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AI6128 Urban Computing

Lecture 4 Cloud Computing Support



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Content

- Introduction to cloud computing
- Cloud service models
- Microsoft Azure (PaaS)
- Virtualization (IaaS enabler)



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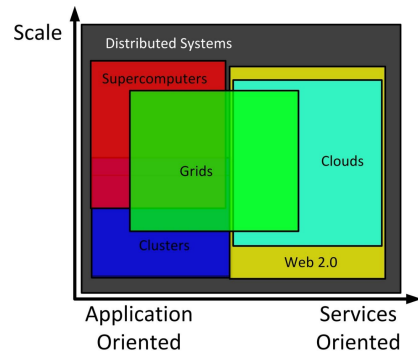
Introduction to Cloud Computing



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Backend Computing Schemes



Supercomputing (from 1960s)

- Computing based on a highly integrated system with a high level of performance and a highly customized OS



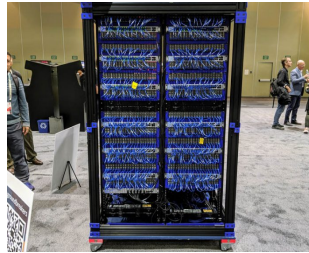
IBM Blue Gene/P
164,000 processors
in 2010s

Cluster Computing (from 1960s)

- Computing based on a cluster of co-located servers running general-purpose OS (e.g., Windows, Ubuntu)



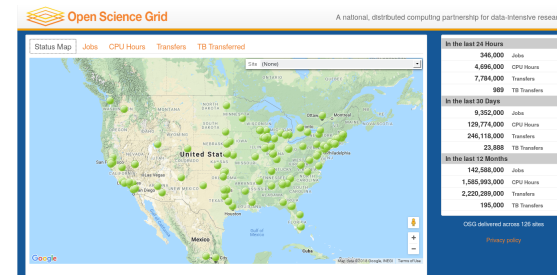
Sun Microsystems Solaris Cluster



Oracle's cluster of 1060 Raspberry Pi nodes
(each node \$35, 2019)

Grid Computing

- Interconnected clusters that are geographically distributed



Utility Computing

- Packaging of computing resources (computation, storage, etc) as a **metered service** similar to a traditional public utility
- Not a new concept
 - “If computers of the kind I have advocated become the computers of the future, then computing may someday be organized as a public utility just as the telephone system is a public utility... The computer utility could become the basis of a new and important industry.”
-- John McCarthy, MIT Centennial in 1961



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Cloud Computing

- Is cloud computing
 - grid computing + utility computing ?
 - Difficult to define
 - Means different things to different parties
- Various definitions
 - NIST (National Institute of Standards and Technology)
Universally accepted definition



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Cloud Computing - NIST

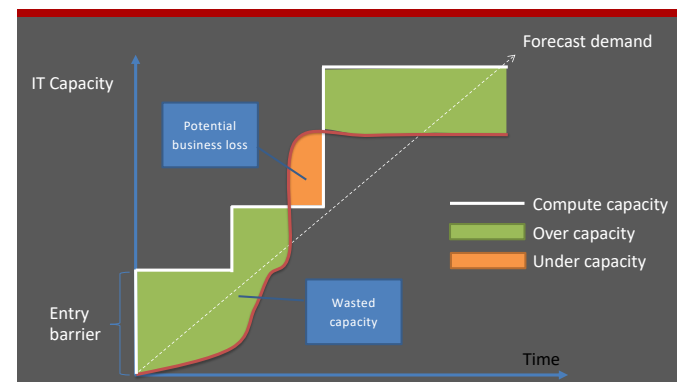
- “Cloud computing is a model for enabling convenient, **on-demand** network access to a **shared pool** of **configurable** computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”



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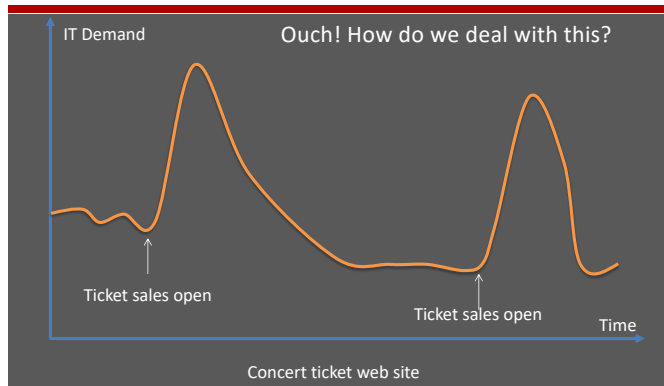
Managing Demand



