White Paper

Transforming Care Delivery with Windows Azure

Scenarios for Windows Azure in Health

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Summary

Whether you are a care provider or government organization, a software vendor developing care systems, or systems integrator assembling complex solutions—cloud computing has the potential to enable delivery of better quality care to more people at lower cost. This paper describes some typical scenarios where the new opportunities and flexibility offered by the Windows Azure™ platform allow expanding health information and communication technology (ICT) to the cloud, rethinking how solutions are developed and delivered, and realizing significant benefits for the stakeholders.

Microsoft Cloud Strategy

Let us refer to “Cloud” by using a definition from the National Institute of Standards and Technology (NIST): "a computing capability that provides an abstraction between the computing resource and its underlying technical architecture—servers, storage, and networks—enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction”.

This definition embodies distinct characteristics of the Cloud:

1. On-demand service – Utility model that allows you to access resources based on demand when you need it
2. Broad network access – anytime, anywhere ubiquitous access via network
3. Resource pooling – location independent and geographically distributed computing resources
4. Rapid elasticity – Demand-driven provisioning of resources in a rapid self-service fashion to enable scale-up/down scenarios
5. Measured service – Usage is metered and you only pay for resources that you use

Cloud offerings can be distinguished into the following categories:

Software as a Service (SaaS) are end-user applications people rely on for business, personal use, and more. These applications are consumed via the Internet through devices such as PCs, TVs, gaming consoles, phones, and more.

Platform as a Service (PaaS) is an operating environment for cloud-based applications—similar to the capabilities that an operating system (OS) provides to application developers. With PaaS, you concentrate on creating functionality for your cloud-based applications rather than the underlying infrastructure/environment that will be offered by the cloud vendor.

Infrastructure as a Service (IaaS) provides on-demand datacenter capacity for servers, storage and networking.

With the XaaS offerings described above, the Microsoft cloud strategy encompasses a range of dimensions on what the cloud should enable with services and offerings that span across Search, Social Networking, Gaming, Smart Devices, Business Productivity and Server advancements. In this paper, however, we will discuss the Windows Azure platform specifically.

Windows Azure Platform

The Windows Azure platform is a set of cloud computing services that can be used independently or together. Windows Azure's flexible and interoperable platform is used to build new applications to run from the cloud or enhance existing applications with cloud-based capabilities. It allows developers to quickly and easily build, deploy, scale, and manage applications and web services by focusing on delivering business logic and functionality to applications rather than worrying about the underlying infrastructure and operational obstacles when it comes to cloud applications. Developers benefit from having an integrated toolset and seamless testing mechanisms through the Microsoft Visual Studio® development environment which has been updated to support cloud-based development projects.

Windows Azure simplifies maintaining and operating applications by providing on-demand compute capabilities and storage to: host, scale, and manage web services and connected applications.

The platform is a set of cloud computing services that enable:

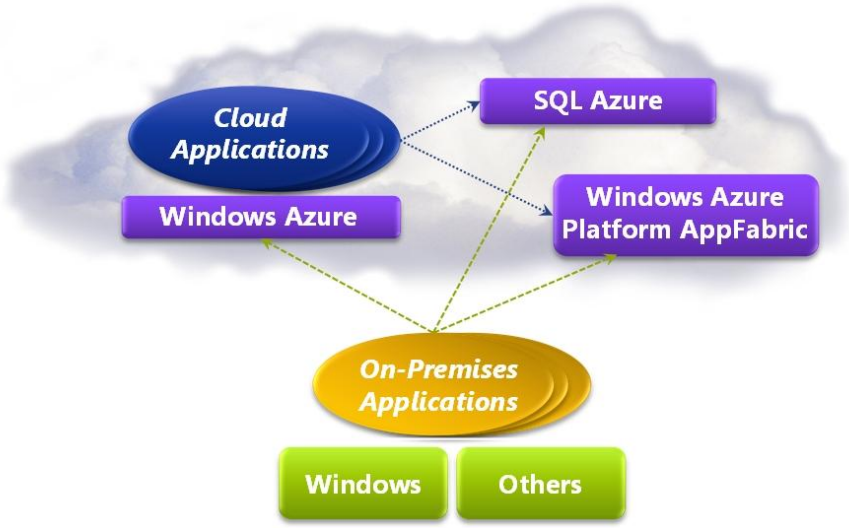
- Developers to use existing skills and familiar tools to develop cloud applications,
- Independent Software Vendors (ISVs) and Systems Integrators (SIs) to rapidly reach market and pay as you go,
- IT Managers to gain access to a new set of resources without adding complexity, and
- Organizations of all sizes to quickly respond as business needs change.

