Connected Health Framework Architecture and Design Blueprint

A Stable Foundation for Agile Health and Social Care

Part 1 – Introduction and Overview

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Preface to the Second Edition

The first edition of the Microsoft "*Connected Health Framework – Architecture and Design Blueprint*" (CHF ADB) was published in 2006 in response to a need to bring together and rationalize a large amount of advice and guidance on how to design and build patient-centric Health and Social Care systems.

Since its publication, the CHF ADB has been widely used and referenced by healthcare providers and independent software vendors around the world. In the two years since publication, it has been used, at least in part, in more than 30 countries with over 20,000 downloads of the documentation. As a consequence, much experience has accrued from "on- the- job" experience and the resulting feedback has been carefully evaluated and is reflected in this Second Edition.

Further, in June 2008, a White Paper titled "*Connected Health and Human Services*" was published by Microsoft US Public Sector. This paper described an approach to the delivery of individual- and family-centric Health and Human Services and was based on the CHF Reference Architecture. Although this was primarily focused on US requirements, the principles put forward are of much wider applicability.

Thus a major requirement that has been identified is to extend the applicability of the CHF from solely health to a much wider coverage of both Health and Social Care and to address both the business and technical aspects of the wider domain. The approach is aimed at "lifelong well-being", which encompasses a person's wider care needs from cradle to grave. This is not something a person can normally achieve unaided – it involves numerous, complex interactions with family, friends, health and care professionals, personal carers, government organizations, and private and voluntary agencies, to mention but a few.

A further important requirement is to extend the focus of the CHF from a primarily patient-centric one to a number of additional viewpoints such as those focused on the needs of the wider family, care professionals, care providers, and the funders of care services. This will allow such users to benefit from business services specifically focused on their requirements. In particular, support is provided for the financial aspects of care provision. Importantly, however, all such services should draw upon a single, virtual data resource ensuring consistency and synchronization of all services and views – the copying of data and subsequent multiple updating of multiple versions is a practice that should be strenuously avoided.

The CHF ADB is unusual in that it offers architects both a *Business Pattern* and a *Reference Architecture* for designing and building healthcare and associated systems, and does so in a *platform-agnostic* way. We believe that this is an essential approach because most healthcare systems use hardware and software platforms acquired from multiple vendors over a long period of time. Since wholesale platform change is not an option for most care providers, interoperability and integration of these systems is vital to the improvement of patient care. We address the need to enable the inclusion of legacy applications operating on diverse platforms in the integration scheme. As a result, the CHF ADB interoperability recommendations should be implementable using any competent and complete software product stack.

The CHF ADB advocates and describes a standards-based approach to systems integration that emphasizes four key architectural concepts: Service Orientation, Federated Data, Federated Security, and Trustworthiness. These concepts are further developed by providing enhanced models, covering both Health and Social Care, that have been tested in actual implementations, and by including more "how" guidance in addition to "what to do" recommendations. Where appropriate, we include carefully chosen case examples.

Accordingly, the CHF ADB has been updated in this Second Edition to:

- Reflect the actual experience in the use and application of the first edition.
- Extend the coverage from healthcare to social care and provide support for lifelong well-being.
- Retain the patient-centric nature of the CHF but broaden this to be person-centric by adding a social care dimension and provide additional viewpoints focusing on the needs of families, care professionals, care providers, and the funders of care services.
- Verify, extend, and clarify the Business Pattern to reflect experience of its use. In particular, the business components and services are updated and described in further detail.
- Verify, extend, and clarify the Reference Architecture to reflect experience of its use. In particular, the use of federation methods for identity management, authentication, authorization and data integration is described in detail.
- Retain and emphasize the platform agnosticism of the CHF.
- Extend the guidance for the re-engineering and non-invasive enablement of legacy applications to participate in the service-oriented architecture of the CHF.
- Provide more case examples and step-by-step design guidance.

March 2009

Health and Social Care – an Introduction for Architects

Lifelong Well-being and the Continuum of Care

We explain the concept of "Lifelong Well-being" and describe its gradual change in nature from youth to old age. We will emphasize that well-being involves more than health and describe the idea of the longitudinal, lifelong record of a person's well-being, which can be made available to those with a need to know in a consistent but controlled way, and, further, be presented in a form that is appropriate to the role and needs of the both the citizen and the carer.

On Lifelong Well-Being …

A newborn child is usually wished "a long, healthy, and happy" life. This is not something they can normally achieve unaided – it involves numerous, complex interactions with family, friends, health and social care Health and Social Care professionals, personal carers, government organizations, and private agencies, to mention a few.

Over a lifetime, most of these interactions are forgotten, or at least, become insignificant from a care perspective. However a few will be vital events and remain so throughout life. Similarly, personal relationships fade and organizations disappear. The issue faced by most people at some time in their lives is how to carry forward vital personal information from earlier interactions into new relationships. Most people rely on memory, or the memory of others, and if really necessary in new and important situations, can recall salient information for those with a need to know. However, with the passage of time and increasing age, such information becomes unreliable and would not be trusted by a physician or care professional.

These interactions are not all medical, of course. In the wider care context, they would include interactions with a host of professionals, agencies, charitable organizations, and official bodies dedicated to improving a person's social and economic status and general well-being. These interactions would include services for children and the elderly, assistance for those with disabilities, home care, and simply help for those who need it. Many of these contacts are deeply personal, of course, and the resulting data highly confidential.

So by lifelong well-being, we mean the creation of the best possible standard of physical and mental health for each individual; the provision of a secure living environment in which a person's particular needs for personal care are adequately met; and the on-going maintenance of a rewarding personal, family, and community life are assured.

Figure 1 shows a simplified representation of this concept. We see "care" as comprising a number of autonomous areas or "domains", each of which addresses a particular aspect of care. Each domain has its own qualified and authorized practitioners, operates its own processes, and maintains its own data within stringent privacy and confidentiality boundaries. Each domain has traditionally operated independently with little intercommunication. Increasingly, however, the emerging requirements for more integrated and comprehensive care are leading to a degree of controlled data sharing within new "joined-up" processes.

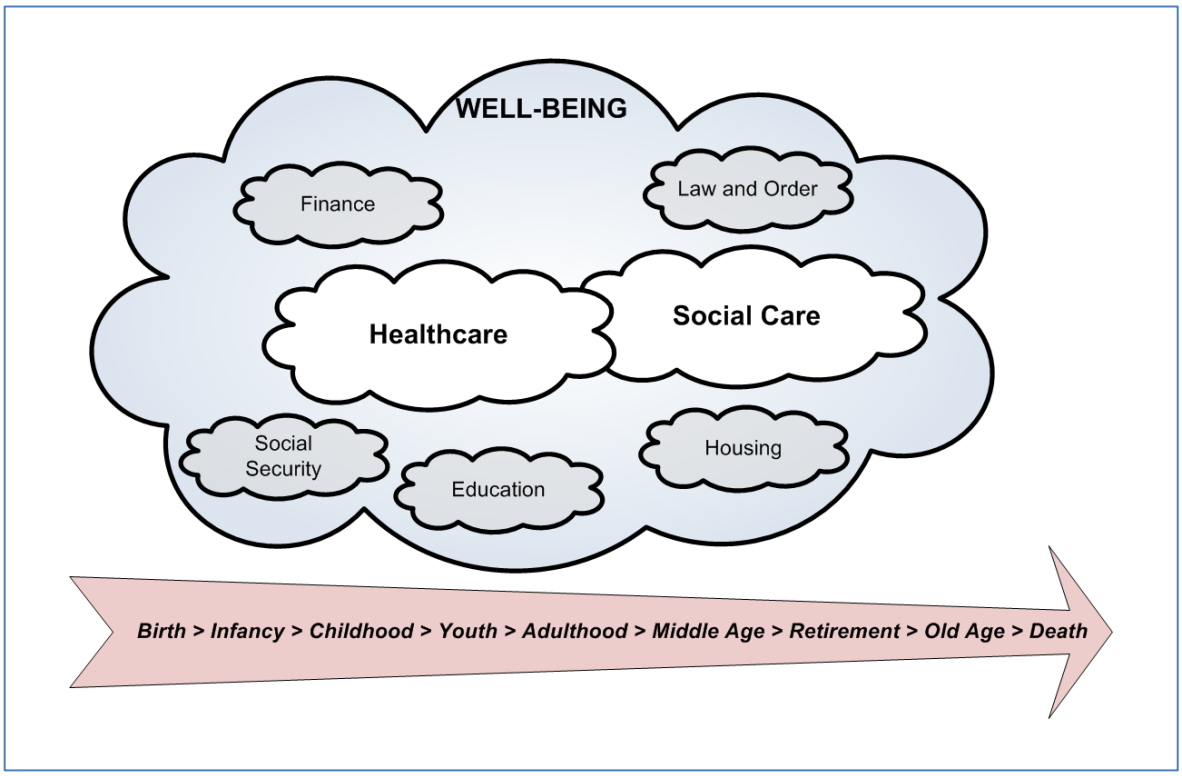

Figure 1. Care Domains and the Continuum of Care

In particular, this is evident between healthcare and social care in the form of multi-disciplinary decision-making and shared assessments, for example in improved care for the elderly. There are also examples of multi-agency cooperation in areas such as child protection and enhanced support for people with disabilities and mental health problems. From an information point of view**,** the data sharing involved is on a "need-to-know" basis with appropriate consent and authorization. The agencies involved could include – in addition to health and social care – education, housing, social security, financial support**,** and the law and order functions. The nature of these interactions does, of course, change as the person ages – childhood situations are quite different from those that arise in old-age. This leads to the concept of the continuum of care.

The Continuum of Care

In the past, continuing care was very often delivered by the family doctor who might well know the person, and their problems, for up to 40 or 50 years. Today a person may consult a doctor, particularly if within a large-scale public service, whom he has never seen before and quite probably will never see again. Continuity and consistency of treatment on a personal level is difficult to achieve and, at best, depends on the scope, accessibility, relevance, and accuracy of the care records. Furthermore, citizens do not seem to be particularly keen on a more anonymous, if more efficient, service, as evidenced by the usual public outcry when the closure of a local hospital is proposed.

It is clear that the nature of these interactions changes as the subject's life progresses – the situations of childhood are not common in old age – but the players in the scenarios, or at least their roles, do remain broadly constant. Further, the changes in the kinds of interaction are not sudden but rather happen gradually over time as the subject ages. Thus we can see the formation of ongoing relationships within a care domain, and the controlled availability of

pertinent information about the subject's interactions with the domain, could be very useful in enabling appropriate, prompt, and effective care throughout a person's life.

Some information could be of great help in interactions in other domains – for example, some health information, say about allergies, could be useful in a social care scenario, like providing care in a residential home. It is important to stress that we are not advocating the building of a large dossier on each citizen to be examined at every decision point in someone's life – far from it. What we are suggesting is that the subject should have the capability of referring to his or her own history and granting consent to a trusted professional to use relevant information so as to provide the best possible care in a current situation. This, of course, happens today when a professional takes a patient's or client's "history" – we are merely seeking to make this a rapid and reliable process, both saving the professional's time and improving the accuracy and speed of treatment.

We call this process the "**Continuum of Care**" – a seamless progression through life with the appropriate care being available wherever and whenever it is needed.

From a systems architecture point of view, this presents some interesting challenges, which we will address in this Architecture and Design Blueprint.

What Do We Mean by Health and Social Care?

What do we mean by Healthcare?

Webster's Dictionary defines **healthcare** as follows:

> *"Healthcare as a general term refers to the delivery of medical services by specialist providers, such as midwives, doctors, nurses, home health aides, vaccination technicians and physician's assistants. Usually such services receive payment from the patient or from the patient's insurance company, although they may be government-financed or delivered by charities or volunteers, particularly in poorer countries." 1*

Although some view healthcare from an economic perspective as being no different from other products or services, others believe it has many characteristics that encourage government intervention or regulation. The provision of critical healthcare treatment is often regarded as a basic human right, regardless of whether the individual has the means to pay for it. At the same time, some forms of healthcare treatment cost more than a typical family's life savings.

This definition is a fairly broad and, as we can see, fringes on what many would consider to be Social Care.

What Do We Mean by Social Care?

Social Care is more difficult to define due to its wide coverage and the differing ways in which it is provided. The terminology is also more diffuse and terms such as Social Work, Social Services, Social Welfare, and Human Services can be used almost interchangeably. For the purposes of the CHF, we prefer the term "Social Care" because it seems to concentrate on the delivery of help to the individual and thus is more indicative of the citizen-centric focus of the CHF. However, will use whichever term seems most appropriate in particular contexts.

The International Federation of Social Workers offers the following lengthy definition of what the Social Worker does:

[1] http://www.websters-online-dictionary.org/definition/healthcare

> *"The social work profession promotes social change, problem solving in human relationships, and the empowerment and liberation of people to enhance well-being. Utilizing theories of human behavior and social systems, social work intervenes at the points where people interact with their environments. Principles of human rights and social justice are fundamental to social work. …*
>
> *… Social work interventions range from primarily person-focused psychosocial processes to involvement in social policy, planning, and development. These include counseling, clinical social work, group work, social pedagogical work, and family treatment and therapy as well as efforts to help people obtain services and resources in the community. Interventions also include agency administration, community organization, and engaging in social and political action to impact social policy and economic development. The holistic focus of social work is universal, but the priorities of social work practice will vary from country to country and from time to time depending on cultural, historical, and socio-economic conditions."*[2]

The English Department of Health offers the following descriptions of the tasks of Social and Social Care workers:

> *Social workers form partnerships with people: helping them to assess and interpret the problems they face, and supporting them in finding solutions. They have to know how the law works and be fully up to speed with the social welfare system. They will liaise regularly with other professionals – teachers, doctors, nurses, police, and lawyers – acting on behalf of the people they are working with. Social care workers provide the practical support to help people cope with the day-to-day business of living. Social care workers may be home care assistants or work in residential care homes, and there's a wide range of jobs working with older people, children and families, and people with disabilities.*[3]

Social Care usually includes many diverse services and activities. For example, the following personal services are offered in England:

- Services for Children and Families in need:
  - Children's Homes
  - Secure Accommodation
  - Fostering Services
  - Family Centers
  - Home Care
  - Providing Equipment, etc.
  - Youth Justice – Secure Accommodation and Youth Offender Services
  - Adoption Services
- Services for Older People and Adults with Physical Disabilities, Sensory Impairment, Learning Disabilities, Mental Health Needs, etc.:
  - Assessment and Care Management
  - Nursing Homes
  - Residential Homes

[2] http://www.ifsw.org/en/p38000208.html
[3] http://www.socialworkandcare.co.uk/

- Home Care
- Day Care
- Providing Equipment, etc.
- Meals

- Services for Other Groups:
  - Asylum Seekers
  - Those with HIV/AIDS
  - Substance Abusers

Additionally, vital work is done in areas such as child protection and the care of vulnerable adults. These services often involve liaison with other care domains such as law and order, housing, education, social security, and financial organizations.

What Are e-Health and e-Care?

We define e-Health and introduce the notion of e-Care, and merge it with the established notion of e-Health. We will point out that e-Health and e-Care have boundaries and that correlation of data from some sources (for example, joining health and financial data) is not appropriate, or even permissible, due to confidentiality or legal constraints.

We will discuss the business models for e-Health and e-Care and highlight the similarities and differences. The important point to make is that many important, everyday business processes span both the e-Health and e-Care domains.

What Is e-Health? How Are These Related?

The European Commission offers the following two definitions of **e-Health**: [4]:

> *"e-Health refers to the use of modern information and communication technologies to meet needs of citizens, patients, healthcare professionals, healthcare providers, as well as policy makers."*
>
> *"e-Health is today's tool for substantial productivity gains, while providing tomorrow's instrument for restructured, citizen-centered health care systems and, at the same time, respecting the diversity of Europe's multi-cultural, multi-lingual health care traditions. There are many examples of successful e-Health developments including health information networks, electronic health records, telemedicine services, wearable and portable monitoring systems, and health portals."*

The commission goes on to state:

> *"Realizing these benefits, however, is complex and long-term. Healthcare systems are immensely complicated, both in terms of organization and technologies. Health data is also particularly sensitive, so individuals' health information must be protected. Indeed, this is a very data-intensive sector.*

[4] http://europa.eu.int/information_society/eeurope/2005/all_about/e-Health/index_en.htm

[5] Definitions from ***Health Consumer Powerhouse*** *Euro Health Consumer Index 2008 reportReport* © Health Consumer Powerhouse AB, 2008. ISBN 978-91-9768 74-5-4 http://www.healthpowerhouse.com/files/2008-EHCI/EHCI-2008-report.pdf

Many of these issues, such as data privacy and public health, are evolving daily. Health authorities throughout Europe are now learning actively from each others' experience, sharing in building roadmaps and action plans. Coordinating research and development across Europe is helping accelerate the development of new e-Health technologies."

What Is e-Care?

Similarly, **e-Care** is concerned with the use of information and communications technology in the social care domain. The problems are similar, characterized by an even larger number of diverse delivery organizations and a correspondingly large and diverse number of unconnected systems and applications. The issues of privacy and confidentiality are as sensitive as in healthcare and indeed the rules that govern data sharing between agencies are complex and difficult to apply.

How Are e-Health and e-Care Related?

As we have observed, the boundary between health and social care is fuzzy. Traditionally the domains have been kept separate in most countries, but with today's focus on lifelong well-being there is an emphasis on working together across health and social care and into neighboring areas.

In terms of the role of information systems and technology, the cooperation usually takes the form of controlled data sharing and the secure operation of long-running, person-centric business processes that span both the health and social care domains. If we regard the overall health and social care domain as a coherent whole with autonomous sub-domains, the questions of organizational and procedural boundaries cease to be barriers to effective systems.

Who Are the Players?

There are effectively six main types of "customers" or "consumers" of e-Health and e-Care solutions:

Persons are national citizens; resident aliens; short- term visitors; and tourists in need of or receiving medical attention, social care, or allied treatments. When healthcare is involved they are called "*Patients"*, if social care then "*Clients*" and in commercial situations "*Customers*".

Care Professionals, in a medical context, include doctors, nurses, and allied care professionals. *Doctors* would include general practitioners, physicians and surgeons, and mental health specialists, etc. *Nurses* would include hospital, community, and specialized nurses, such as cancer care nurses. *Allied Care Professionals*, who usually need formal training and accreditation before they are employed, would include, for example, medical assistants, dental hygienists, physio- and occupational therapists, laboratory technicians, medical equipment technicians, radiographers, medical secretaries, medical coders, care assistants, caterers, porters, and drivers to name but a few.

In a social care context, care professionals would include social workers, counselors, community care workers, and many accredited volunteers and private sector carers. In certain, clearly defined circumstances, they might include special needs teachers, home care assistants, personal financial and legal assessors and counselors, police and probation officers, and addiction treatment and prevention specialists.

Care Providers include hospitals, clinics, care and residential homes, medical practices, laboratories, and other organizations that accommodate and treat patients or clients. They will provide physical premises and facilities and operate medical and other equipment. They will operate administrative and clinical systems and employ care professionals.

Policy Makers and Legislators are government departments, quasi-government organizations, and professional bodies responsible for the organization and regulation of care services on a national or regional basis. This would include the enactment of legislation, the provision and control of funding, and the setting and governance of professional standards of care, process and privacy.

Funding Organizations are those bodies – public or private – that provide the funding for e-Health and e-Care. They include national and local government departments like Ministries of Health or Social Work Departments, official agencies like National Health Services, insurance companies, and charities and philanthropic organizations.

Researchers and Analysts are scientific, medical, statistical, and other professionals, institutes, and bodies interested in the analysis of trends, treatments, procedures, medications, facilities, screening programs, care initiatives, and many other aspects of health and social care. Typically their interest lies in the experiences of groups of patients or clients rather than individuals, and patient information should be anonymized before use.

