DELL Services

Cloud Computing:

Clear Benefits: The Emerging Role of Cloud Computing in Healthcare Information Systems

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Executive Summary

In 1986, John Gage, then Chief Technology Officer at Sun Microsystems, defined the technical underpinnings of the Internet age with his prophetic observation that "The Network is the Computer." As profound as they have been already, changes in the way we live and work brought about by the availability of a worldwide networked computer (the Internet) are still in their early stages from a historical perspective. Indeed, as fiber-optics and high-speed wireless technologies extend the reach and power of computer networks more deeply into our individual lives, the Internet of today will likely be viewed by future generations as a curious anachronism, in the same way we consider the Model-T Ford car a historical artifact that shares little in common with today's vehicles.

For many organizations, decisions made in the next several years about how to access and appropriate the power of networked or "cloud" computing in their business, charitable, or social endeavors will be a key determinant of success or failure in comparison to other organizations in their field of interest. This is especially true for healthcare, where information technology, often previously relegated to the automation of business processes in hospitals, labs, and doctors' offices, is emerging as a central component in how patients are diagnosed, treated, and managed.

A cycle of technical innovation is driving another wave of change in the way IT is provisioned and managed. In his book "The Big Switch," Nicholas Carr, a respected commentator on the social, political, and business implications of information technology, compares the emergence of a public computing utility or "cloud" in the next decade to the transition of American industry in the early 1900s. The migration at that time was from internally generated electrical or mechanical energy for manufacturing to the use of abundant, inexpensive electricity provided from central generating plants by dedicated utilities such as the Edison Companies. This same type of "Big Switch" from company-owned and provided applications and computer resources in dedicated data centers to a varying mixture of internally and externally hosted applications and computing resources has already begun. We experience "cloud-based" technologies personally whenever we use Google to search, Quicken.com to balance our online checkbooks, Skype to talk, Amazon to shop, Facebook to share, or web-hosted e-mail utilities such as Gmail to stay in touch.

The "cloud" has already begun to impact healthcare. Patients are using Google Health and Microsoft Health Vault to build and maintain Personal Health Records (PHRs) over the Internet. Doctors' offices that might never have been able to provision and manage their own ambulatory electronic health records and practice management systems are accessing offerings from Allscripts, eClinicalWorks, NextGen, and others that are provided as "Software-as-a-Service" (SaaS) via both the Internet and private networks. An increasing number of hospitals are hosting some part of their healthcare information systems as a way of ensuring timely updates, greater uptime, and more focus on applications success than infrastructure management. The regional and national Healthcare Information Exchanges (HIEs) envisioned by the Office of the National Coordinator of Health Information Technology (ONCHIT) and funded through the American Recovery and Reinvestment Act (ARRA) will emerge almost exclusively as public and private "cloud" services.

Hospitals and healthcare providers are perennially challenged to improve patient care while controlling or reducing costs through workflow and technology innovation. This whitepaper seeks to outline the definition, role, and potential use of cloud computing as a platform to assist healthcare organizations in achieving these goals.

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Behind the Clouds: A Disciplined Style of Managing Technology Infrastructure

The name "cloud computing," while well-intended, is in some ways unfortunate, as the word "cloud" in normal usage tends to denote something mysterious or poorly understood. In truth, cloud computing represents a new level of discipline in the provisioning and utilization of technology infrastructure. In this case, "cloud" is intended by industry engineers and architects to describe the technical process of abstraction or virtualization that is the key enabling technology in the cloud computing model. The use of the term "cloud" is a throwback to the early days of public packet-switching networks and even current-day representations of the Internet as an amorphous "cloud" in technical diagrams. The simple point of this representation was that you did not need to understand the precise web of interconnections and the protocols in the network in order to connect to and successfully utilize these public or private means of data transport. The analogy extends to the cloud-computing model: in a well-designed compute cloud, you need only know the basic service parameters and provisioning details required by your application; then the internal management and provisioning tools in the cloud dynamically create the environment your application needs.

