The Cloud: Computing in the 21st Century, Opportunities and Challenges
Ian Osborne MSc, MBCS, CITP
April 14th 2011
About the Speaker

• Project Director, Intellect
• 39 Year Career in IT, and counting ...
  – Computer Science background
• British Airways, ICL, HP, Intellect
  – Software Development, Project Management, Quality, Marketing
• MSc Sussex/Brighton & Cranfield
  – Management of Technology & Innovation
• Knowledge Transfer Networks – Innovation Agenda
• ICT Knowledge Transfer Network (April 2011)
• Enterprise IT
  – IT as a Service; Government Computing; Scalability; Sustainability
  – In 2009/10 G-Cloud team, focus on Apps Store
• BCS Distributed and Scalable Computing Specialist Group
Lean IT – Of Our Time?

Agenda

- *Industry Drivers*
- Towards IT as a Service
- Data Centre Efficiency
- Cloud Challenges
- Government ICT
- Getting Started
Industry Drivers

• Moore’s Law
  - Processor; Memory
  - Virtualisation
  - Energy Management

• Internet
  - Web
  - Mobility

• Thin Client/Appliance
  - Network enabled
  - Services
Where are we heading?

Old World
Static
Silo
Physical
Manual
Application

New World
Dynamic
Shared
Virtual
Automated
Service
Lean IT – Of Our Time?

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"Software as a service is just the tip of the iceberg. We’re moving to a future state where everything will be delivered to you as a service."

— SHANE ROBISON, EXECUTIVE VICE PRESIDENT & CHIEF STRATEGY AND TECHNOLOGY OFFICER, HP
The Cloud!

- On Demand Self-Service
- Broad Network Access
- Resource Pooling
- Rapid Elasticity
- Measured Service
NIST Cloud Definition

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. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models.

http://csrc.nist.gov/groups/SNS/cloud-computing/
Deployment Model Overview

PRIVATE CLOUD
Operated solely for an organization.

COMMUNITY CLOUD
Shared by several organizations and supports a specific community that has shared concerns.

PUBLIC CLOUD
Made available to the general public or a large industry group and is owned by an organization selling cloud services.

HYBRID CLOUD
Composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability.
## Delivery Model

<table>
<thead>
<tr>
<th>Model</th>
<th>Capability Provided</th>
<th>Example Services</th>
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| SaaS  | 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 | ▪ Productivity Tools  
▪ Information Services  
▪ Business Enablement (Salesforce.com)  
▪ Enterprise Applications (Core Mission & Business Services) |
| PaaS  | To deploy onto the cloud infrastructure consumer-created applications using programming languages and tools supported by the provider (e.g., java, python, .Net) | ▪ Application Development  
▪ Database and Database Management Systems  
▪ Developer / Testing Tools  
▪ Virtual Environments |
| IaaS  | To provision 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 | ▪ Computing  
▪ Storage  
▪ Network  
▪ Application hosting |
The Next Virtualization Milestones

2006
- Business Critical HA 3%
- Production Consolidation 50%
- Planned Migrations 9%
- Software Development and Testing 38%
- Utility computing 1%

Resource Utilisation

Virtualization 1.0
- Encapsulation
- Resource Sharing
- Dynamic Consolidation
- 2005

Dynamic Capacity

Virtualization 2.0
- Mobility
- Planned Downtime
- Network Resiliency
- 2007

Data Centre as a Service

2010
- Software Development and Testing 8%
- Production Consolidation 27%
- Planned Migrations 18%
- Business Critical HA 18%
- Mission Critical HA 9%
- Workload Balancing 4%
- Utility computing 16%

