# Hospital Information Systems

## Unit 4: Cloud Computing

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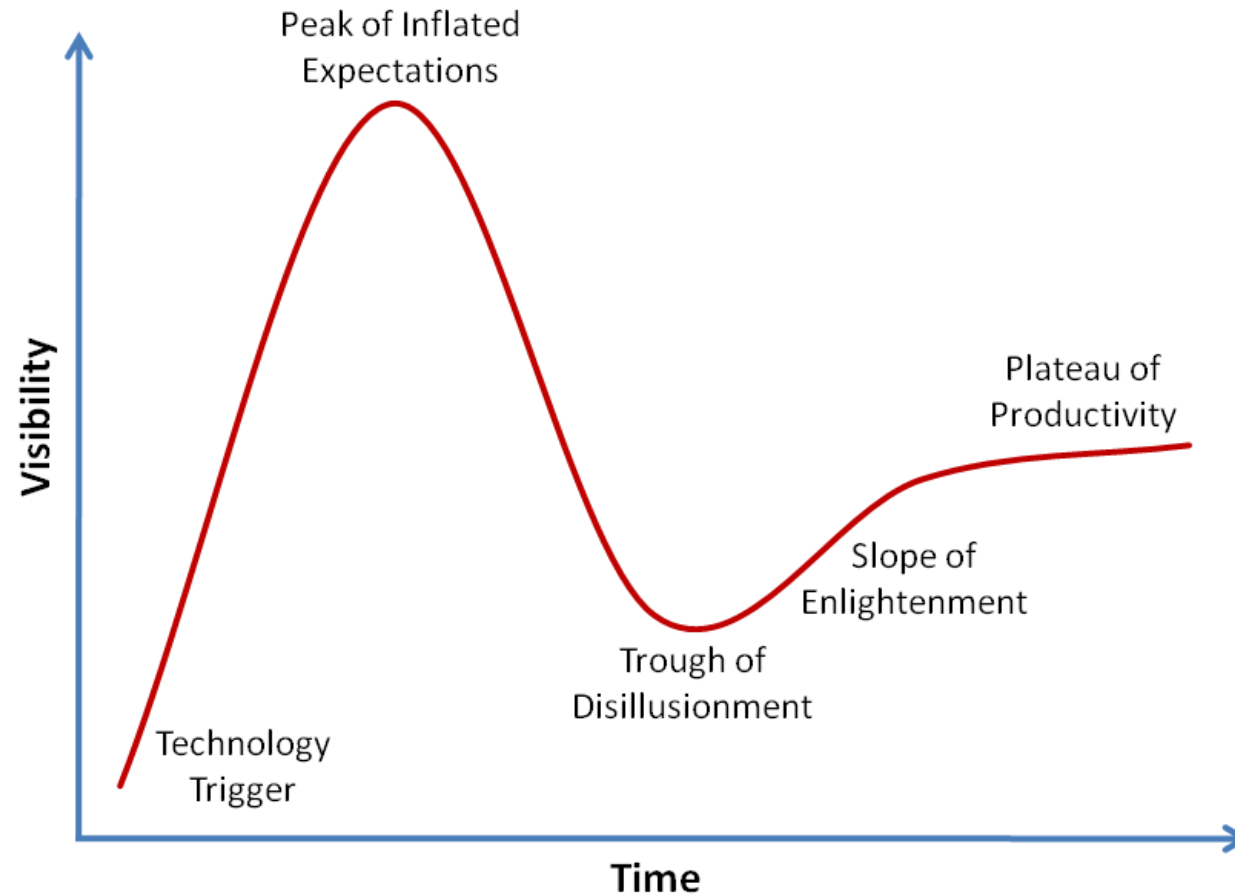6. How to Select a Cloud Provider

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# *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.

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The Hype Cycle diagram showing Visibility (y-axis) versus Time (x-axis) with stages: Technology Trigger, Peak of Inflated Expectations, Trough of Disillusionment, Slope of Enlightenment, and Plateau of Productivity.

- Cloud computing has reached the Slope of Enlightenment.

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# 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

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# *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.

