

Demystifying Cloud Computing



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What is Cloud Computing?

First, a little history.

Mainframe Era (1944-1978)



Workstation Era (1968-1985)



Xerox Star 1981

Microcomputer Era (1978-1994)

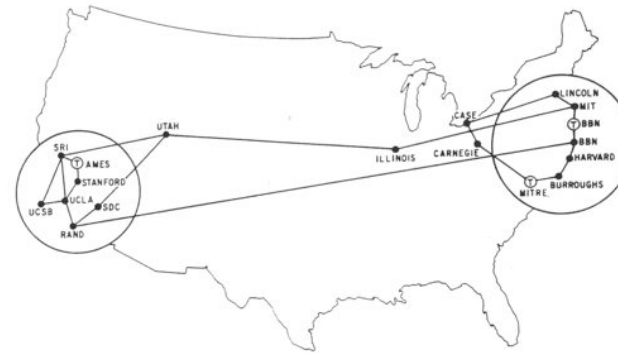


Macintosh (1984)



IBM PC (1982)

The Internet Era (1994-Present)



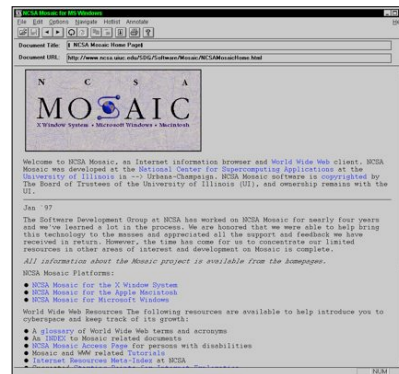
ARPANET (1971)

Email (1972)

The Internet Era - Web



Tim Berners-Lee (1989)



Mosaic web browser (1993)

The Internet Era - Social Networks



Delivery of IT is Changing

Gartner predictions for 2013

Mobile Device Battles

- Gartner predicts that by 2013 mobile phones will overtake PCs as the most common Web access device.
- By 2015 over 80% of the handsets will be smartphones.
- By 2015 tablet shipments will reach 50% of laptop shipments and Windows 8 will likely be in third place behind Google's Android and Apple iOS systems.

Mobile Device Battles

- Enterprises will need to support a variety of form factors reducing ability to standardize PC and tablet hardware.
- The implications for IT is that the era of PC dominance with Windows as the single platform will be replaced with a post-PC era where Windows is just one of a variety of environments IT will need to support.

Bring Your Own Device (BYOD)



Growth in mobile devices (Q2, 2012)

- 2012 - 479 million Android smartphones
- 2012 - 136 million iPhones
- 2012 (Q4) 1.3 million Android activations each day
- 2012 (Q4) 81 million Samsung
- 2012 (Q4) 37 million iPhones
- 2012 (Q4) 39 other companies



Personal Cloud

- There will be a long term shift away from native apps to Web apps as HTML5 becomes more capable.
- Nevertheless, native apps won't disappear, and will always offer the best user experiences and most sophisticated features.



Software Development for Mobile Devices



Personal Cloud

- The personal cloud will gradually replace the PC as the location where individuals keep their personal content, access their services and personal preferences and center their digital lives.
- It will be the glue that connects the web of devices they choose to use during different aspects of their daily lives.

Personal Cloud



Data Growth

- Every day, we create 2.5 quintillion (10^{30}) bytes of data — so much that 90% of the data in the world today has been created in the last two years alone.
- Dealing with data volume, variety, velocity and complexity is forcing change.



Data Growth

- This data comes from everywhere: sensors used to gather climate information, posts to social media sites, digital pictures and videos, purchase transaction records, and cell phone GPS signals to name a few.
- This data is big data.



Server Virtualisation

Let's look at the technologies involved

Virtualisation

- **Virtualisation** is the creation of a virtual (rather than actual) version of something, such as a hardware platform, operating system, a storage device or network resources.
- **1965** - IBM announced the IBM System/360-67, a 32-bit CPU with virtual memory hardware
- **1999** - VMware introduced the first x86 virtualization product.