Other participants, not shown explicitly in the model for simplicity, include the following: Third parties administering services or managed care solutions (PHR, health portal, employer health portals, etc.); Bio-surveillance, hazard control, population health and intelligence agencies. Some of these may be grouped together with the main types identified above.

We illustrate the typical relationships and services in Health and Social Care in *Figure 2*.

We have placed the citizen at the center of the diagram showing some important interactions that take place between the individual citizen, care professionals, care providers, funding organizations, and policy makers and legislators.

C = Citizen, Client, or Patient

D = Care Professional (Doctor, Nurse, or Social Worker)

P = Care Provider (Hospital, Clinic, Practice, Social Work Department, or Care Home)

F = Funding Organization (Executive Agency, Insurer, Health Plan, Charity, or Local Government)

G = Policy Makers and Legislators (National, Regional, and Local Government; Professional Bodies; Regulators; or Official Bodies, etc.)

R = Researchers and Analysts (Medical and Social Care Researchers, Statisticians, Clinical Trialists, or Methods and Procedures Analysts)

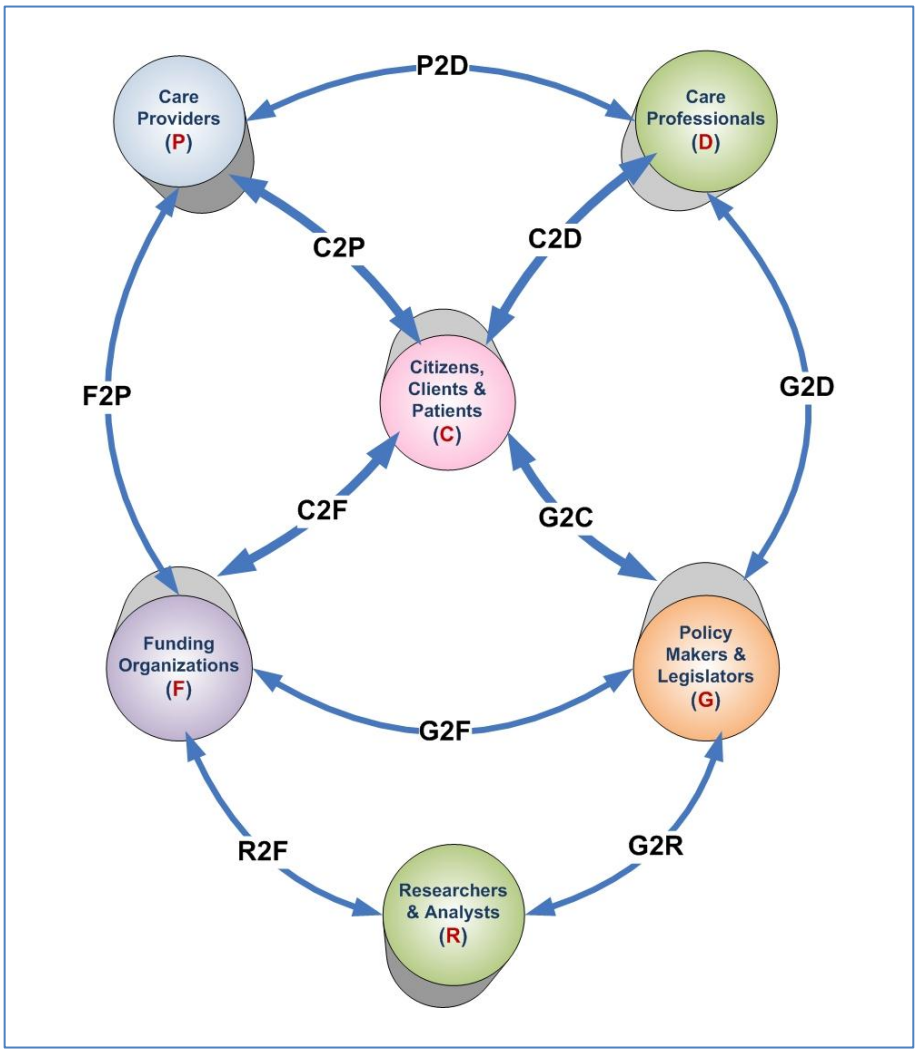

Figure 2. Players and Relationships

Whilst we often describe health and social care as "citizen- or patient-centric", the views of data can be centered on each of the above players. These "viewpoints" require the accessing, retrieval, analysis, and presentation of data starting from the appropriate entity – the citizen or the care professional or the provider and so on – and navigating the natural relationships between entities.

Each user can access "viewpoints" depending on his or her organizational role held within the Health and Social Care domain with the actual data they see being governed by the necessary consents and permissions. Each viewpoint looks at the data with the users' professional requirements in mind, and in the most appropriate form for the users' purposes.

The main possible relationships between the players (for example, C2P, C2P) are described in *Part 2*.

e-Health and e-Care – Scope and Types of Solutions

Health and Social Care, by its nature, involves constant and repeated communication between government and care agencies; insurance companies and funding organizations; employers; hospitals, clinics, doctors' practices, and care facilities; clinicians, allied healthcare professionals, social workers, and carers; and the citizen – whether a patient or a social care client. The population in general, and various community groups and voluntary organizations within the population, are also deeply involved.

The delivery of care, whether medical or social, is frequently organized through a variety of separate health and care facilities and their constituent departments, which often have no regular or formal connection with each other in the way their services are delivered. Each department or organizational unit tends to implement its own processes and delivery channels. Citizens, who are effectively the end consumers of care services, often have to deal with several departments, units, or individuals that have no apparent commonality in the way that they work – or even in the way that they appear to the client or patient.

With the technology of the Internet, mobile communications, and powerful yet affordable computers now being commonplace, there is an opportunity to redesign the way many of these services are delivered. The overall aim is to move Health and Social Care towards a series of easily available, interconnected, reliable, and efficient services.

Of course, the Health and Social Care industry constantly adapts and refines the range of functions and services it provides – and the amount of interaction with its "customers" – to match the ever-more complex society in which we live.

Almost every country in the world has made, and is making, major efforts to improve the delivery of appropriate care at the right time and in the most effective and efficient way. Information systems and technology usually are usually at the heart of these efforts. We can detect three distinct types of solutions, which roughly are roughly in chronological sequence:

Level 0 – sometimes called "Health 0" or the "baseline" or the "legacy" environment – in which systems are essentially stand-alone applications, possibly quite old and often with paper-based inputs and interfaces. Nevertheless, they perform a vital function. There is occasionally some small-scale interoperability or integration based on location or by standardizing on a particular vendor's offerings. A key feature, however, is that the scope of a business process is usually limited to the scope of a single application or two, and the execution sequence of process steps is usually controlled by manual triggers and human interpretation of events and situations. Data is usually stored in "silos", often in proprietary formats, which are hard to access and present semantic and synchronization problems.

Level 1 – sometimes called "Health 1.0", in which strenuous attempts are made to "integrate" the legacy. This involves creating larger, more all-embracing applications that more comprehensively address specific functional areas (Table 1 on p.*32* provides some examples) and enable interoperability between functional areas. Attempts are made to merge the data silos involving much effort to resolve semantic differences and implement a standards-based data exchange capability – these often foresee large, multi-terabyte databases that are difficult to secure and protect. Essentially these are B2B – business to business – approaches in which the patient or client is the subject of a transaction rather than the focus of a long-running process. They do not necessarily support person-centric care pathways in an efficient or effective way. The difficulties that are encountered include the following:

- The costs of integration and complexities in quantifying benefits make the return on investment seem risky and speculative.
- There is resistance to "opening up" proprietary environments not just from vendors but from users with concerns over data ownership and interpretation.

- Integration is problematic when different legacy environments use different primary identifiers and coding standards.
- Agreeing on domain-wide standards is a slow process.
- Privacy and confidentiality at a domain level is a major concern, especially when consents and permissions are granted only at a local level.

Level 2 – sometimes called "Health 2.0" shifts the focus of Health Information Systems from the provider to the consumer – for example, from a Business-to-Business (B2B) pattern to a Business-to-Consumer (B2C) pattern. Consumers, by which we mean patients, clients, care professionals, and administrators, are starting to connect with virtual healthcare communities and turning to online sources of health information. This is achieved through patient, clinical, and management portals; unified communication systems; mobile devices and facilities; and the provision of "call center" types of services. A further trend is now evident is that patients and clients have become dissatisfied with their records being fragmented across islands of automation and multiple data silos, which are inaccessible to their carers, and are starting to compile their own integrated records. This is particularly evident in countries that don't have coordinated consumer-centric systems and databases. This presents issues of accuracy and trust, but some countries are encouraging the trend and providing controlled means of consumer access to care information.

An Architect's Viewpoint

This progression presents something of a dilemma to architects. The jump to Health 2.0 cannot happen overnight since there is a need to form a sound foundation (i.e. a perceptive Health 1.0 solution) and, obviously we need to preserve "business as usual" as any transformation takes place. Thus the roadmap is complex, involving:

- A stabilization of the Level 1 legacy environment to maintain vital services and open up data silos
- The design and implementation of a "lean" Level 2 integration platform that offers functionality and data to new, expanded business process and creates a standards-compliant virtual data resource
- The creation of controlled access mechanisms that allow citizens, care professionals and administrators to work with "their" data in the most convenient and appropriate way – collaborating with colleagues and other interested parties in a reliable, secure and verifiable manner that protects privacy and confidentiality.

The Microsoft *Connected Health Framework Architecture and Design Blueprint* provides a model on which such solutions can be built.

e-Health and e-Care – A Maturity Model

The evolution of e-Health and e-Care systems is similar to that of general e-business offerings – from basic Internet presence and publishing of information; through development of new interaction channels and online transactions; to transformation of the underlying business processes. In the United States, this transformation is being driven by commercial health interests driven by both consumer expectations and the increasing hand of government; in the European Union, governments have historically played a greater role and continue to do so.

The evolution of information systems is often divided into four distinct phases that indicate the progression and maturity of electronic interactions between service providers, customers, and consumers:

- **Presence**, such as non-interactive Web sites where the main intent is to disseminate information.
- **Interaction**, where limited online features are available, such as searching for information, sending e-mail messages, and possibly viewing data dynamically.

- **Transaction**, where the user can take advantage of one or more services such as making appointments, or renewing prescriptions for medication.
- **Transformation**, where services become integrated, and perhaps even expose portals tailored to specific sections of the community where the appropriate services combine and are orchestrated together. For example, when a patient makes an appointment with a healthcare provider for a particular medical examination, the required scanning equipment is booked, specialist staff are scheduled, laboratory time is reserved, and the supervising clinician is alerted to oversee the process and counsel the patient.

These phases are shown in *Figure 3*. The following paragraphs discuss the various characteristics of the phases, beyond simple Web presence, in more detail.

Interaction

The *Interaction* phase offers services that are more advanced than mere presence. Larger volumes of available information enable customers and consumers to search for relevant content, communicate with care providers, participate in online case and clinical discussions, and submit opinions and requirements. The user experience may be personalized and customized – based on the user profile and interests.

In addition to potential cost savings through reduced traffic over traditional communication channels, interaction services can provide additional value by extending the range and intensity of communications with care providers and professionals, thereby increasing the rate of participation in discussions and decision-making.

Implementing interactive services is more complex and more costly. To work effectively, they may require access to data and some level of integration with departmental and “back-office” systems.

Transaction

The focus of the *Transaction* phase is to build channels for online access to services, to enable completion of whole tasks electronically. Typical examples of such services are appointment making, referrals, clinical data retrieval, test requests, and patient record updating and maintenance. Uses of online facilities to establish availability of specialist professionals and facilities and to order and deliver medication are also popular scenarios.

Transactional services can dramatically increase the convenience and efficiency of interactions with care entities and reduce the costs. Integration with other systems (both on the care provider and on the "client" side) can streamline processes and eliminate errors introduced by manual data entry.

The implementation of transactional services requires higher levels of security and reliability. Online submissions are subject to stringent legal requirements in terms of non-repudiation, archiving, privacy, and so on.

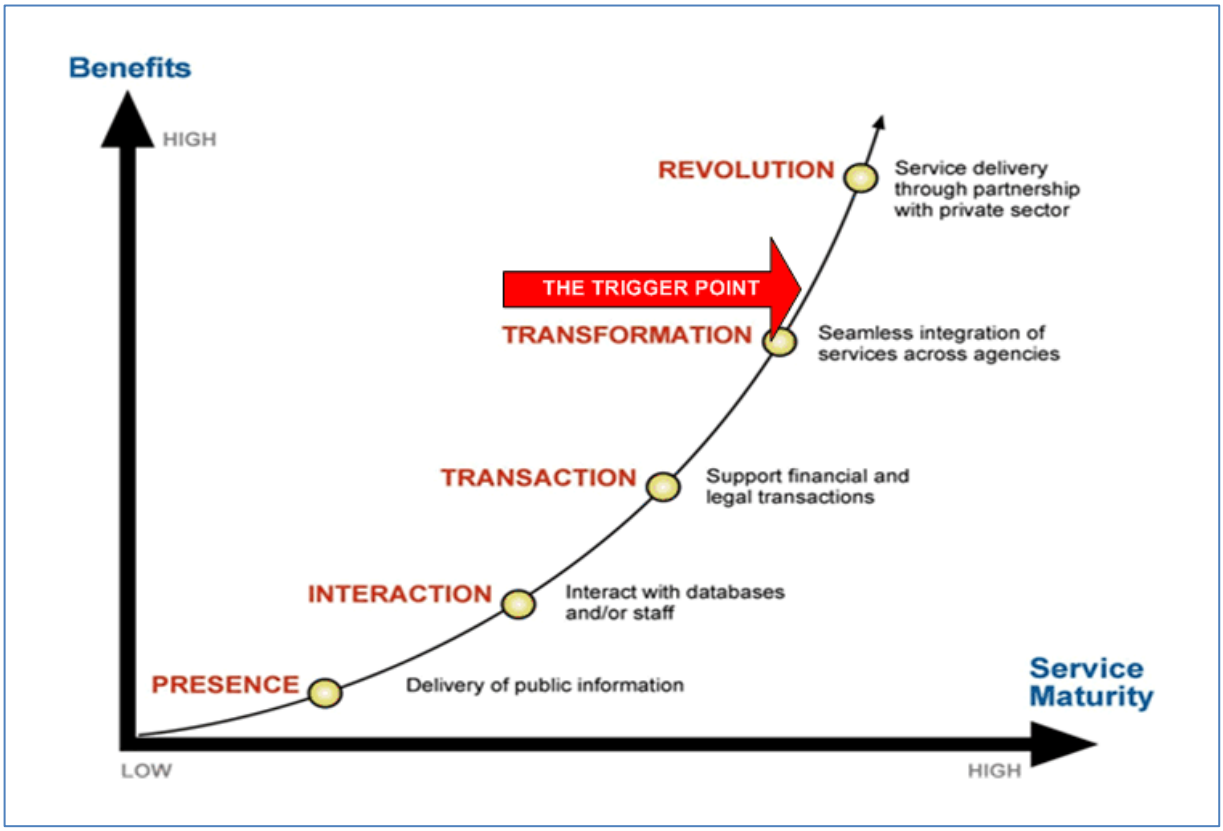

Figure 3. Phases of Maturity

Transformation

In the *Transformation* phase, existing business processes and workflows (perhaps those replicated and enabled through online channels in the previous stages) are redefined and rationalized to take advantage of the new delivery capabilities. Traditional point-to-point interactions of users with each care service individually (even if through online channels) are replaced by more user-centric aggregated services, which isolate the consumer from the multitude of services and systems and present a unified view appropriate for the user. Examples are "treatment events" for patients or "enablement events" for healthcare providers. A single interaction with such a "virtual service" can result in multiple subsequent operations against the appropriate back-end systems – orchestrated and coordinated by the service itself and transparent to the user.

The greatest value in this phase derives from new types of joined-up, streamlined, and efficient services better tailored to suit the needs and preferences of the end users, instead of asking them to adjust to the way various care entities and their systems operate. This changes the nature of the relationship between care entities and their constituencies, putting the consumers at the center, and the care providers at their service. The implementation of the transformation phase utilizes the foundations built for the transaction phase, with incremental development of the new joined-up services and applications.

The Trigger Point

Figure 3 also shows how the phases of maturity move towards providing better value to the communities that use the online services as time goes by and as complexity increases. The costs involved in providing the online services increase at each phase, but they can often be offset by the savings over traditional Healthcare services.

However, it is at the trigger point that the real changes appear. A huge leap in the value to the user communities as e-Health applications become able to provide wider and deeper interaction with the core services of Healthcare balances the increases in cost and complexity. In addition, as more and more services integrate into the system, the savings in traditional processing and transaction efficiency will increase dramatically.

In *Figure 4*, we superimpose the types of e-Health and e-Care solutions as described earlier upon the maturity curve. The main thrust of the CHF Architecture and Design guidance is to help bridge the gap between Level 0 (the Baseline) and Level 2 (Health 2.0) by ensuring that Level 1 (Integration) is effectively and efficiently implemented. By doing so we believe that the Trigger Point will be reached, enabling progression to the "revolution" in the provision of Health and Social Care information systems.

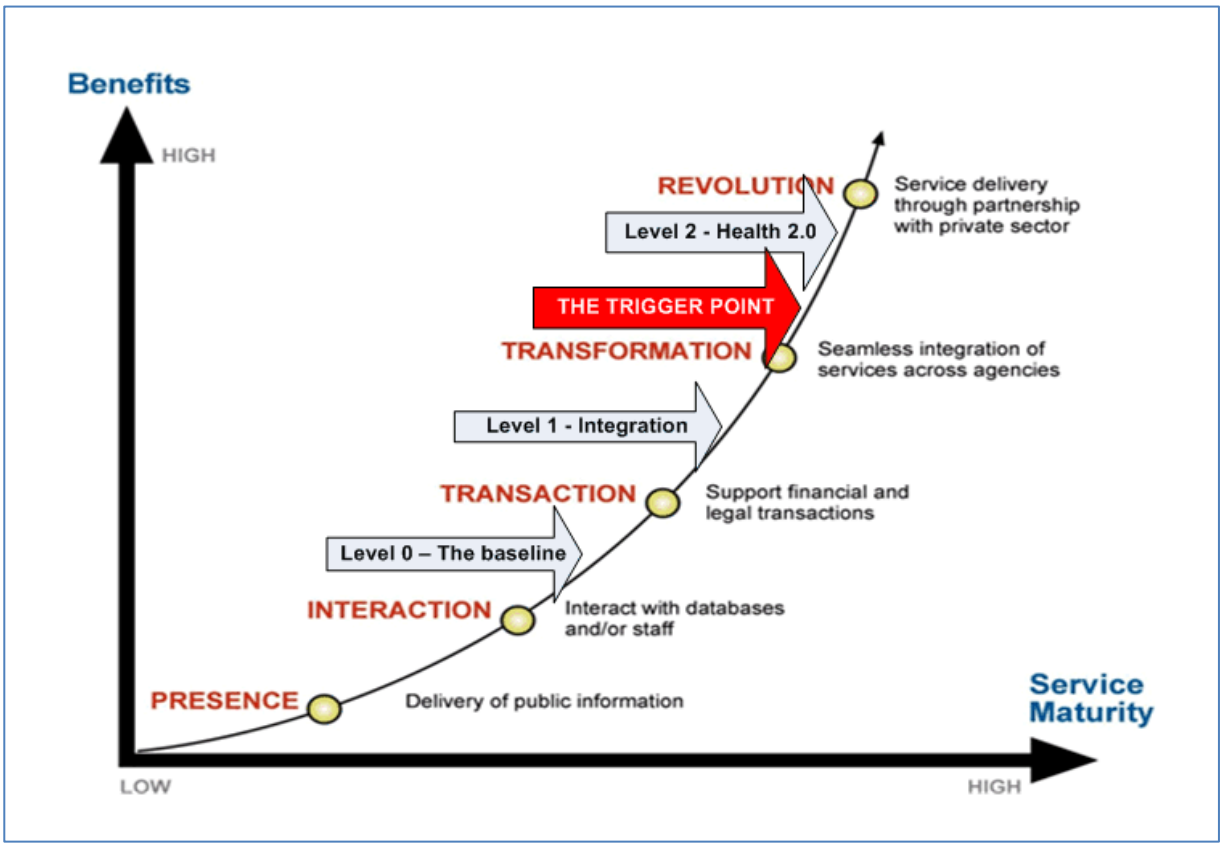

Figure 4. Phases of Maturity and Types of Solution

Health and Social Care as an Industry

Our definition of the Health and Social Care industry includes the delivery of health-related services by doctors, nurses, hospitals, clinics, laboratories, pharmacies, and many other players; and the delivery of Social Care services by social workers, care professionals, care and residential homes, ancillary care workers, private and voluntary sector personnel, and many carers both from care-providing organizations and the community at large. These both include the provision and operation of physical facilities.