Operational Cost Reduction

CAPEX

© 2007 IDC
Market Examples

**SaaS:**
- E-Mail Services (Hotmail, Gmail)
- CRM Systems (SalesForce)
- Office Systems (Google Docs/Apps/Office 365)

**PaaS:**
- Force.com
- Google Docs
- Apple Applications Store

**IaaS:**
- Amazon Web Services
- Rackspace
- FastHosts

**Virtual Data Centres**
- Cisco, Betfair

**Outsourced IT Services**
- Bechtel
- RNLI
- Comic Relief Charity

**Financial Sector**
- CRM, Private Cloud

**UK Government**
- G-Cloud

James C. Best Jr.
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Sustainability and IT

• Not our problem, right?
• Average utilisation of equipment in the Data Centre is 10-15%
  – Worse with redundancy
• Powering processors consumes about 6-10% of the Data Centre budget.
  – The rest goes on UPS; Lighting; Cooling; AC:DC:AC
• Total carbon emissions is estimated at around 2-3% and rising
• And energy costs continue to rise too!
Energy, Carbon and ICT

- Estimated energy cost in USA (2011) - $7.4 billion
- Estimated energy cost in Western Europe (2007) - £4.48 billion
- Estimated energy cost in Western Europe (2020) - £8.32 billion

- What can you afford?

http://www.greenm3.com/2008/05/christian-bel-1.html
Carbon Economics – The challenge ahead

Key Facts

• Kyoto/Burden Sharing Agreement requirement to cut greenhouse gas emissions by 12.5% by 2012 versus 1990 base year

• National goal of a 20% CO² emission reduction by 2010 versus 1990

• Energy White Paper ambition for a 60% cut in carbon emissions by 2050

• Real progress on the path to 60% by 2020

➢ Carbon Reduction Commitment, a Tax not an offset!
Google Data Centres – Benchmark?

• 1M(est) Servers in 3 doz. Data Centres
• Power Usage Effectiveness (PUE)
• EPA 2011 Forecast Average 1.9 with equipment trends
• Google attained 1.10/Qtr in best facility (10% overhead!)
• Five step plan
  1. Minimize electricity used by servers
  2. Reduce the energy used by the data center facilities themselves
  3. Conserve precious fresh water by using recycled water instead
  4. Reuse or recycle all electronic equipment that leaves our data centers
  5. Engage with peers to advance smarter energy practice

Tech Titans Building Boom By Randy H. Katz
http://www.spectrum.ieee.org/print/7327 and Google’s own information
http://www.google.com/corporate/green/datacenters/
CPU Management Virtualisation Increases Hardware Utilisation

Virtualization enables consolidation of workloads from underutilized servers onto a single server to safely achieve higher utilization.
Higher utilisation reduces power and cooling

BEFORE

> 1000 servers
> 200 racks

AFTER

> -920 servers
> -190 racks
Modern Processor Architectures

Increased efficiency through:-
• Multiple cores
• Greater processing capacity
• Lower clock speed
• Lower power consumption
• Less heat generated
• Less cooling required
• Variable power utilisation
• Reduced idle power
• Remote “LAN” switching

• The battle is joined …
Practical Steps

• Industry Metrics (PUE)
  – **BCS DCSG** Standards Activity
  – No measure of effectiveness

• EC Code of Conduct on Data Centres
  – Voluntary Code
  – Participants: Subscribe, document your results
  – Endorsers: Support
  – Best practice guide – Peer Reviewed

• Cooling Strategies
  • Virtualisation
  • Server
  • Storage
  • Desktop
  • Network
  • Data Centre!

• Clean Energy Sources
  • Case studies available

[^www.ictktn.org]
But the real benefits …

• Using IT to reduce the carbon costs of our existing “business” services…
• Minimising Transport (17% of Carbon Use)
  • Optimising delivery and logistics
  • Avoiding travel, commuting costs
  • Intelligent transport services
  • Avoid delays, service disruptions
• Find new ways to deliver services
• Online access
• Integrated government services
• Local collection services
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Future Risks in the Cloud

• Denial of service
  – Resource consumption, traffic redirection, inter-cloud, to the user
• Trojan Clouds
  – Imitate providers, infiltrate supply chains – ID & Authentication
• Application Framework attacks
  – Repeatable, pervasive
• Separation and Inference
  – Virtualisation, Inference attacks due to privileged access
• Covering Tracks
  – Data Movement
The Cloud Complications

The following should be considered:

– Geography. Various countries with different laws and regulations.