Behind the enabling virtualization layers and management tools that shape the cloud is an almost religious adherence to a disciplined style of managing technology infrastructure. This cloud infrastructure philosophy rejects the notion of matching applications to specific server types, overly granular storage resources, or in some cases even specific operating systems in favor of scale and simplicity. Whether it is Google's cloud or your private cloud, the infrastructure that defines a cloud environment shares a number of common characteristics:

- A common pool of servers, configured identically, with multiple pools created when there is a need to differentiate service levels. This commonality reduces maintenance and operating costs, allows efficiency in purchasing and replacement, and drives availability levels up through simplicity of design and ease of distributing compute workloads.
- Flexibly configured pools of storage at different service levels, which can often be "thin provisioned" or delivered as capacity on demand without disruption to the applications.
- Virtualization software as the primary tool for managing, abstracting, and provisioning the infrastructure.
- Availability driven not just by sound technology design and operational simplicity, but also by sheer scale and often by geographic distribution, effectively lowering the cost of delivering a more highly available service.

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Defining The Cloud

As the cloud computing model of IT evolves, the industry will continue to debate and refine the definition of cloud computing, with competing providers of cloud-related software, technology, and services attempting to guide the way enterprises evaluate and ultimately appropriate cloud-based IT services. A quick survey of public sources suggests a variety of related, although not fully congruent definitions of cloud computing.

The differing definitions, while illustrating some of the different facets of the cloud model, orbit tightly around an applications or computer resource provided as a service either over the Internet or through a private network, fulfilling Gage's prophecy that "The Network is the Computer."

Source	Definition
Encyclopedia Britannica	A method of running application software and storing related data in central computer systems and providing customers or other users access to them through the Internet.
Gartner Group Cloud Framework	• A cloud is service-based; • A cloud is scalable and elastic; • A cloud uses shared infrastructure to build economies of scale; • A cloud is metered with users paying by use; and • A cloud uses Internet technologies.
IDC	An emerging IT development, deployment, and delivery model, enabling real-time delivery of products, services, and solutions over the Internet (i.e., enabling cloud services).
Industry Acronyms & Terminology	• Infrastructure-as-a-Service (IaaS) • On-demand computing • Platform-as-a-Service (PaaS) • Utility grid computing
Whatis.com	Cloud computing is a computing paradigm in which tasks are assigned to a combination of connections, software, and services accessed over a network. This network of servers and connections is collectively known as 'the cloud.' Computing at the scale of the cloud allows users to access supercomputer-level power. Users can access resources as they need them.
Wikipedia	A style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet.

Exploring The Cloud

The Gartner framework provides a useful departure point for a deeper understanding of cloud computing. Let's take a look at the facets of that framework and how they relate to the world of Healthcare IT.

Service Based Applications such as Electronic Health Records (EHRs) or infrastructure-like archival storage for Picture Archiving and Communication Systems (PACS) provided through a cloud computing model are provided as a service that has been predefined to operate within well-known, easily managed operational parameters. The provider of the service may allow customization or localization of the service by individual customers, or may limit these customizations to the minimum required in order to maintain the technical and financial viability of the application. While the customer may (or may not) give up some of the control they would have over a purchased and self-hosted application, they gain speed in implementation time, predictability in costs, and instant scalability. Early successful cloud implementations in healthcare will likely be focused around applications that require minimal upfront customization and provide a similar service to all potential users.

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Infrastructure as a Service (IaaS) includes virtualized servers, storage, networking, firewalls, backup, recovery, archiving, and associated management tools. IaaS providers create a dynamic, managed technical environment that includes one or more of these services. Some services focus very specifically on a single component, such as network-based backup, while other services provide complete virtual data centers which can be configured on the fly by customers to run their own applications in the cloud. Healthcare organizations that need or want extensive applications customization can still benefit from the scale and flexibility of the cloud model by considering IaaS as a means of hosting some or all applications.