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# *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.
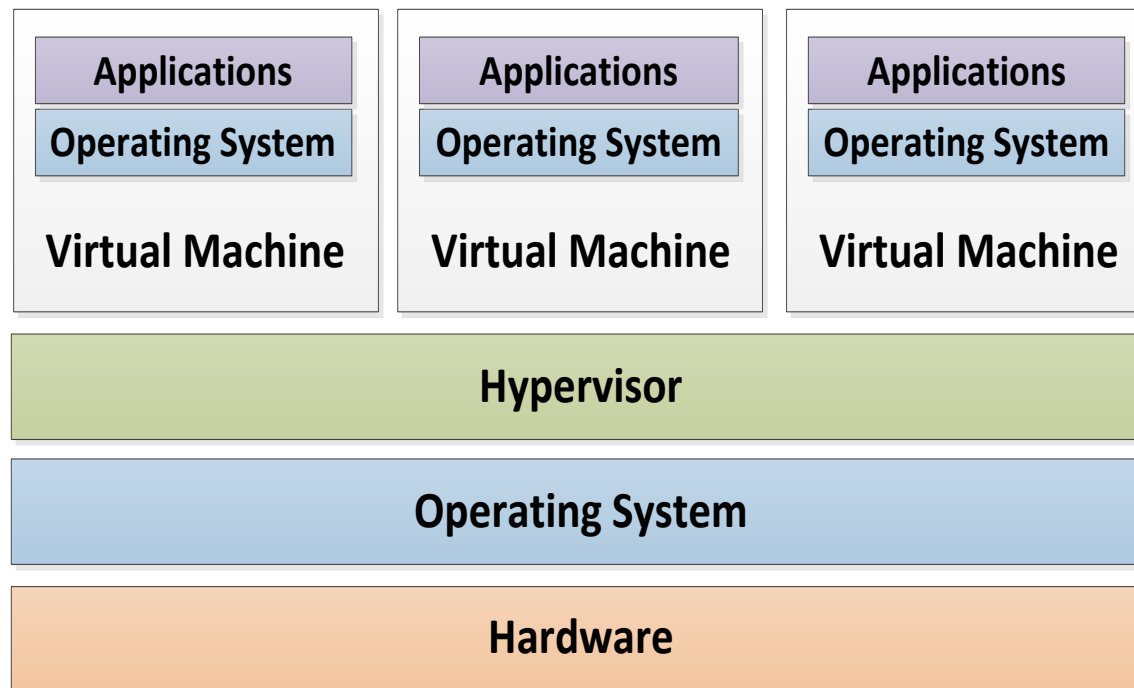
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# *Origins of cloud computing*

- **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).

| Applications | Applications | Applications |
|---|---|---|
| Operating System | Operating System | Operating System |
| **Virtual Machine** | **Virtual Machine** | **Virtual Machine** |

