

# Assignment Project Exam Help

Operating Systems and Concurrency

Lecture 24: Virtualisation and the Cloud II  
G52OSC

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- Virtualisation provides the illusion that software has full control over the hardware
- Different approaches (Type I, Type II)
- Virtualise main OS duties (Privilege instructions, CPU, I/O and memory)

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- Cloud computing: the legacy of virtualisation
- Cloud Service Models
- Case study: Nottingham cloud

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# Cloud Computing

## Context

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- Consider a company that has an e-mail server, a web server, an FTP server, etc
- We now use virtualisation to use more effectively our hardware
- What are the costs of maintaining this cluster?
  - Electricity
  - System administrators
  - Upgrading pricey hardware
  - ...

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Figure: A cluster of computing nodes

# Cloud computing

What is it?

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What is **Cloud Computing**?

- A new computational paradigm
- Out-source your computation and storage needs to a well-managed data center
- No worries about the physical machines: power, cooling, maintenance
- Virtualisation provides the necessary isolation to share multiple clients on a single physical machine

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# Cloud computing

## Basic Cloud Characteristics

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A number of characteristics define cloud data, applications services, and infrastructure:

- **Remotely hosted:** services or data are hosted on remote infrastructure
- **No-need-to-know** in terms of the underlying details of infrastructure, application interface with the infrastructure via the API;
- **Ubiquitous:** services or data are available from anywhere (**always on, anywhere and any place**)
- **Flexibility and elasticity** allow these systems to scale up and down at will
  - Utilising resources of all kinds
    - CPU, storage, server capacity, load balancing, and databases
- **Commodified:** the result is a utility computing model similar to traditional utilities, like gas and electricity - "**pay as much as used and needed**" !

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# Cloud computing

What is it? in a nutshell

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There is no cloud  
it's just someone else's computer

# Cloud computing

## Caveats

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- Is it easier now for IT managers to deal with the computing compare to ten years ago?
- Scalability, backups, depreciation, reliability, performance ... that is reduced.
- But, new problems/worries may emerge
  - How reliable is my cloud provider?
  - Where is my data? Is that relevant?
  - Will a competitor running on the same infrastructure be able to infer information you want to keep private?

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# Cloud computing

Caveats: Rapid elasticity

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- Rapid elasticity is currently one of the key challenges in Cloud Computing
- Capabilities can be rapidly and elastically **provisioned**, in some cases automatically, to quickly scale out and rapidly released to scale in
- To the consumer, resources often appear to be unlimited and can be purchased in any quantity at any time
- Optimisation of the current usage will save energy! (e.g. putting unused machines to sleep)
- **Prediction** techniques may help alleviate the problem based on historical data (e.g. machine learning applied to cloud computing).

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# Cloud computing

A successful application of Virtualisation

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Virtualisation does not only allow us to run multiple different OSs on the same hardware. It will also allow us to carry out a **clever management**:

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- What happens if a node needs servicing (or replacing)?
- Shut down and migrate VMs => significant downtime
- The challenge is to move the VM from the hardware that needs servicing to a new machine without taking it down at all. Is that possible?

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# Cloud computing

A successful application of Virtualisation

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- **Non-live Migration:**

- Instead of shutting down the computer, we could pause the VM (*checkpointing*)
- Then, copy over the memory pages used by the VM to the new hardware as quickly as possible => less downtime, but still noticeable

- **Live Migration:** the idea is to start moving the virtual machine while it is still operational (pre-copy memory migration)

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## Cloud Service Models

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Three main service models:

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

More recently, new services are being defined. For example, Desktop as a Service (DaaS)

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Figure: Cloud computing layers (Source: RackSpace)

# Cloud computing

## Cloud Service Models: IaaS

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- IaaS provides **resources** of the underlying cloud infrastructure to customers
- Virtual machines (with different OSs) and other virtualised hardware, processing, storage, networks, etc
- Example of IaaS: Amazon EC2 (Xen hypervisor - paravirtualisation)
- End-user: typically a system administrator

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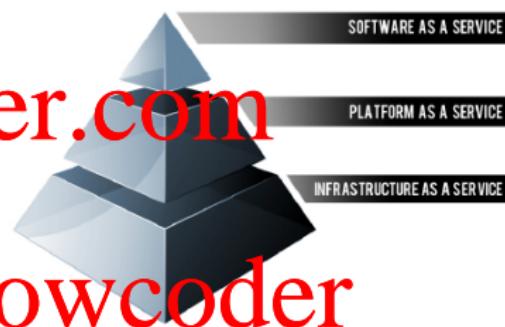


Figure: Cloud computing layers  
(Source: RackSpace)

# Cloud computing

## Cloud Service Models: Paas

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- Paas provides service in the form of a **platform** on which the customer's applications can run
- Tools to create your own applications (e.g. development environment, programming language tools)
- Examples: AppEngine, Microsoft Azure, Force.com, Heroku
- End-user: developers

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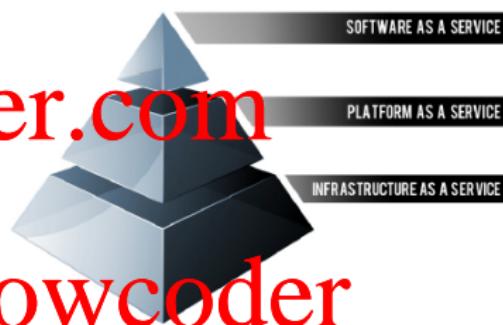


Figure: Cloud computing layers  
(Source: RackSpace)

# Cloud computing

## Cloud Service Models: SaaS

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- SaaS provides service to customer in the form of software
- Applications that run on the Cloud
- Examples: G-mail, Microsoft 365, Dropbox
- End-user: regular users