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Demand Burst



Cloud Computing Solution

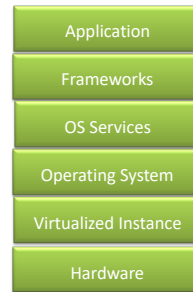
- Shared, multi-tenant environment
- Pools of computing resources
- Resources can be requested as required
- Available via the Internet
 - Private clouds can be available via private WAN
- Pay as you go

Cloud Service Models

Cloud Service Models

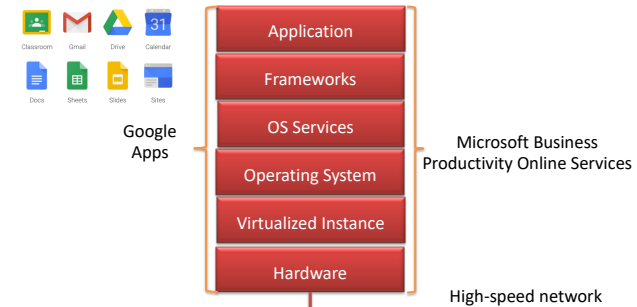
- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

The Stack



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Software as a Service (SaaS)



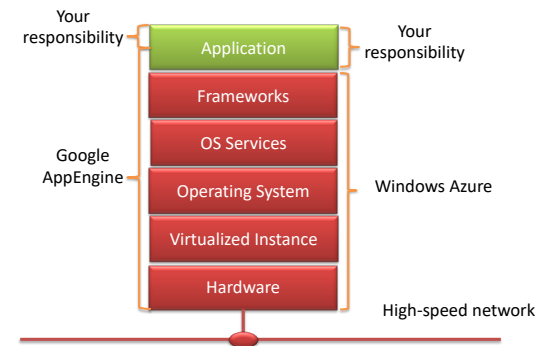
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Famous SaaS

- Dropbox
- Zoom
- Cisco WebEx
- Google Apps
- Salesforce
- Concur

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Platform as a Service (PaaS)



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Famous PaaS

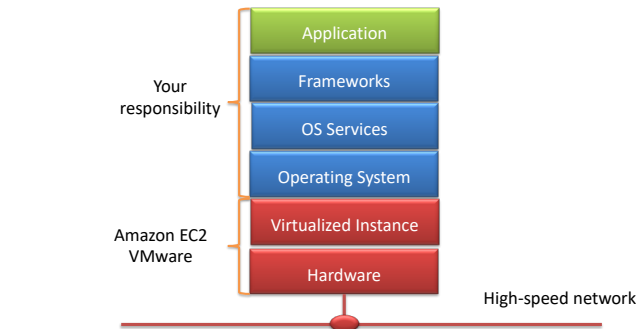
- Microsoft Azure
- Google App Engine
- Heroku
- Apache Stratos
- OpenSHIFT



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Infrastructure as a Service (IaaS)



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Famous IaaS

- Microsoft Azure
- Linode
- DigitalOcean
- Rackspace
- Amazon Web Services (AWS)



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Geo-Distributed Data Centres



- Larger vendors have proven track records for running services for large numbers of customers
 - Hosted in their own data centres

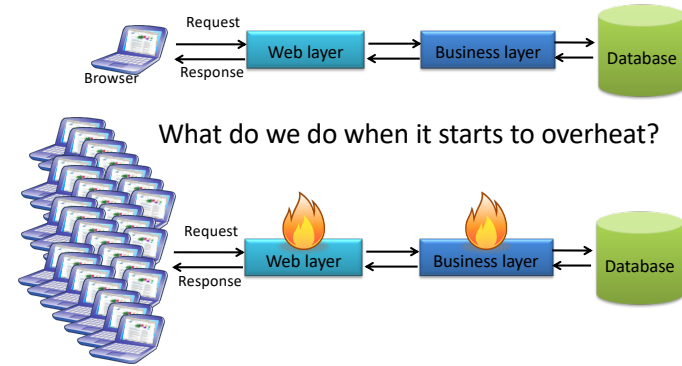


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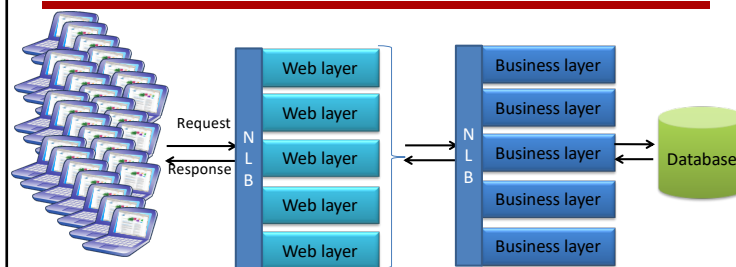
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Microsoft Azure: An example of PaaS