The Windows Azure platform is a group of cloud technologies, which can be used both by applications running in the cloud and by on-premises applications.

The components of the Windows Azure platform are:

- **Windows Azure:** Provides a Windows®-based environment for running applications and storing data on servers in Microsoft® data centers.
- **SQL Azure™:** Provides data services in the cloud based on Microsoft SQL Server®.
- **Windows Azure platform AppFabric:** Provides cloud services for connecting applications running in the cloud or on premises, and for managing access.

For a more detailed overview, see the paper *"Introducing the Windows Azure Platform"* (http://go.microsoft.com/fwlink/?LinkId=158011), and other materials available on http://www.microsoft.com/windowsazure/getstarted/.



The Windows Azure platform offers a generic environment to create cloud applications and services. It is agnostic of healthcare concepts and standards such as DICOM, ICD9, SNOMED—which apply at the higher levels of semantic interoperability. Rather, its primary goal is to be a toolset and the platform on which ISVs, organizations, and developers can create and deploy cloud-enabled or cloud-based applications using existing popular Internet standards (SOAP, REST, XML) and a variety of modern development languages (.NET, Java, PHP).

As Healthcare specific solution scenarios and workloads are expanding into the cloud-based offerings, vendors and customers will be required to build highly scalable, reliable services that can be used simultaneously by any number of users and devices. They will be required to build their own foundation, invest in their own infrastructure and develop their own software to handle Internet-scale traffic and demand. Just as the Windows operating system (OS) allowed ISVs, customers, developers to focus on building value-add on-premise applications instead of building OS specific features, components, and drivers, the Windows Azure platform enables the same foundation for cloud applications (apps).

Today, the Windows Azure platform enables data replication, fault-tolerance, geo-distribution of data, Internet scalability, service bus connectivity, security and identity federation, storage, and more through offerings such as Windows Azure (computation and unstructured/semi-structured data storage); Windows Azure platform AppFabric (service bus and security); SQL Azure (SQL-based structured storage). Previews of future functionality will be provided through early adoption programs such as Community Technology Previews (CTP), Betas, and Azure Labs—an incubation place to access early bits. Current previews of future services include:

Data Synchronization: Using SQL Azure Data Sync, organizations can leverage the power of SQL Azure and Microsoft® Sync Framework to build business data hubs in the cloud, allowing information to be easily shared with mobile users, business partners, remote offices, and enterprise data sources; all while taking advantage of new services in the cloud.

Codename "Dallas": A new service allowing developers and information workers to easily discover, purchase and manage premium data subscriptions in the Windows Azure platform. "Dallas" is an information marketplace that brings data, imagery, and real-time web services from leading commercial data providers and authoritative public data sources together into a single location, under a unified provisioning and billing framework. In addition, "Dallas" APIs allow developers and information workers to consume this premium content with virtually any platform, application or business workflow.

In the future, we should see other offerings become available, such as:

Workflow Services: A new service part of the AppFabric, which enables workflow orchestration of composite web services.

Architecting Health Solutions for Azure

The design principles and architectural guidance in the *Microsoft Connected Health Framework (CHF)*—available free from http://www.microsoft.com/industry/healthcare/technology/Healthframework.mspx—are also applicable when architecting solutions for the cloud. Following the tenets of service-oriented architecture, modularity, and interoperability facilitates easy transition of data services, or entire solutions to the cloud.

