

Connected Health Framework Architecture and Design Blueprint

A Stable Foundation for Knowledge Driven Health

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Abstract

Public health is a major concern that extends across public-private boundaries, touches the lives of all people and has national and international implications. Policy makers, legislators and agencies interact with healthcare providers, healthcare professionals, citizens and patients in complicated ways. Healthcare's broad scale, data-intensive nature and sensitivity to privacy concerns make healthcare IT an important issue for both governments and private organizations. Governments and health care providers around the world are aware that e-health, or technology-enabled healthcare, has the potential to improve health service delivery for those who consume health services.

The primary driver for improving e-health services is the value to the community of improved public health – including quality and promptness of treatment, cost savings in provision of services, and effectiveness with compliance issues and other mandates. Today's patients deal with many different departments and health entities that have no apparent commonality in the way they work, often leading to duplicate entry of information or lack of access to critical care information. With Internet technologies, mobile communications, and powerful yet affordable computers commonplace, there is an opportunity to redesign the way many of these services are delivered. It is within our reach to move healthcare towards a series of easily available, interconnected, reliable and efficient services.

To encourage creation of Health Information Networks that serve the broadest range of healthcare needs, Microsoft has developed a guideline for e-health software solutions called the Connected Health Framework Architecture and Design Blueprint. The Connected Health Framework is an architectural approach to developing health information networks with common business and technical design definitions for public and private organizations. Connected Health Framework puts the patient at the center, and recommends a path for transforming healthcare through technology solutions that are dependable, economical, productive, and connected by design. This white paper provides an overview of the transformation process.

Introduction

Healthcare is a universal need, a major government concern and a significant business engine. In 2004, the U.S. spent \$1.9 trillion on health care, or \$6,280 per person. This represents 16 percent of U.S. GDP.¹ According to OECD Health Data 2006, health spending between 1990 and 2004 grew faster than GDP in every OECD country except Finland. In 1990, it accounted for an average of 7% of GDP across OECD countries, but reached 8.9% in 2004². While government's role in healthcare varies greatly by country, evolving technology has a role to play in all healthcare delivery systems.

Healthcare systems are extremely complex. They operate in a mixed environment of public and private services, with a variety of business models that make the design, implementation and operation of integrated healthcare systems both difficult and expensive. Information technology for healthcare has developed around independent entities and functions that are not coordinated. Government agencies, hospitals, clinics, laboratories, doctors' offices and insurance companies have all invested in information technology to organize and expedite work, yet each entity tends to implement its own processes and delivery channels. Patients, the end consumers of healthcare services, must deal with several departments that have no apparent commonality in the way they work or appear to the patient. Each takes its own approach to controlling information flow and access, such as keeping an individual's data private.

Many of the solutions currently in use deal with complexity by limiting their scope, requiring use of rigid, pre-determined business processes and struggling to offer even minimal user-friendliness. The result is a collection of isolated islands of automation, using disparate technical platforms and standards that make it extremely difficult to access the right information at the right time. Significant prior investments keep healthcare entities working within the restrictions of their legacy technologies. These limitations must be overcome for doctors, patients, administrators and others to embrace e-health solutions that have the potential to transform healthcare delivery.

This lack of integration between services offered by multiple organizations, either public or private, is a reflection of the fact that these organizations themselves are in most cases unable to efficiently and effectively integrate data within their own confines.

With the advancing capability for technology to work in seamless, integrated ways, healthcare and delivery entities are re-thinking the ways they use technology. Increasingly, they are looking for ways to make lasting investments in solutions that help manage the enormous complexity of large-scale healthcare systems, help healthcare workers perform their jobs more effectively, and manage the sensitive and private data for each individual in the system in a way that improves service. Governments play an active role in expediting e-Health initiatives in many places. In the eEurope 2005 Action Plan³, for example, the European Union mandated health information networks between points of care (hospitals, laboratories and homes) via broadband connectivity, where relevant.

Microsoft has taken a deep look at healthcare business and systems, and developed a Knowledge Driven Health vision for healthcare transformation. Microsoft's broad vision is to:

Enable the transformation of healthcare delivery through innovative technology and partnerships that advance health programs by enabling breakthrough results in patient care, improving quality of care and safety, and reducing the healthcare cost burden.

Toward realizing that vision, Microsoft has developed the Connected Health Framework Architecture and Design Blueprint for software solutions. Its recommendations are based on a thorough analysis of the requirements for e-health transformation and the technology designs that will help fulfill those requirements in a practical, effective manner.

