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Cloud Computing in Institutions

A Briefing Paper

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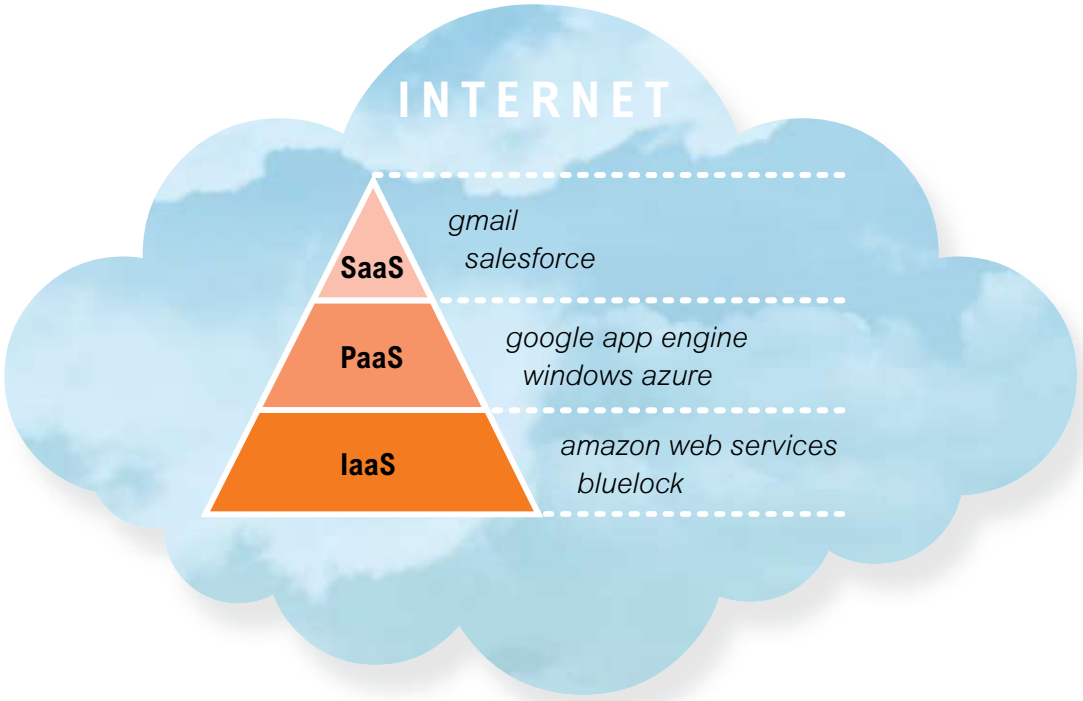
The term "Cloud Computing" refers to any computing capability that is delivered as a service over the Internet. While there is no authoritatively accredited definition of the concept, one of the most frequently used definitions is the one given by Gartner, who describe cloud computing as "a style of computing where massively scalable IT-related capabilities are provided 'as a service' across the Internet to multiple external customers."[1]

This briefing paper will explain some of the key characteristics and delivery levels of current development and implementations that provide a basis for understanding cloud computing and the ongoing discussion about it.

http://jisc.cetis.ac.uk



Five Key Characteristics

RAPID ELASTICITY: Capabilities can be rapidly and elastically provisioned to quickly scale up and rapidly released to quickly scale down.

UBIQUITOUS 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 and laptops, etc.).

PAY PER USE: Capabilities are charged using a metered, fee-for-service, or advertising based billing model to promote optimisation of resource use.

ON-DEMAND SELF-SERVICE: With many cloud computing services, a consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed without requiring human interaction with each service's provider.

LOCATION INDEPENDENT DATA CENTRES: The provider's computing resources are usually pooled to serve all consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.

Three Delivery Levels

Three cloud computing delivery levels can be identified as;

SOFTWARE AS A SERVICE (SaaS): The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure and accessible from various client devices through a thin client interface such as a Web browser (e.g., web-based email, SalesForce.com[2] and Google Mail[3] in the diagram above).

PLATFORM AS A SERVICE (PaaS): The capability provided to the consumer is the ability to deploy onto the cloud infrastructure, consumer-created applications that use a specific environment and toolset supported by the provider (e.g. specific APIs defined on a limited list of languages such as java, python, .Net. Examples include App Engine[4], and Windows Azure[5]).