– Ownership and rights. Clear responsibilities associated with data assets must be established even though the data is transient. Establishing boundaries is key.

– Potential for users to gain access to shared resources, and possibly to other users.

– Data loss. An incident may lead to a loss of system information and data for several customers on shared infrastructure.

– If hardware is seized as part of a legal investigation, it may contain data relating to several customers and may incur the loss or disclosure of that data.

– Secure disposal. Disposing of servers, hard drives etc is challenging for Cloud Service providers.
Security

80% Of enterprises consider security the #1 inhibitor to cloud adoption
48% Of enterprises are concerned about the reliability of clouds
33% Of respondents are concerned with cloud interfering with their ability to comply with regulations

Source: Driving Profitable Growth Through Cloud Computing, IBM Study (conducted by Oliver Wyman)

Concerns:
1. Reliability of network access
2. Data held insecurely
3. Data stored illegally
4. Denial of Service attacks
5. “Insider” attacks

Remedies:
- Ensure path to service provider is secure and operable
- Ensure Public Cloud operators run highest data centre standards
- Ensure Data location is mandated to comply with regulation
- Ensure Cloud and Infrastructure service providers have capabilities required
- Theoretical exposure of data stored in shared infrastructure
Selecting Services

A Cloud Service Provider is just that:-
• Due diligence on the company (CIF*)
• ISO 27000 and SAS 70
• Service Level Agreements
• Data Security Plan
• Application Escrow or Portability
• Network Access Security
• Billing Mechanisms/Controls
• Location of Data Storage
• Disaster Recovery Plan

*http://www.cloudindustryforum.org/
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Government as a Service: Why change?

- Citizens are moving on-line
- They expect to access Government Services on-line
- Their expectations are influenced by Industry Leaders
  - Retail; e-Commerce; Application and Content vendors
- They expect to access information from any platform
- Scale of uptake is huge
- Existing solutions are not designed to scale
- New strategies are required to deliver IT Services
- New choices for implementation
What does Government as a Service imply?

“For a few applications you may need to run your own infrastructure. For most you will be able to pool, in the fashion of shared services. But increasingly we will all be drawn to the benefits of scale of the public cloud. Lower cost, higher reliability, and one day more control.” - Government Chief Information Officer
Enabling Government as a Service

• Linking Agencies
• Sharing Resources
• Sharing Information
• Service Delivery
Smartphone Applications

Description
FREE live travel information – the official UK government travel app with up-to-the-minute advice on public transport and roads.

What’s New In Version 1.6
OS 4 compatible and fix for iPad

iPhone Screenshots

Directgov Web Site + Travel News Support + Application Licence Agreement +

More iPhone Apps by Directgov

jobcentreplus By Directgov
Open iTunes to buy and download apps.

Description
The official UK government jobcentre app brings you jobs from all over Great Britain straight to your phone.

What’s New In Version 2.1
Correct minor issues with location detection, blank screens and crashing.

iPhone Screenshots

jobcentreplus Web Site + jobcentreplus Support + Application Licence Agreement +

More iPhone Apps by Directgov
Social Networking
Information Services ...
Buckinghamshire County Council

Transport and roads
- Blog
- Clearing snow and ice yourself
- Salt bins & heaps
- School closures
- Winter driving

Grifting decisions
- Gritting: Dec 24: South Buckinghamshire - Precautionary routes 10pm (dry salting) at 19:00 tonight.
- Gritting: Dec 30: North Bucks -

RST = Road Surface Temperature

Winter maintenance

Winter maintenance precautionary gritting routes for 2010-2011 (PDF 2.2MB). These are the most important routes to keep everyone moving.