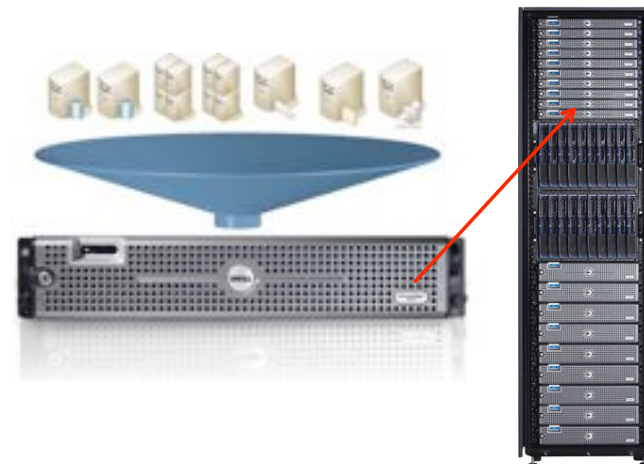
Hypervisors

- A **hypervisor**, also called virtual machine manager (VMM), is one of many hardware virtualisation techniques allowing multiple operating systems to run concurrently on a host computer.

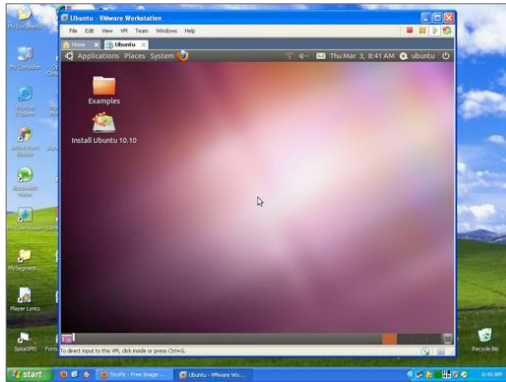
Server Virtualisation & Hypervisors



Server Consolidation



How to run Ubuntu in Windows/Mac



Microsoft Windows

- Microsoft Virtual PC
- VMware Workstation
- Xen
- VirtualBox

OS X (Mac)

- Parallels
- VMware Fusion

VMware Fusion on OSX



So, what is Cloud Computing?

IT as a service (ITaaS)



The NIST Definition of Cloud Computing

- According to the official NIST definition, "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."

<http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>

Essential Characteristics 1

- **On-demand self-service:** A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.

Essential Characteristics 2

- **Broad network access:** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

Essential Characteristics 3

- **Resource pooling:** The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.

Essential Characteristics 4

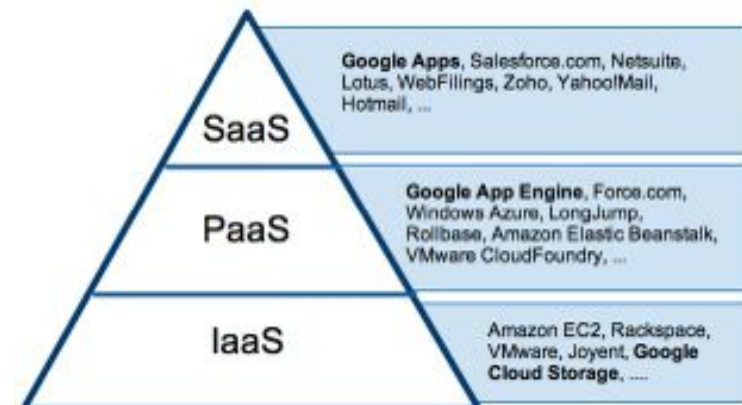
- **Rapid elasticity:** Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

Essential Characteristics 5

- **Measured service:** Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

Cloud Computing Service Models

Cloud Computing – Service Models



Software as a Service (SaaS)

- Software applications that are only available online fall into the "Software-as-a-Service" category, also known as "SaaS". The simplest example to understand is e-mail.
- The easiest way to think of SaaS is like this: it's software that you access using a web browser or mobile app.
- Because these applications run (and store their data online), users no longer need to worry about managing, saving, and backing up their files.

Software as a Service (SaaS)



Platform as a Service (PaaS)

- At this service level, the vendor takes care of the underlying infrastructure for you, giving you only a platform to build and host your applications. We could say that a PaaS user is a SaaS developer.
- Google App Engine, Salesforce's Heroku and force.com, Microsoft Azure, and VMware's Cloud Foundry, all fall under the PaaS umbrella.
- Companies are using PaaS is for operational improvement, as PaaS eliminates the need for teams to manage their own technology stacks.

Platform as a Service (PaaS)



Infrastructure as a Service (IaaS)

- Infrastructure-as-a-Service or IaaS is where you outsource the hardware.
- In such cases, it's not just the computing power that you rent; it also includes power, cooling, and networking.
- Furthermore, it's more than likely that you'll need storage as well. Generally IaaS is this combination of compute and cloud storage.