INFRASTRUCTURE AS A SERVICE (IaaS): The capability provided to the consumer is to rent processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications.(e.g. various server hosting solutions Amazon Web services[6] and BlueLock[7])

Some Illustrations

EMAIL: What makes cloud computing a relatively new phenomenon in the education sector is that, in the past, institutions would own, control and provide computing capabilities at all levels. For example, email typically ran on a server owned by the college, that sat in a college building, hooked up to the rest of the college's network, tended by college employees, using software licensed by the college for the benefit of its students and staff:

	PROVISION	OWNERSHIP
SOFTWARE	COLLEGE	COLLEGE
PLATFORM	COLLEGE	COLLEGE
INFRASTRUCTURE	COLLEGE	COLLEGE

With a cloud computing solution to email such as Google Apps for Education[8] or Microsoft's Live@Edu[9], this picture changes considerably:

	PROVISION	OWNERSHIP
SOFTWARE	COLLEGE	GOOGLE / MICROSOFT
PLATFORM	GOOGLE / MICROSOFT	GOOGLE / MICROSOFT
INFRASTRUCTURE	GOOGLE / MICROSOFT	GOOGLE / MICROSOFT

The server, buildings, network infrastructure in cloud computing case are all owned and provided by a third party. The College still provides email to students and staff, but it no longer licenses email software directly, or has employees looking after the service beyond hooking the external email system up to the local infrastructure.

CUSTOMER RELATIONSHIP MANAGEMENT: Cloud computing also enables different parties to share effort in interesting new ways. For example, Enrollment Rx[10] offers student enrollment management as Software as a Service to institutions. In turn, Enrollment Rx is built on the Platform as a Service offered by force.com[2], a company that offers generic Customer Relationship Management (CRM) as SaaS, but also allows others to build specialised CRM applications on its own platform. The whole picture looks like this:

	PROVISION	OWNERSHIP
SOFTWARE	ENROLLMENT RX	ENROLLMENT RX
PLATFORM	FORCE.COM	FORCE.COM
INFRASTRUCTURE	FORCE.COM	FORCE.COM

Note that Enrollment Rx[10] is providing the platform to the institution, not the institution to its staff or students.

CONTENT TRANSCODING: Platform as a Service offerings also make it easy to try out new services without major investment. At JISC CETIS, for example, a need to be able to convert between different educational content formats was identified. In order to be able to meet an unknown amount of demand, and to enable the developers (Knowledge Integration ltd[11]) to develop and deploy a service rapidly, the new application was developed as a service that runs on Amazon's web services:

	PROVISION	OWNERSHIP
SOFTWARE	JISC CETIS	JISC / HEFCE
PLATFORM	AMAZON.COM	AMAZON.COM
INFRASTRUCTURE	AMAZON.COM	AMAZON.COM

Risks and Opportunities

Moving significant chunks of an institution's IT systems to third parties can enable a lot of flexibility and efficiency, but also has consequences in a number of areas that require some thought.

RISKS:

INTEROPERABILITY: As with conventional software, there is a danger that communicating with a cloud computing application or platform is specific to only one supplier. Such proprietary standards make moving one's data or software from that supplier to another difficult.

Fortunately, independent implementations of popular Platforms as a Service such as Google's App Engine already exist, which provides one way out of vendor lock-in. Also, some organisations are developing open standards for cloud computing, which could inspire participating vendors to compete on openness rather than lock-in.

SECURITY: Any cloud computing solution, by definition, processes an organisation's private data on shared systems, and that data is generally transported to and from the cloud over the internet. This naturally raises some concerns about the total security of any given cloud computing service. Reasonably robust technical solutions to the issues exist, but it is still clear that a lot relies on the degree of trust between the institution and the cloud computing vendor. For that reason, many institutions try cloud computing solutions with non-critical data first.

RELIABILITY: In principle, the economies of scale involved should mean that cloud computing vendors have more to invest in multiply redundant, fail-proof systems than most colleges. Still, a number of well-publicised cases have shown that large platforms can still fail. Strong Service Level Agreements (SLAs) can help manage, but not eliminate the issue. It could well be the case that failures become much rarer as the cloud computing approach matures- vendors have a powerful incentive to keep their products going.

LEGAL ISSUES: Certain types of data, particularly those relating to students, are prohibited from travelling out of the institution's jurisdiction. Archetypal cloud architectures are not geographically determined, resources go to whichever datacentre is available and capable. Because of legal concerns, however, vendors are starting to be able to give some guarantees that, for example, no data will leave the EU.

"PRIVATE CLOUDS"

One way of mitigating some of these concerns is the idea of a 'private cloud'. In most cases, these are effectively a variation of institutionally owned and run IT systems, configured to run like cloud services. To what extent these are re-badged traditional enterprise products remains to be seen.

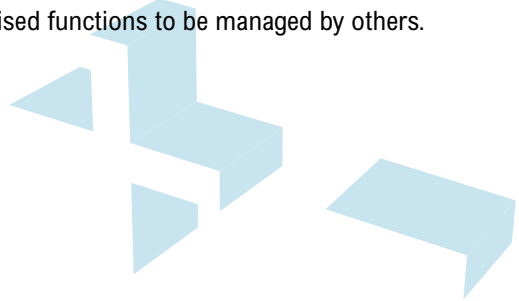
OPPORTUNITIES:

DEALING WITH PEAK DEMAND: Events such as clearing in August or enrollment in September can place a significant strain on IT infrastructure. Buying in-house capacity to deal with such a peak means that expensive systems are under-utilised the rest of the year. Computing capacity that can be rented quickly and flexibly has clear advantages in this regard.