You can see our fleet of vehicles in their current location. Please note: Some of the vehicles are used on other duties during the day so they may be active on the map below.

Key: Blue line = precautionary gritting route. Red line = County boundary.

The Chartered Institute for IT

15/03/11
How safe is your street?

Many were alarmed when they logged on to the new crime maps, but the government insists they will improve our lives — once faults are ironed out

Matt Rudd
Published: 6 February 2011

So have you done it yet? Have you typed your postcode into the national crime-mapping website? Of course you have. We are, after all, a nation of curtain-twitchers and this is the latest, greatest curtain-twitching tool.

Police uk, the Government’s £300,000 website, was launched on Tuesday with the promise of up-to-date, accurate maps of all the crime in your street.

It promptly crashed under the weight of visitors. At its peak, 18m people an hour were attempting to access the site and on day one it was offline from 8am to 9pm.

Now that it is working, it is something of a revelation. It is the first website in the world to attempt to map all reported crime, as well as antisocial behaviour, at such a local level.

And it is incredibly simple to use. Type in your postcode or your street name and up pops a screen with details of your local bobby, perhaps your hapless community support officer and lots of detail about policing in your area. Click on “crime maps” and it zooms in on a Google map of all the crimes in your neighbourhood. With a series of colour-coded, numbered map pins. It marks the exact number of burglaries, robberies, vehicle crimes, violent crimes, incidents of antisocial behaviour and the catch-all “other crimes” in the previous month (the site will be updated on a monthly basis and you will be able to access the data from previous months).

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G-Cloud – A Key Policy Enabler

Benefits
- Modernise digital services for citizens
- Save money
- Speed up business change
- Address sustainability agenda

Enablers
- Leverage investment of global ICT industry
- Public Cloud services and shared applications
- CTO Council governed standards and champion assets
- Infrastructure standardisation and process automation
Government Applications Store Principles

- "Find it – build it – run it – share it", the “one stop shop” for Public Sector business and ICT services
- Based on a central catalogue of pre-procured and G-Cloud certified services and applications. Business services, Development platform and Infrastructure.
- Presented in the context of “your organisation”, “your sector”
- Services instantiated in your data context
- Lowest price for the Public Sector, all benefit from the volume driven price reductions
- Choice of infrastructure platforms for all applications
- Innovation encouraged – a market place for new ideas from suppliers and end users
- You can “see what’s coming” as well as “what’s there”
Management Challenges

• Evolving legacy commitments in Government
• Sharing services
• Secure solutions for Identity and Authentication
• Updated thinking on Information Assurance
• Secure solutions for use of public resources
• Reduced switching cost
• Digital Asset Security
• Digital Inclusion
CAMERON'S BIGGEST NIGHTMARE
THE STRUCTURE OF GOVERNMENT
A Government Cloud Computing Framework

Software as a Service (SaaS) / Applications
- Citizen Engagement: Wikis / Blogs, Social Networking, Agency Website Hosting
- Gov Productivity: Email / IM, Virtual Desktop, Office Automation
- Gov Enterprise Apps: Business SaaS Apps, Core Mission Apps, Legacy Apps (Mainframes)

Platform as a Service (PaaS)
- Database: DBMS
- Testing Tools: Directory Services
- Developer Tools

Infrastructure as a Service (IaaS)
- Storage: Virtual Machines
- Web Servers: CDN
- Server Hosting

Service Mgmt & Provisioning
- Service Provisioning
- SLA Mgmt
- Performance Monitoring
- DR / Backup
- Operations Mgmt

Security & Data Privacy
- Data/Network Security
- Data Privacy
- Certification & Compliance
- Authentication & Authorization
- Auditing & Accounting

Data Center Facilities
- Routers / Firewalls
- LAN/WAN
- Internet Access
- Hosting Centers

Cloud User Tools
- Application Integration
- User/Admin Portal
- Reporting & Analytics