A Typical Application

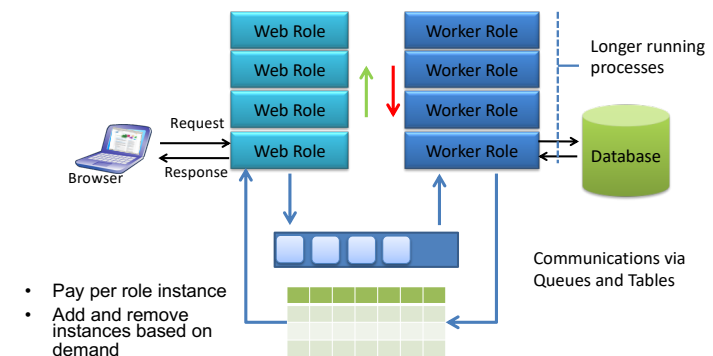


Scale Up

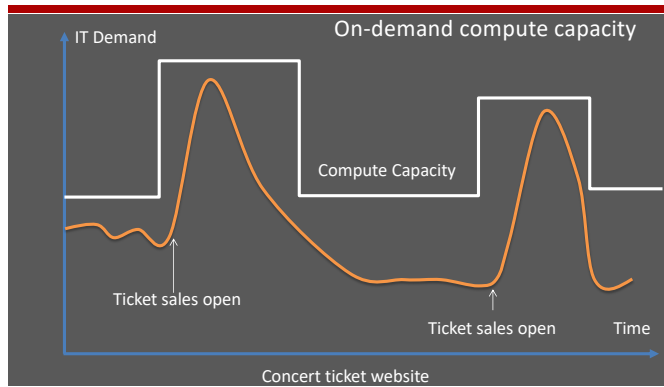


- How much is that going to cost you?
 - Do you need it all the time?
- How long will it take you?
- Do you have the capital expenditure budget?

Azure

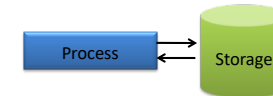


Demand Burst with Azure



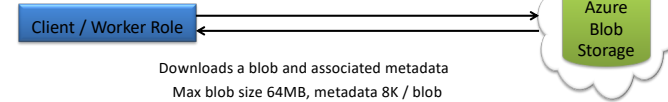
Storage

On-Premise: Tight relationship between process and storage



The Cloud abstracts the data

GET <http://accountname.blob.core.windows.net/containername/blobname>



What We Get with PaaS

- An elastic computing platform
- Connect from anywhere, with any device
- Low barrier costs to deploying new applications
 - Rapid provisioning
- Pay as you go
 - Operational costs directly related to profit
- A marketplace through which to sell our services
 - Customers continue to pay as long as they use our services
 - Stop paying, stop providing service
 - No chance of licence abuse

Virtualization: Enabler of IaaS

Virtualization

- **Virtualization** is the ability to run multiple operating systems on a single physical system and share the underlying hardware resources
- It is the process by which one computer hosts the appearance of many computers.
- Virtualization is used to improve IT throughput and costs by using physical resources as a pool from which virtual resources can be allocated.

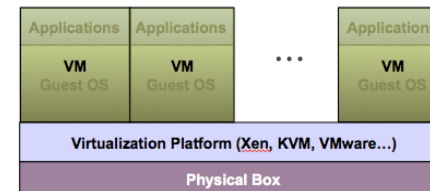


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Virtualization Architecture

- A Virtual machine (VM) is an isolated runtime environment (guest OS and applications)
- Multiple virtual systems (VMs) can run on a single physical system



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Hypervisor

- A **hypervisor**, a.k.a. a virtual machine manager/monitor (VMM), or virtualization manager, is a program that allows multiple operating systems to share a single hardware host.
- Each guest operating system appears to have the host's processor, memory, and other resources all to itself. However, the hypervisor is actually controlling the host processor and resources, allocating what is needed to each operating system in turn and making sure that the guest operating systems (called virtual machines) cannot disrupt each other.



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Benefits of Virtualization

- Sharing of resources helps cost reduction
- Isolation: Virtual machines are isolated from each other as if they are physically separated
- Encapsulation: Virtual machines encapsulate a complete computing environment
- Hardware Independence: Virtual machines run independently of underlying hardware
- Portability: Virtual machines can be migrated between different hosts.



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IaaS

Cloud computing takes virtualization one step further:

- You don't need to own the hardware
- Resources are rented as needed from a cloud
- Various providers allow creating virtual servers:
 - Choose the OS and software each instance will have
 - The chosen OS will run on a large server farm
 - Can instantiate more virtual servers or shut down existing ones within minutes
- You get billed only for what you used



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Learning Objectives

- Understand cloud computing and benefits
- Differentiate cloud service models
 - Tell examples in each model



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