Hospital Information Systems

Unit 4: Cloud Computing

Master in Biomedical Engineering
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1. Introduction to Cloud Computing
2. Cloud Computing Characteristics
3. Deployment and Service Modes
4. Available Solutions
5. From Virtual Datacenter to Design for Cloud
6. How to Select a Cloud Provider
INTRODUCTION TO CLOUD COMPUTING
What is Cloud Computing?

• The *cloud*, a *buzzword*.

• Several definitions:
  – Each source its own.
  – NIST: *Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.*

• In reality, cloud computing is two separate and different things:
  – The applications offered as a service through the Internet.
  – The hardware and systems, located in datacenters, that enable the provision of these applications.
• Cloud computing has reached the Slope of Enlightenment.
2017 Gartner’s Hype Cycle for Cloud Computing

- **On the Rise**
  - Blockchain PaaS
  - Digital Applications
  - Immutable Infrastructure
  - Multicloud
  - Serverless PaaS
  - Subtenancy

- **At the Peak**
  - Digital Business Platform
  - Edge Computing
  - Hyperscale Computing
  - API Economy
  - IoT Platform
  - Business Process as a Service (BPaaS)
  - Container Management
  - Function PaaS (fPaaS)
  - Machine Learning
  - Cloud Marketplaces

- **Sliding Into the Trough**
  - Internal Cloud Service Brokerage
  - Hybrid IT
  - Software-Defined Anything (SDx)
  - Cloud Service Brokerage
  - Cloud Office
  - Hybrid Cloud Computing
  - iPaaS
  - Private PaaS
  - Cloudbursting
  - Integrated IaaS and PaaS
  - Private Cloud Computing
  - Cloud Management Platforms

- **Climbing the Slope**
  - Platform as a Service (PaaS)
  - Public Cloud Storage
  - Application PaaS
  - Public Cloud SaaS Administrative ERP
  - Cloud-Testing Tools and Services
  - Cloud Computing
  - Cloud Security Assessments
  - Infrastructure as a Service (IaaS)
  - IaaS+

- **Entering the Plateau**
  - Database Platform as a Service
CLOUD COMPUTING CHARACTERISTICS
Cloud computing characteristics

- A cloud computing architecture is made up of:
  - A set of abstract and interconnected resources that can be offered on demand.
  - A way of using these resources when they are needed, scaling up or down, to provide the illusion of infinite resources.
  - A Service Level Agreement that determines how these resources can be used.
  - A management interface that allows the remote automation of this process.
  - An accounting system that allows a pay-for-use model.
Benefits of cloud computing

- Better use of the infrastructure.
- Optimization of the use of resources attending to the particular needs of the moment.
- Support for several users.
- Quick adaptation to changes in needs or use modes.
- Reduction in personnel cost, since operations are automated.
- Low start-up cost.
- Only the used resources are paid for.
- Integration of third parties’ capabilities at a low cost.
- Communications and computing services ecosystem, with free market competition mechanisms.
Origins of cloud computing

• Utility computing:
  – First proposed during the 1960s.
  – Turn computation into the fifth utility.
  – Access to resources on demand.
  – Pay for use instead of a flat rate.

• Grid:
  – Developed in research centers during the 1990s.
  – Pool disparate resources to perform a complex task.
  – Similar requirements to cloud computing.
  – Volunteer computing or scavenging computing.
    • Resurrected for cryptocurrencies
Necessary Technologies

• What has made cloud computing possible?
  – High computing power
  – Service Oriented Architectures (SOA)
  – Hardware virtualization
  – Advanced network infrastructures
Hardware Virtualization

- Split one real resource into several virtual resources.
- The virtual resources are isolated among themselves (sandboxed).
Advanced Network Infrastructures

- Network counterpart to the hardware virtualization.
- Definition of virtual networks between remote locations.
- Software Defined Networks.
Cloud Computing Architecture

Application

Platform

Infrastructure

Cloud computing

Servers

Laptops

Desktops

Monitoring

Content

Collaboration

Communication

Finance

Identity

Runtime

Queue

Database

Object Storage

Compute

Block Storage

Network

Phones

Tablets
DEPLOYMENT AND SERVICE MODES
Deployment modes

• Ways in which a cloud can be deployed.

• Private cloud:
  – Exclusive use for the owning organization

• Public cloud:
  – Can be used by third parties.
  – For free or paying for the used resources.

• Community cloud:
  – Owned by several organizations that pool resources together.
  – Could be public or private.

• Hybrid cloud:
  – Two or more clouds of the previous types put together.
Service Modes

- Multilayered architectures.
- Several stakeholders: providers and users.
- Origin of the XaaS (anything as a service) paradigm.

