that interact between various repositories, registries and the EHRS Locator. It also handles interoperability between EHR infostructures (i.e., between jurisdictions)</td>
<td>• Interoperability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Search/Resolution</td>
</tr>
<tr>
<td>Privacy &amp; Security Services</td>
<td>Authentication and authorization services: includes policy and permission management, as well as interfaces to security mechanisms</td>
<td>• Identity Protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Identity Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Access Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Anonymization</td>
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<tr>
<td></td>
<td></td>
<td>• User Authentication</td>
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<td></td>
<td></td>
<td>• Secure Auditing</td>
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<tr>
<td></td>
<td></td>
<td>• General Security</td>
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<td></td>
<td></td>
<td>• Consent Directives</td>
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<tr>
<td></td>
<td></td>
<td>• Encryption</td>
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<td></td>
<td></td>
<td>• Digital Signature</td>
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<tr>
<td>Subscription Services</td>
<td>Provide the capabilities to subscribe to events and manage the alerts and notification functions when enabled</td>
<td>• Alert/Notification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Publish/Subscribe</td>
</tr>
<tr>
<td>Management Services</td>
<td>Provides services to configure the EHR and the associated HIAL as well as providing services to carry out management function</td>
<td>• Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Configuration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Policy Management</td>
</tr>
<tr>
<td>Context Services</td>
<td>Provides session and caching services</td>
<td>• Caching</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Session Management</td>
</tr>
<tr>
<td>General Services</td>
<td>Provides services for auditing; log management and general error and exception handling</td>
<td>• Auditing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Log Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Exception/Error Handling</td>
</tr>
</tbody>
</table>
EHR Data & Services

In order for EHR data to be stored in and retrieved from the shared EHRi repositories, there needs to be a set of services that deals with accessing and managing that data. This set of services substitutes for the direct database access performed by software applications, encapsulating the data in a manner that ensures the data is managed in a consistent and coherent manner, regardless of the underlying database technologies.

The components of this grouping provide the actual business logic that allows EHR data to be stored, searched and accessed by PoS applications.

**Figure 12**

EHR Data Repository Services

<table>
<thead>
<tr>
<th>SERVICE TYPE</th>
<th>DESCRIPTION</th>
<th>SERVICE COMPONENTS</th>
</tr>
</thead>
</table>
| Business Services (service requests management) | Handle the business messages (services requests) sent by PoS applications for processing | • Normalization  
• EHRi interoperability  
• Business Rules  
• Assembly |
| Data Services | Handles the interfaces to the data repositories and manages the inflow and outflow of data | • Key Management  
• Data |
As described earlier, the LRS layer is responsible for "knowing" where EHR information is held and how to access or place it in the EHRi repositories (whether the data is held locally or one-or-more other infostructures). In order for the LRS to perform its duties properly, it must include the four key components shown at right.

Of key importance in this set of services is the EHR Index. This is the “heart” of the LRS. It contains indexed information (a.k.a. metadata) about every document, event or record published to the EHR. For each one, it maintains a small set of attributes (i.e., patient ID, type of entry, date, etc.) about that EHR Data and a pointer to indicate where it is stored within the domain repositories.
The EHR Viewer is used by persons who do not have an EHR-enabled PoS application. Because it provides an integrated view-only access to the data, the viewer is typically implemented within a web-browser interface. There are certain functions, however, that must still operate to ensure secure, appropriate access to information. For this reason the EHR infostructure must support a set of services that act as “middleware” between the EHRi and the EHR Viewer. These services allow the EHRi to interact with the viewer as if it was “just another” PoS application.

### Service Components

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Description</th>
<th>Service Components</th>
</tr>
</thead>
</table>
| Business Services (service requests management) | Handle the business messages (services requests) sent by the Viewer for processing | • EHR Viewer Business Objects Components  
• Normalization  
• Business Rules  
• End-User Navigation  
• End-User Display |
| Data Services                       | Handles the interfaces to the data repositories and manages the inflow and outflow of data | • EHRI Interoperability  
• Data Access |
FOR AN EHRS TO BE USEFUL AND EFFECTIVE, VARIOUS STAKEHOLDER COMMUNITIES MUST UNDERSTAND IT. These stakeholders will be responsible for implementing the EHRS. Using accepted industry methodologies, the Blueprint is expressed from several different perspectives.