Analytic Tools
- Data Mgmt
- Reporting
- Knowledge Mgmt

Reporting & Analytics
- API’s
- Workflow Engine
- EAI
- Mobile Device Integration
- Data Migration Tools
- ETL
- Product Catalog

Certification & Compliance
- Customer / Account Mgmt
- User Profile Mgmt
- Order Mgmt
- Trouble Mgmt
- Billing / Invoice Tracking
- Product Catalog
Technical Challenges in the Cloud

<table>
<thead>
<tr>
<th>Obstacle</th>
<th>Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Availability of Service</td>
<td>Use Multiple Cloud Providers; Use Elasticity to Prevent DDOS</td>
</tr>
<tr>
<td>2 Data Lock-In</td>
<td>Standardize APIs; Compatible SW to enable Surge Computing</td>
</tr>
<tr>
<td>3 Data Confidentiality and Auditability</td>
<td>Deploy Encryption, VLANs, Firewalls; Geographical Data Storage</td>
</tr>
<tr>
<td>4 Data Transfer Bottlenecks</td>
<td>FedExing Disks; Data Backup/Archival; Higher BW Switches</td>
</tr>
<tr>
<td>5 Performance Unpredictability</td>
<td>Improved VM Support; Flash Memory; Gang Schedule VMs</td>
</tr>
<tr>
<td>6 Scalable Storage</td>
<td>Invent Scalable Store</td>
</tr>
<tr>
<td>7 Bugs in Large Distributed Systems</td>
<td>Invent Debugger that relies on Distributed VMs</td>
</tr>
<tr>
<td>8 Scaling Quickly</td>
<td>Invent Auto-Scaler that relies on ML; Snapshots for Conservation</td>
</tr>
<tr>
<td>9 Reputation Fate Sharing</td>
<td>Offer reputation-guarding services like those for email</td>
</tr>
<tr>
<td>10 Software Licensing</td>
<td>Pay-for-use licenses; Bulk use sales</td>
</tr>
</tbody>
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Above the Clouds: A Berkeley View of Cloud Computing

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Getting Started

• Consolidate your list of applications/licenses
• Remove duplication, complexity
• Adopt Virtualisation
• Increase utilisation, flexibility – available capacity?
• Look at options to out-SaaS “standard” business services
  – E-mail, CRM, Payroll, HR, Project Management, etc.
• Look at in-SaaS options for core business applications
  – Cloud enabled business applications suite
  – Multi-tenanted
• Look at options to extend your own Data Centre
  – Cloud bursting for peak demand
• Disaster Recovery Services
Cloud case studies

• **Smith Electric Vehicles**
  Smith Electric Vehicles uses StormMQ’s cloud based message queuing system to handle the enormous amount of telemetry data collected every second from its fleet of electric commercial vehicles.

• **Simmartec**
  Marine simulation company Simmartec is using Inkspot’s Science’s cloud service to scale to levels it could never have managed on its own.

• **Symbian Foundation**
  Why have any servers on-site, when you can do all your work in the cloud? The Symbian Foundation is saving huge amounts of money, and managing an international workforce, by using cloud based services for everything they can.

• **BAFTA**
  The British Academy of Film and Television Arts (BAFTA) has been using Amazon”s cloud services for several years to manage complex projects.

• **Recruitment Genius**
  Recruitment Genius has used cloud hosting supplier ElasticHosts to manage over 700 job boards and offer very low cost recruitment advertising.

• **Norfolk County Council**
  Norfolk County Council Children’s Services has signed a deal with BT for a Virtual Data Centre service that will help them manage their ICT overheads by moving applications, storage and security into the cloud.

• **CWL Systems**
  CWL is using Symetriq’s cloud services to offer high-availability disaster recovery services to its clients.

• **DPS**
  Strategies and challenges shifting from Licensing to Software as a Service model.

• **Acutest/Flexiant**
  A persistent cloud based test system for testing on the go!
THANK YOU!

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