Identifying common functionality and decoupling it from individual applications as a "shared service" not only simplifies development and avoids duplication, but also enables the flexibility to deploy and consume such functionality from other nodes and levels in the system, including the cloud. Many essential elements of health solutions (reference information, clinical pathways, terminology services, health records) can often be developed and maintained more effectively at enterprise, group, regional, national or global levels. The right distribution of functionality and topology of the system would be different depending on the specific context and constraints, but maintaining the flexibility to be able to deploy (and possibly change over time) different services without major redesign of the entire system is essential for harnessing the new opportunities offered by the cloud.

Liberating health data from individual application silos not only facilitates easier collaboration and continuity of care across multiple professionals and organizations, but also allows the flexibility to store, manage, and offer data resources to relevant applications and users from different nodes in the system, including the cloud. The location of data can be optimized depending on cost, capacity, resilience, security and other considerations, and easily changed as needed, with minimal disruption of the running systems.

Architecting solutions, to allow multiplicity and independence of different modes of authentication and access control (claims-based, identity federation, identity mapping)—a good general approach for any kind of health solution—is also essential to enable moving some services or entire applications to the Windows Azure platform.

Windows Azure Scenarios for Health

This section describes some typical scenarios where the Windows Azure platform can open up new approaches to delivering innovative services and improving efficiency in healthcare and citizen services.;

Enterprise Image Archive

Gartner 2010 Healthcare Predictions research shows a strong interest in centralized image archiving from individual care delivery organizations (CDO) with multiple departmental picture archiving and communication systems (PACS), regional multi-hospital organizations, health information exchanges (HIE), and from regional and national healthcare systems. Gartner defines the enterprise image archive (EIA) as a centralized, long-term storage facility for medical images maintained in multiple PACS. Each PACS contributes studies to the archive while maintaining its own local transactional cache, although after a study attains a certain age or meets certain migration requirements, it is removed from the local cache and archived. Enterprise image archiving replaces local storage with more-scalable and cost-effective storage in the cloud, which reduces storage expenses, along with associated datacenter facility expenses (including power, cooling and staff), and helps to improve CDO's disaster preparedness. Maintaining images in an EIA also enables easier integration with computerized patient records (CPRs), electronic medical records (EMRs), and portals, and makes it possible for images to be used by HIE initiatives. The trend is to expand EIA to include other objects such as audio, video, images (JPEG, TIFF, BMP), scanned and Microsoft® Office documents. [1]

[1] **Vi Shaffer, Jonathan Edwards, Thomas J. Handler, M.D., John-David Lovelock, Wes Rishel, Barry Runyon,** *Predicts 2010: Healthcare Providers and Governments Seek the Benefits and Address the IT Implications of Electronic Health Records,* http://www.gartner.com/ (December 2009)

In recent news, Image Movement of Montana, an organization composed of 30 healthcare facilities will be sharing radiological data through cloud-based technologies offered by eMix (Electronic Medical Information Exchange). The Cloud platform, in this case, provided institutions with disparate PACS the ability to exchange full resolution images and reports and drive operating and integration costs down.

Image archiving is one example of using cloud services to offset data explosion and on-demand storage management requirements.

Cloud Storage

The healthcare industry is experiencing explosive growth of data being collected from a variety of diagnostic and monitoring equipment, which needs to be stored securely and efficiently—and made available when needed. Just as in the case of radiology image archiving discussed above, other types of healthcare data can take advantage of cloud storage that could be elastic on demand—meaning increased capacity could be provisioned in the matter of seconds rather than days or months required to deploy on-premise systems. Physical storage will continue to increase in capacity at a lower unit price, but over time operating and capital expenses for maintenance, hardware, cooling, and power of data centers can increase. Cloud storage provides opportunities to lower capital and operating expenses while providing on-demand data storage. An initial wave of adoption will be around "cold" clinical data—historical data that is a prime target for archiving, which is not accessed frequently. This data could be moved to the cloud storage to make room for "hot" data—data that is operational and requires frequent access from clinical systems.

Storing data in the cloud also provides new ways of providing the necessary resilience and recovery.