¹ U.S. Department of Health and Human Services historical data http://www.cms.hhs.gov/NationalHealthExpendData/02_NationalHealthAccountsHistorical.asp#TopOfPage

² OECD Health Data 2006 http://www.oecd.org/document/37/0,2340,en_2825_495642_36986213_1_1_1_1,00.html

³ eEurope 2005: An information society for all: http://europa.eu.int/information_society/eeurope/2002/news_library/documents/eeurope2005/eeurope2005_en.pdf

The Value of Healthcare Transformation

Healthcare systems are highly complicated both organizationally and technically. They accommodate enormous amounts of medical information for healthcare professionals, keep records for huge numbers of patients, and facilitate maintenance of records for long periods of time. Medical records are extremely sensitive and private information. Because of this scope, changes to healthcare systems are neither cheap nor trivial.

Despite the complexity, the most powerful driver for e-Health transformation is the potential to improve public health. Technology has the potential to enable broader reach and improve quality and effectiveness of healthcare. Improved systems have the potential to reduce costs (e.g., reducing the number of duplicate tests, reducing the number of hospital admissions, etc.) and improve patient care (e.g., reduce the number of preventable medical errors and provide proactive health advice based on chronic health conditions). They can help manage important issues such as compliance in legal and regulatory matters. Information technology can transform access to information and services, promote self-service, and reduce the costs associated with traditional delivery involving paper forms, data entry, paper filing and reception services.

Evolving healthcare solutions need to accommodate the data, interactions and transactions for at least four types of customers: patients, healthcare professionals, healthcare providers and policy makers and legislators. The relationships and services can be visualized through a schematic drawing (below) showing the basic interaction patterns among these groups.



Figure 1: Healthcare Relationships and Services

As e-Health matures, it has a potential to deliver rising benefits to the community. Starting with "presence" or basic public information access, e-Health can evolve to be more interactive through limited online features such as information search. This stage is followed by transactional capabilities, such as making online appointments or filling prescriptions online. Ultimately, we can look forward to transformation of e-Health, where appropriate services are combined and orchestrated with seamless integration and new services delivered broadly. Over time, as trust develops in the new systems, we foresee that the general public will take more advantage of services available online, which should reduce the cost and inconvenience of handling routine health problems in traditional ways such as doctor visits.

A Common Health Infrastructure

Enabling such a transformation builds on the concept of a common health infrastructure. Patients, healthcare professionals, application developers, independent software providers, and government agencies all can derive significant benefits from the creation of a common infrastructure. Potential benefits include accelerated time-to-use for new services; common consistent building blocks such as user identity management, authentication and authorization across services, and improved user experience. For example, a common infrastructure could offer a single sign-on for each patient for all healthcare services, regardless of who provides them.

A common infrastructure also has the potential for improved developer experience via consistent interfaces and specifications to which they adhere – thus encouraging a broadening range of healthcare solution choices for all types of organizations. Organizations would benefit through applications that enable effective re-use of resources, standards-based interoperable solutions on a variety of platforms and ‘always-available’ 24 x 7 services.