It is important to clarify the difference between traditional hosting and IaaS. Traditional hosting dedicates specific infrastructure to a hosted organization. It is essentially the same configuration the organization would run on-premises, delivered from a hosting provider. The hosting provider must bring operational and technical disciplines to bear to overcome the added cost (versus self-hosting) of the wide area network resources.

By contrast, IaaS is designed to function as an efficient compute utility. Portions of a shared, highly-scalable infrastructure are dynamically allocated to each customer, producing cost savings for the customer through an inherently more efficient utilization of the service provider's pooled resources, with the possible trade-off that the IaaS might in some cases have a maximum service level that is not a best fit for the organization's IT requirements. In these cases, hybrids of IaaS and traditional hosting can still be beneficial to both the customer and the service provider. In any case, healthcare organizations considering data center investments, whether in-house or in a service provider's "cloud," would be well-advised to apply cloud design disciplines to the infrastructure in order to gain best use of the resources.

Just because IaaS creates "virtual data centers" we need not limit our vision for IaaS to replacing traditional data center assets. One of the lowest-value but highest-visibility services provided by hospital IT departments are PC or client provisioning, management, administration, and support. It is a thankless task, which is almost never satisfactory for users and generates burnout, turnover, and poor morale in the IT department. Through the virtualization of desktop operating environments, such as Windows XP, Windows Vista, or Windows 7, or even through the virtualization of single applications, it is now technically possible to fully manage desktop images in a compute cloud using the same fundamental resources and management techniques that are used for data center assets.

Desktop Virtualization is a developing and powerful tool that healthcare organizations can use to improve the end-user customer experience, create a consistent look and feel across a variety of computing devices, and enhance security while lowering provisioning and administration costs. As virtual desktop offerings begin to fully embrace healthcare standards such as single sign-on using biometric passwords and context-sensitive computing, healthcare providers will gain a powerful tool for lowering customer costs while improving the user experience. Some IT visionaries even forecast a day when laptops, desktops, or mobile devices are no longer provided by the employer, but will be an individual choice that employees make of the device they use to access cloud-hosted virtual desktops, with companies offering a supporting stipend or a choice of supported platforms offered at deep corporate discounts.

Platform as a Service (PaaS) extends basic Infrastructure-as-a-Service with some core applications, operating systems, and often software development tools that are implemented and managed by the service provider. Increasingly, these applications and operating environments are open-source software or derived from open-source software, which has been altered to be "enterprise-class." The customer is able to use these pre-built environments to quickly implement applications. An often-cited success story of this model is the classified ad site "Craigslist," which was created and is still operated in a PaaS model and is effectively maintained by a surprisingly small group of developers and managers. In healthcare, some physician portals and HIEs are being built in the PaaS model by specialized healthcare IT service providers who then use PaaS tools to adapt the platform to their actual healthcare provider customers' requirements.

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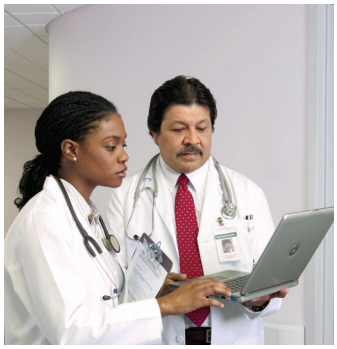
Software as a Service (SaaS) is the heart and soul of providing cloud-based software solutions where consumers receive a "seat" or a login with access to the software capabilities granted by the provider. If you use Gmail, Facebook, or online banking, you are a user of SaaS. SaaS is, to many industry analysts, the ultimate market expression of the value of the cloud model. SaaS is built on cloud platforms and architecture and is a completely "arms-length" service where the user has no role in the design, provisioning, or management of the provided software, but simply utilizes the application "as-is" under a fee model that begins with pricing that may be advertiser-supported, and extends to price per seat per month, as well as specific metered usage. SaaS is emerging in healthcare most visibly in physician EMRs or EHRs, as noted previously, but also in web-based portals to more traditional HCIS applications, in Healthcare Information Exchanges, and in applications as diverse as materials ordering and fund raising.

