Cloud Computing in Medical Imaging

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Conflict of Interest

No conflicts of interest to declare

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Introduction to Cloud Computing I

'Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared poll of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction'

(NIST)

• It is emerging as a solution to the challenge of delivering complex services and data interchange over the Internet

Introduction to Cloud Computing II

• Part of our daily life; Gmail, Google docs, Dropbox, etc.
• Major reason for its success is due to the ever-decreasing cost and ubiquitous presence of fast networks: access large data sets remotely in real-time.

Grids

Computational power similar to large distributed and parallel high performance computing systems

Clouds

Challenge Internet-scale computing limitations such as application accessibility and storage space

Cloud types - IaaS

• Uses virtualization technology to allow several virtual systems to operate on top of a single physical hardware infrastructure in an isolated manner.
• The key sw module in virtualization is the hypervisor that manages and organizes the virtual resources on the physical hw
• Providers can deliver on-demand virtual machines with configurable resources.
• Easy scalability of hw resources (i.e. storage)
• No need to care about wasting resources
• Virtualization facilitates a faster recovery from hw and system failures.

Cloud types - PaaS

- PaaS includes all the features provided by IaaS, but the user is able to use the provider's system platform.

- PaaS allows clients to develop their own system using the platform tools, without having to install and maintain them.

- Users get OS and tools ready and need not worry about keeping them updated

Cloud types - SaaS

- In SaaS cloud providers install, manage, and operate the sw application, and the user has neither knowledge nor control of the underlying infrastructure.

- The end user has the least flexibility but the cost is lower (Gmail, Google Docs, Dropbox, etc.).

What is the need for cloud computing in healthcare?

- Patient data can be easily stored in virtual archives, facilitating data sharing and reducing storage requirements.

- Continuing education teaching files – shared access to learning tools.

- Cloud storage prices are dropping faster than enterprise storage prices.

- CT and MR studies continuously increase in size

Cloud computing and medical imaging

- The main driving forces for cloud computing use in medical imaging are data management, image processing and sharing demands.

- Quantitative imaging relies on heavy computational workload where sharing computing facilities through the use of cloud can play a critical role.

- Development of benchmarks allowing image processing algorithms comparison under common measures and standards.

Cloud PACS

Advantages
- Shared resource utilization
- Economies of scale
- Lower maintenance – management overheads
- Location and device independence

Components
- Image visualization application
- Workflow engine
- Image archiving system

Cloud based image visualization I

- Cloud PACS uses remote visualization where servers in the cloud data center are responsible for rendering the images and sending them to the remote client or end-point device.

- End-point device to cloud PACS communication; thin client applications, rich Internet applications and desktop virtualization.

## Cloud based image visualization II

- With the advent of HTML5, zero-footprint clients have become ubiquitous for clinical viewers. Users only need to have their browser up-to-date (expected to continue and accelerate).

- Desktop virtualization provides remote access to full featured OS environment running in a remote machine (expected to gain FDA approval).

Cloud based workflow

- Moving the engine to the cloud provides several opportunities for improvement within and across healthcare organizations:

  – Ability to distribute work more efficiently
  – Balance work across the physician population by specific criteria

Cloud based image archive

- Aggregation of imaging records

- Prior studies are available for comparison

- Reduce unnecessary repeat exams

- Reduce archiving to CDs/DVDs

- Image sharing for referrals

- Cross-enterprise archives
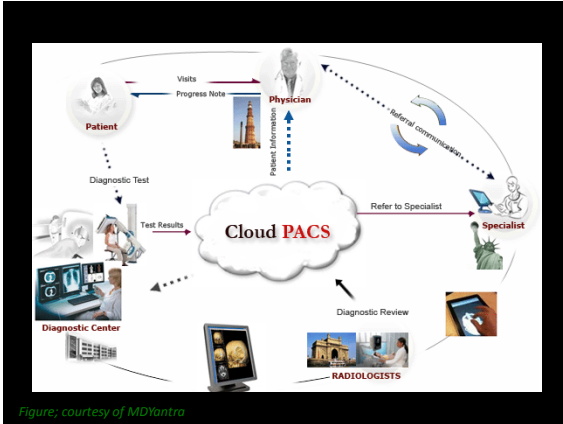
Figure; courtesy of MDYantra

Cloud computing in Research I

- Cloud-based research applications make parallel computation on large datasets easier and more cost-effective; bioinformatics discipline will be highly affected.

- Clinical trials are well suited for cloud-based infrastructures. Analyses can be parallelized by treating each datum concurrently.

Cloud computing in Research II

- Greatly improved data accessibility and efficiency of analysis.

- Beyond data storage, the analysis platform of the cloud is the critical component which needs to support a wide spectrum of queries to the data.

- Machine learning is well-suited to cloud-based infrastructures and could improve the power of the trial's conclusions and provide comparisons between inter-institutional practices.

Schematic diagram of a cloud-based clinical trial system
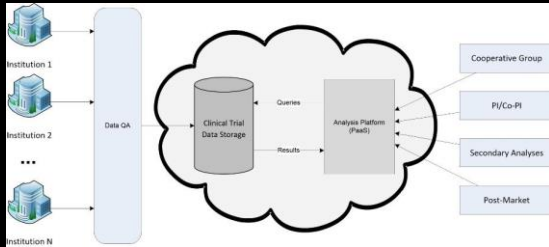
Ethical issues and security I

- The major concerns are to ensure privacy and security of patient data, as well as to make certain that only authorized individuals have access to the data.

- The service provider should provide written assurance for data protection from unauthorized use or from uses not originally intended by the researchers.

- The service provider must be able to destroy data upon client instruction in the event of security breach.

- Researchers should ensure they retain ownership of the data, through a written clause in the contract for cloud services.

Ethical issues and security II

- Security can be defined by: confidentiality, integrity and availability.

- For medical records, security is complicated since few requirements must be fulfilled to ensure protection of personal data

- For data exchange over the Internet techniques such as SSL and TLS provide strong data protection.

- Network security can be strengthened by secure VPNs between the organization and the cloud.

- Data integrity must be assured at all levels. Cloud providers protect storage with the aid of technologies like RAID - RAIN

Literature

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