Business Models for Health and Social Care

There is a spectrum of "business" models that describe the provision of care services ranging from fully state-operated to fully private service provision. Healthcare service provision is typically national in scope and usually operates in a mixed environment of public and private services. In most countries, the majority of citizens pay for some services, such as dentistry or optical care, and medicines. However, hospital services are often free at the point of care, being publicly funded from general taxation or from a variety of insurance schemes.

An important factor is how funding is channeled to the point of need. In Europe, the so-called "Bismarck" and "Beveridge" models predominate. ***Bismarck*** healthcare systems are based on social insurance, where there is a multitude of insurance organizations, and organizations like the Krankenkassen in Germany, who are *organizationally independent of* healthcare providers. ***Beveridge*** healthcare systems, on the other hand, are systems where financing and provision are handled *within one organizational system*; for example, financing bodies and care providers are wholly or partially within one organization, such as the NHS of the United Kingdom, or in some of the Nordic countries.[5] Beveridge model systems are sometimes described as providing care free of charge at the point of need.

There has been, and no doubt there will continue to be, much debate about which model is the most effective and efficient. It does appear that Bismarck model systems are better at handling the procedural aspects of healthcare systems— for example by having noticeably shorter waiting times for treatment— but not as good at sharing data between providers. On the other hand, Beveridge model systems seem to be better at managing a data resource, but often have complex, inflexible management and administration processes.

An Architect's Viewpoint

It can be argued that differing business models only influence the business processes being operated. The fundamental business functions and the underlying conceptual data are constant factors. It is the assembly of these basic artifacts into differing procedural configurations that are operated by differing organizational structures that characterizes specific business models. This is the principle that underpins the BPBusiness Pattern offered by the CHF which is summarized later and described in detail in Part 2.

This may be because care providers in a Bismarck model tend to be smaller, more specialized, and autonomous; whereas in a Beveridge model, care providers are larger, more generalized organizational units with more difficult management challenges but, due to their wider scope, have the ability to consolidate patient data more easily. In fact elements of both models are present in most countries' approaches – evidence might be found in initiatives to introduce "market forces" and finer-grained accountability into Beveridge-type systems, and equally in attempts to "join up" the activities and patient data of separate provider organizations in Bismarck-type systems.

[5] Definitions from ***Health Consumer Powerhouse*** *Euro Health Consumer Index 2008 report*Report © Health Consumer Powerhouse AB, 2008. ISBN 978-91-9768 74-5-4 http://www.healthpowerhouse.com/files/2008-EHCI/EHCI-2008-report.pdf

It is believed that the future development of care systems will follow an integrated "citizen-centric" model. There are two aspects to this. The first is political in that policy makers are keen to show that their concern is improving the health and well-being of the individual. The second is more technical in that the "person entity" forms a common fact around which integration of both function and data can take place, with all services and communications being linked via the person identifier. Of course a person can have many identifiers – perhaps one for each domain or service used – and mechanisms are required for inter-domain navigation.

Social Care is usually coordinated and delivered by local government agencies, although a very substantial amount of care is delivered by private and voluntary sector organizations. In some countries this may amount to 75 or 80 percent of the delivered care time. In addition, much care and attention is provided by "unofficial" carers such as family members, friends, and neighbors. This activity should not be underestimated, and the requirements of these carers in terms of focused information and procedural support should receive specific attention in designing, implementing, and operating care systems.

The business models for social care tend to resemble the Beveridge-type model following the principle of care being free of charge at the point of need, although charges may be levied based on an assessment of "ability to pay". Because the delivery mechanisms for social care are often fragmented with much care being provided by private and voluntary organizations, the systems portfolio also tends to be fragmented with many small, "stand-alone" and inaccessible applications. There are countries in which integration mechanisms are in place. Typically these operate between official agencies and occasionally also at an inter-domain level, such as between Health and Social Care and possibly with other domains such as law and order or education. The integration mechanisms used are of course similar to those used in health.

This variability in business models can make the design, implementation, and operation of integrated care systems both difficult and expensive. Issues of system ownership, and the varying scope and boundaries of business processes are difficult to resolve, and this has tended to encourage the creation of systems and applications of comparatively limited scope, addressing perhaps only one aspect of care or supporting specific, self-contained services. Most national Health and Social Care systems comprise thousands of such systems, – largely independent of each other. Such integration as has taken place is often to be found within isolated islands of automation, often with each island using disparate technical platforms and standards from the others.

The Funding Model – Who Pays Whom?

Given the players identified earlier, where does the money come from and where does it end up? *Figure 5* shows the common pattern of monetary flow between the players in the Health and Social Care domain.

Most countries have complex arrangements designed to organize the provision of care in an effective way and to ease the financial burden on the citizen in times of need.

Typically, this gives rise to care-providing organizations that are often focused on the provision of primary, secondary (acute) or tertiary (long-term) care, as well as to funding organizations such as local health authorities, insurance companies, and co-operative health schemes.

The Health and Social Care economy is usually controlled and regulated by governments in terms of provision and by professional institutions in terms of standards of care.

At its simplest, this financial model can be reduced to just two players: the person (patient or client), and the care professional. The patient simply pays the doctor and that's that. Ultimately, whatever the intermediate detail, the citizen pays via fee, insurance premium, or taxation, or a mixture of the three. The care professional is remunerated

by means of fee or salary with the costs of facilities, medication, equipment use, tests, and ancillary services being deducted at point of use.

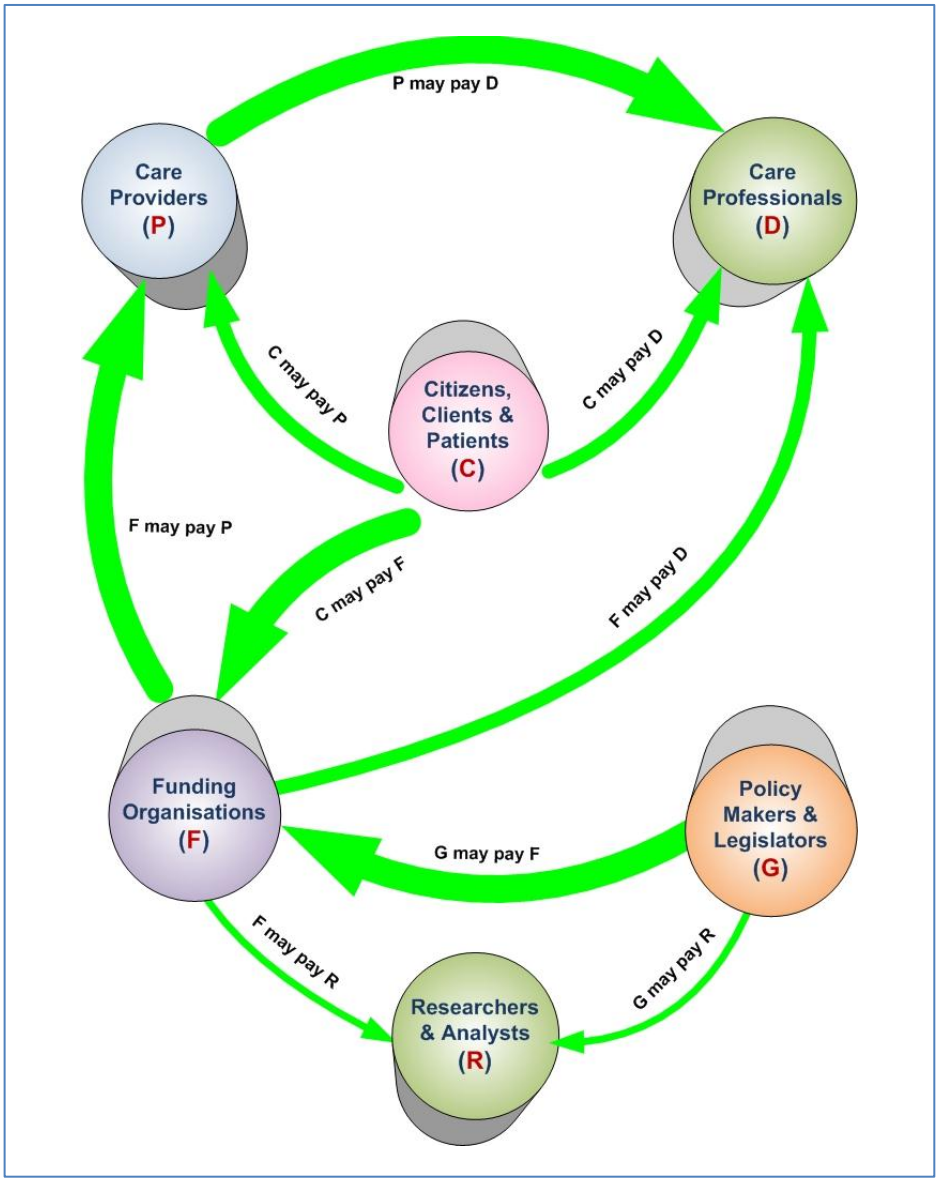

Figure 5. Monetary Flow

Expenditure

Healthcare is one of the world's largest and fastest-growing industries, although growth may be leveling off. According to OECD (Organization for Economic Cooperation and Development) Health Data 2006, health spending grew faster than GDP in every OECD country except Finland between 1990 and 2004. On average, it accounted for 7 percent of GDP across OECD countries in 1990, but reached 8.9 percent in 2004. Statistics for 2006 indicate expenditure remained at 8.9 percent of GDP.

The OECD Health Data 2008[6] indicates that the United States is, by far, the country that spends the most on health as a share of its economy. In 2004, the U.S. spent $1.9 trillion on health care, which represents 16 percent of U.S. GDP. This reduced to 15.3 percent of GDP in 2006 ($6,714 per citizen).[7] By the year 2016,

Expenditure is expected to increase to US$4.2 trillion, or 20 percent of the nation's GDP.[8]

After the United States, Switzerland, France, and Germany spent the most on healthcare in 2006, at 11.3, 1.1, and 10.6 percent of GDP respectively. Total health spending accounted for 8.4 percent of GDP in the United Kingdom in 2006, compared with an average of 8.9 percent across OECD countries. Belgium, Portugal, Austria, and Canada also devote at least 10 percent of their GDP to health.

These figures are summarized in *Figure 6* below.

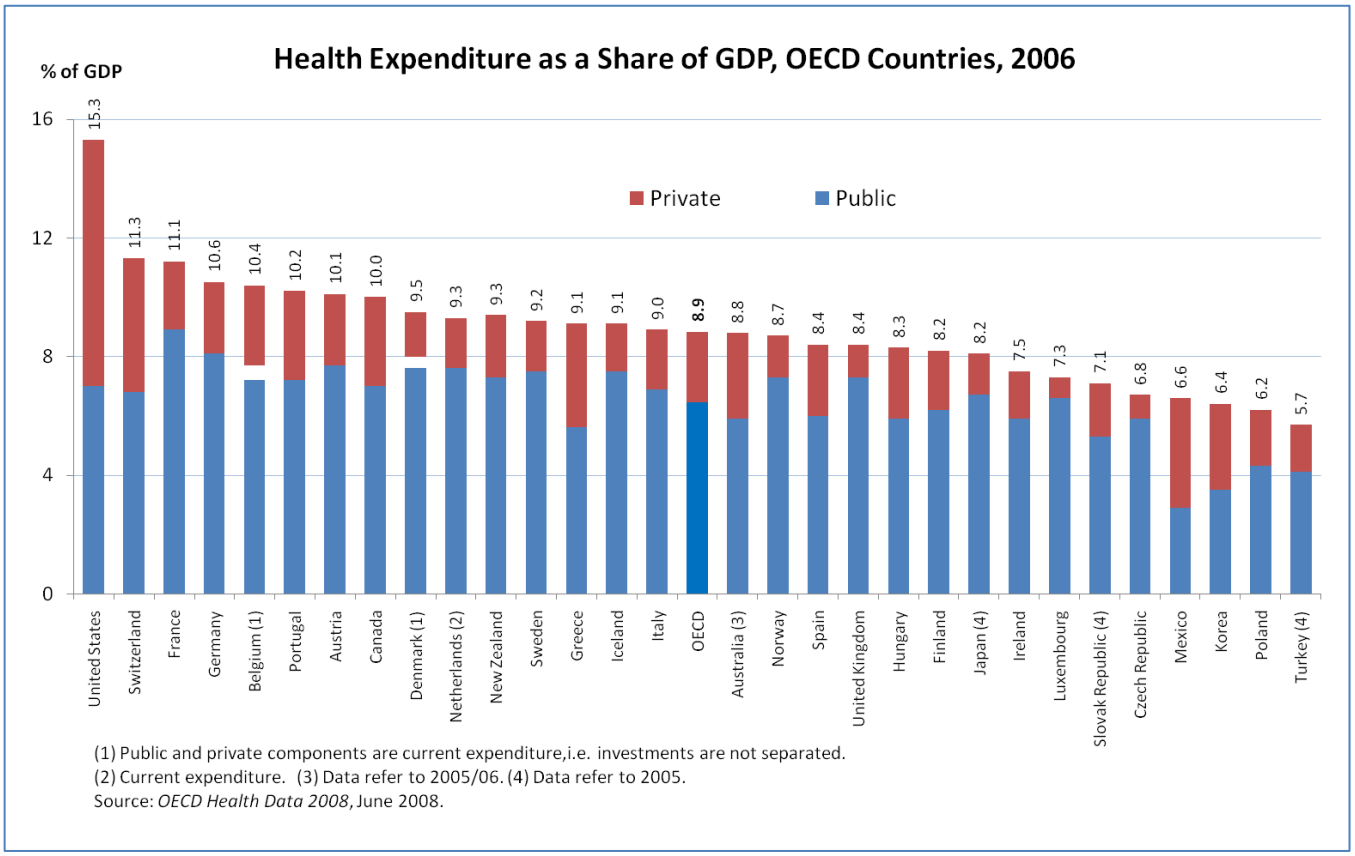

Figure 6. Health Expenditure as a Share of GDP

[6] Source: *OECD Health Data 2008* available from http://www.oecd.org/document/27/0,3343,en_2649_34631_40902299_1_1_1_1,00.html
[7] Source: *As above*
[8] The National Coalition on Health Care. "Healthcare Costs." 2008. www.nchc.org

All healthcare systems are expensive, whichever business model is in place. *Figure 7* shows health expenditure per capita, both public and private, for the OECD countries in 2006.[9] This expenditure ranges from US$6,714 per citizen in the U.S. (approximately $2 trillion in total) to US$591 per citizen in Turkey. The average OECD nation spent US$2,824 per citizen in 2006. The approximate split between public and private expenditure is shown with the U.S. having the largest proportion of private expenditure (>55%) and the U.K. the largest proportion of public expenditure (>80%).

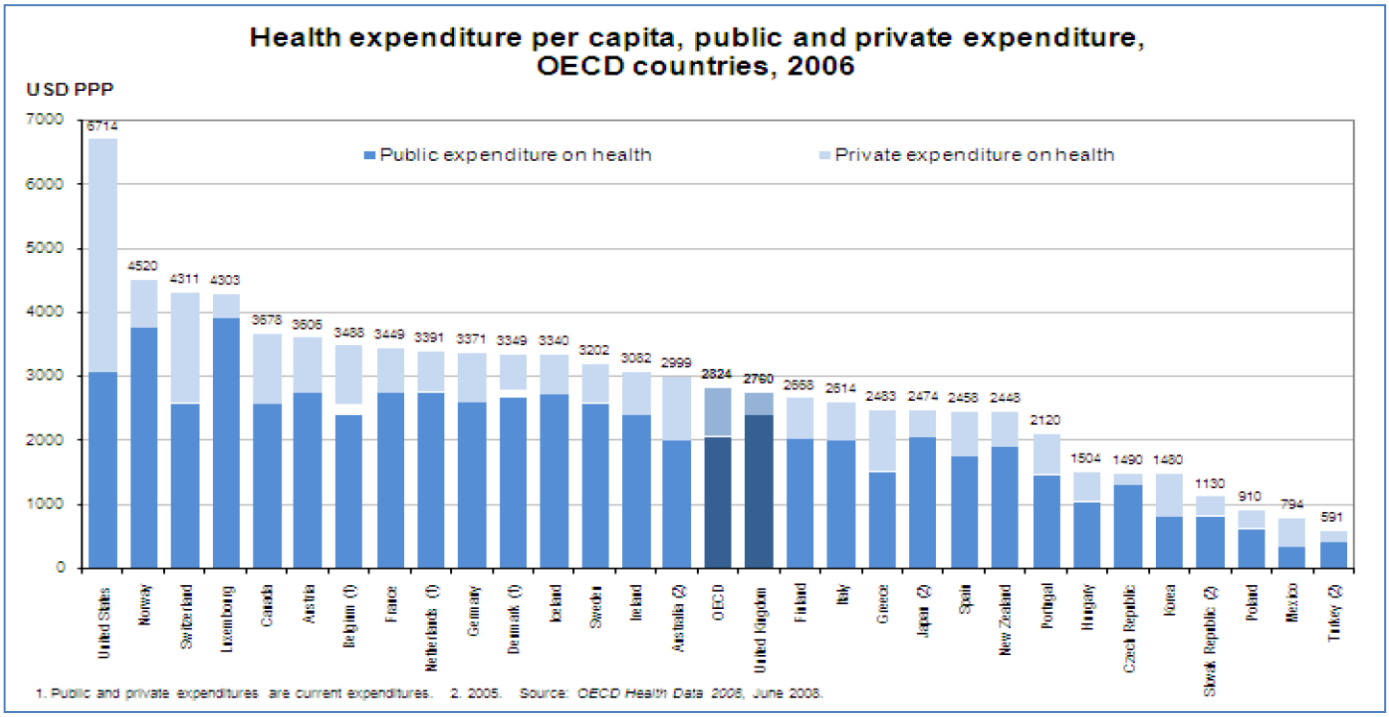

Figure 7. Health Expenditure per Capita

The leveling-off trend may no longer apply to the United States, where spending seems to be on the rise again. Reuters report figures for 2007 that indicate that total U.S. spending on healthcare was $2.2 trillion ($7,412 per citizen), an increase of more than 6 percent over 2006. This now represents 16.2 percent of U.S. Gross Domestic .[10]

Some further U.S. statistics from Reuters for 2007 are as follows:

- Regarding total health care dollars, 31 percent of healthcare dollars went to hospitals, 21 percent to physicians and clinics, 7 percent on administrative costs, 10 percent to drugs, 25 percent to "other" and 6 percent to nursing homes.
- Private insurance paid 35 percent of this; Medicare 19 percent; Medicaid and the State Children's Health Insurance Program 15 percent; other public funds 12 percent; from other private sources 7 percent; and 12 percent was paid for out-of-pocket by patients.
- Hospital spending was $696.5 billion, while doctor and clinical services spending was $478.8 billion.

[9] Source: As 6
[10] Source: http://www.reuters.com/article/marketsnews/idINN0538325220090106?rpc=33

- Medicare, the federal health insurance program for the elderly, spent $431.2 billion overall in 2007 while Medicaid, the state-federal health insurance plan for the poor and disabled, spent $329.4 billion.
- Private health insurance premiums were $775 billion, while patients spent $268.6 billion out of their own pockets.