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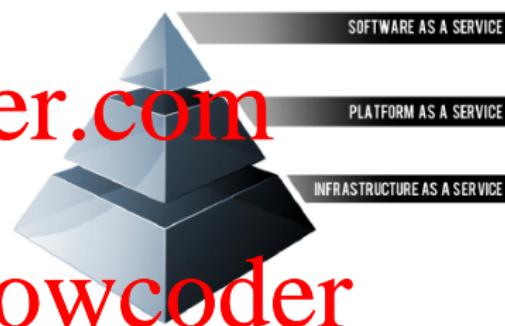


Figure: Cloud computing layers  
(Source: RackSpace)

# Cloud computing

## Cloud Service Models

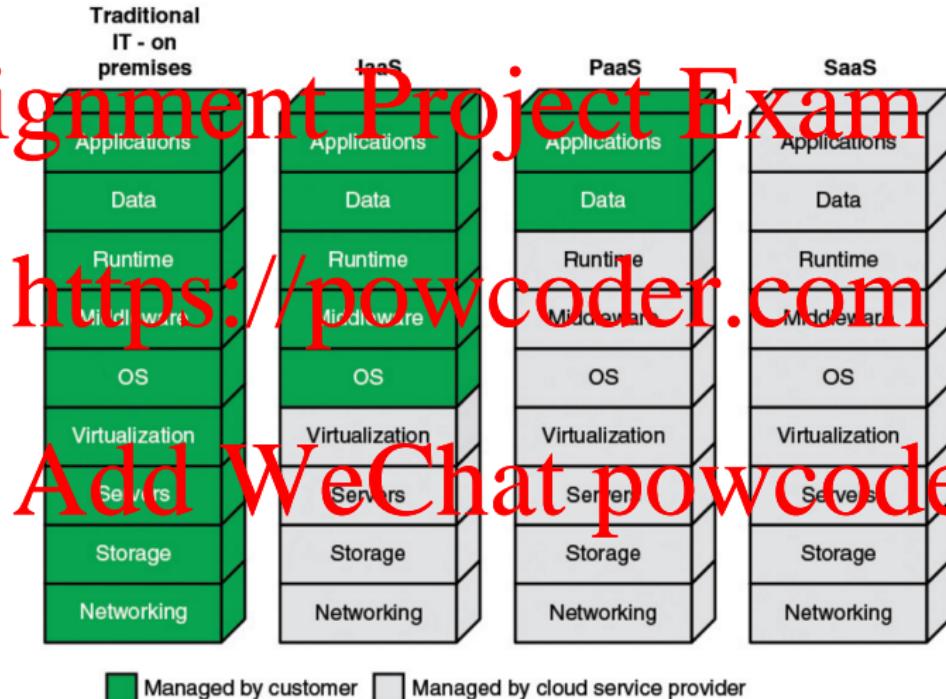


Figure: Separation of responsibilities in Cloud Computing (Stallings)

# Cloud computing

## Cloud Deployment Models

- **Private:** implemented within the internal IT environment of an organisation
- **Public:** an organisation selling cloud services to the general public
- **Community:** somewhere in between private and public
- **Hybrid:** composed of two or more clouds

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	Private	Community	Public	Hybrid
<b>Scalability</b>	Limited	Limited	Very High	Very High
<b>Security</b>	Most secure option	Very secure	Moderately secure	Very secure
<b>Performance</b>	Very good	Very good	Low to medium	Good
<b>Reliability</b>	Very High	Very High	Medium	Medium to high
<b>Cost</b>	High	Medium	Low	Medium

Figure: Comparison of Cloud Deployment Models (Stallings)

# Cloud computing

Nottingham Cloud - The origin

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Nottingham Cloud - The origin

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# Cloud computing

Nottingham Cloud

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School of Computer Science Cloud Services  
Research Systems Team • University of Nottingham

How does it work?

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- It provides Linux virtual machines (Cent OS)
- Purely based on VMWare ESXi 6
- You need to install a VMWare client on your computer and log in - Remote desktop
- Home folder is mounted (Virtual SAN)

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<https://www.nottingham.cloud/>

# Cloud computing

Nottingham Cloud

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(Physical) Technical aspects:

- We have 6 Servers of the following specifications:

Dual E5-2670v3 2.3GHz

24 physical/48 logical cores

- The local storage from each of the 6 servers is combined into a 54TB Virtual SAN which holds all the VM images
- Across all 6 servers, there are between 208 and 403 VMs across all servers at any one time

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Nottingham Cloud

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The whole system consists of:

- 2 nodes for load balancing and providing High Availability to the connection servers
- 6 connection/security nodes passing session data between the desktop nodes and end-user clients
- Between 200 and 400 nodes each providing a Linux desktop to a single user
- For most of the year there will be 200 active nodes. When a new image is being distributed there can be up to 200 additional nodes as the new VMs are created and unused previous images are destroyed

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Build your own cloud  
Open Source Software

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openstack



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# Problem

From last year exam

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- **Briefly explain** the difference between connecting to the School's servers via ssh (e.g bann.cs.nott.ac.uk) or using the Nottingham Cloud (i.e. using the VMware client). Give one reason why you would use ssh over Nottingham Cloud, and one reason to use Nottingham cloud over ssh.
- Submit your answers at:

<https://b.socrative.com/login/student/>

Room name: G52OSC

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## Summary

Take-Home Message<sup>1</sup>

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- Cloud computing - a new computational paradigm
- Virtualisation is the base of Cloud Computing
- Different kinds of Clouds

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<sup>1</sup>Tanenbaum Section 7.11