**Hypervisor**
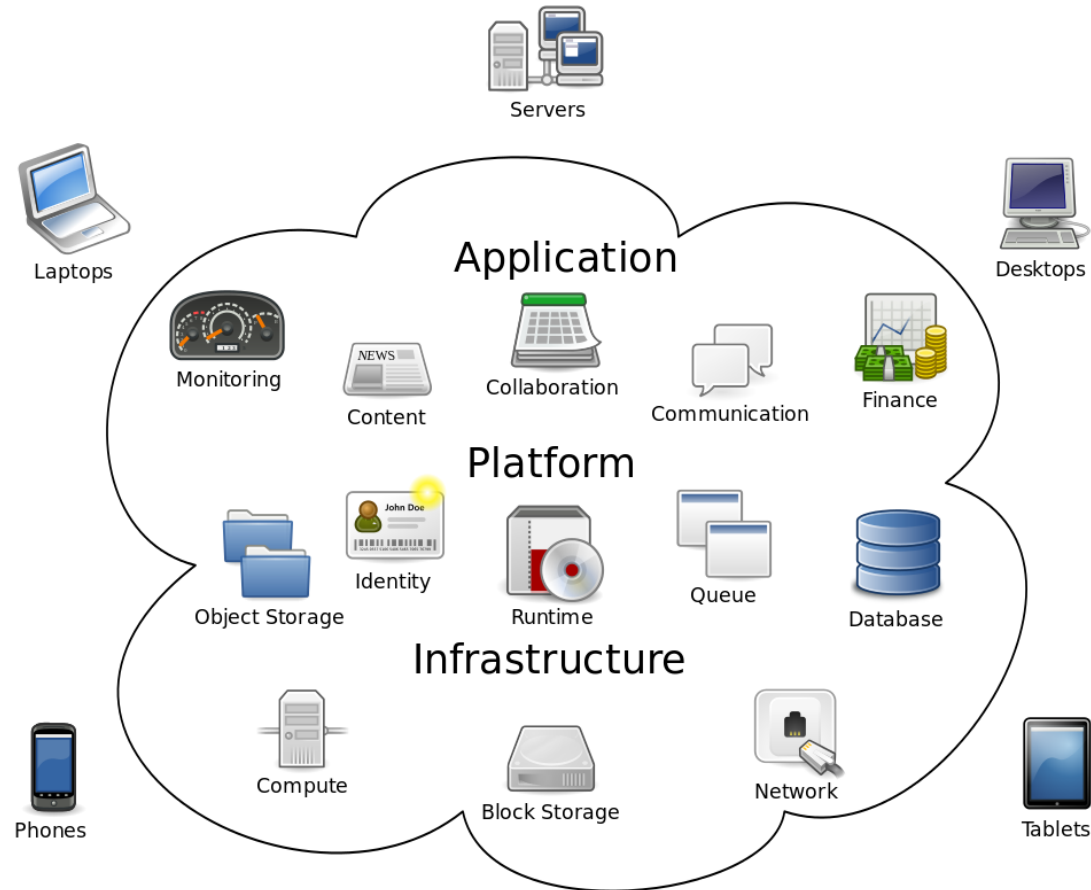
**Operating System**

**Hardware**

# Advanced Network Infraestructures

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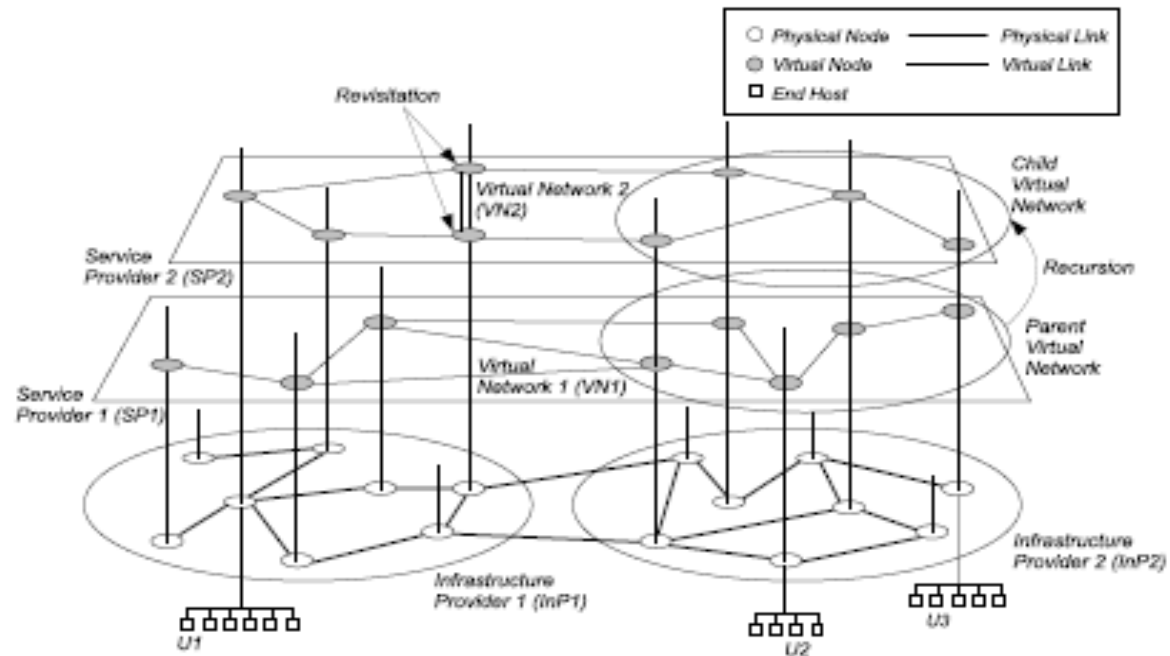
# *Cloud Computing Architecture*