SaaS will be adopted slowly at first for demanding Healthcare Information System applications, which need Online Analytical Processing (OLAP)-style database performance and extensive customization of user and organizationally defined parameters. SaaS in its purest and most efficient form depends on multi-tenant, multi-occupancy technical architecture, which is another way of saying that multiple organizations can share both a common applications set and a common technology infrastructure, with any required compliance "walls" between data sets imposed either by the application software itself or the virtualization layer. The success of highly visible SaaS platforms in the commercial space, such as Salesforce.com, is driving innovation in this segment. Healthcare organizations will not have to wait very long for Independent Software Vendors (ISVs), technology developers, and service providers in the SaaS market to create software and management tools that allow necessary customizations while preserving the model's innate efficiency.



Other potential benefits of SaaS to healthcare organizations are functions such as micro-releases and community-sourcing. Driven by their healthcare customers, ISVs and service providers in the SaaS space will make more frequent, customer-driven updates to healthcare applications without workflow disruptions or downtime. The centralized control of these updates ensures that all subscribers receive and benefit from the changes simultaneously. Community sourcing allows technically proficient SaaS customers to actually develop and propose updates to the SaaS software based on their experience. This capability has the potential to quickly propagate major software and operating improvements in Healthcare Information Systems across diverse populations. This type of organic response to environmental changes holds the promise of better linkage of drug development to real-world clinical experience and the potential for more coordinated responses to future broad-scale healthcare emergencies.

Scalable and Elastic

Cloud computing offers the unique benefit that it is fully scalable and can grow and shrink within well-known parameters. In the global industry of cloud computing, even the largest have trouble managing the edges of elasticity. Amazon and Google, arguably two of the behemoths in this space, have suffered crippling outages due to the unpredictability of demand for certain web-based applications which are nearly impossible to predict and scale in advance to adequately absorb peaks in computing demand. These "consumer-grade" service levels will not be acceptable in healthcare, where increasingly, patient lives and operational integrity can be threatened by IT outages. As a result, healthcare organizations will observe the emergence of hybrid cloud providers who combine specific healthcare domain expertise with cloud disciplines to produce the financial benefits of cloud computing for their customers while mitigating risks through time-tested IT management processes and thoughtful cloud design.

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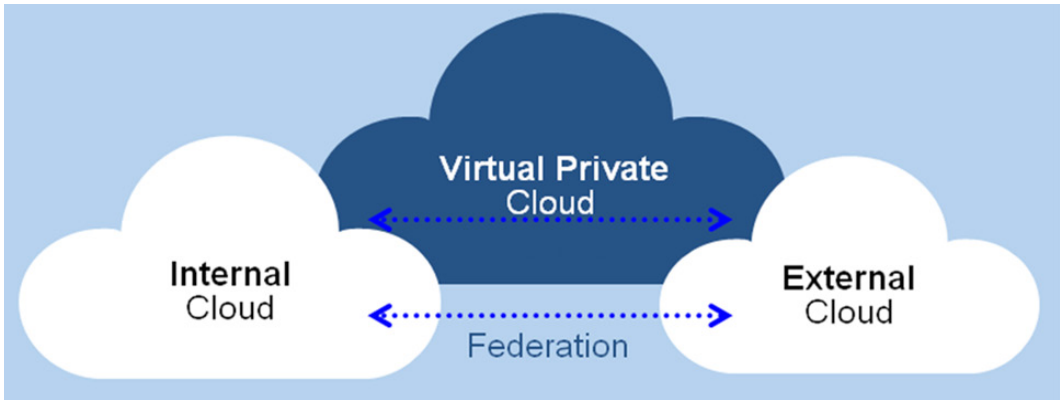
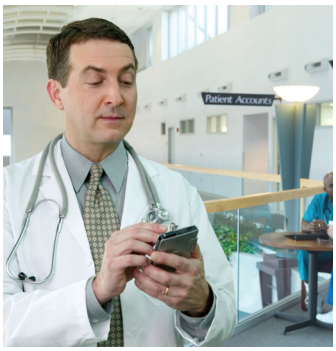
Shared Infrastructure to Build Economies of Scale