Disaster Recovery and Business Continuity

Off-site data management offers new ways of providing resilience, recovery of data, and business continuity after a disaster. Data replication and mirroring with the cloud service creates another layer of protection when it comes to disaster recovery. In turn, cloud platform vendors may offer an additional level of replication of cloud data. Depending on SLAs and vendors, they could replicate data multiple times to allow fault tolerance and offer geo-distribution of data as well. A common disaster recovery (DR) scenario has been storage-facilitated, which refers to data replication to an alternative site. As cloud platforms mature, they will get increased attention for comprehensive disaster recovery and business continuity (BC) scenarios and clinical application vendors will most likely create more DR and BC offerings for care delivery organizations.

Endpoint and Application Configuration and Management

Care organizations often have to manage geographically distributed points of care and devices used by the mobile workforce. Software vendors and systems integrators have to deploy, maintain, and update applications for their customers and have traditionally invested in building sophisticated in-house systems for that. Cloud's capabilities such as storage, scalability, and access via Internet friendly protocols enable application configuration and management scenarios for organizations that are looking to simplify software distribution, updates, and device management—achieving new flexibility and reducing costs.

FullArmor PolicyPortal (http://www.fullarmor.com/products-policyportal.htm) is a Microsoft® Software + Services offering built on top of Windows Azure that provides scalable endpoint management through the cloud. PolicyPortal can deliver applications, secured documents, and security policies through Group Policy Objects to any remote, heterogeneous end-point. It extends the reach of Active Directory® Group Policy to non-domain end-points with location aware policies, optimizes management of software applications delivered through the cloud, and reports centrally on all endpoint applications and operating system compliance and status. *PolicyPortal* helps organizations standardize endpoints, centrally manage settings and configuration, and implement comprehensive PC security, using cloud technology to

eliminate the need to install or support an infrastructure to deliver the management best practices. This can result in gross savings over $1,000 per endpoint per year, reduced service desk calls by 10 percent or more, and improved business agility by deploying new applications 20 percent faster.

(http://fullarmor.com/documents/documents/TCO%20&%20ROI%20Analysis%20of%20PolicyPortal.pdf)

Case study: http://www.microsoft.com/casestudies/Case_Study_Detail.aspx?CaseStudyID=4000006283
In another example, Siemens is using Windows Azure to remotely support more than 80,000 devices for their customers worldwide. They store and manage software packages and distribution information using computing resources hosted in the cloud. Cloud-based application notifies a customer's on-premise application when new software packages are available, then downloads and installs them on individual devices, and notifies the cloud application of completion status. By moving to Windows Azure, Siemens can now dynamically scale its global software distribution, while reducing costs, enhancing services, and avoiding significant capital investment in its own data centers. Estimates show that the software distribution system built with Windows Azure is 10 times cheaper than the previous solution.

Case study: http://www.microsoft.com/casestudies/Case_Study_Detail.aspx?CaseStudyID=4000005945
Other scenarios for application configuration and management include cases where a vendor pre-configures hardware to be delivered on-site to a customer and then uses remote connectivity to conduct data migration between newly delivered and legacy systems or perform remote installation of the vendor's software. In such cases, the vendor invests into the datacenter and virtual private network (VPN) infrastructure, which could sit idle or underutilized during periods of lower demand. To reduce capital investment and operating costs of internal datacenter infrastructure, cloud platforms offer higher scalability, on-demand infrastructure that has the ability to be scaled-up or down during peak and off-peak times.

Clinical Groupware and Electronic Medical Records

The idea of clinical groupware is evolving into a model for the development and deployment of clinical applications which emphasize the use of the web as a platform to create composite applications aggregated together to meet specific clinical, workflow, and decision support, needs. The model is intended to have health data exchanged amongst providers, patients, and consumers with an emphasis on online communication and integration by combining healthcare data about the patient across multiple organizations and companies, including hospitals, laboratories, pharmacies, public healthcare record repositories, and more.

Clinical Groupware represents a shift from a traditional model of delivering packaged EMR software to practitioners. Doctors have been demanding to lower cost, increase flexibility and have easier-to-use solutions for their practices, especially for smaller practices that don't have dedicated IT staff to maintain operations. This approach helps to: lower the price of purchase, provide greater convenience, shorten deployment time, configuration, and training; and offers up-to-date feature availability on-demand.