Infrastructure as a Service (IaaS)



Microsoft's Data Centre in Dublin



The Dublin-based data centre, which began operation in 2009 with an initial investment of \$500 million, with a \$130 million extension opening this year.

Microsoft's Data Centre in Dublin

- The Dublin-based data centre, which began operation in 2009 with an initial investment of \$500 million, will grow to 415,000 sq ft and 29.4 megawatts of power. Initially, the centre was 303,000 sq ft.
- The centre currently provides computing capacity to customers across Europe, the Middle East and Africa.
- It was the first Microsoft mega data centre built outside of the US, and was designed to support the company's cloud services.

Data Centres



Impact on the environment

- How much energy is required to power the ever-expanding online world?
- What percentage of global greenhouse gas emissions is attributable to the IT sector?
- This report ⁽¹⁾ takes a look at the energy choices some of the largest and fastest growing IT companies.

(1) <http://www.greenpeace.org>

GREENPEACE

Data Centre Concerns



Apple to build 20MW solar farm at North Carolina data centre

21.02.2012

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In its latest environmental report, Apple has revealed how it is planning to build a 100-acre solar farm around its data centre in Maiden, North Carolina. Apple is also building a fuel cell installation powered by biogas at the site.

In 2011, Apple commissioned the North Carolina data centre, which already has taken on some energy efficiencies, such as a white cool-roof that was designed to provide maximum solar reflectivity.

The [Facilities Report](#) is one of the first times that Apple has given some definitive statistics on how it powers up its data centres.

In early February, Greenpeace omitted Apple from its Cool IT Leaderboard, which pitches IT giants against each other for how



Apple to build 20MW solar farm at North Carolina data centre
Apple data centre in Maiden, North Carolina. Image courtesy of the Apple Facilities Report. See: <http://www.apple.com/enhancedreports/>

Data Centre Innovation

Microsoft to pilot data centre powered by biogas

23.11.2012

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Microsoft is teaming up with US firm FuelCell Energy to pilot a data centre research project in Wyoming that will see biogas generated by a wastewater treatment plant being used to power up a data centre that will be independent of the grid.

With IT giants trying to find cleaner ways of powering up their energy-hungry data centres – think Google's new [air-cooled data centre in Dublin](#) or Apple's [solar farm](#) around its new data centre in Maiden, North Carolina – Microsoft is taking it one step further, looking to the potential of the process of anaerobic digestion from sewage to create biogas and power its data centres of the future.



Microsoft to pilot data centre powered by biogas

Microsoft is planning to invest around US\$5.5m in the R&D project, which will be located in the Dry Creek Water Reclamation Facility in Cheyenne, Wyoming.

Data Centre Innovation

Google opens new €75m air-cooled data centre in Dublin

28.09.2012

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A year after announcing its plans to construct a €75m data centre in west Dublin, Google has this morning opened the new centre at Profile Park in Clonsilla.

In all, it took more than 1,000 people working for more than 90 building and engineering companies to carry out the build, which took less than a year.

Google said today the centre will provide [employment](#) for 30 people, with roles ranging from computer technicians, electrical and mechanical engineers to catering and security staff.

The data centre will host computers to run cloud computing services, such as the Google search engine, Gmail and Google Maps. According to Google, it will rank as one of the most energy-efficient data



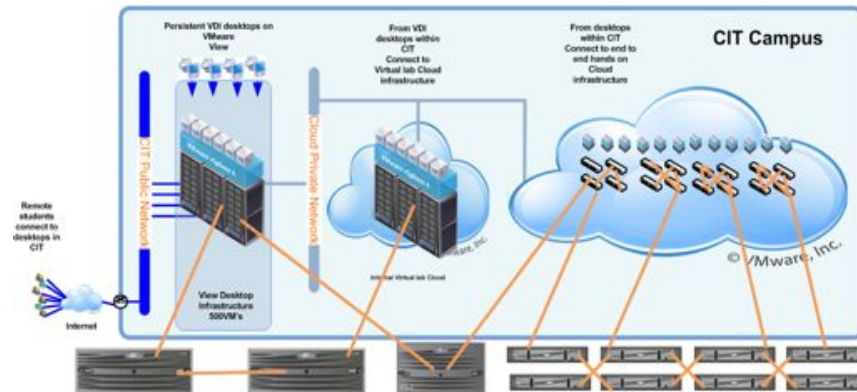
Google opens new €75m air-cooled data centre in Dublin
Richard Bruton, TD, Minister for Enterprise, Jobs and Innovation, and Paul Dunne, facilities manager at Google's new data centre in west Dublin

Cloud Computing Deployment Models

Private Cloud

- The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units).
- It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.