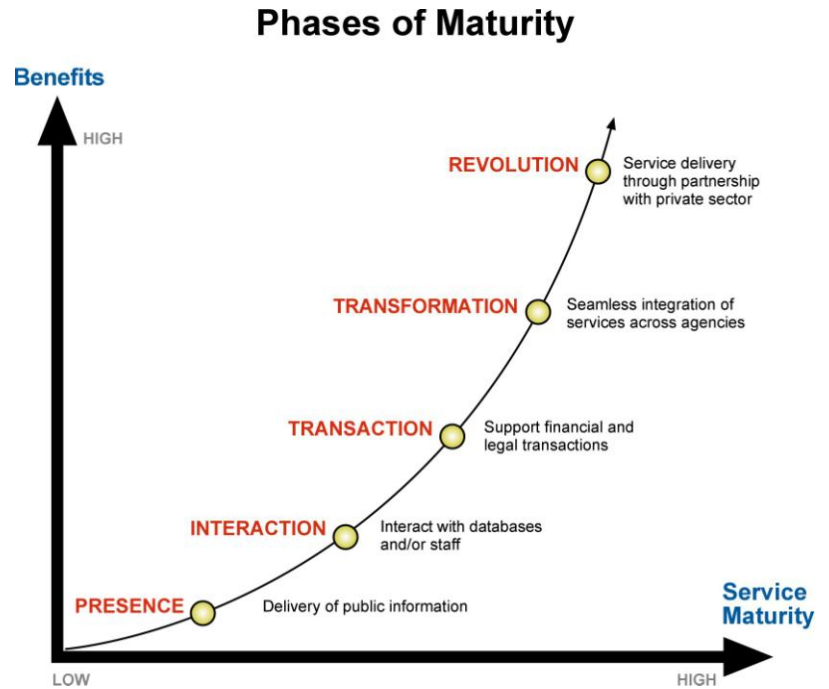


Figure 2: Phases of Maturity

Requirements for Connected e-Health Services

A public-private collaborative think tank called "Connecting for Health"⁴ has studied the barriers and opportunities for developing an interconnected health information infrastructure for the United States. It has considered such hot-button issues as a national health ID – rejecting this approach because there is "no easy way to achieve the benefits of linking records without jeopardizing privacy and associated values." Connecting for Health, which is funded by the Markle Foundation, suggests an alternate approach. "Under the system we propose, decisions about linking and sharing are made at the edges of the network. {Such a} system supports: 1) linking of records via a directory of pointers and sharing among healthcare providers in the system, but it also allows: 2) linking without sharing, or sharing pursuant only to higher authorization, as well as 3) the ability to choose not to link information in certain treatment situations, such as drug or alcohol rehabilitation."

Connecting for Health recommends the "creation of a non-proprietary 'network of networks' to support the rapid acceleration of electronic connectivity that will enable the flow of information to support patient care." They recommend a network based on a common framework of agreements among participants—a federated architecture that is based on standards, safeguards patient privacy, and is built incrementally—without the use of a national health ID or a centralized database of records.

Separately, Microsoft has studied the healthcare industry at length through work with customers, developers, and independent software providers, and has developed a consolidated view of the top healthcare issues to be addressed for e-Health transformation. Key challenges – whether in emerging nations or developed countries – involve security, interoperability, privacy, legacy, and trust, the intangible quality required to draw a critical mass of data to into a broad e-Health system.

⁴ "Connecting for Health" is a public-private collaborative established by the Markle Foundation in the USA in 2002 designed to address the barriers to development of an interconnected health information infrastructure. See http://www.connectingforhealth.org/resources/cfh_aech_roadmap_072004.pdf

The top ten issues can be summarized as follows:

Ten Key Issues in Healthcare Systems

- How to create a patient's health record
- How to build a lifelong health history for a patient from information stored in multiple, diverse systems
- How to manage identity and authorities
- How to identify a patient (or a healthcare professional) uniquely and reliably
- How to "join-up" different systems on different platforms
- How to interconnect diverse systems and how to make them interoperate
- How to communicate with remote systems
- How to reuse legacy systems
- How to achieve flexibility and agility
- How to achieve performance and scalability

By aggregating these requirements, Microsoft' has developed a vision for the evolution toward e-Health that consists of three core types of capabilities. They are:

- Connected systems – software networks that span applications, devices, services, and healthcare organizations to help streamline processes, improve knowledge sharing and reduce costs. Connected systems rely on the use of open standards which enable interoperation of legacy and third-party applications.
- Information-driven software – new applications that dramatically improve the way healthcare workers find, organize and act on information, facilitating better collaboration and quality of care.
- Collaborative environments – rich interfaces and new experiences that help improve collaboration and consultation for healthcare works and patients using high-quality audio, video and natural language.

Microsoft created the Connected Health Framework Architecture and Design Blueprint to facilitate the emergence of an ecosystem of healthcare solutions that deliver on those capabilities. Developers and independent software vendors are invited to use the Connected Health Framework to create e-Health solutions that seek to deliver agile healthcare solutions on a stable foundation.

Description of the Connected Health Framework Architecture and Design Blueprint

The Connected Health Framework Architecture and Design Blueprint recommends an approach to addressing the requirements described above, while capitalizing on the benefits of e-Health transformation. It provides generic and scenario-specific recommendations illustrating how to design, develop, deploy, and operate an architecturally sound application portfolio and interoperability infrastructure in a healthcare environment.