Global estimates of expenditure on social care are hard to find, although national statistics are available. Difficulty arises in establishing the boundary between health and social care and the split between public and private provision. However as an example, the "official" expenditure on social care for children, adults and older people in England in 2003/4 amounted to £16.7 billion Stg. (US$ 25-30 billion) for a population of about 50 million. This compares with equivalent health expenditure of about £80 billion (US$120-160 billion) in the same period. However, these figures do not include care services delivered by the private and voluntary sectors, which in some countries can reach 80 percent of activity.

It can clearly be seen that health and social care is big business and further that it is highly complex and variable in terms of organization and management. It is one in which Information Systems and Technology (IS/IT) has a big part to play. Industry experience suggests that an IS/IT expenditure of 1 – 2 percent of overall expenditure might be the norm, while some major, national-level developments might require as much as 5 percent of overall expenditure. Benefits are harder to quantify, although we make some effort below in the section on health and social care needs.

What Do Consumers Want?

Establishing the functional requirements for health and social care systems is a difficult task. The health and social care domains are complex with many competing and ever-changing demands. End users find it difficult to express their IT needs and usually are only aware of their own area – thus they often express requirements within a limited perspective and as a function of their existing system. Two simple messages emerge for end users, however. First, they want their systems to be "user friendly" and second, they want the operation of the system to be "intuitive". They do not want to have to search for data and interact with other systems through obscure interfaces over slow, unreliable connections. They want their system experience to be swift, relevant, and "seamless" without needing to have knowledge of system structure, data format and location, and operating idiosyncrasies.

Establishing requirements at a national level can be even more difficult. Many national requirements specifications run to thousands of contradictory pages. National specifications are usually a mixture of political objectives, a conceptual view of an overall solution, some high-level system designs, some consolidated user requirements, an implementation schedule, and contractual demands.

Another approach to requirements definition might be to find out what consumers like.

It would be interesting to establish whether there are any particular characteristics of healthcare systems that win particular favor with the consumers – patients and care professionals.

Perhaps some guidance can be gained by examining some successful services and asking some key questions:

1. What do the consumers think of their health and social care systems?
2. What do successful systems do?
3. Is the expenditure good value for money?
4. Are there any key areas where good returns on investment are apparent?

What Do the Consumers Think of Their Health and Social Care Systems?

The Euro Health Consumer Index (EHCI)[11] is a compilation and analysis of consumer opinions and information on healthcare in a number of European countries. It analyses 34 healthcare performance indicators for 31 countries. EHCI are at pains to point out that this is not a scientific analysis. Its aim is to select a limited number of indicators, within defined evaluation areas, which in combination can present a picture of how the healthcare consumer is being served by the respective systems. By "consumer", EHCI primarily means "patient".

The evaluation areas are as follows:

- Patient rights and information
- e-Health
- Waiting times for treatment
- Outcomes
- Range and reach of services provided
- Pharmaceuticals

Consumer Opinions

The results for 2008 are shown in *Figure 8*. It will be seen that the "best" European healthcare system in terms of customer satisfaction is that of the Netherlands, followed by Denmark and Austria.

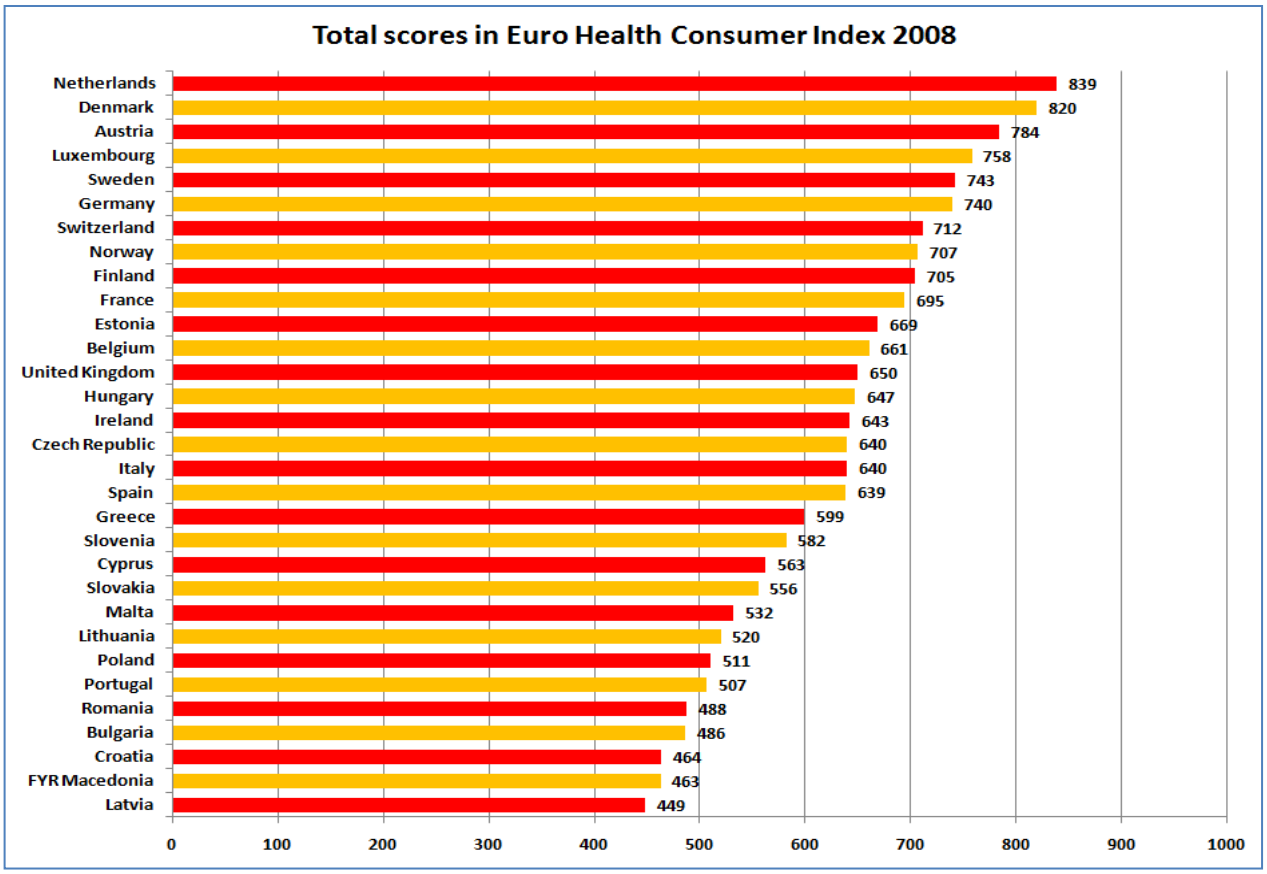

Figure 8. Customer Satisfaction

[11] *Euro Health Consumer Index 2008 Report* © Health Consumer Powerhouse AB, 2008. ISBN 978-91-9768 74-5-4
http://www.healthpowerhouse.com/files/2008-EHCI/EHCI-2008-report.pdf

The Netherlands scored full maximum points in "Range and reach of services provided". EHCI states that the Dutch healthcare system does not seem to have any really weak spots in the other sub-disciplines, except possibly some scope for improvement regarding the waiting times situation, where some other central European states "excel". Denmark came out top in the e-Health area. EHCI states here that "It would seem that the dedicated efforts made by Danish politicians and public agencies, to achieve a real upgrade of the healthcare system in Denmark, are paying off." Austria scored well due to its pharmaceuticals systems capability.

So what do consumers really want in terms of information systems?

We think that *citizens* want their health and social care information to accurate, complete, secure and accessible to those with a verified need to know such information, wherever and whenever that might be. They want to have consultations with their chosen care professionals to take place as soon as possible and any hospital treatment to be scheduled at a convenient time and place.

We think that *care professionals* want their information systems to be swift, accurate, consistent, and easy to use with the supply of information tailored to the task in hand for the specific patient or client being treated. They do not want to search for information or have to make frequent switches of application, especially when look and feel and data formats vary.

We think that *administrators* want their systems to function in the way we have described for care professionals with the addition of more end-to-end support for long-running business processes. They do not want to carry out fragmented tasks, such as entering the same or similar data into multiple applications, nor do they want to do high-volume data entry.

We hope that the CHF will provide architecture that meets these consumer needs.

What Do Successful Health Care Systems Do?

Of particular interest to us in terms of the CHF architecture are the results on e-Health, the indicators for which are:

- The *availability* of a Healthcare Provider catalogue with a quality ranking – the extent to which patients can see the track record of the hospitals they are considering for treatment.
- The *penetration* of Electronic Patient Records (EPR) – the extent to electronic patient records are used for diagnostic purposes in GP practices.
- The *e-Transfer of Medical data* – the extent to which GP practices use electronic means to transfer medical data to care providers and other care professionals.
- The *use of e-Prescriptions*— – the extent to which GP practices use electronic means to transmit prescriptions to pharmacies.

The top country in e-Health, Denmark, scores highly in all four indicators. The Netherlands and the U.K. do well in three: both score highly in EPR and e-Transfer, with the Netherlands doing well in e-Prescribing and the U.K. in the healthcare provider catalogue area. A number of other middle-ranking countries score well on EPR use.

Good Value for Money?

Also as part of the EHCI study, there is an attempt to calculate the value for money resulting from e-Health developments – the so-called "Bang for the Buck" study[12]. This takes the OECD Per Capita Healthcare spend (*Figure 7*) and compares it with the Customer Satisfaction ratings (*Figure 8*). ECHI emphasize the non-scientific nature of this calculation, which is shown in *Figure 9*. The resulting figures are very interesting.

It can be seen that Estonia, Hungary, and the Czech Republic punch above their weight in this analysis, doing rather better than their relative positions in the satisfaction and spending tables. This illustrates that comparatively small countries can produce good results from modest expenditure given that the right priorities are set, achievable targets are chosen, and good solutions are efficiently implemented.

An Architect's Viewpoint

We think that gaining value for money requires a sound architectural foundation with clear concepts and a careful separation of business solutions and technical platform. Design and implementation are not tightly bound and accordingly there is scope to get the solution right and track inevitable changes in the business environment. The CHF business pattern and technical reference framework support and encourage such an approach.

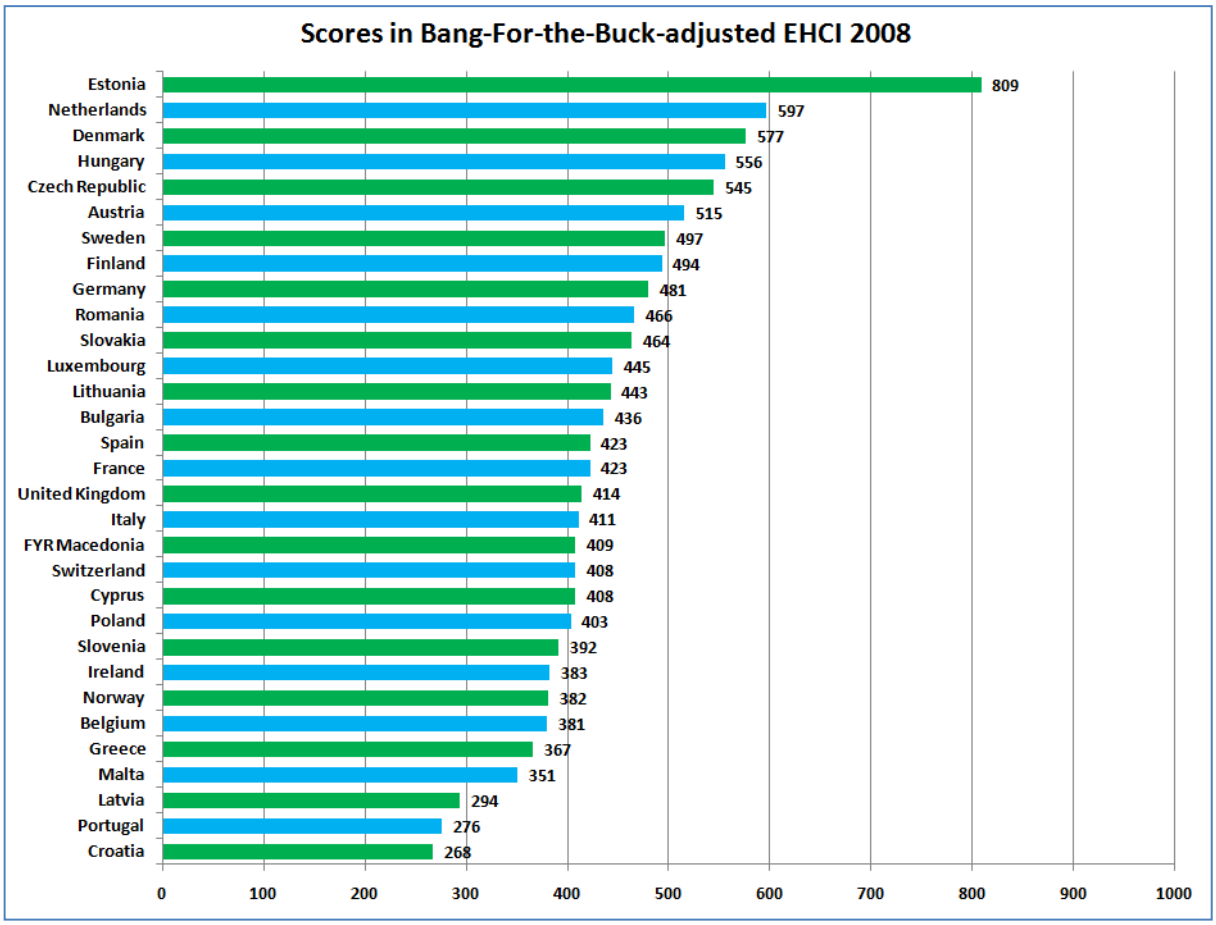

Figure 9. Bangs for your Buck

[12] *Euro Health Consumer Index 2008 Report* © Health Consumer Powerhouse AB, 2008. ISBN 978-91-9768 74-5-4 http://www.healthpowerhouse.com/files/2008-EHCI/EHCI-2008-report.pdf

Key Areas for Return on Investment

The publication "*e-Health is Worth it*" is an analysis of the economic benefits of implemented e-Health solutions at ten European sites. [13] Published in 2006, the report states:

> *"The results of the study show that given the right approach, context and implementation process, benefits from effective e-Health investment are indeed better quality and improved productivity, which in turn liberate capacity and enable greater access. Once development and implementation stages have been successfully realized, the value of these benefits, for what we have called a 'virtual health economy' consisting of the 10 evaluated cases, rises each year and exceeds the costs, usually very significantly. Annual costs are broadly stable once implementation has been completed, whereas net benefits tend to grow each year with expanding usage, showing that e-Health can contribute increasingly to satisfying citizens' needs and wants for healthcare."*

A our view assessing the return on investment and continuously measuring delivered business value is a vital activity. In terms of health and social care developments, the expected values and expectations should be stated in the business case that is presented to gain approval for the program or project. The business case should contain a forecast of the expected return and metrics put forward that should be tracked throughout the project or program life. The forecast should be updated as work progresses and, just as with a financial investment, you should be in a position at any time to know whether to increase your investment or sell.

The comparable decision-making in health and social care programs is more complex, of course, but the principle is the same. The investment decision is embodied in the business case for the program or project, and each business case should contain not only a forecast of return on investment but also a realistic risk analysis including available mitigation strategies. Most investors have a limited budget, so the question arises as to the "best" investments to make recognizing potential return and the risk involved. There should be a constant review of the program portfolio, with each constituent business case being evaluated for its "worth" and probability of success. A priori, the "best" investments are those that bring the greatest return with the lowest risk. Unfortunately, life is not quite that simple and the decision-making process is often agonizing; "playing it safe" usually means a reliable but lower return on investment, while "taking a risk" means higher returns but possible disaster. Financial advisers stress the need for balanced portfolios with a spread of investment type and a graduation of risk. They caution against putting all your eggs in one basket. This is fine if you have lots of eggs, but if you only have a few there might not be much choice.

An Architect's Viewpoint

We recommend that health and social care development programmes be constructed into a number of phases, or releases, defined in such a way that "go/no go" decisions can be made at these break points. This means that each phase should represent a viable assembly of business functionality and be assessable in terms of return. Wherever possible the programme elements with the optimum value in terms of return and risk should be included in the earlier phases.

There is an aspect of information systems investment that is unlike financial investment. IS and IT programs can be long running with much of their value only accruing at the end. There is usually little opportunity to "sell" during a program without losing the entire investment. Programs can also be interlinked, although we would caution against "tight coupling" of programs, so the abandonment of a program is often not a viable option because it can have serious repercussions in other areas.

[13] http://www.e-Health-impact.org/download/documents/e-Healthimpactsept2006.pdf

Health and Social Care Directions

In this section we discuss various economic, government, and environmental factors that influence, control and regulate e-Health and e-Care, as well as the gaps between aspirations and reality – and how these influence the development of e-Health and e-Care solutions.

Mandates and Directives

The European Union mandated, as part of the *e*Europe 2005 Action Plan[14], that member states should develop health information networks between points of care (hospitals, laboratories, and homes) with broadband connectivity where relevant. Further, by the end of 2005, Member States were required to ensure that online health services were provided to citizens (such as information on healthy living and illness prevention, electronic health records, tele-consultation, and e-reimbursement).

The European Commission intended to support a common approach to patient identifiers and electronic health record architecture through standardization and to support the exchange of good practices on possible additional functionalities, such as medical emergency data and secure access to personal health information.

The new administration of the US President Obama, committed to deliver on election promises, is initiating a healthcare reform aimed to provide more equitable coverage and access to care for all citizens. Improving the exchange of health information and interoperability between different providers is an essential part of the plan.

Where such directives and mandates exist, they bring additional urgency to the e-Health efforts and initiatives beyond that of a slow, gradual introduction of electronic services driven purely by local initiatives and drivers. They can act as a powerful catalyst, bringing numerous, often poorly coordinated, initiatives into a coherent model – often supported by centralized funding.

Trends, Aspirations, and Realities

So how has this progressed since 2005? In terms of care professionals as "consumers", the EU Report "*Benchmarking ICT use among General Practitioners in Europe*" [15] observes that there has been a rapid development in e-Health in Europe and that infrastructure has increasingly become less of an issue. However the use of e-Health varies across EU countries, and there is a gap between readiness for use and actual use. Computers are available in most GP consultation rooms but they are not always used. Furthermore, patient data is stored electronically in many European GP practices, and broadband connections are available, but the electronic transfer of data between providers is still at a fairly low level. The report also provides some interesting information into how GPs use computer systems. This is shown in *Figure 10*[16].

An Architect's Viewpoint

This might suggest that, although the provision of equipment and communications capability is improving, the roll-out of applications that the care professional sees as integral to his or her job may lag behind somewhat. Care professionals often comment that they do not have time to learn complicated computer dialogues or search for data they need. When asked for their main computer requirement they often say "user friendliness". We like the term "user seductive".

[14] http://europa.eu.int/information_society/eeurope/2002/news_library/documents/eeurope2005/eeurope2005_en.pdf
[15] http://ec.europa.eu/information_society/eeurope/i2010/docs/benchmarking/gp_survey_final_report.pdf
[16] Source: empirica: *eHealth Indicators - use of ICT by primary care physicians in the EU*. Bonn, Germany, 2008. Reproduced with permission.

The trends are that evident are that the computer is being used routinely in consultation by around 80 percent of GPs in Europe with around 60 percent having broadband access for connection to other systems, although such usage is comparatively low. However, the computer is used less frequently (<50%) to illustrate points to the patient. This raises the suggestion that GPs are less comfortable using computers as an integral part of their patient dialogue and perhaps there is a feeling that a patient would not benefit from, or maybe even understand, electronic-based records and treatment plans. However there is a general requirement to make the EPR available to the patient, so there is a need to bridge this gap in practice.