The scalability and sharing of infrastructure in compute clouds reduces comparable unit costs to traditional infrastructure management and hosting by leveraging volume, services, and delivery capabilities across large populations and ultimately, across public and private networks. It is worth investigating how a solution integrates into the balance of your internal IT operations or with other cloud-based services. To meet computing requirements, the cloud model will ultimately force us to expand our definition of shared infrastructure to include infrastructure dynamically allocated in external private clouds and in the public cloud. An entirely new segment of the security software industry is being created to ensure that this fluid allocation of infrastructure across seamless networks can be implemented securely.





To gain full leverage of the possibilities of IaaS, PaaS, and SaaS offerings in service providers' private external clouds, organizations will need to develop disciplined internal private clouds which will, as technology evolves, utilize secure network techniques and evolving virtualization Application Programming Interfaces (APIs) to seamlessly federate locally hosted applications and services with those provided in the public cloud, or the Internet, as well as those provided in the external private clouds of service providers.

Metered with Users Paying by the Use

Enabling organizations to "pay by the use" is an emerging trend in the financing and delivery of service for the IT environment. In healthcare, this model has begun to emerge from some PACS systems provided "as-a-service" with the application providers basing payment on either money saved on film or a "per-study" fee. These pricing models challenge traditional thinking about IT spending and may prompt senior decision-makers to evaluate these emerging costing options in all business sectors.

Recognizing and understanding the real Total Cost of Ownership (TCO) for a given product or service is often a painstaking and imprecise process. A service cannot inherently be consumed as a traditional IT investment with high initial capital outlay and relatively lower expenses for maintenance. Services are simply not assets. As a result, many businesses find it difficult to compare their current costs, which reflect assets to be depreciated, with a pay-by-the-use pricing structure. However, a financial analysis might consider the total cost of ownership beyond the depreciation schedule. The useful life of a solution is rarely as short as its depreciation period, and software and hardware maintenance costs tend to rise relative to the initial investment as the life of application is extended.

Healthcare Information Systems have high entry costs and high switching costs due to the extensive localization and user training that is necessary for a successful implementation. As the cloud model matures, healthcare organizations will benefit from predictable application delivery costs that can be measured in ways which are ultimately a better fit for the organization's workflow. The current system of capitalizing and depreciating IT investments, while well understood, has the drawback of requiring dizzying periodic re-investments in software and infrastructure. Leveling these costs out in future pay for usage models will help hospital administrators plan service expansions without the "IT startup penalty" and without constant trade-offs being made between capital investments for IT versus capital investments to directly impact patient care or add new service lines.

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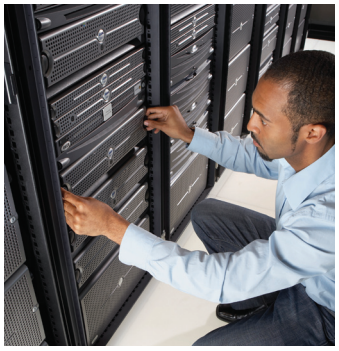
Appropriating computing resources in a "pay as you go" model is not appreciably different than paying your electric bill or buying food to consume. For most consumers, growing their own crops or managing their own electrical generation is neither practical nor efficient. For many hospitals and healthcare providers, the increasingly complex job of providing up-to-date, reliable IT services to meet clinical and administrative requirements is becoming a major management and financial burden which detracts from execution of the core mission. The cloud model represents the maturation of the concept of utility-grid computing, and as it evolves, will allow seamless transition of enterprise applications between your internal private cloud, external service providers, and public, Internet-based services. Just as the healthcare industry is focusing more sharply on patient outcomes and aligning quality, delivery, and payment models around achieving desired outcomes, so also is the IT industry moving away from the management of technical capabilities and towards the management of outcomes.