The technical guidance was created, reviewed, and approved by Microsoft architects, engineering teams, consultants, product support engineers, and Microsoft partners and customers. The result is a thoroughly engineered and tested set of recommendations to assist in creating a reliable, connectable solution based on open standards and protocols to help enable faster ROI for enterprise, state, province and country-wide projects.

Through the Connected Health Framework, Microsoft recommends addressing healthcare transformation issues by using a coordinated set of business and technical frameworks. Connected Health Framework addresses two main subjects: seamless application integration and technical connectivity and interoperability.

Seamless application integration is addressed in the Connected Health Framework Business Framework. Connectivity and interoperability are addressed in the Connected Health Technical Framework. Used together, they comprise a practical set of architecture and design guidelines for stable and agile healthcare solutions.

Application Integration through the Connected Health Framework Business Framework – the Seamless User Experience

The Connected Health Framework Business Framework addresses application integration by enabling systems and applications to talk to each other in mutually understandable terms. It uses four key architectural concepts to help achieve a seamless user experience. They are:

- Service-orientation – a modular approach that reduces dependencies between systems, using open standards and protocols to promote data application and interoperability.
- Federated data – given the local nature of healthcare delivery, data should reside as close as possible to where it's created and administered, caching information at different levels within the system (departmental, regional, national) to allow for different levels of service.
- Federated security – allowing easier management of identities and security credentials by delegating aspects of authentication and role assignment to trusted parties.
- Trustworthiness – reliable, fault tolerant systems that "just work."

Connected Health Framework Business Framework describes the characteristics of service orientation and suggests a way of defining business services working from business requirements. It describes some key healthcare system design concepts, suggests a set of business components and services required for a patient-centric health records system, and considers how to service-enable existing applications. It also comments on the deployment of healthcare application packages as part of regional or national level solutions.

For greater value in solutions development, it offers an architectural template for business solutions known as a Business Pattern for Healthcare. A business pattern describes a reusable approach to the solution of a particular business problem, usually scoped by a business process such as the creation, management and usage of patient health records. Besides being deployed in the suggested usage scenarios, the business pattern can be used as a "first pass filter" for evaluating requirements and solutions.