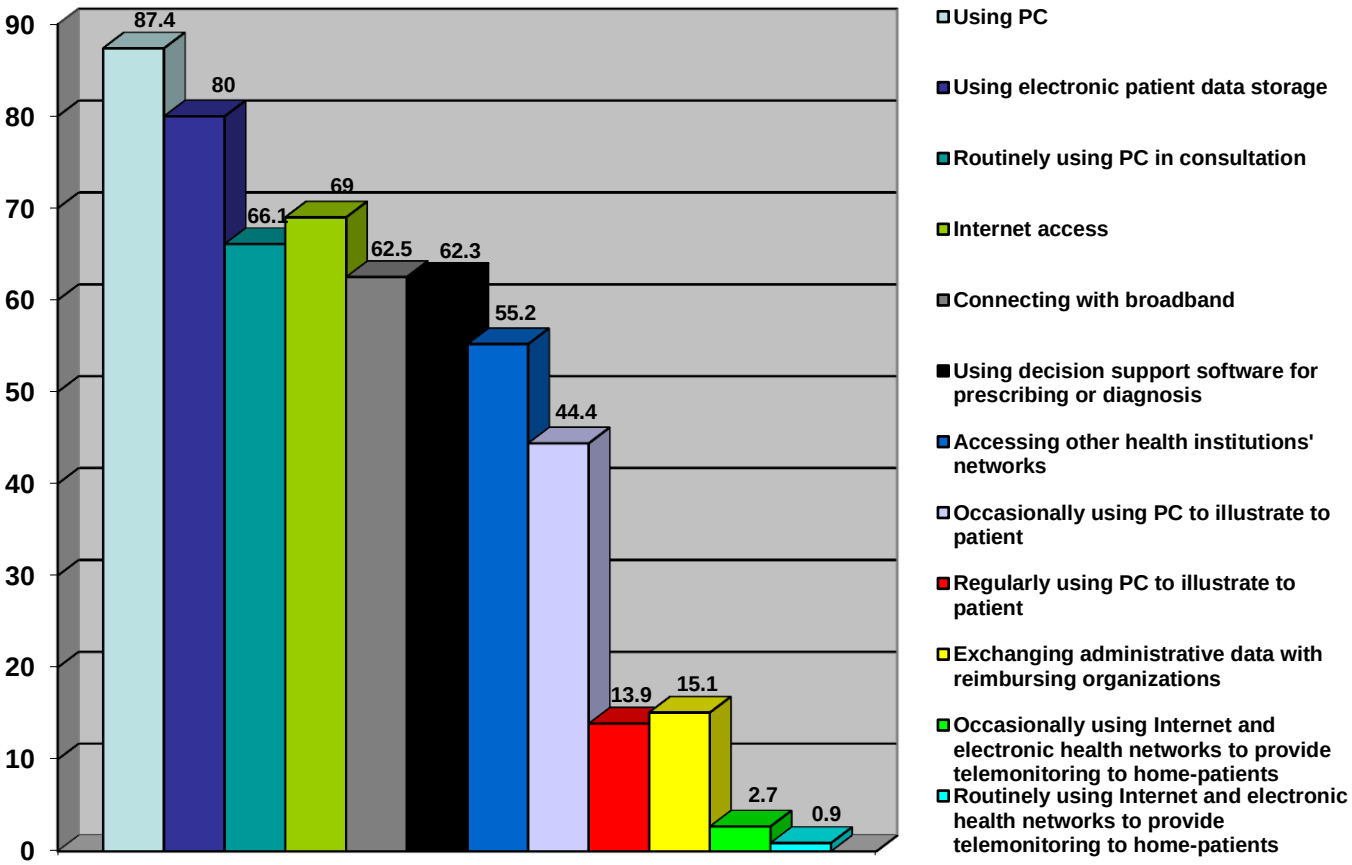

Figure 10. IT Deployment in Primary Care (EC Study 2007)

Table 1[17], indicates the stated priorities of European National e-Health strategies with some examples. The aspirations are high, but he points out that they are some way ahead of reality in so far as full implementation of e-Prescription systems have been achieved in only three countries and implementation of complete eHR/Interoperability, for example in the transfer of medical data to other carers, has been achieved in none.

Priorities in National e-Health Strategies	No. of Countries (out of 22)	Examples
Electronic Health Records - EHR, EPR, Medical Records, Patient Summary, Emergency Data Set	17	DMP - Dossier Médical Personnel (FR) BEHR - Basic Structure for the EHR (DK) NHS Care Records Service / Spine (UK), Patient Summary (SE, FI) SumEHR (BE), eGP file (NL)
Infrastructures and Networks Broadband communication networks and associated technology and basic services	12	MedCom – the Danish Healthcare Data Network (DK) Sjunet (SE) National Health Network (NO) National e-Health VPN (DE, AT)
e-Prescription Management and implementation of e-Prescribing	16	Apotheket (SE) ePrescription (DK, NL, SI) eRezept (DE)

Table 1. National e-Health Priorities in Europe

Implementing e-Health solutions is neither a cheap nor a trivial task, so there must be clear benefits available to Healthcare providers and consumers in order to drive the process. Probably the main factor is the value to the community in general in terms of improved public health; standards and promptness of treatment, and the availability and standard of care services. In due course, this will enable potential cost savings in the provision of such services. There is also the issue of compliance with external directives and other mandates across a range of healthcare activities.

In order to achieve e-Health solutions, health information must first be integrated so that all relevant data is accessible to the information system. This requires a disciplined focus on interoperability and system integration. Without this integration, critical data can and will remain on legacy systems throughout an organization – potentially hindering e-Health initiatives.

[17] Source: *The eHealth ERA project - Towards the Establishment of a European eHealth Research Area (2007)* www.ehealth-era.org

Online electronic delivery of healthcare services to the respective constituencies can act as an enabler for broader reach and the improved quality and effectiveness of services.

Through various electronic channels and call centers, healthcare providers can offer convenient, easy access to information and services and promote "self-service" (examples might include "NHS Direct" in England and "NHS 24" in Scotland). This also reduces the cost and resources required for traditional delivery mechanisms such as letter writing, processing paper forms, data entry, paper filing systems, and the staffing of reception offices. It should be noted, however, that the introduction of electronic service delivery requires its own support infrastructure (including helpdesk call centers) capable of handling the new type of inquiries, the cost of which offsets some of the savings.

An Architect's Viewpoint

It seems that successful countries are succeeding with the creation of Electronic patient records at least for use at a GP level. We should also consider building the EPR in a standard transportable way such that is can be used by other care professionals and providers, in other words forming a longitudinal, time sequenced record of a patient's history. This aligns with the patient-centric view of the CHF. Note that this does not mean building a massive central database holding every item of data for every citizen. Rather it means knowing what data is relevant, where it is stored and how to access it. However there is also a focus on Care Providers and systems should be created to record, analyze and present provider capabilities, capacities and outcomes information. This amounts to also having a provider-centric view.

Knowledge Driven Health

Another major trend is towards "Knowledge Driven Health". It is pointed out that "*many of the growing costs associated with healthcare come from challenges in managing vast amounts of clinical data … and that any technology solution must conform first and foremost to the needs of simplicity, speed, and portability*"[18].

Some of the key challenges identified include the following:

Interoperability of Health Information

- The seamless transfer of clinical patient data between healthcare providers is one of the greatest challenges faced by the health eco-system. Despite many advances in healthcare over the past half-century, on-demand access to clinical data remains inadequate in most settings.
- Care providers simply do not have systems that enable them to synthesize and apply the appropriate data at the time of decision-making. One of the key problems facing clinicians today is that too much time is spent gathering clinical data from fragmented and incomplete sources, both electronic and paper-based.

Clinical Adoption

- A secondary challenge is that, although a government or hospital may provide core IT systems, neither can force the clinical staff to use these systems. As long as computers within the health ecosystem remain separated from the care process, clinical staff will see recording care as secondary to providing care.
- Any technology solution that seeks to replace traditional practices must conform first and foremost to the needs for simplicity, speed, and portability. A clinical information system should be as simple to learn as electronic banking or buying an airline ticket online. The most successful deployments of clinical information

[18] "*The Next Wave of Innovation in Healthcare*", The People-ready business Whitepaper, Microsoft, 2009 (p.5)

systems will require little or no formal training, and users will be proficient following a short introduction to the system.

- Ideally, clinical information systems should look and work like the Web-based environments that most people already know and use outside of work. The less intuitive a system is, the more it is prone to failure caused by human factors. The need for significant amounts of training may be an indication of poor system design, and it should be avoided.

The Information Glut

- The amount of data being generated by researchers is increasing faster than any individual can absorb it. This data deluge makes it difficult for doctors to keep up with the latest treatments and practices.
- Everyone from practitioners to administrators to support staff depends on having access to the right data at the right time, and in an optimal format that enables quick, effective decision-making in what can literally be life-or-death situations.
- Given these demands for synthesized information from affordable and easy-to-use systems, it is ironic that the health industry in many developed countries has been among the slowest to adopt the kinds of ICT solutions that have driven efficiencies and productivity improvements in so many other industries.

Mobile Computing

- The benefits of mobility in the delivery of healthcare services are readily apparent. Doctors and nurses spend most of their time on their feet, working in teams to ensure the health and safety of patients. The ability to alert staff quickly and obtain medical information from any location within the hospital is lifesaving and mission-critical.
- What if doctors could access clinical information databases from the bedside of a patient? Or access a patient's complete medical record on a wireless-enabled tablet computer? What improvements and savings would be possible if nurses could enter medical information directly into electronic charts at mobile carts and avoid duplicate work?
- Consumers can benefit from advanced home-based monitoring systems, tele-consultations, personalized care, and individualized treatments.

Consumer-Driven Health

- Consumer-driven health is a shift in how to deliver care. It focuses on wellness and disease prevention, rather than illness and episodic treatment, which is significantly more costly to consumers and governments.
- As consumers become more knowledgeable about their general health and are empowered to use information tools, they consume fewer health resources and their healthcare usage becomes more cost-efficient as a result of their improved health.
- A key factor in the success of consumer-driven health initiatives is the Personal Health Record (PHR). The PHR mandates that patients own all of their relevant clinical information for the purpose of a healthy outcome. PHRs will help drive better health and better health information systems.

Retail Healthcare

- Waiting times to see doctors in many countries are becoming longer. So, the idea of retail healthcare – or healthcare clinics in airports, shopping malls, and department stores— with services paid in cash and delivered by nurse practitioners, physician assistants, or general practitioners to help consumers with simple health problems makes sense. It is taking off in urban markets, where it can be difficult and time-consuming to see a clinician.
- Most simple health problems may be treated economically by following strict, clinical best-practice protocols. As consumers are forced to pay more out-of-pocket for healthcare, and as information becomes more widely accessible, retail healthcare markets can emerge.

Worldwide Access to the Healthcare Economy

- ICT can enable globalization of the health ecosystem. If medical services can be provided remotely, they will be. Services such as radiology and pathology are already provided in remote and rural locations.
- As people face higher insurance deductible liabilities or no insurance coverage at all, they will increasingly seek lower-cost medical procedures in countries like India, Thailand, and Mexico.

Coping with Shortages of Qualified Professionals

- Doctors, nurses, and midwives are immigrating from developing countries to wealthier nations in pursuit of higher wages. This worldwide migration is creating significant concern and leaving serious shortages of health professionals in developing countries.
- Many of the poorest countries struggle to provide even the most basic medical care. According to the World Health Organization, Canada, Britain, the United States, and New Zealand import a quarter or more of their physicians from other countries, some of which face serious medical challenges.

The Central Role of Information for Clinicians

- Improvements in clinical data acquisition, storage, retrieval, sharing, and presentation must be a primary goal in any nation's healthcare strategy. The problem today is that existing information typically resides on legacy systems. As a result, it is generally not available when, where, or in the manner it is needed. This data includes test results, images, medication and allergy information, chart notes or entire charts, and details about the care process itself.
- Electronic data is essential, yet an electronic medical record is not the same as a clinical information system. And the mere existence of an electronic medical record does not guarantee that clinical data will be available when needed.

The conclusion is that the primary requirement today is for comprehensive data systems that deliver seamless access to all existing clinical data and health management information regardless of source.

The *Connected Health Framework Architecture and Design Blueprint* sets out to provide guidance on how these requirements can be met.

Health and Social Care Needs

We discuss the challenges and opportunities, extending these to cover the lifelong well-being target. We highlight the breadth and depth of e-Health and e-Care and show that individual countries, regions, communities, families, and people are interested in the breadth of care with detailed, focused care being available when it is required. Most people want the continuum of care to be "seamless" – this means common infrastructure, interoperability, and seamless integration.

Challenges and Opportunities

Figure 11 summarizes our view of the challenges and opportunities presented by the healthcare environment in 2006. As may be expected, the challenges were very different between developed and emerging nations, but nevertheless, all have five key, central challenges in common: security, interoperability, privacy, legacy, and trust. To these should be added the differing requirements for defense, relief, and emergency healthcare.

Figure 11. Global Health Challenges

We believe these challenges have not substantially changed over the past three years since the first edition of the *Connected Health Framework Architecture and Design Blueprint* was published. They still are:

- **Security**, in which the challenge is to help keep data safe. This means not only "locked away" but also guarded against misuse, unauthorized access, malicious amendment, and the consequences of computer

failure and malfunction. A key factor is establishing and verifying the identity of users and their authority to access specific systems and patient data.

- **Interoperability**, in which the challenge is to draw together accurate, relevant data from many diverse sources and systems and to present that data in a coherent, fit for purpose, format. Further, the capability of carrying out a single business process across many systems and ensuring complete and accurate execution is required.
- **Privacy**, in which the challenge is to help make patient-related data available at the point of need to those, and only those, with a need to know. The patients have the right to restrict access to their information to the healthcare professionals of their choosing and further to help control the availability of sensitive information. When used outside a legitimate patient–professional care relationship, health data must be made anonymous to help prevent identification of the patient.
- **Legacy,** in which the challenge is to use the capabilities and data managed by the many thousands of existing healthcare systems. This use must be "seamless" to the user and extends the challenge of interoperability, mentioned above, to existing applications.
- **Trust**, in which the challenge is to help ensure that all data recorded, stored, retrieved, and presented is in context, accurate, timely, and relevant— and may be relied upon in making decisions that are literally matters of life or death. Similarly, requests for action must happen, quickly, accurately, and completely, with appropriate confirmations. Only by establishing trust, will systems be used and the necessary critical mass of data formed that will provide the desired foundation for electronic healthcare services.

Given that these fundamental challenges are met, the emphases are as follows:

IN DEVELOPED COUNTRIES:

Patient Safety and Improved Health

- Citizens have high expectations of healthcare following great strides in treatments for the majority of conditions during the twenty-first century.
- In the United Kingdom, approximately 40,000 annual admissions (enough to fill four hospitals) are related to incorrect treatment (often resulting in adverse drug reactions) caused by incomplete information at the point of prescription.
- In the United States, as many as 98,000 Americans die from inpatient medical errors each year, and 770,000 people are injured or die in hospitals from adverse drug events each year.[19]

Long- Term Conditions

- Patients are living longer and there are many diseases which require long-term care, such as asthma, diabetes, and chronic heart conditions. This type of care requires teams of specialists, primary care providers, and community services to work together to provide patient care. This means that teams need to work together for long periods of time and have access to common, shared information.

Outcome-Based Funding

- Many countries are committed to outcome-based funding as a means of achieving a consistency of care across a geographic area. At the moment, the care provided is often dependent on the individual specialist

[19] Institute of Medicine (IOM), Corrigan et al., 2000

and his/her treatment regimes, which in turn will be influenced by the specialist's medical training and immediate peer group.

Productivity and Service Delivery Reform

- Everyone would like to improve the quality of patient care, but this has a cost associated in terms of people and medication. To enable the change, health authorities are looking for ways of controlling costs and reworking service delivery to better meet the patient needs, such as providing care in the home. (In Paris there is a "virtual" hospital that provides patent care in the home rather than in the hospital ward.)

IN EMERGING COUNTRIES:

Disparity of Access

- Patients have a different level of care provision in rural (low-tech) locations as compared with city (high-tech) locations.

Medication Tracking and Costs

- There is a need to ensure that drugs, which are a major part of the healthcare budget, are tracked and made available to the patient and only the patient.

Public Health Education

- There is a need to improve the understanding of healthcare in the population.

Disease Prevention

- Disease prevention focuses on immunization programs (smallpox and TB), improved health awareness, epidemic tracking, and delivery of associated medication (AIDS, SARS, etc.).

Skills Availability

- Many trained healthcare providers are choosing to work in Western Europe and so depriving countries such as those in Africa of the trained doctors and nurses they need.

Knowledge Driven Health

Figure 12 illustrates the Microsoft view of healthcare needs in terms of the solutions, infrastructure, architecture, policy, and citizenship.

The vision is one of Knowledge Driven Health through connecting people and systems to enable enhanced collaboration for more informed decision-making, improving patient safety, personal health and clinical outcomes. This is achieved by ensuring that each care professional involved in patient or client care has immediate access to the necessary information, and that this information is consistent across all of the professionals involved in a particular case.

The vision is attained by providing a computing platform upon which optimum health solutions can be delivered in accordance with clear policies in areas such as privacy, security, standards, and interoperability. These policies are grounded on the principles of social and economic development. The *Connected Health Framework Architecture and Design Blueprint* provides prescriptive business systems and technical architecture guidance to assure design and implementation of solutions and platform.

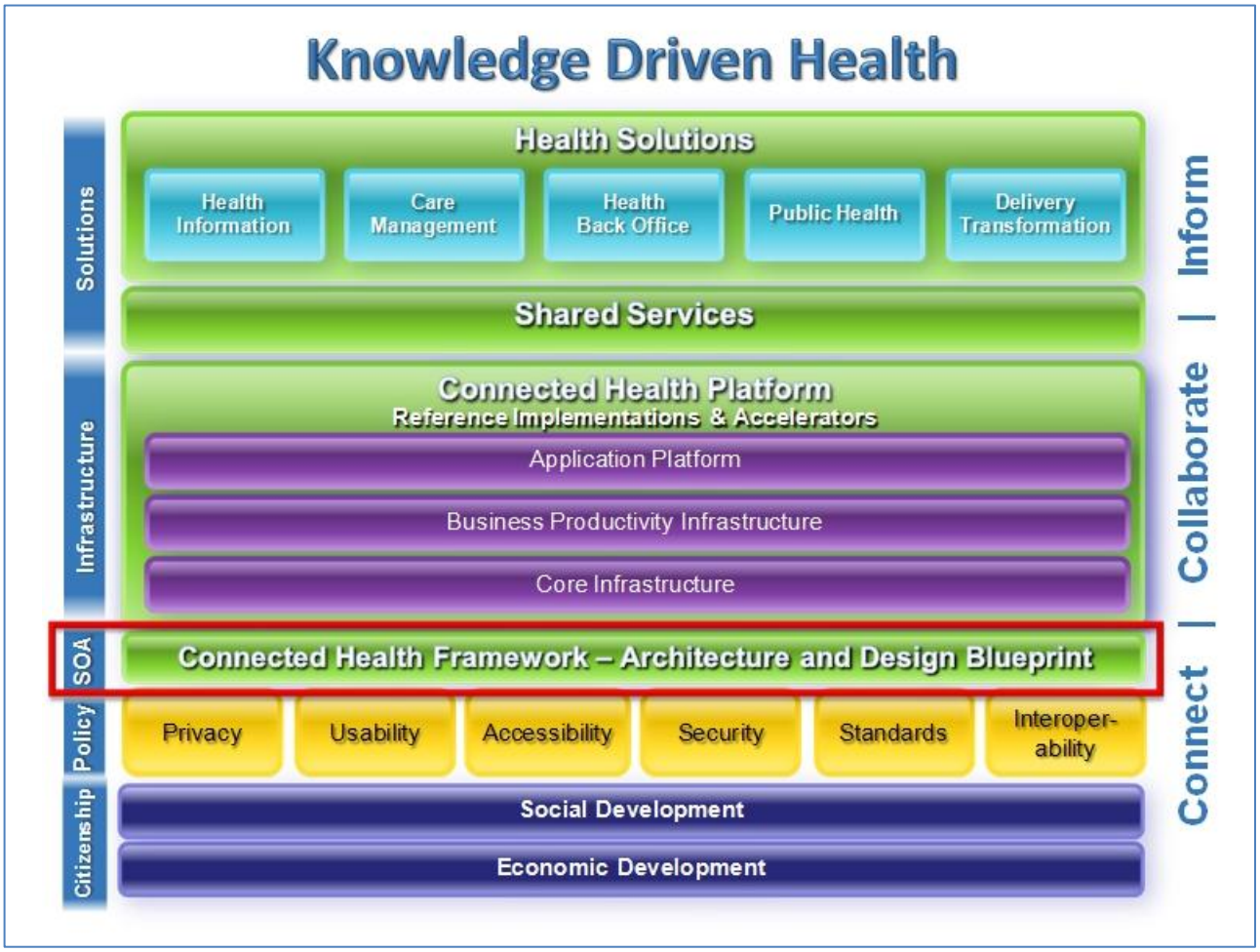

Figure 12. Knowledge Driven Health

Microsoft Partners, through the Connected Health Framework, would work to build and operate the systems environment which addresses the important functional areas of Health and Social Care. The solutions consist of key applications, usually built by Independent Software Vendors, which would be implemented by System Integrators into the comprehensive services that Health and Social Care market demands.