Using Internet Technologies for Delivery

Cloud enthusiasts enjoy engaging in fervent debate over whether a "pure" cloud service must be delivered through the Internet or merely use "Internet technologies." The market has already voted and the answer is both. There is no need to delay the delivery of cloud-based benefits while we wait for security and quality of service software to improve the sometimes inconsistent user experience of the Internet. Fifty million simultaneous downloads of the latest pop music hit cannot be allowed to interrupt the considerations of a radiological consult that may impact the way a surgery is performed. As a result, cloud services will be offered in and through the Internet as well as within private networks for a long time to come.

While some consider presentation of applications in a browser as the benchmark for Internet-based technologies, clinical super users in healthcare are wary of lowest-common-denominator solutions. Well-documented failures of mobile computing initiatives in healthcare decry the discomforts and inconveniences to clinicians of non-intuitive operating systems and software that is better adapted to administrators than care providers. While clinicians have learned to live with the trade-offs, ISVs, and service providers that implement more intuitive, workflow-sensitive solutions will experience success whether or not they choose browsers as their delivery model. Desktop virtualization, which frees a secure end-user computing experience from being tied to a specific device while enabling organizations to take advantage of cloud economies, will make it easier for healthcare organizations to satisfy users and gain more ROI from their investments in advanced clinical software.



Service-based — Adoption Factors

Private Clouds. Private Clouds that connect fully secure extensions of an organization's network are the defacto standard for delivery of SaaS to hospitals. Physicians and patients access important information enabled by SaaS through portals which are essentially private cloud solutions hosted by the hospital or their IT service provider. Adoption of the SaaS model that supports private cloud delivery for Healthcare Information Systems is most frequent around the Electronic Health Record. Sometimes the SaaS-hosted EHR is simply a real-time reflection of data held in an existing acute-care Electronic Medical Record or an Electronic Health Record hosted by the hospital or a service provider. In some cases, (private) cloud-based Healthcare Information Exchanges enable the SaaS EHR to roll-up both acute care and ambulatory health records in one convenient view.

Public Clouds. Many hospitals also use public clouds to consume or deliver services that are otherwise impractical to consider. Outpatient diagnostic centers share results via public cloud access by hospitals. Public cloud delivery of SaaS is also prevalent in physician offices. Even more closely akin to the average consumer at home, physicians running small businesses as customers of SaaS are highly accepting of Internet-based delivery of SaaS solutions. The emergence of Personal Health Records (PHRs) and efforts to integrate both acute care and ambulatory data into these patient-centric, public cloud hosted vehicles could prove to be an important societal trend, reflective of the profound impact the Internet has had on other areas of culture and commerce. Consumers making information-empowered choices may become a primary force in improving the efficiency and quality of the healthcare system. While global banking and other forms of business integration rely heavily on public cloud services delivered via the Internet, the pace of adoption in the healthcare industry has been impacted by factors ranging from privacy

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and security considerations to interoperability issues and concerns over service maturity. Existing technical trends and market dynamics are expected to resolve these issues in the short-to-medium term.

Security. Assuming standard security and encryption methods are used, it is unlikely Internet service delivery will be the cause of any substantive data breaches. As more desktops and services migrate into the cloud, central administration offers the opportunity to overcome flaws in security practices that make traditional infrastructure and services vulnerable to attack. Currently, vulnerabilities to data security can include locally stored data, weak password criteria, unattended computing devices which can be accessed by unauthorized people, computing resources without appropriate intrusion protection and/or lack of virus protection – these security safeguards are equally important to address in both traditional and cloud environments.