The vision for Clinical Groupware is to deliver offerings via 'software as a service' model, which is a proposition and will depend on specific needs and usage scenarios of individual providers. A hybrid model may work as well in this scenario by combing the benefits of on-premise deployments with the flexibility of services-based offerings.

Vocabulary Transformation, Standardization and Catalogs

Existing on-premise and off-premise applications can be extended with auxiliary services running in the cloud. Those auxiliary services can provide catalog, vocabulary transformation or reference data as a service to any number of consumers. Case scenarios may include cloud services hosting SNOMED-CT (Systematized Nomenclature of Medicine - Clinical Terms) data or providing vocabulary transformation services from ICD9 to ICD10 codes (International Statistical Classification of Diseases and Related Health Problems).

Offering healthcare standards-based data as a service or specific transformational service, shields consuming applications from the need to duplicate, keep data up to date, or reinvent transformational complexities within their applications.

To accommodate demanding workloads and unpredictable number of users and applications, Microsoft industry partners offering specific healthcare web services may be looking at the cloud platform as a way to be able to scale on-demand, provide resilient caching capabilities for frequent data requests, and offer ubiquitous access and availability to consumers making requests from the Web, PC, Mobile device, or other devices.

Public Data and Syndicated Content

Data as a service also plays into another scenario where the content could be syndicated, provided on subscription basis, or available for free public access.

Initiatives such as *Data.gov* provide an indication into the way data can be shared, accessed, and consumed. This particular project offers a free public access to government datasets such as census, geo data and more. The goal is to encourage wider use of the data and come up with interesting solutions and applications. An example cited by Vivek Kundra, US Federal Chief Information Officer, is the availability of a Global Positioning System (GPS) data that drives commercial applications and uses in transportation systems worldwide and other areas such as disaster relief and emergency services or everyday activities such as banking and mobile phone operations.

Whether you're sharing human genome data to enable medical researchers worldwide to collaborate on studies, sharing health data for public health officials to assist in early identification and tracking of disease outbreaks, or tackling environmentally related health problems; availability of healthcare data could be transformational. One recent example is sharing N1H1 (swine flu) outbreak data. Individual Healthcare ISV application vendors were enlisting their customers and encouraging them to share data to understand outbreak "hot zones".

On the commercial side, shared and aggregated data could be syndicated or offered on a fee based subscription basis. A scenario might be an application vendor aggregating data from multiple hospital sites, de-identifying the data, adding value-add services on top of the aggregated data and offering it to hospital sites, and researchers for benchmarking, analytical purposes, clinical studies, and more. In a sense, the application vendor becomes a data service content provider.

The cloud could provide a flexible platform for collaboration, knowledge sharing, and syndication of the content in the abovementioned scenarios.

Public Health Applications Hosted in Windows Azure

At the peak of the H1N1 (swine flu) pandemic, one of the biggest challenges for health authorities in affected countries was dealing effectively with the massive number of people needing assessment and guidance. Offering online self-service facilities allowed concerned citizens to assess themselves (or their friend and family), receive advice, and take necessary actions—with minimal impact on the scarce medical practitioner resources, and avoiding spreading the virus further by visiting a doctor unnecessarily. One example of such an application, built and deployed on Windows Azure, is the *H1N1 Flu Response Center* (http://h1n1.cloudapp.net). It allows users to take flu self-assessment by answering questions, and then offers the appropriate advice.

Users can give explicit consent to share the anonymous information they provided during self-assessment for public health, education, and research purposes. As a result, apart from the value to the individual (assessment and advice), the application also provides valuable aggregated information for assessing parameters of the epidemic.

The H1N1 Flu Response Center can also work jointly with Microsoft HealthVault™. HealthVault would allow the user to store the results of the assessment, combine them with their information already in

HealthVault (health history, allergies, chronic conditions, etc.), print a summary, or share electronically with the chosen doctor through HealthVault.

Using the Windows Azure platform allowed deploying the application to the cloud very quickly, and making it available to the public. Increased demand and usage can also be managed effectively by the scalability features of Windows Azure without investing in servers and data centers.