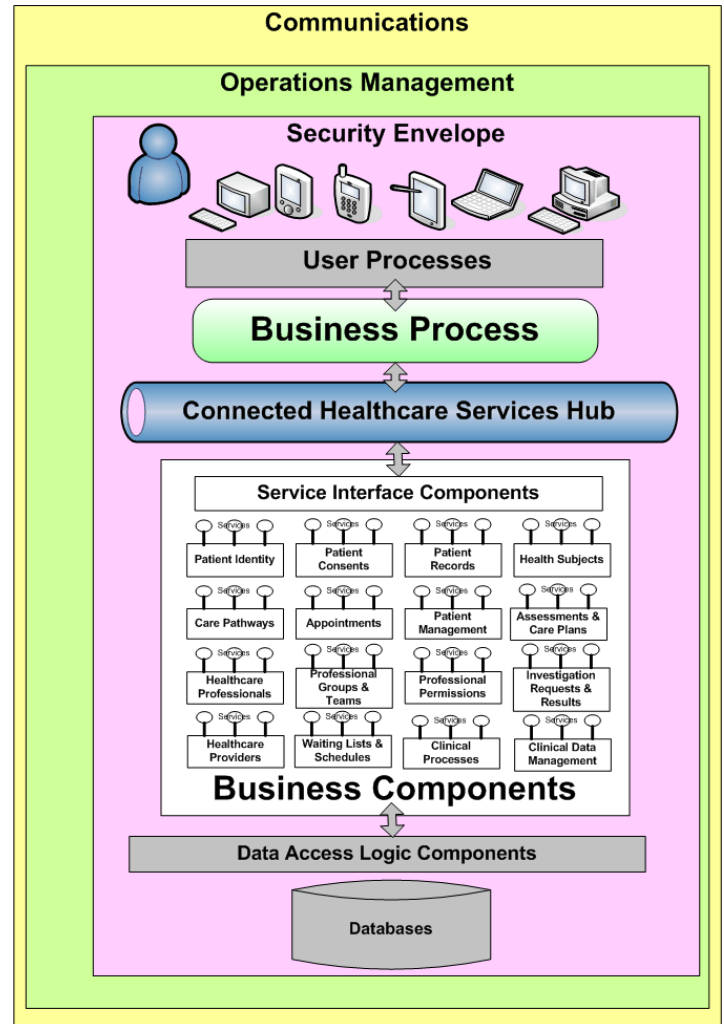


Figure 3 - A Business Pattern for Healthcare

Service Oriented Approach

The current trend in application integration is to move away from tightly coupled monolithic systems and toward systems of loosely coupled, dynamically bound components, as in service oriented architectures. Looking at the long list of business requirements for a new generation of healthcare system and current application portfolios, Microsoft has identified service oriented architecture (SOA) as a practical approach. This is in response to the need to achieve integration on two major levels – application integration, in which systems and applications can talk to each other in mutually understandable terms (also identified in the industry as “Syntactic Interoperability”) and technical interoperability, in which systems can be interconnected in a secure and reliable manner. These two levels of integration would help healthcare systems to interoperate and collaborate at a much higher level, enabling applications such as decision support, patient and business intelligence (also identified as “Semantic Interoperability”).

SOA has two separate but vital functions. From a business perspective, it is a way of making enhanced business capability and information available to consumers both inside and outside the enterprise in a controlled manner, particularly by supporting improved business processes. This is achieved by joining up systems at the application level and resolving issues of data consistency and business interoperability.

From a technical viewpoint, it is a design paradigm aimed at creating or enabling applications to interoperate across diverse technical and operational platforms. This is achieved at a technology level by observing detailed international standards and protocols, in particular those of Web services.

Based on standards such as XML, SOAP and the Web services stack, an SOA provides a means of achieving the necessary agility and flexibility to support rapidly evolving business processes and changing business objectives and goals. Further, most of the building blocks in the SOA will exist in the form of legacy applications that can be reengineered rather than discarded, giving access to their functionality and data.

Achieving interoperability through the Connected Health Framework Technical Framework

The Connected Health Framework Technical Framework describes the many issues involved in achieving successful healthcare-oriented interoperability at the infrastructure level – together with the tools, technologies and standards to connect systems. It recommends a flexible, agile platform and a standards-based approach. And it builds on the principles and practices covered in the white paper “Government Interoperability – Enabling the Delivery of E-Services”⁵. Architectural challenges include the following:

- Multiplicity of platforms, locations, languages, capabilities and credentials
- Identity management
- Integration challenges
- Flexibility and agility
- Security
- Scalability, performance and availability
- Achieving the Common Hub