# *DEPLOYMENT AND SERVICE MODES*
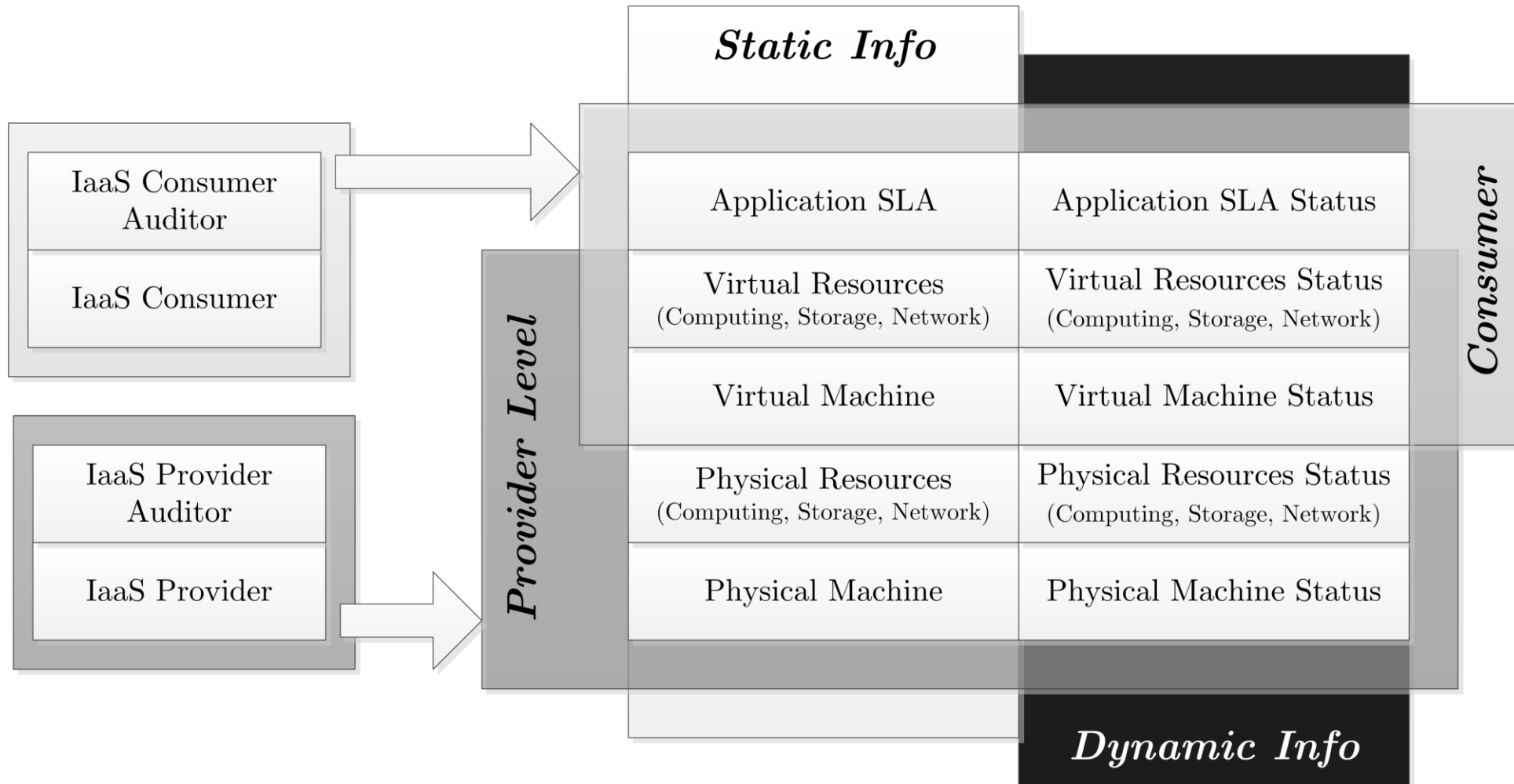
# Deployment modes

- 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.

| User | Access Tool | Service Offered | Service Model | Architectural Layer |
|---|---|---|---|---|
| End User | Browser / Light Client | Final User Software | SaaS | Application |
| Developer | IDE | Libraries | PaaS | Platform |
| | | Framework | | |
| IT Manager | Virtual Infrastructure Manager | Virtual Infrastructure Manager | IaaS | Infrastructure |
| | | | | Hardware |

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# Cloud Stakeholders in IaaS



IaaS Consumer Auditor

IaaS Consumer

IaaS Provider Auditor

IaaS Provider

**Provider Level**

**Static Info**

| | Static Info | Dynamic Info |
|---|---|---|
| | Application SLA | Application SLA Status |
| | Virtual Resources (Computing, Storage, Network) | Virtual Resources Status (Computing, Storage, Network) |
| | Virtual Machine | Virtual Machine Status |
| | Physical Resources (Computing, Storage, Network) | Physical Resources Status (Computing, Storage, Network) |
| | Physical Machine | Physical Machine Status |

**Consumer**

**Dynamic Info**

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# *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

# *PaaS Solutions*

- **Private:**
  - Openshift
  - Stackato
  - CloudFoundry
  - Appscale
  - eXo Platform
  - Cocaine
- **Public:**
  - Google App Engine
  - Microsoft Azure
  - Amazon Beanstalk
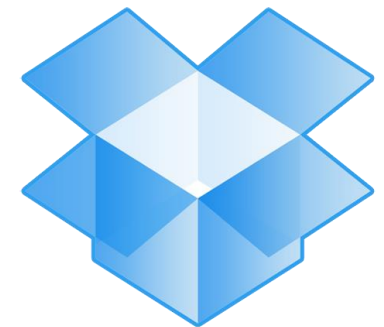  - CloudFoundry
  - Heroku
  - Force.com
  - IBM Bluemix

# 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*

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# 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

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# *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