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<th>Access Tool</th>
<th>Service Offered</th>
<th>Service Model</th>
<th>Architectural Layer</th>
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<td>End User</td>
<td>Browser / Light Client</td>
<td>Final User Software</td>
<td>SaaS</td>
<td>Application</td>
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<td>Developer</td>
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Cloud Stakeholders in IaaS
AVAILABLE SOLUTIONS
IaaS Solutions

- **Private:**
  - Eucalyptus
  - Nimbus
  - OpenNebula
  - OpenStack
  - CloudStack

- **Public:**
  - Amazon Web Services
  - Microsoft Azure
  - Google Cloud Platform
  - IBM Cloud Computing
  - Rackspace
  - Fujitsu S5
• **Private:**
  – Openshift
  – Stackato
  – CloudFoundry
  – Appscale
  – eXo Platform
  – Cocaine

• **Public:**
  – Google App Engine
  – Microsoft Azure
  – Amazon Beanstalk
  – CloudFoundry
  – Heroku
  – Force.com
  – IBM Bluemix
SaaS Services

- **Office applications:**
  - Google Apps
  - Microsoft Office 365

- **Storage:**
  - Dropbox
  - Google Drive
  - Onedrive
  - Box

- **Videogames:**
  - Onlive
  - Gaikai
  - PlayFab

- **Business:**
  - SalesForce

- **Video:**
  - Netflix
  - Hulu
FROM VIRTUAL DATACENTER TO DESIGNED FOR CLOUD
**Cloud Usage Models (I)**

- **Virtual Datacenter:**
  - IaaS only
  - Move the infrastructure (part or all of it) to the cloud
  - Move resources “one to one”
  - It is the same infrastructure, but in a remote, cheaper location
  - Cost savings
  - More OPEX, less CAPEX
  - The cloud is used as a “cheaper datacenter” or a backup solution. Just a virtualization platform.

- **Cloud-based scalability and reliability:**
  - IaaS and some PaaS or cloud services
  - Use several clouds to improve reliability
  - Use some cloud features to achieve scalability
  - Applications are still designed for a traditional datacenters
Cloud Usage Models (II)

- **Designed for Cloud**
  - Full embrace of PaaS and cloud-only services
  - Automated scalability and reliability
  - Best principles:
    - DevOps
    - Agile
    - Continuous Delivery / Integration
    - Immutable Infrastructure
    - Containerization
  - Certifications (ISO 27000, HIPAA)
  - Cloud Service Brokers (Managed Service Providers)
  - Identity Management
  - Specialized Solutions
  - Everything as a Services (XaaS)
  - Datacenter as a computer
  - Serverless Computing and microservices
HOW TO SELECT A CLOUD PROVIDER
How to Select a Cloud Provider

• Choosing a cloud provider is difficult
  – Different providers have different strengths
  – Different pricing models
  – Not a one-time event, but an ongoing process

• But can provide many benefits
  – Lower costs
  – Improved performance
  – Greater agility, availability and reliability

• Multicloud strategy
  – Ad-hoc approach: a different vendor for each application
  – Leverage strong points of each solution
  – Performance improvements and cost savings
  – Difficult management
  – Complicates auditing
Cloud Provider Selection Consideration

- Considerations of the provider
  - Pricing and services offered
  - Certifications and standards
  - Longevity
  - SLAs and history of downtimes
  - Datacenter’s locations
  - Vendor strengths and weaknesses
  - Support for existing technology and tools
  - Avoidance of vendor lock-in
  - Speed of setup
  - Customer support and strategic partnerships

- Considerations of the application
  - Data backup frequency
  - Downtime tolerance
  - Technologies used
  - Company politics
Exercise: Cloud Provider Selection

- Select a Cloud Provider
  - And explain why!

- Choose from:
  - Amazon Web Services
  - Google Cloud
  - Microsoft Azure
  - IBM Cloud

- Application Characteristics:
  - Management of clinical histories for a hospital
  - 2 machines (4 cores, 4GB RAM) for a PostgreSQL database (2 copies, backup and replication)
    - Hourly backup to an off-site database
  - 6 machines (4 cores, 4GB RAM) with Windows Server 2012 for a web application to access the clinical histories.
    - All 6 are used at peak time: (10:00 ~ 16:00)
    - 4 are used at non-peak times: (06:00 ~ 10:00) and (16:00 ~ 20:00)
    - Only 2 are used during night time: (20:00 ~ 06:00)
  - 1 machine (2 cores, 1 GB RAM) with RedHat Linux 7 for a load balancer
  - 1 machine (2 cores, 1 GB RAM) with RedHat Linux 7 for a firewall