Benefits from the Common e-Health Infrastructure

Well architected and competently implemented-Health systems have the potential to realize significant benefits for all major stakeholders.

Overall Benefits

The overall benefits from the common e-Health infrastructure may include:

- Accelerated time-to-use for new services.

- Common, consistent building blocks such as user identity management, authentication, and authorization across all healthcare services.
- Improved user experience – a single sign-on for all healthcare services regardless of who provides them, and interaction across the whole of healthcare rather than separately with each of its silos.
- Improved developer experience – providing a consistent set of interfaces and specifications that apply to all applications, regardless of which department's services they interact with.
- Effective reuse of resources, rather than duplication of common components and infrastructure.
- A standards-based, interoperable solution – which can integrate easily with systems running on a wide variety of platforms.
- An always-available, 24x7 set of services

Benefits for Patients and Professionals

The benefits for the "clients" of e-Health services may include:

- Single online identity to access multiple healthcare services.
- Reductions in cost and time to enable online transactions in a consistent, reliable fashion.
- Hidden complexity and multiplicity of back-end systems interactions at the point of delivery, presented as a single online interaction.
- Simplified processes for interacting with healthcare across silos, including the potential for "joined-up" services.
- Faster access to services.
- Security-enhanced two-way communication between clients and healthcare services.

Benefits for Application Developers and Independent Software Vendors

For application developers and software vendors building e-Health solutions, the common infrastructure:

- Provides a single, consistent authentication and authorization model.
- Is platform- and technology-independent.
- Supports open standards.
- Provides consistent interoperability – standards-based interfaces help expose the functionality, regardless of the services and departments concerned, so applications may be able to submit all transactions through a single delivery point.

Benefits for Healthcare Providers

The common e-Health infrastructure:

- Supports a common user identity management model for all healthcare services.
- Shares common costs across multiple care providers rather than repeating expenditures multiple times by duplicating identical pieces of core infrastructure for each service.

- Enables innovative, joined-up services.
- Provides a single, consistent access path for healthcare services.
- Accelerates the delivery of e-Health services by providing reusable common components needed for online service delivery.
- Scales to meet the growing demand.
- Drives the take-up of e-Health services.

Integration and Interoperability in Health and Social Care

There is a major need, now recognized in most healthcare communities, to enable the interoperation of the existing systems in Health and Social Care and to augment them with a new generation of integrated systems focused on patient and client care. In considering integration and interoperability, there are three main aspects that require careful attention. They are:

- Semantic or Data Integration – the ability to understand exchanged data accurately, effectively, and consistently
- Application or Systems Integration – the ability to work together across organizational boundaries and use the information that has been exchanged
- Infrastructure or Technical Interoperability – the ability to ensure the uniform movement and presentation of data while helping to protect the its security and reliability

Semantic or Data Integration

We address this first because without complete, unambiguous understanding of the data, all attempts at integration will fail, perhaps disastrously. We assume that we know the definition of data items, so that when we say "patient" in one system context it means exactly the same in some other context. Unfortunately, without specific effort, this is not always the case. Before we attempt to transfer data from one system to another, we must ensure that the meaning of the data item is the same to the users of each system. The IT guru, James Martin, used the term "semantic disintegrity" to describe the confusion and errors that occur when definitions have not been agreed and mutually understood.[20]

Health and Social Care offer many opportunities for semantic disintegrity and the industry has expended much effort in defining terms and their meanings, and further has built extensive data models and data dictionaries. Comprehensive work has been done to define a number of standard terminologies – some narrowly focused, others broad and overlapping. Paradoxically, models and terminologies do not necessarily make integration and interoperability any easier.

Besides data definition and data descriptions, there are two further key factors that must be addressed before successful integration can take place: the way data is identified, and the standards used to encode and communicate the data.

[20] Strictly, "Semantic Disintegrity" occurs when a user submits a query and receives an answer, but the answer is not the answer to the question they believe that they asked. The phenomenon is caused by incorrect normalization of data or alternatively by misunderstanding any de-normalization that has occurred.

The **Identification of Data** is a major point of difficulty. In health, perhaps an obvious thing to do is to allocate a unique number to each patient and thereafter the patient number acts as the primary identifier for all patient data. This is done in the U.K., where each patient in England has an NHS number that is used in all patient-related transactions. However, in Scotland, each patient also has a unique number (the CHI number) but this is different from the English one. Since a substantial number of U.K. citizens have lived on both sides of the border, it would be necessary to use both identifiers to form a complete, life-long health record. The situation is similar between Canadian provinces and between countries in Continental Europe.

A more complex situation arises in social care, where care is delivered by many agencies, each using its own system of identifiers. This leads to the need to form a domain-level index accessible by matching "natural" attributes such as name, address, and date of birth to identify the individual and, as a the second step and subject to privacy and confidentiality constraints, obtaining a list of the secondary services applicable to the citizen with the identification numbers or keys required for access to the appropriate agencies' data. Clearly the agencies would be required to register with the indexing service and keep their entries up to date.

An Architect's Viewpoint

Identifying data uniquely and unambiguously is a vital action but too often architects and system designers jump to a hasty and over simple solution – they allocate a serial number to identify an occurrence of a data object or entity. They do not pause to think about the "natural keys" that uniquely identify a data occurrence. How, for example, do you identify a patient – by their number (which they probably do not know) – or by their name, address and date of birth?

We suggest that each and every entity should have a defined natural key that provides (or can be mapped to) a unique identifier. We do this in the CHF business pattern.

Using a generated number is a convenient processing device but can conceal a deeper underlying meaning.

In the United States, an influential "think tank" named "Connecting for Health" (coincidentally the same name as the group in England) concluded that a single national health ID is unworkable in the U.S. and would not provide the hoped-for benefits even if it could be implemented.[21] It stated that "there seemed to be no easy way to achieve the benefits of linking records without jeopardizing privacy and associated values. Previous proposals for a national health identifier have been a major source of contention in the privacy debates and a stumbling block to linking health records. One major concern was that any identifier created for healthcare purposes would become as ubiquitous as the Social Security Number, becoming the single national identifier for every purpose. If the health identifier became a key that could unlock many databases of sensitive information, it would make all personal data more vulnerable to abuse and misuse."

It continues, "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 participating 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. The approach is based on the proposition that we should leave it to patients to determine locally with their providers what to link and what to disclose. By leaving these decisions at the edges, the architecture supports a range of approaches. It also allows higher levels of approval to be set locally for sharing some records."

[21] "*Connecting for Health*" is a public-private collaborative established by the Merkle Foundation in the U.S.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

This is a similar solution to our Social Care multi-agency index suggestion above. Further discussion on this topic can be found in the section *Identity Metasystem – Laws of Identity* in Part 3 of the CHF Architecture and Design Blueprint.

The **Coding of Data** also presents problems. There are a number of systems and standards for the classification of medical conditions and the coding of clinical data – for example, Systematized Nomenclature of Medicine - Clinical Terms (Snomed CT), the Reed Clinical Classification (RCC), the American Medical Association Current Procedural Terminology (CPT), the World Health Organization International Classification of Diseases (ICD-10) and others are in use – and they all have specific purposes. This leads to issues of translation when one standard is used in one system and another standard is used in a second, especially since there is not a 1:1 mapping between terms.

Having achieved an understandable classification of a medical condition, the issue then arises about what data is needed to describe the condition and how that data should be packaged for communication purposes. There is almost universal agreement that XML offers an appropriate vehicle for information exchange.

An Architect's Viewpoint

"Translation engines" such as those available from *Health Language* (http://www.healthlanguage.com) besides offering conversion from one code to another include free-format text parsers. Such parsers can be used to assemble data from diverse sources and using diverse coding systems, perhaps accessed using a multi-agency index, into a lifelong, longitudinal electronic patient or client record.

Health Level Seven is one of several American National Standards Institute (ANSI)-accredited Standards Developing Organizations (SDOs) operating in the healthcare arena. HL7's domain is clinical and administrative data and is a not-for-profit volunteer organization.

Since 1996, HL7 has been working on a new generation of standards known as Version 3 (V3). This new generation differs from V2 in that all standards developed under V3 arise from an underlying Reference Information Model (RIM), by applying a set of development steps defined in the HL7 Development Framework (HDF).

The aim of V3 is to produce consistency in the definition of different information objects and their representation in messages, thus allowing for easier implementation and the definition of clearer conformance requirements. Furthermore, the underlying modeling approach allows for the definition of standards for information representation other than just messages, including forms, decision-support mechanisms, and electronic patient record structures.

HL7 V3 standards are developed as models independent from the actual implementation. The current preferred implementation technology is Extensible Mark-up Language (XML).

A difficulty that arises is that many existing systems do not use HL7 V3, often using HL7 V2 or other formats for their external communications. This means that conversion modules have to be written to compose HL7 V3 message payloads.

***open*EHR**[22] is an open standard specification that describes the management and storage, retrieval, and exchange of health data in electronic health records (EHRs). In *open*EHR, all health data for a person is stored in a 'one lifetime',

[22] See *openEHR Architecture Overview*, openEHR 2007, eds. S. Heard & T. Beale and *Archetype definitions and principles*, openEHR 2005, eds. S. Heard & T. Beale.

vendor-independent, person-centered EHR. The primary focus of *open*EHR is NOT the exchange of data between EHR-systems; this is the primary focus of Message standards such as ISO13606 and HL7.

The key innovation in the *open*EHR framework is to leave all specification of clinical information out of the information model but, most importantly, provide a powerful means of expressing what clinicians and patients report that they need to record so that the information can be understood and processed wherever needed. Clinical information models are specified in a formal way, ensuring the specifications, known as “archetypes”, are computable.

Of course all health records will be different, but the core information in the *open*EHR framework always complies to archetypes. How can this work? Archetypes must express clinical information in a way that is as reusable as possible. To get to the point where information is suitably presented for clinical care, it always involves a number of archetypes. These are called “templates”, aggregations of archetypes that may also be refined for use in a particular situation. Templates may be used to specify forms, documents, or even messages.

IHE (Integrating the Healthcare Enterprise)[23] is an initiative by healthcare professionals and the industry to improve the way computer systems in healthcare share information. In 1997, a consortium of radiologists and information technology experts formed IHE, or "Integrating the Healthcare Enterprise". IHE aims to create a process through which interoperability can be implemented. The group gathers use case requirements, identifies available standards, and develops technical guidelines that manufacturers can implement. IHE also stages “connectathons” and “interoperability showcases” in which many vendors assemble to test and demonstrate the interoperability of their products.

IHE is an international organization that focuses on the development of global standards and on the regional deployment of interoperable products. Because of its limited resources, IHE concentrates on specific projects. It solicits proposals, and after surveying its members to better understand their priorities, it chooses areas to focus on.

Many purchasers and users report that systems that support IHE Integration Profiles communicate better, are easier to implement, enable care providers to use information more effectively, and facilitate more efficient delivery of optimal patient care.

IHE Integration Profiles describe a clinical information need or workflow scenario and document how to use established standards (such as HL7, DICOM, and LOINC) to accomplish it. A group of systems that implement the same Integration Profile address the need/scenario in a mutually compatible way.

Application or Systems Integration

The widespread adoption of clinician-controlled electronic health records (EHRs) is critical — but is not enough. A key part of a necessary transformation in healthcare is putting patients’ information directly into their own hands, and enabling patients to put often-missing information (such as what medications they are actually taking) into the hands of their clinicians. Personal health records (PHRs) can and should play an important role in helping bridge an information gap that exists too often today between people and the health professionals who serve them.

To bridge this gap, we believe that all PHR models need to evolve in a number of common ways. These include:

- Common means of correctly identifying each person and ensuring privacy protection

[23] See http://www.ihe.net/

- Common data sets, common secure data exchange standards, and common data coding vocabularies.
- Common sets of values and policies that place each person at the center of controlling his or her own information, support the secure storage of both professionally sourced and patient-sourced data, and promote the portability of the information based on each person's needs and wishes.

We expect that individual countries will need to implement healthcare solutions that:

- May or may not use a common national patient identifier.
- May use differing schemes for functional and data distribution ranging from complete distribution to complete centralization with many intermediate variants or hybrids.
- Will want to apply differing "rules" for user authentication and authorization.
- Will want to use differing standards for data coding.
- Will want to use XML, HL7 V3, and other broadly supported healthcare industry standards for data exchange.

Further, we expect that individual countries will have differing business requirements and priorities and, without doubt, will seek to minimize new software build and infrastructure, preferring to rebuild and rejuvenate existing applications and infrastructure wherever possible.

Most healthcare providers run a large inventory of applications, running on varying platforms and with patchwork coverage of requirements with many gaps and overlaps in the functionality. By and large, they are stand-alone applications with a low level of integration or interoperability. Additionally, many of these applications are old or proprietary application packages or sometimes both. In any case, they are difficult to modify or upgrade.

Health and Social Care – Summary of Requirements

In this section we discuss e-Health and add e-Care business and technical requirements. We do not address clinical requirements.

Summary of Business Requirements

Typical "business" requirements for the new generation of Health and Social Care systems may include the following:

- Construction of a **Lifelong Personal Health and Care Record**
- Enabling **Access for Each Citizen** to his/her own health and care records
- Providing **Portals and Gateways** to health and care information and advice
- Provision of new, consistent, **Role-Based User Interfaces** drawing their data from the underlying current applications
- Preservation of Person, subject, and time **Context** across services
- Maintenance of **Citizen Confidentiality** including the "anonymization" and "pseudonymisation" of data when used outside a valid person/professional relationship
- Compliance with national **Consents/Permissions** legislation and governance standards

- Use of XML, HL7 V3, IHE, openEHR, and **encoding standards** for clinical data
- Management and application of **Person/Professional Legitimate Relationships**
- Construction and supervision of **Personal Care Pathways** and Journeys
- Definition and management of **Clinical and Administrative Processes**
- **Delegations of Authority** and Group Authorizations to view personal data
- Interfacing and service- enablement of **Legacy Applications**
- **Bio-Surveillance** and **Population Health**

This list is in no particular order or ranking of importance, nor is it complete.

An Architect's Viewpoint

Service orientation is a means for building distributed systems. A *Service-oriented architecture* (SOA) maps capabilities and interfaces so that they can be *orchestrated* into processes.

SOA is about application interoperability, distributed systems, service provision and consumption, supporting business processes that provide better response and performance to their users, represent data and functionality at an appropriate level of granularity and, of course use carefully constructed interfaces that are independent of implementation.

Our concentration in these guidelines is towards the course-grained, business service rather than the fine-grained technical service.

We will explain this approach in detail in Part 2.

We are convinced that the best way to provide new facilities such as these, based on current application portfolios, is to use a service-oriented architecture approach.

In this, the current applications are "service-enabled" such that they offer their functionality and data to external consumers in a predefined format in response to predefined requests. Requests and responses are subject to "contract" that specifies factors such as availability, and accuracy, and "rules of engagement" such as authorization and confidentiality provisions.

We address these business requirements in detail in *Part 2 – Business Framework* of the CHF Architecture and Design Blueprint.

Summary of Technical Requirements

Typical technical requirements, aimed at creating the computing platform upon which these "business" requirements will operate, include:

- **Open Standards** for data and communications, including service-oriented technologies such as Web services.
- **Security-Enhanced Operations** for data and communications, providing authentication and authorization mechanisms as well as business continuity and data management facilities.
- **Interoperability** across diverse platforms, bringing together diverse systems and data sources into a coherent, controlled environment.
- Reliable and security-enhanced **Messaging** facilities, enabling flexible and agile orchestration of business processes and linking of disparate islands of automation.

- **Legacy Integration** including connectivity with existing systems in multiple domains, on multiple platforms, using open standards.
- **Privacy and Confidentiality** mechanisms that help provide patient control over his or her medical data, the uses to which it is put, and the healthcare professionals to whom it is made available.
- **Managed Computing Environments** that are self-monitoring and fault-tolerant, thus providing high levels of robustness and reliability.
- **Performance** both in terms of response and ease of use.
- Robust 24/7 **Availability** achieved by sound hardware configuration, rigorous software testing, and system design.
- Hot back-up and **Disaster Recovery** to mitigate service interruptions due to external factors.

We address these technical requirements in detail in *Part 3 – Technical Framework* of the Connected Health Framework Architecture and Design Blueprint.

An Overview of the Connected Health Framework

The lifelong record is a virtual record containing references to the "episodes of care" that have taken place in a person's lifetime. The purpose of the CHF ADB is to provide guidance about how to construct, maintain, and disseminate a longitudinal, lifelong record of a person's health and personal care. The record has to be stringently safeguarded and would be the property of the subject, who would have the means of controlling its use and distribution.

The Vision – "Seamless" Health and Social Care

The Microsoft vision for Health and Social Care is to enable the transformation of Health and Social Care delivery through innovative technology and partnerships that advance public health programs by enabling connected citizen care, improving quality of care and safety, and reducing the Health and Social Care cost burden.

Health and Social Care professionals— and increasingly the citizen too— require complete, readily accessible, and reliable access to care records and treatment information. Yet basic information — such as medical records that span prescribed medications, laboratory results, allergies, and family history — is often unavailable in an easy-to-access and reliable format. The key to increasing the quality of Health and Social Care while reducing cost is to provide care professionals with the right information at the right time —so that they can ensure the best possible provision of Health and Social Care. Further providing the patient or client with access to that information helps them be aware of the process of which they are the central focus. With access to their own record, subject to the appropriate safety controls, patients and clients can provide a wider context to their carers, point out errors, and guide the professional to information that might not be immediately obvious.

Microsoft believes that the effective use of Information Technology (IT) has a central role to play in helping to transform and improve Health and Social Care delivery and the operation of our Health and Social Care systems. An effective IT strategy can help reduce operational inefficiencies and deliver cost savings, enabling Health and Social Care providers to enhance the ways in which they deliver care. A truly integrated environment will help authorized professional staff access timely patient clinical information and case data, reliably and securely — in a way that not only best reflects the citizen's circumstances, but is also understandable to the citizen.

Our aim is to help Health and Social Care players to address their most pressing objectives while enabling a considered migration process to be implemented, offering a potentially rapid return on investment. By providing an approach that can help integrate the existing facilities and investments of a care-providing organization by using open industry standards, we gain a powerful vision of how IT can help deliver on Health and Social Care policy objectives, and a set of standards-based tools to deliver on that vision.