"The site saw peak traffic on November 9, 2009 with 123,746 page views – an unexpected 365 percent increase over the previous day. In addition, by using Windows Azure we were able to go from idea to deployment in just three weeks. As anybody who has built out data centers can tell you, this is a really incredible timeline. Being able to use our existing skills and all of our familiar tools, such as the Microsoft Visual Studio development system, was another plus. Without all of this, there is no way we could have had the site ready in time for flu season."

– Sean Nolan, Microsoft Distinguished Engineer

More details about the H1N1 Flu Response Center application are available in the article http://blogs.msdn.com/windowsazure/archive/2010/05/20/real-world-windows-azure-interview-with-sean-nolan-distinguished-engineer-at-microsoft.aspx

A second example of a cloud application harnessing the power of the Windows Azure platform and Bing™ Maps visualization data is *Eye On Earth* (http://eyeonearth.cloudapp.net)—a European Environment Agency cloud application for real-time monitoring of environmental factors, such as air and water quality. Users can search for and view information about any location in Europe, as well as contribute their own data and ratings.

Solution Scenarios – At a Glance

Solution Scenario	Description	Examples
Enterprise image archive	Centralized image archive aggregated from multiple PACS to enable medical image archiving and exchange of radiology images. Expanding in the future to support non-DICOM data such as images in different formats (JPEG, BMP, and more), audio and video data, scanned and electronic Microsoft Office documents.	eMix, Candelis Cloud, MedCommons
Cloud storage	Off-premise cloud storage of clinical and other data with lower capital and operating expenses, while providing on-demand access.	
Disaster recovery and business continuity	Off-site data management and replication for disaster recovery. Expanding in the future to provide more comprehensive scenarios around business continuity.	
Endpoint and application configuration and management	Remote configuration management of software and devices, system upgrades and remote data management/migration.	Siemens, FullArmor
Clinical Groupware and EMR	Clinical groupware is a new and evolving model for the development and deployment of health information technology (HIT) platforms and applications having the following characteristics: • Use of the Internet and the web for EHR technology • Explicit design for information sharing and online communication among providers and patients/consumers • A modular or component architecture upon which applications can be aggregated to meet specific clinical and workflow tasks • Patient/consumer engagement tools that facilitate ongoing health management and care coordination • Interface and data exchange standards for information sharing that emerge in a market-driven manner	http://clinicalgroupwarecollaborative.com
Vocabulary transformation, standardization and catalogs	Providing healthcare vocabulary transformation services (Example: ICD9 to ICD10 conversions). Storing catalog data in the cloud that is frequently or semi-frequently updated to be accessed by on-premise and off-premise applications. (Example: SNOMED)	Health Language, First Data Bank
Public Data and Syndicated content	Sharing clinical data for research, collaboration and public access. Providing syndicated health data web services on subscription basis.	Data.gov, Eye On Earth
Public applications hosted in Windows Azure	Online self-service facilities for health assessment and advice, sharing public health and environmental information.	H1N1 Flu Response Center, Eye On Earth

Conclusion

Cloud computing is becoming a transformational force in delivery and consumption of applications and offers new opportunities for software developers, ISVs, enterprises and consumers to take advantage of cloud-based or cloud-enabled applications. The software industry has gone through major changes—from mainframe computing, to desktops, to web, and now we are standing at the next phase of innovation. The cloud has a potential to reduce deployment and operating cost, speed up implementation times, provide massive scale and reach, and offers new economic opportunities.

Momentum is building around cloud scenarios applicable to Healthcare by enabling delivery of better quality care to more people at a lower cost, faster time to value, and improving efficiency in healthcare and citizen services. Microsoft has made a strong commitment to the overall cloud strategy and Windows Azure is one of the pillars we offer you—a platform for building the next generation of applications.

Resources

- Windows Azure:
  http://www.microsoft.com/windowsazure
- Microsoft for the Health Industry:
  http://www.microsoft.com/health
- Microsoft Health ICT Resource Center:
  http://www.microsoft.com/healthict
- Microsoft Connected Health Framework (CHF):
  http://www.microsoft.com/industry/healthcare/technology/Healthframework.mspx