Figure 15
Business Perspectives

FRAMEWORKS WITHIN THE EHRS BLUEPRINT
Business Architecture

In order for the business of healthcare to function optimally to benefit a person's health over the course of a lifetime and within whatever setting or circumstances that care is required, the information solutions need to make this information available over time and at different points of service. The business architecture outlines those business requirements as well as the solutions which address them.

Some key business requirements that shape the solution defined in the Blueprint include:

• That there be capacity for a life-long longitudinal record of clinically relevant data for a unique person, that is shareable beyond the boundaries of the organization providing care and generating the information.
• That each unique person’s information is held and moved in such a way as to be private and secure.
• That there is a governance and management structure with accountability for how a person’s health information is recorded, stored, moved and accessed by others.
• That the information solution is sustainable for the long term and the costs are appropriate in relation to other community priorities.
• That complex needs are addressed through as simple a design as possible, that is flexible and extensible.
• That information is available to ensure that public health needs are also met.

All of these requirements helped to shape the business architecture.

Clinical Work Process Architecture

The Clinical Work Process Architecture contains the clinical business requirements in use cases that describe how healthcare providers will interact with the EHRI System. These use cases were authored by medical experts working with the Blueprint team, and have been validated by practitioners and health information professionals familiar with EHR requirements and implementations. The EHRS Blueprint use-cases:

• Describe the end-user actor actions and system functional requirements and assumptions for use of an EHR Solution.
• Establish when and how PoS applications are expected to interact with an EHRI System within the context of daily work activities for caregivers.
• Are representative of the spectrum of use rather than a description of all possible uses.
• Cover a large spectrum of healthcare and public health service delivery.
It is expected that, as more detailed clinical business requirements are understood, these use cases will continue to be added to, refined and elaborated.

The Blueprint project uses the HL7 HDF methodology as a guideline to gather clinical business requirements into a set of use cases at increasing level of detail and then translate those use cases into a collection of high-level system design documents. Thus, the artefacts used to document the Clinical Work Processes are expected to be reusable uniformly within established standards and structured software engineering methodologies, such as HL7 HDF, IHE and others.

In order to provide enough detail to be able to design the conceptual and technical architectures on the basis of the clinical business processes, these use cases:

- Document clinical business process through the use of storyboards and encounters;
- Capture process flow through activity diagramming;
- Capture information structure;
- Capture clinical business rules, including relationships, event or decision triggers, and constraints; and
- Ensure that the appropriate HL7 standards are applied.

System Architecture

The conceptual system architecture view describes the future state of the EHRS system components within the context of a Service Oriented Architecture (SOA). The importance of this system architecture is that it establishes a strategic goal towards which all partial implementations will aim while still delivering specific short-term results. Intermediate solutions that move in the direction indicated can and will be deployed.

Information Architecture

This view describes the different data domains and types of data that are contained in the EHRI repositories as well as the key types of metadata, clinical vocabularies, data persistence and data integrity requirements.

Technical Architecture

This section takes a more technical perspective on the definition of key elements or foundations for the development and operation of EHR infostructure solutions. It includes a definition of key functioning principles as well as a perspective on how commercial off-the-shelf software can be used to deploy an EHR infostructure solution.

Deployment Models and Potential Applications

The deployment of EHR infostructures across the different jurisdictions will create opportunities for innovation in many areas resulting in a continued expansion of the use and value of the EHRS Blueprint. These include:

- Developing and deploying systems required to initiate EHR infostructures. These projects may pertain to many different aspects of the strategy, development or implementation of EHR infostructures in any jurisdiction.
- Extending current applications to new areas of healthcare concern or opportunity, such as public health surveillance, chronic disease management and others.
- Enabling new areas of application, such as clinical decision-support tools, support for new areas of healthcare-related research and others.
- Supporting new models of healthcare delivery as they arise.
Our ability as a nation to sustain universal access to healthcare in Canada depends on the effective use of timely, accurate, and comprehensive information at all levels, from front line care providers through CEOs of health regions to the ministers of health at territorial, provincial and federal levels. This includes patients who are ever more likely to manage their own health, educators preparing the next generation of healthcare providers and leaders, and researchers working on ways to improve health.