What Is the Connected Health Framework?

In the Microsoft Connected Health Framework (CHF) we seek to accommodate the full architectural spectrum by establishing a coordinated business and a technical framework for application integration and technical interoperability.

The framework takes into account the Health and Social Care environment within which requirements arise and solutions are devised. The Connected Health Framework aims to guide and support the analysis, design, development, and implementation work needed to produce working solutions to complex, interrelated

requirements on a national, regional, or local scale. To do so, the Connected Health Framework recognizes national Health and Social Care policies, the aims and objectives of Health and Social Care systems provision, and the goals of individual projects – all within the context of Health and Social Care needs, capabilities, and available computing and communications infrastructure. We illustrate the Connected Health Framework within this context in *Figure 13*.

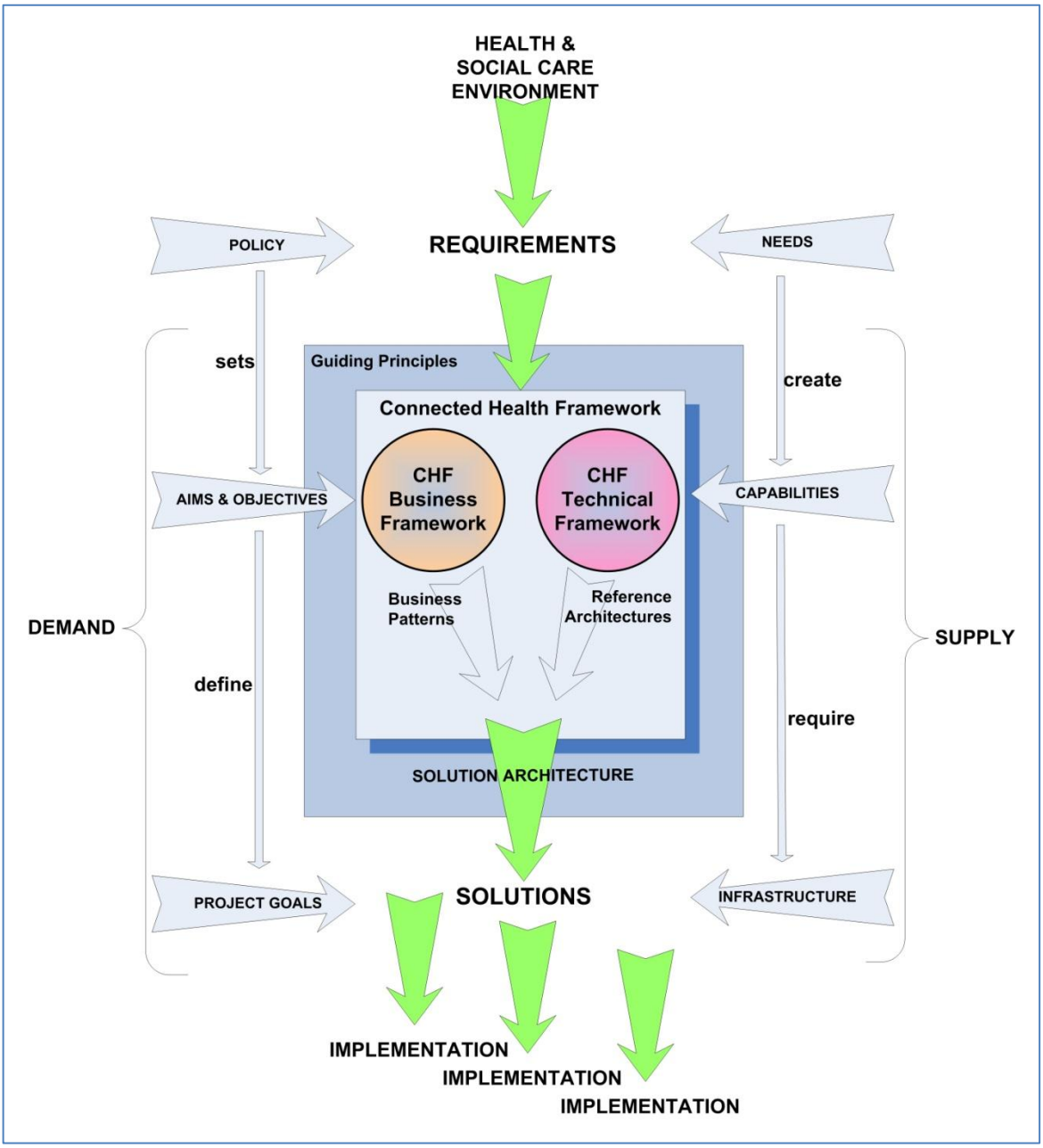

Figure 13. Connected Health Framework in Context

Guiding Principles

The Connected Health Framework is guided by the following principles:

- Achieve Application Integration, through
    - A stable foundation and agile implementations
    - Managed multiplicity of platform and location
    - Flexible application configuration and process engineering
    - Consistent, available, understandable data sources
    - Legacy rejuvenation and reuse

  Application Integration is enabled by the Connected Health Framework—Business Framework and is expressed as a Business Pattern for Health and Social Care.
- Achieve Technical Interoperability, through
    - Open standards
    - Best practice guidelines
    - State-of-the-art technical capabilities
    - Security-enhanced, manageable, efficient infrastructures

  Technical Interoperability is enabled by the Connected Health Framework—Technical Framework and is expressed as a Reference Architecture for Health and Social Care.

Aims and Objectives

Any solution to requirements developed using the Connected Health Framework will address the following aims and objectives. These are frequently demanded by Health and Social Care governing organizations and Health and Social Care providers in seeking e-Health solutions:

Application Integration

- Agility and Flexibility
    - "Plug and Play" application integration
    - Use of open industry standards
    - Process orchestration
    - Use of clinical messaging – HL7 V3, SNOMED - CT, IDC10
    - Module reusability and "replaceability"
- Legacy Integration
    - Integration of existing applications
    - Integration with legacy messages,

  - Integration with terminology coding structures
  - User interface and process design
  - Across multi application, multi platform environments (for medical error reduction)
  - Managed context for patient, user, and encounter
- Privacy and Confidentiality
  - Patient consent
  - Improved security of data (encryption, sealed envelopes)
  - Gatekeepers and guardians
- Health and Social Care Business Intelligence
  - Data analysis
  - Identification of best practice (role of coding)
  - Forecasting future Health and Social Care needs (could be based on Genomics-based medicine)
- Decision Support
  - Knowledge tools
  - Digital content
  - Material on the Web
  - Medic-to-Medic collaboration
- Role of Terminology
  - Event coding in linking and growing functionality

Technical Interoperability

- Agile, Flexible Architecture
  - Cross-platform interoperability
  - Use of open industry standards
  - Service buses and hubs
  - Message routing and transport – Web Services
- Identity management, authentication and authorization
  - Patient/citizen access control
  - Professional access control
  - Single sign-on to multiple systems
  - Role-based access control
  - Patient - Professional care relationships

- Reliability
    - 24/7/365 operation
    - Business continuity
    - Robust
    - Graceful degradation
- Data Availability and Audit
    - Disaster recovery
    - Logging, auditing access, and controlling changes
- Mobility
    - Use of personal devices (PDAs, tablets, mobile phones)
    - Data synchronization
    - Transaction freezing and resumption
- Performance
    - Fitness for purpose (response, dialogue optimization)
    - Ease of use
- Scalability - scale-up and scale-out capabilities
- Security features - business continuity and data management facilities

Capabilities

In developing and implementing solutions to requirements, the Connected Health Framework uses analysis and design methods and techniques and the facilities offered by available software products. The following capabilities or features are relevant:

- Development Methods
    - Component-based development and object orientation
    - Service-oriented architecture and Web Services technology
- Identity and Access Control
    - Directory services
    - Federated identity and authentication
    - Single sign on
- Enterprise Application Integration
    - Flexible architectures (federated through to centralized topographies)
    - Persistent to transient data stores and records

  - Middleware
  - Security-enhanced and more reliable messaging
  - Adapters and connectors
- User Interfaces and Processes
  - Role based
  - Device sensitive
  - Context sensitive
  - Consistency across platform
- Collaboration
  - Calendaring and e-mail
  - Conferencing services, presence, and real-time collaboration
  - Document management
- Business Process Orchestration
  - Synchronous and asynchronous operations
  - Service invocation
- Data Management
  - Clustering
  - Failover
  - Disaster recovery—mirroring, logging, and backup
- Scalability
  - Scale-up, scale-out capability
- Performance
  - Tuning services
  - Dialogue optimization
- Security features
  - Authentication and authorization mechanisms
  - Encryption
  - More secure messaging
- System management, monitoring and software distribution

Content of the Connected Health Framework

The cornerstone of this vision for seamless Health and Social Care is an efficient, effective IT infrastructure. Beyond simple connectivity, this demands systems that interoperate with each other seamlessly to reduce duplication, errors, wait times, and management overheads. Such a holistic environment would enable efficient planning and maximize resources. The Microsoft Connected Health Framework is a model on which such solutions can be built.

To support the common business processes and technical architecture, Microsoft has developed the Connected Health Framework. The Connected Health Framework has been created, and will continue to evolve, to help move Health and Social Care towards a series of easily available, interconnected, reliable, and efficient services. The Connected Health Framework provides a reference architecture and guidance in the following areas:

- **Infrastructure** to help enable a robust, manageable environment
- **Identity management** to help ease the burden of access and authentication
- **Integration** to share information
- **Information** to help turn data into knowledge
- **Interaction** to allow clinicians to work more efficiently

Microsoft is involved in projects around the world—including in the United States, the United Kingdom, New Zealand, Australia, Germany, Israel, Singapore, and Canada—that share goals that the Connected Health Framework addresses, including patient safety, improved health, and productivity and service delivery reform. Health and Social Care applications, built by Independent Software Vendors and often implemented by System Integration partners, can fully leverage the Connected Health Framework to support their legacy applications and the development of future applications.

The flexible and agile Microsoft framework is built on open standards that support seamless interoperability between platforms and vendors and help ensure that systems are highly scalable and secure. Additionally, the entire framework is modular, allowing Health and Social Care organizations and partners to select the pieces of the solution relevant to their needs.

The online electronic delivery of Health and Social Care services can act as an enabler for broader reach and improved quality and effectiveness of services. With architectures based on Connected Health Framework, Health and Social Care providers may be better positioned to offer convenient, easy access to information and services through various electronic channels and call centers. In addition, they will be able to promote “self service” to help reduce the cost and resources required for traditional delivery mechanisms, such as letter writing, processing paper forms, data entry, paper filing systems, and the staffing of reception offices.

Ten Key Health and Social Care Issues Addressed by the CHF

We have identified a number of important themes that run through the Connected Health Framework in general and this guide in particular. We have consolidated these into ten key issues that we will attempt to address in this guide. These are:

Ten Key Issues in Health and Social Care Systems

1. How to define and create a citizen's Health and Social Care record
2. How to build a lifelong history for a citizen from information held in multiple, diverse systems
3. How to identify citizens or Health and Social Care professionals uniquely and reliably
4. How to manage citizen consents and professional authorities to ensure privacy and confidentiality
5. How to create a "seamless" user experience
6. How to "join up" diverse systems on diverse platforms with diverse data and make them interoperate
7. How to manage business processes that span multiple systems and multiple domains
8. How to enable legacy systems to participate in new, wider, integrated scenarios
9. How to achieve flexibility and agility to cope with rapid change
10. How to achieve performance and scalability as user populations, transaction numbers, and data volumes grow

The information provided in the *Connected Health Framework Architecture and Design Blueprint* guide is extensive, running to several hundred pages, and addresses both the business and technical aspects of Health and Social Care systems focusing on the ten issues above.

The Vision: "Seamless" Integration

The **Connected Health Framework—Business Framework** addresses application integration and is based on a service-oriented approach focused on defining a set of business components, each addressing a major subject area and offering a range of services that can be "orchestrated" to enable and support the wide range of healthcare business processes. Wherever possible, existing sources of functionality and data are used. A set of business components and service definitions for citizen-centric care is offered, and this constitutes our Business Pattern for Health and Social Care. This is described in Part 2 of this guide.

Figure 14 shows a Business Pattern for Healthcare as envisioned by the Connected Health Framework.

Patterns are useful in that they describe generic solutions to recurring problems, within a defined context. The basic premise of patterns is that, if something has been done successfully before, don't "reinvent the wheel." Developing

and implementing a Service Oriented Architecture is amenable to a pattern-based approach. Patterns are available to address the business, integration, and technical aspects of SOA.

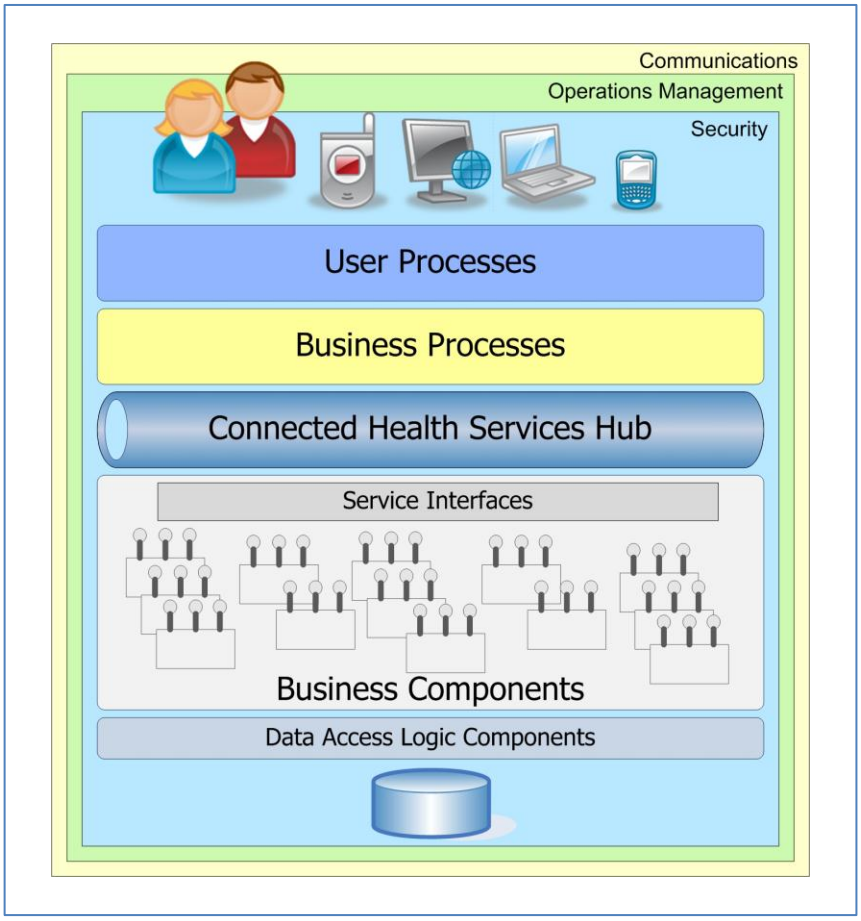

Figure 14. A Business Pattern for Healthcare

There are two possible, but complementary, ways to look at this. One is to use the CHF Business Pattern as a guide for analyzing and defining the business components appropriate for the specific context and requirements. Chances are that the resulting specifications will be pretty similar to those offered in this guide. The other is to use the specifications provided in the CHF Business Pattern as a starting point, and modify as appropriate. We hope that with either one of these approaches the CHF Business Patterns will prove useful, saving a significant amount of effort.

The implementations will be different because the infrastructural environment will be different; however, in terms of conceptual function and data, they will be similar. For patient-centric Health and Social Care, we have defined of a number of business components and services.

These were derived from real-life and proof-of-concept projects and include the following:

1. Persons and Identities Component
2. Patient and Client Groups Component

3. Personal Health and Care Status Component
4. Personal Affiliations and Entitlements Component
5. Personal Consents Component
6. Patient and Client Journeys Component
7. Personal Care Records Component
8. Patient and Client Management Component
9. Assessments and Care Plans Component
10. Health and Care Classifications Component
11. Medications and Treatments Component
12. Investigations, Orders, Tests and Results Component
13. Care Pathways Component
14. Processes and Protocols Component
15. Organizations, Care Providers and Services Component
16. Care Facilities and Schedules Component
17. Waiting Lists Component
18. Care Professionals' Component
19. Professional Roles and Teams Component
20. Current Clients, Patients and Care Relationships Component
21. Costs and Prices Component
22. Clinical and Care Data Management Component
23. Rules Engine Component
24. Clinical Coding and Datasets Component
25. Social Care Coding and Datasets Component

This list forms a basic inventory of components for a patient-centric care record system.

Specializing the above definition, a Business Pattern describes a re-usable approach to the solution of a particular business problem, usually scoped by a business process. It offers a solution based on previous success in defining solutions to the same, or similar, business problems. A business pattern may be described as an "architectural template for a business solution".

The component definitions are platform- and technology-independent; each is also functionally independent and uniquely "owns" its data. Indicative contents (function and data) have been defined. The functionality and data is made available via defined services. These services have been identified. The component-based approach provides a highly modular Integration Framework and, besides providing a development specification, provides a means of evaluating the content, coverage, and fit of third-party and legacy-derived components.

Given an inventory of components and services such as this, we can foresee a potential service-oriented architecture for Health and Social Care as in this diagram.

The formation of this Business Pattern is described in detail in *Part 2* of the Connected Health Framework Architecture and Design Blueprint.

The Vision: "Joined Up" Technical Interoperability

The **Connected Health Framework—Technical Framework** is concerned with interoperability and discusses approaches to addressing the common architectural challenges:

- Flexibility and Agility
- User Experience and Acceptance
- Support for Multiplicity of Platform, Location, Language, Capability and Credentials
- Handling Health Data
- Identity and Access
- Interoperability
- Securing the Solution
- Scalability and Performance
- Availability, Resilience and Disaster Recovery
- Realizing the Value of Common Infrastructure

Figure 15 presents a typical Reference Architecture for implementing an e-Health solution at any level – from local enterprise to regional to national and cross-agency systems. It introduces the concept of a generic e-Health Node providing a common infrastructure that can be shared by multiple e-Health providers, and discusses the *typical services* that may be provided:

- Identity Management Services
- Authentication and Authorization Services
- Service Publication and Discovery Services
- e-Health Business Services
- Electronic Health Record Services
- Health Domain Services
- Health Registry Services
- Integration Services
- Data Services
- Communication Services

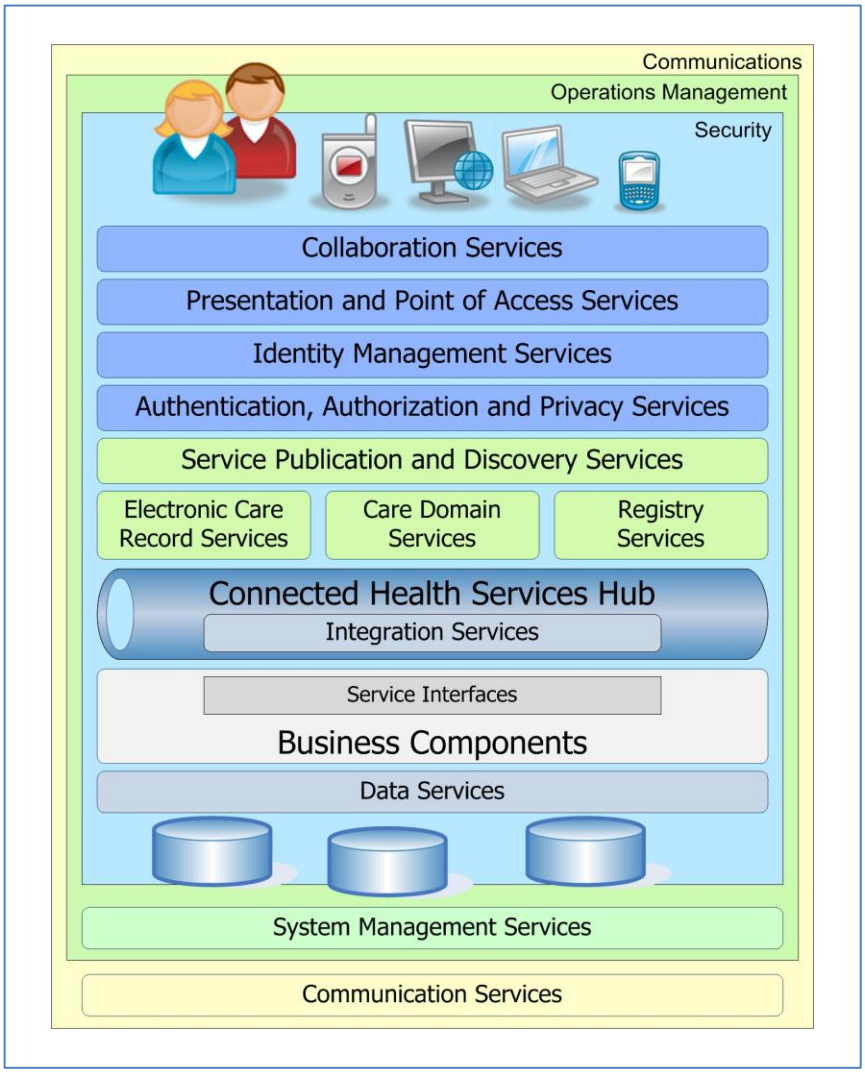

Figure 15. Reference Architecture for Health and Social Care

These are described in detail in *Part 3* of the Connected Health Framework Architecture and Design Blueprint, which also provides *architectural guidance* on the following topics:

- Deployment Options – various deployment models to be considered when implementing the e-Health reference architecture against varying jurisdictional requirements and constraints.
- Securing the System – pointing to generic guidance on the subject available elsewhere, and focusing on some aspects specific for large-scale e-Health systems
- Performance and Scalability, which looks at the issues involved in creating a solution that meets the criteria for availability, robustness, and performance. Techniques include capacity planning, and implementing a scalable hardware and software architecture.