⁵ <http://www.microsoft.com/interop/govt/govteservices.msp>

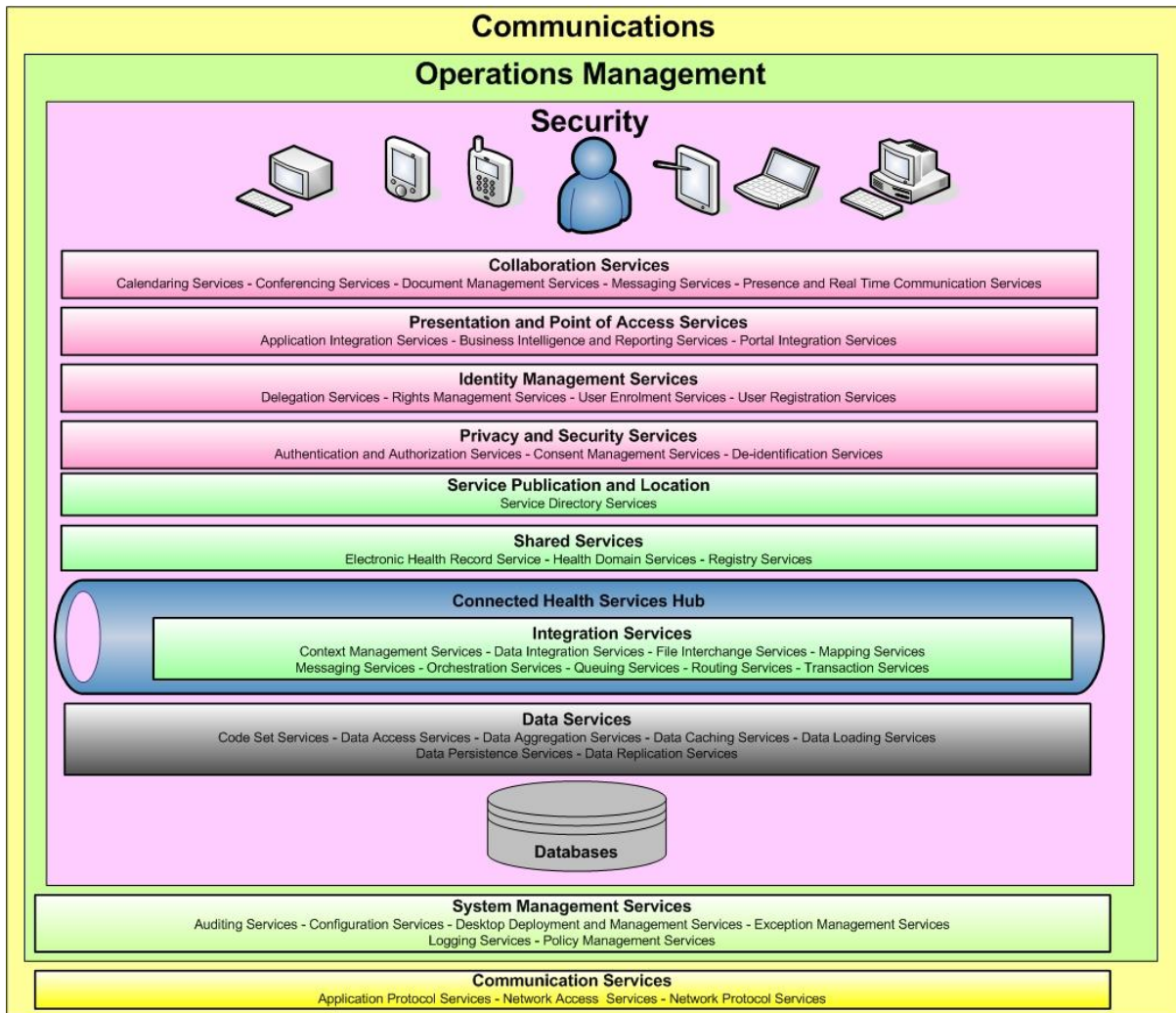


Figure 4 - Reference Architecture for Healthcare

Figure 4 above shows a typical reference architecture, based on the Microsoft Connected Health Framework, for implementing an e-Health integration solution.

The Reference Architecture is centered round the use of the Connected Health Services Hub, which enables the provision of a number of services including:

- Collaboration services
- Presentation and point of access services
- Identity management services
- Privacy and security services
- Service publication and location services
- Shared services
- Connected Health Services Hub
- Integration services
- Data services and databases
- System management services
- Communication Services

Alignment between the business pattern and the reference architecture is depicted below:

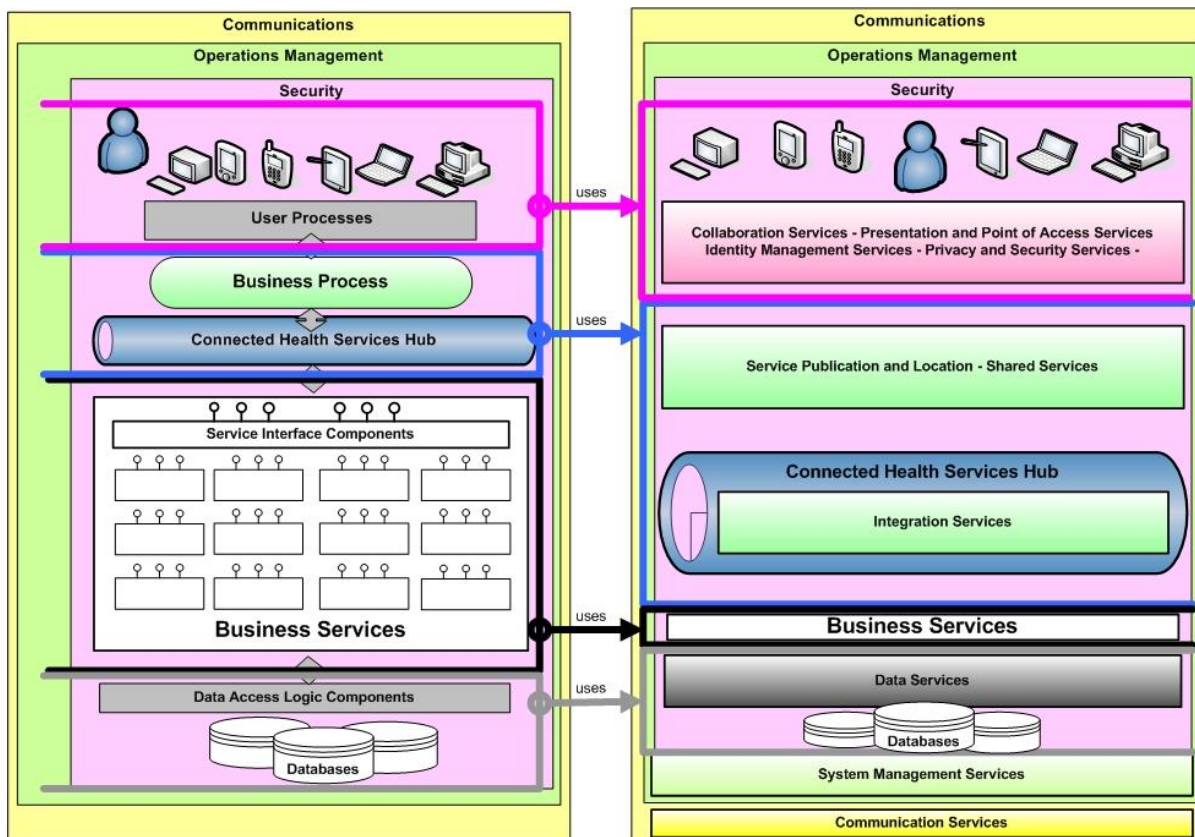


Figure 5 - Alignment of Business and Technical Architectures

In the environment of adaptive healthcare solutions, Microsoft recognizes the need for agility. The Connected Health Framework helps provide that agility by separating the more volatile user and business processes from the more stable business and data services. The joining element between the agile and stable worlds is provided by the Connected Health Services Hub.

Additional Guidelines and Resources for Putting into Action

For further guidance in using the Connected Health Framework in practical, effective solutions, Microsoft offers four scenarios:

- Formulating Requirements, in which we describe how a healthcare provider can categorize, order and prioritize requirements against the business and technical frameworks provided by the Connected Health Framework.
- Aligning an Application, in which we describe how an Independent Software Vendor can structure its healthcare applications to dovetail with the business pattern and reference architecture of the Connected Health Framework, helping to achieve connectivity and interoperability with other applications and a larger scale technical environment.
- Establishing the Operational Environment, in which we describe how a Healthcare Provider or a System Integrator may use the Connected Health Framework Technical Framework to guide the design of an overall technical framework, hosting a variety of healthcare applications, to meet requirements at a national, regional or local level.
- Devising Solutions, in which we describe how to use the Connected Health Framework business pattern and reference architecture as a framework to respond to a Request for Proposal. The Connected Health Framework provides a vehicle for assessing requirements, hypothesising and synchronizing elements of a solution, and forming a consistent and comprehensive response.

Finally, we offer references and further information links to other resources and a glossary of terms commonly encountered in e-Healthcare solutions in the complete Connected Health Framework Blueprint document.

Summary – the Long-term Benefits of Knowledge Driven Health

Microsoft offers the Connected Health Framework to government and healthcare organizations as a path to realizing Knowledge Driven Health. Applying Connected Health Framework can be beneficial regardless of the particular technologies used. Combined with the Microsoft platform, it carries even more benefits, which may be summarized as follows:

The Microsoft value proposition for healthcare

- Connected – Interoperable by design
 - Open architectures build on industry standards that facilitate the flow of health information and clinical knowledge seamlessly through the healthcare continuum and across agencies
 - Leverage legacy application and infrastructure investment
- Collaborative – Familiar tools to automate the way you work
 - Let clinicians be clinicians: improve adoption
 - Enable delivery of health services in a standardized, replicable manner
- Better Economics – Driving down the cost of healthcare technology
 - Create ROI faster than traditional investments
 - An integrated platform that lowers TCO
 - Local delivery model
 - Scalable from single providers to country-wide programs
- Dependable – Proven and robust
 - Applications that support 24x7x365 healthcare operations
 - Financially stable
- Extensive partner ecosystem gives decision makers a choice.

Through the Connected Health Framework Architecture and Design Blueprint⁶, Microsoft envisions a network of Connected Health Framework-enabled solutions that have the potential to transform healthcare. With health information systems that enable knowledge driven and agile e-Health services and an ecosystem of seamless, interoperable healthcare solutions built on a common framework, we can advance the goal of improving patient and personal health.

⁶ Available here: <http://www.microsoft.com/industry/healthcare/default.mspx>