CIT Cloud Infrastructure



CIT Student Registration



Student ID Card & a Virtual Desktop



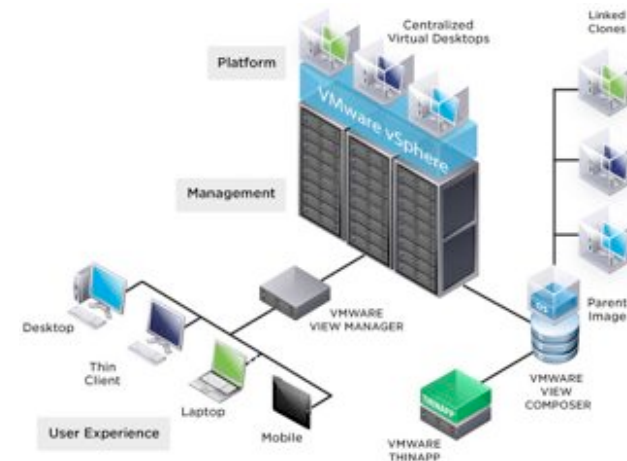
Desktop Virtualisation

- Desktop virtualization involves running virtual machines on a hypervisor in a datacenter, instead of running individual desktops.
- The centralized nature allows users to access their data and applications from almost any remote device (e.g.. desktop, laptop, tablet, smartphone, etc.).
- Helps maintain compliance, quickly add new users profiles to the network, address corporate security and user storage concerns.