While there are many information systems in use across the spectrum of healthcare, we need a robust and flexible framework that supports the sharing of critical information in the most sustainable and efficient way. If we do this well – create systems that distribute critical information to and from points of care – and this information is valid and reliable for individual patient care, then we can be confident that such information can form the basis of effective administrative, program, and policy level decision making.
The EHRS Blueprint provides an extensible, flexible EHR enterprise architecture that provides the necessary framework to share the right information, with the right people, at the right time to support all of the decisions that lead to improved health and healthcare for Canadians.
ACRONYMS & TERMS

Blueprint

The Electronic Health Record Solution framework developed by Canada Health Infoway, Version 2.0 of which is described in summary form in this document.

CIS

Clinical Information System – A system dedicated to collecting, storing, manipulating and making available clinical information important to the delivery of healthcare (usually within larger healthcare delivery organizations, such as hospitals or health districts/regions). Clinical information systems may be limited in scope to a single area (i.e., lab system, ECG management system) or they may be comprehensive and cover virtually all facets of clinical information (i.e., electronic patient/person the original discharge summary residing in the chart, with a copy of the report sent to the admitting physician, another copy existing on the transcriptionist’s machine, etc.).

DIS

Drug (Pharmacy) Information System – A system that contains information related to medications for individually identified patients. Often considered to be the medication component of an Electronic Health Record.

EHR

Electronic Health Record

1. Provides each individual in Canada with a secure and private lifetime record of their key health history and care within the health system. The record is available electronically to authorized healthcare providers and the individual anywhere, anytime in support of high quality care.

2. The central component that stores, maintains and manages clinical information about patients/persons. The extent of the clinical information sustained by the EHR component may vary based mainly on the presence or absence of Domain Repositories in any given jurisdiction.

EHRI

EHR Infostructure – A collection of common and reusable components in the support of a diverse set of health information management applications. It consists of software solutions to support integration with the EHR, data definitions for the EHR and messaging standards for integration and interoperability.

EHR IP

EHR Interoperability Profile – A description of the types of business functions/service requests a Point of Service (PoS) system requires the EHRI system to provide in order to support the EHR clinical activity business (use case) requirements.

EHRS

Electronic Health Record Solution – A combination of people, organizational entities, business processes, systems, technology and standards that interact and exchange clinical data to provide high quality and effective healthcare.

EMR

Electronic Medical Record – A general term describing computer-based patient record systems. It is sometimes extended to include other functions, such as order entry for medications and tests. For the purposes of this document, EMR is the system used in ambulatory or community clinic settings.
HL7

Health Level 7 – An all-volunteer, not-for-profit organization that is involved in development of international healthcare standards. HL7 is one of several ANSI-accredited Standards Developing Organizations (SDOs) operating in the healthcare arena to produce communication standards (sometimes called specifications or protocols).

HL7 HDF

The HL7 Development Framework is the structured methodology used by designers and implementers of HL7 messaging to consistently implement the standards. The methodology utilizes industry standard processes for the analysis and description of information interchange between systems.

HIAL

Health Information Access Layer – An interface specification for the EHR Infostructure that defines service components, service roles, information model and messaging standards required for the exchange of EHR data and execution of interoperability profiles between EHR Services.

IHE

Integrating the Health Enterprise – An initiative by healthcare professionals and industry to improve the way computer systems in healthcare share information. IHE promotes the coordinated use of established standards, such as HL7, to address specific clinical needs in support of optimal patient care. Systems developed in accordance with IHE communicate with one another better, are easier to implement, and enable care providers to use information more effectively.

LIS

Laboratory Information System – Generic term to describe application systems that manage all facets of a clinical laboratory operation, including acquiring and distributing results of laboratory exams as part of clinical records.

RIS

Radiology Information System – Generic term to describe the application systems that manage all facets of automated diagnostic imaging systems. This include managing the scheduling of imaging capture, the distribution of the resulting imagery for analysis, and the capture of resulting diagnostic reports to be associated with the images.