The Business Pattern and the Reference Architecture focus on different aspects of the system and represent distinct viewpoints, but they align very closely, as shown in *Figure 16*.

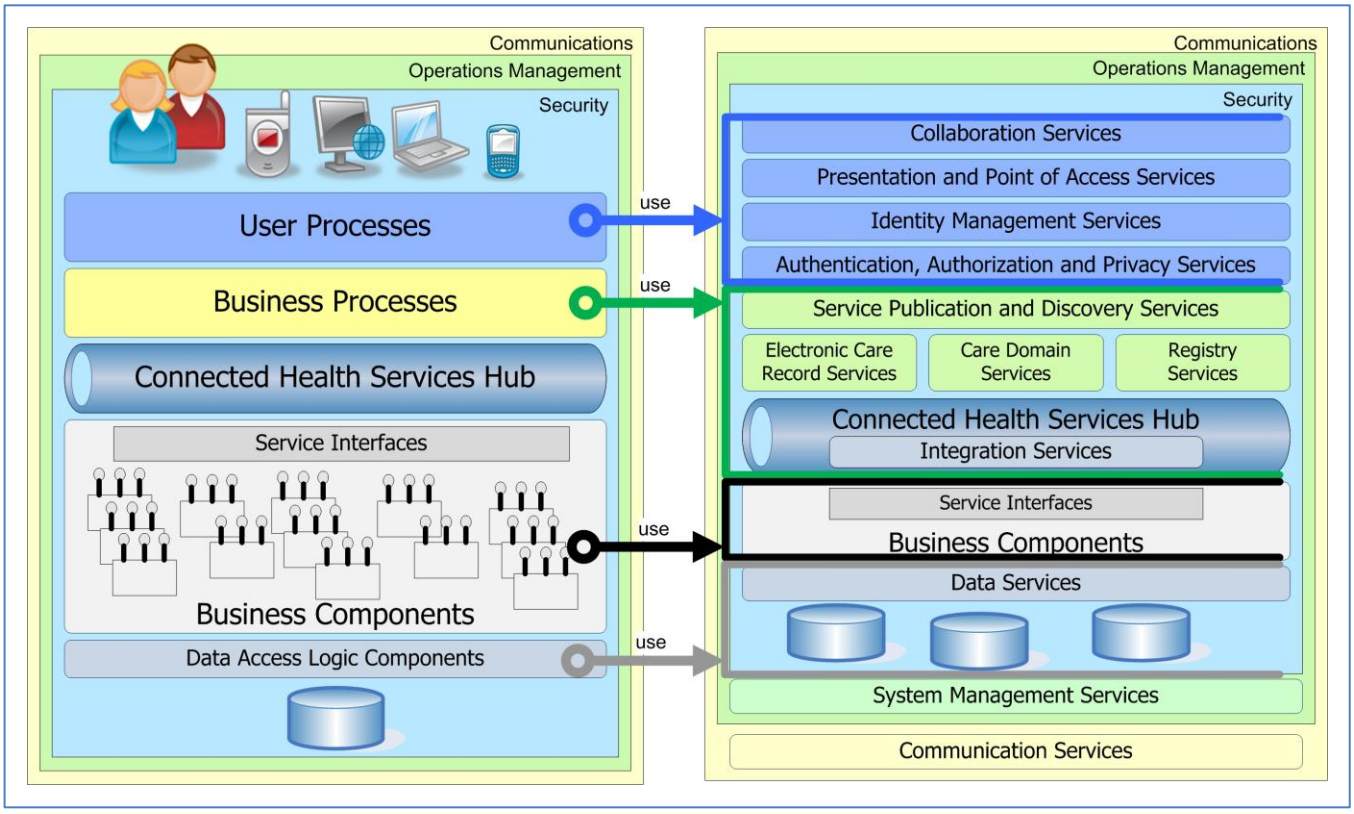

Figure 16. Alignment of the Business Pattern and the Reference Architecture

Figure 17 shows the Business and Technical Frameworks within a combined schematic, aligned around the Connected Health Services Hub.

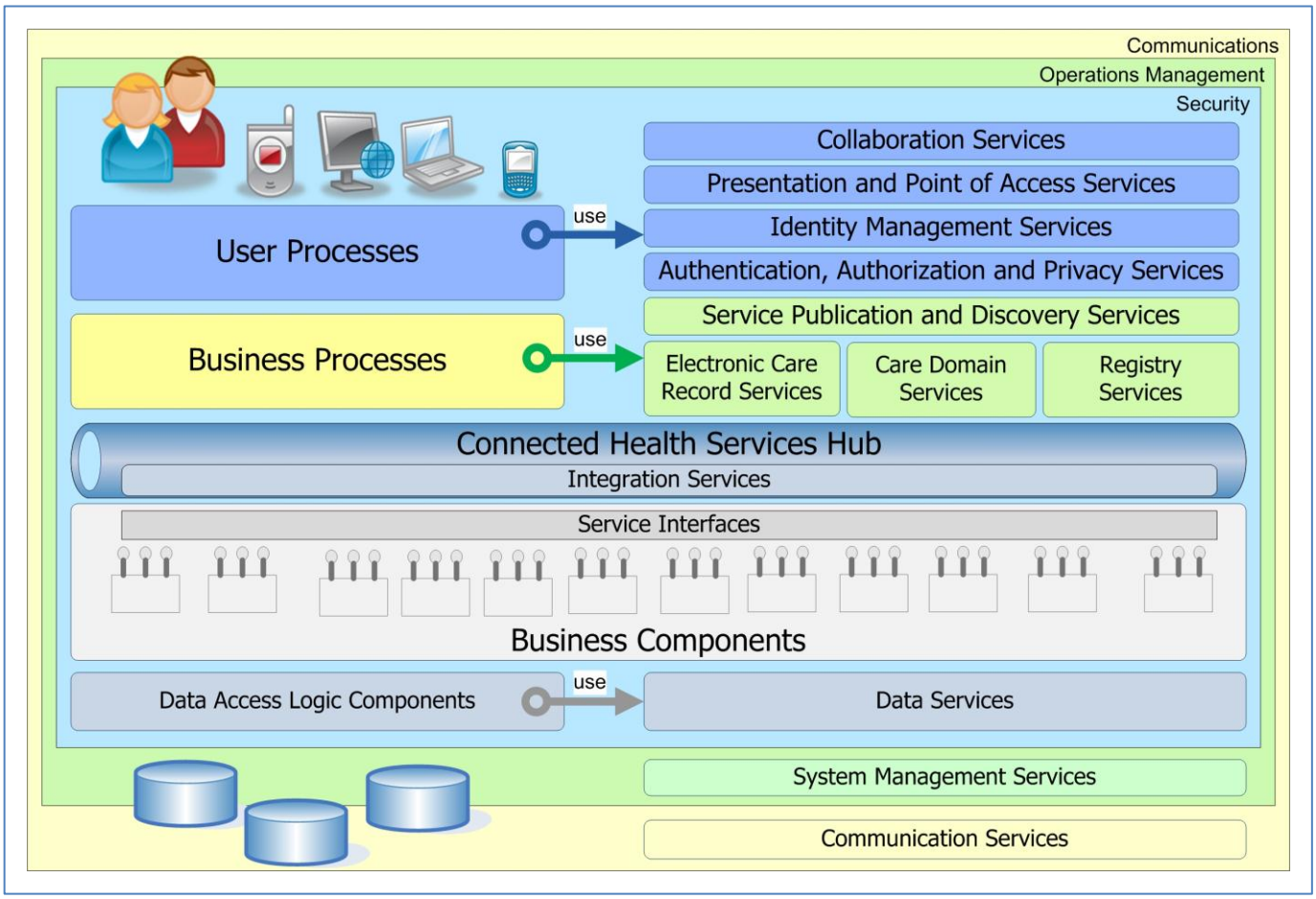

Figure 17. Connected Health Framework Joined-Up Architecture

The presentational business requirements of the user interface and user processes are facilitated using technical capabilities of the Identity Management, Privacy and Security and Presentation and Point of Access Services provided in the Technical Framework. Similarly, the business process requirements are facilitated using the Connected Health and Social Care Services Hub and the technical capabilities of the Service Publication and Location, eHR, Health Domain, Registry, and Integration Services provided in the Technical Framework. The data access requirements are supported by the Data Services capability.

Business Services, identified and componentized in the Business Framework, can now operate upon the platform provided by the Technical Framework and combine through the Connected Health and Social Care Services Hub to satisfy the business requirements of the Health and Social Care domains.

In conclusion, we recognize the need for agility made possible by having a stable foundation. The Connected Health Framework helps support that agility by separating the more volatile user and business processes from the more stable business and data services, the “join” between the agile and stable worlds being provided by the Connected Health Services Hub (*Figure 18*).

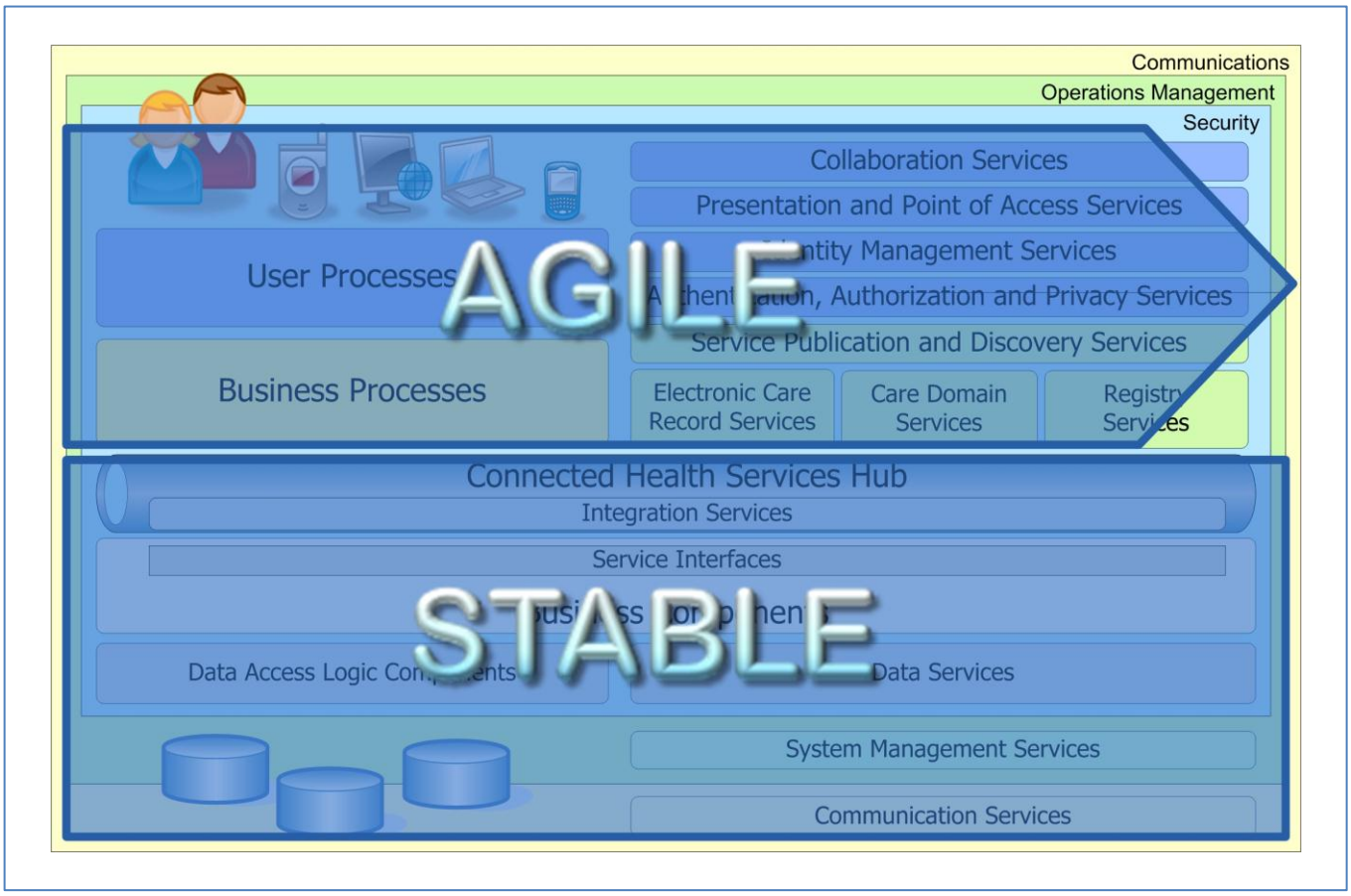

Figure 18. Connected Health Framework – A Stable Foundation for Agile Health and Social Care

Structure of the Connected Health Framework Architecture Blueprint

The **Microsoft Connected Health Framework *Architecture and Design Blueprint*** (*Parts 1 - 5* of this document set) provides generic and scenario-specific recommendations to help design, develop, deploy, and operate an architecturally sound application portfolio and an interoperable infrastructure in a Health and Social Care environment. It offers deep technical guidance based on real-world experience. The technical guidance was created and reviewed by Microsoft architects, engineering teams, consultants, product support engineers, and by Microsoft partners and customers. The result is a thoroughly engineered and tested set of recommendations that can assist with architecting your solution.

The Microsoft Connected Health Framework addresses two main subjects – Seamless Application Integration and Technical Connectivity and Interoperability.

The ***Business Framework (Part 2** of this document set)* addresses the issue of the Seamless Integration of Healthcare applications and builds on Microsoft experience in specifying and building large scale service oriented architectures in general and national level Health and Social Care projects in particular. It describes the characteristics of service orientation and suggests a way of defining business services working from business requirements. It describes some

key Health and Social Care system design concepts and suggests a set of business components and services recommendations for a patient-centric health records system and finally, considers how to service-enable existing applications. It also comments on the deployment of Health and Social Care application packages into a regional or national-level solution.

Importantly, it offers a Business Pattern for Health and Social Care focused on 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. We offer a list of likely business functions or capabilities; a conceptual data model of the business domain including data entity definitions; and a set of business component definitions that include suggested business services that may be orchestrated to provide a tailored solution that meets more specific requirements at local, regional or national level. As experience of use of the Connected Health Framework grows, the business pattern may be expanded and more comprehensive business patterns may be documented.

The ***Technical Framework*** *(**Part 3** of this document set)* addresses the issue of Technical Connectivity and Interoperability in Health and Social Care at the infrastructure level and builds on the principles and practices of interoperability in the delivery of Government e-services. The Connected Health Framework—Technical Framework describes the many issues involved in achieving successful Health and Social Care-oriented interoperability programs – together with the tools, technologies and standards that help make "joined up" systems possible. It discusses approaches to addressing the common architectural challenges listed in the section *The Vision: "Joined Up" Technical Interoperability* (p.*58*).

Part 3 also presents a typical Reference Architecture for implementing an e-Health solution at any level – from local enterprise to regional to national and cross-agency systems. It introduces the concept of a generic e-Health Node providing a common infrastructure that can be shared by multiple providers of e-Health services, and discusses the various services that may be provided. Part 3 provides guidance on various deployment options, security, performance and scalability of e-Health solutions.

In ***Part 4 – Using the Connected Health Framework*** of the Architecture Blueprint we describe how the Connected Health Framework guidance may be used in defining practical, effective solutions to Health and Social Care system requirements. These requirements usually arise at national or regional level, often emanate from government or major Health and Social Care providers, and take the form of formal Requests for Proposal or Tender documents.

We describe four typical scenarios (and respective *viewpoints*):

- Organizing Requirements (*customer view*), in which we suggest a process for formulating and presenting a structured set of requirements for a patient or client-centric Health and Social Care system. Typically this is a difficult process involving many inputs, many changing and challenging opinions and requirements, and an evolving technical platform. We believe that the Business Pattern provided by the Connected Health Framework can help in clarifying and organizing concepts and needs by providing a context in which ideas may be compared and contrasted. In a similar way technical factors may be checked against the Connected Health Framework Reference Architecture.
- Aligning a Health or Social Care Application with the Connected Health Framework (*software vendor view*), in which an existing Health or Social Care application may be assessed for alignment with the Connected Health Framework Business Pattern and Reference Architecture. This suggests areas of the application that might be re-engineered to enable interoperability of the application in an environment built in accordance with the Connected Health Framework guidance. This is achieved by aligning the application with the range of business and technical services described in the Connected Health Framework Business Pattern and Reference Architecture.

- Developing Solutions (*system integrator view*) in which a Statement of Requirements (RFP) is analyzed to clarify and categorize requirements against the business and technical frameworks of the Connected Health Framework. This allows a comparison of requirements to be made against the Business Pattern and Reference Architecture and thus against available, aligned application software and preferred operational environments. This enables identification of gaps and overlaps and provides a vehicle for a structured response to the RFP.
- Defining the Operational Environment (*operator view*), in which we describe how a Health and Social Care Provider or a System Integrator may use the Connected Health Framework—Technical Framework to guide the specification and design of an overall technical framework, hosting a variety of Health and Social Care applications, to help meet requirements at a national, regional or local level.

In all of this work we must stress that the Connected Health Framework is only a Pattern – it is not a solution on its own. The guidance in the business pattern and reference architecture contain generalizations and approximations and are incomplete in terms of coverage of the business domain. They are NOT complete solutions and are offered only as a guideline.

Part 5 - ***References and Further Information*** contains links to additional resources, a glossary of terms commonly encountered in e-Health and e-Care solutions, and some of the more extensive examples referred to in the other parts of the Architecture and Design Blueprint.

Authors and Contributors

The *Connected Health Framework - Architecture and Design Blueprint* guide was produced by an international team of specialists from different parts of Microsoft, and numerous partner organizations – aiming to capture and represent the accumulated experience and lessons learned from many e-Health projects around the world.

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There have been many other contributors, and original authors—too numerous to mention—whose work has been included in the guide, or at least they have provided good ideas and answers. Their help is greatly appreciated.