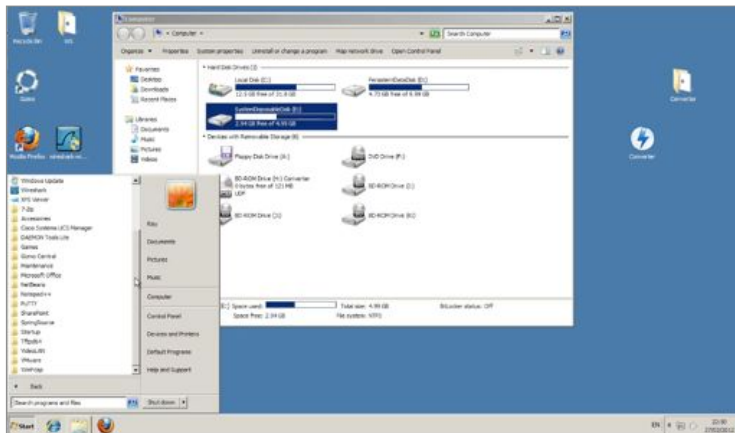
Your desktop on any device



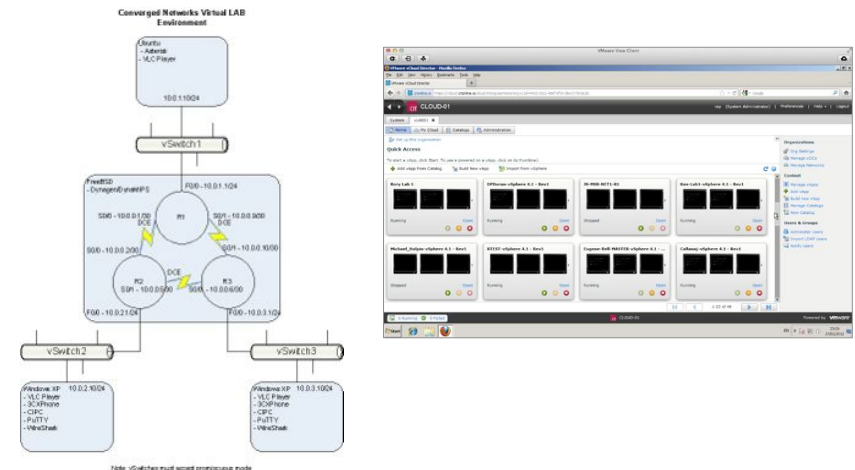
VMware View Environment



Persistent Windows Virtual Machine



Virtual Labs



Public Cloud



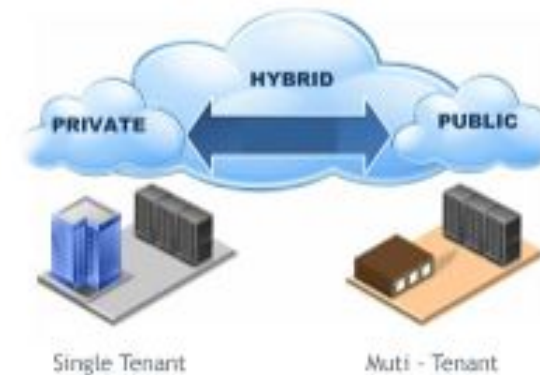
Public Cloud

- The main benefits of using a public cloud service are:
 - Easy and inexpensive set-up because hardware, application and bandwidth costs are covered by the provider.
 - Scalability to meet needs.
 - No wasted resources because you pay for what you use.

Hybrid Cloud

- The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability.

Hybrid Cloud



CIT's Cloud Computing Programmes

Unique Suite of Academic Programmes

- Higher Diploma in Cloud Computing (L8)
- Higher Diploma in Data Science & Analytics (L8)
- Higher Diploma in Cloud & Mobile Software Development (L8)
- BSc (Hons) in Cloud Computing (L8) – 1 year add-on
- MSc in Cloud Computing (L9)

Industry Engagement

- Normally curriculum development takes place within the walls of a higher education institution and industry is consulted at the end of the process
- These programmes are unique as curriculum development was done with industry partners through engagement at the highest level

Industry Partners



Online Delivery

Flexible Learning

- More flexible learning opportunities for students who are in employment or who are unable to commit to regular attendance at higher education institutions are needed.

Geographic Distribution of Students

- Ireland – from Dublin to Galway, Cork to Clare
- UK, Spain, France, Germany
- Netherlands, Russia
- Egypt, India, Saudi Arabia
- USA

Online Lectures

The screenshot shows a web browser window displaying a lecture slide titled "HTTP Request Methods". The slide content includes:

- Each HTTP Request contains method
 - GET to get information about resource given by URI
 - POST to create new resource
 - DELETE to delete resource
 - PUT to update resource
 - other (HEAD, OPTIONS, TRACE,...)
- Safe Methods
 - GET, HEAD
- Idempotent Methods
 - GET, HEAD, PUT, DELETE
- <http://www.w3.org/Protocols/rfc2616/rfc2616-sec9.html>
- Important for RESTful services (later in the module)
- Supported in browser: GET and POST
 - How to handle PUT, DELETE in HTML forms?

The slide footer indicates "28 February 2012" and "Clark Institute of Technology". On the right side of the browser window, there is a video feed of a male presenter and a list of participants including "Attendees (13)", "Presenters (1)", "New Members", "Participants (13)", and "Chat: discussion".

Delivered to any Internet enabled device



Conclusion & Review

Review

- **Why does cloud computing exist?**
 - In summary, legacy machines, equipment, and networking have been a burden for companies to maintain and manage, and one of the more difficult problems is to make good on the investment.
- **What are some of the reasons companies migrate to the cloud?**
 - Cloud computing reduces the burden on corporate IT organisations and offers elasticity by letting firms outsource their computing needs and focus on their customers' solutions. Depending on the need, there are various levels of cloud computing service that companies can use.

Review

- **What are the three primary levels of cloud computing service and what are the main differences between them?**
 1. At the infrastructure level, all hardware resources such as compute, networking, power, and cooling are taken care of by the cloud vendor.

IaaS customers are in full control over the virtual machines, storage, and everything else above in the stack.

Review

- **What are the three primary levels of cloud computing service and what are the main differences between them?**

2. Users of PaaS services have an even greater luxury of only needing to be concerned with creating their customer applications.

All of the hardware and mid-level services such as web and database servers are taken care of by the platform.

Review

- **What are the three primary levels of cloud computing service and what are the main differences between them?**

3. Finally, SaaS applications live ubiquitously in the cloud, allowing their users access from desktops, laptops, or mobile devices.

Questions & Answers



Some Links

- <https://vimeo.com/31464226>
- <http://www.google.com/about/datacenters/inside/streetview/>
- <http://www.apple.com/environment/renewable-energy/>
- <http://www.siliconrepublic.com/clean-tech/item/30386-microsoft-to-pilot-data-cen>
- <http://www.siliconrepublic.com/clean-tech/item/29435-google-opens-new-75m-air-c>
- <http://www.siliconrepublic.com/clean-tech/item/25892-apple-to-build-20mw-solar-f>