Availability and Disaster Recovery. While not necessarily a security issue, the everyday risk to business continuity as a result of system vulnerabilities is also a challenge for solutions that are hosted in a single location. Most organizations have no practical means of affording more than a single instance of a given service when built internally. In-house IT shops have numerous tools that help mitigate this risk through complex and expensive storage solutions, highly available and redundant power/environmental condition controls, clustered computing environments, and in some cases, offsite replication to hot or warm fail-over sites. The expense to build and maintain such levels of redundancy is high, but is increasingly considered by healthcare providers who are concerned about the implications of interruptions to advanced clinical software. Cloud-based hosting solutions, as well as IaaS-model managed disaster recovery services, can be a powerful way to mitigate risk without steep capital investments and their associated operational complexity.

Adoption Factors – The Risk/Reward of Cloud Computing in Healthcare

A number of industries have proven that cloud computing is beneficial and provides a secure and reliable computing model. How quickly healthcare will move in this direction seems likely to be driven by the same forces that drove credit card transactions and e-commerce many years ago.

Commonly accepted statistics show that perhaps the largest risk to quality of healthcare is the lack of access to comprehensive medical records to facilitate appropriate care. Adoption of these systems has become a recent focus for healthcare providers, in part because of the incentive funds that were included in the ARRA.

Service providers who are in the business of providing solutions "as a service" must be examined for their proven ability to maintain service levels through the lifecycle of service adoption and use. To complete this evaluation, healthcare executives might consider the following attributes:

1. Domain expertise in both healthcare and technology to craft a solution that effectively satisfies the business or clinical requirement.
2. Cohesive alliances that eliminate service disappointments. There is nothing more frustrating than being in the middle of a finger-pointing battle over who is responsible for causing or fixing a problem.
3. A known culture of excellence. As the market evolves to price-per-usage models, quality of service becomes a key element of the total cost of ownership formula.
4. A technology neutral viewpoint that includes a more objective approach to selecting vendors and solutions that best serve the customer and consumer. All solutions are not equal. Choosing a subscription model allows easier migration between solutions as improvements become available without loss of the institutional investment in one solution over time.

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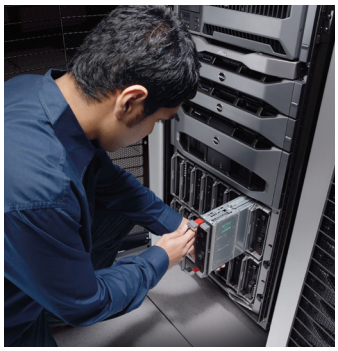
Cloud Computing Offers Benefits that Drive Healthcare Information Technology Outcomes

Increasing regulatory scrutiny, social and cultural pressures, and stark financial realities are forcing healthcare providers to reconsider the ways in which they create, deliver, and bill for healthcare services. This changing dynamic parallels the evolution toward the cloud computing model in the IT industry. Cloud-based services provide a proven method for healthcare administrators to meet their changing needs without incurring the "all or nothing" risk of traditional IT investments. Opportunities for successful early adoption include:

- Fast deployment of EMRs and EHRs in IaaS and SaaS business models to gain ARRA funding, avoid penalties, and capture increased reimbursements.
- Quick startup of hospital-based and regional Healthcare Information Exchanges at low cost, while improving the quality and continuity of care in a community.
- Service-based implementations of disaster recovery solutions to preserve the availability of Electronic Health Records while reducing capital and operating costs.
- Implementations of virtual infrastructure which extend data center capabilities and allow the rapid adoption of new applications while avoiding the pitfalls of over-provisioning.
- Implementations of virtual desktop solutions that increase user satisfaction while enhancing security and reducing device and software management costs.

In summary, cloud-enabled IT business models allow faster adoption, lower cost of entry, and more efficient IT cost and resource management over time. The business result of utilizing cloud solutions is that a healthcare provider's focus can be shifted to their core competency: delivery of high-quality patient care.



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