CUTTING COSTS: The fundamental driver for cloud computing remains price. In that sense, the underlying principle is simply economies of scale. It should cost less per unit to provide a service for many organisations, than it is for the organisation to provide for itself. Though the cost of hosting common functions such as email in-house is marginal for some institutions, an increasing number of surveys do show that cloud solutions can bring savings.

CATERING FOR SPECIALISED NEEDS: The economies of scale principle also suggests that cloud computing may make services viable that are not economical on an institutional scale. The content transcoder above is one example, but many other services are conceivable whose running costs or investment risk can't be justified by known demand within one college, but would work 'web-wide'.

SEPARATION OF CONCERNS / FOCUSING ON ONE'S STRENGTH: More strategically, cloud computing can provide an opportunity for information system departments to reconsider their role. In a time when there are an ever increasing number of technologies and demands to use them, the idea of focussing on some core functions can be quite attractive. As we've seen, cloud computing solutions allow both mundane and generic systems such as file storage, as well as more cutting edge and specialised functions to be managed by others.



Available Products and Services

The range of cloud services is expanding rapidly, particularly those that are offered as Software as a Service to the end user, but are themselves built on Platforms as a Service. Add to that the fluid boundary between Infrastructure as a Service and traditional hosting solutions, and the list of potential products becomes unmanageable. Still, the following products and services are either already in use in Further and Higher Education, or illustrate the principles particularly well.

MICROSOFT LIVE@EDU: A free Microsoft solution that provides email, file storage and a number of other collaboration tools as Software as a Service. At least four different UK institutions are currently piloting the service with undergraduates. A number of technical integration features are available, most notably the ability to brand email addresses with the institution's name (i.e. joe@poppleton.ac.uk, not joe@microsoftlive.com)

http://www.microsoft.com/liveatedu/

GOOGLE APPS EDUCATION EDITION: Offers pretty much the same features as Live@edu, but with the addition of the Google docs office applications. Integrations features are comparable too, and it's also free.

http://www.google.com/a/help/intl/en/edu/index.html

ENROLLMENT RX: Is a relatively small company in the US that offers a Customer Relationship Management solution as Software as a Service. The service allows institutions to track prospective students through the application and enrollment process. The system is not free, but the combination of web delivery on the user end, and Platform as a Service at the back end, are intended to keep prices competitive.

http://www.enrollmentrx.com/

GOOGLE APP ENGINE: Is a Platform as a Service product that allows developers to develop and deploy web oriented applications. Compared to traditional software development, the platform provides a number of commonly used functions that the developer no longer needs to worry about, and the often time-consuming deployment configuration can be streamlined or skipped. It also allows people to skip the capital investment in infrastructure that's normally required for new web application, and just pay for what's used.

http://code.google.com/appengine/

AMAZON WEB SERVICES: Is comparable to Google's App Engine, but more of a family of lower level, differentiated functions. The Simple Storage Service (S3), for example, only does storage of data, and the Elastic Compute Cloud (EC2) only computing cycles. This approach allows for a degree of flexibility that's proven popular with many developers.

http://aws.amazon.com/

RACKSPACE CLOUD SERVERS: Provides Infrastructure as a Service, and is technically a bit more like traditional co-hosted hosting than Amazon Web Services, but more flexible and can scale quicker to meet demand than such hosts.

http://www.rackspace.com/cloud/cloud_hosting_products/servers/

FURTHER READING:

Above the Clouds: A Berkeley View of Cloud Computing, Armbrust. M, et al., (2009).

http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28.pdf

The 2009 Horizon Report, Johnson, L., Levine, A., & Smith, R. (2009). The New Media Consortium. Austin, Texas.

http://wp.nmc.org/horizon2009/chapters/cloud-computing/

Cloud Computing's Top Issues for Higher Education, Nicholson, J. L, (2009).

http://www.universitybusiness.com/article/cloud-computings-top-issues-higher-education

Five cloud computing myths exploded, Everett, C, (2009), ZDNet.

http://resources.zdnet.co.uk/articles/0,1000001991,39605991-1,00.htm

REFERENCES:

1. **Gartner Says Contrasting Views on Cloud Computing Are Creating Confusion (2008).**

http://www.gartner.com/it/page.jsp?id=766215

2. **SalesForce.com**

http://www.salesforce.com/uk/

3. **Google Mail**

http://mail.google.com

4. **Google App Engine**

http://code.google.com/appengine/

5. **Windows Azure**

http://www.microsoft.com/windowsazure/

6. **Amazon Web Services**

http://aws.amazon.com/

7. **BlueLock**

http://www.bluelock.com/

8. **Google Apps for Education**

http://www.google.com/a/help/intl/en/edu/index.html

9. **Microsoft Live@Edu**

http://www.microsoft.com/liveatedu/

10. **Enrollment Rx**

http://www.enrollmentrx.com/

11. **Knowledge Integration ltd**

http://www.k-int.com/

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