2013 OFA Developer Workshop

DoD Cloud Computing

Virginia Watson Ross
Air Force Research Laboratory
Virginia.Ross@wpafb.af.mil
937-656-6980

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Outline

- Introduction
- Cloud Computing Background
- Federal Government Cloud Computing
- Organizational Benefits Gained from Cloud Computing
- Summary
Introduction

• Rapid computer usage growth and Internet expansion along with growth in big data and analytics present opportunities for cloud computing

• Large IT investment for computing
  – Financial
  – Manpower

• Centralization of function via cloud computing
  – Economy of scale
  – Efficient resource usage
  – Availability to large user base
  – Agility to meet changing needs
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What is Cloud Computing?

- Computing resources held by provider
- Internet access to resources via PCs, laptops, smart phones, and PDAs
- Access to programs, storage, processing, and applications development
- Precursors include:
  - Thin clients
  - Grid computing
  - Utility computing
NIST Definition of Cloud Computing

• 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.

  (Mell & Grance, 2011, p. 2)
Essential Cloud Characteristics

• On-demand self service
• Broad network access
• Resource pooling
• Rapid elasticity
• Measured service
DISA - IT Trends Enabling Cloud Computing

- Increased Parallelism
  - *New Moore’s Law - 2X processors per chip generation*
  - *Parallel software industries emerging to address challenges*
  - *Redundant networks and storage increasing performance*
- Increased Virtualization
  - *Processing, Storage, Bandwidth, Delivery*
- Commodity Components
  - *X86 servers, consumer hard drives, ethernet*
  - *Open Source SW – Freedom to customize and adapt*
- Increased Outsourcing of Core Elements
  - Carbon Disclosure Project estimated cost savings to 2000 large US companies from cloud computing adoption to be $12.3 B/year by 2020
Four Cloud Deployment Models

- Internal (private) cloud
  - Enterprise owned or leased
- Community cloud
  - Shared infrastructure for specific community
- Public cloud
  - Sold to the public, mega-scale infrastructure
- Hybrid cloud
  - Composed of two or more cloud types
Cloud Delivery Models

- Business Process as a Service (BPaaS)
  - Delivery of business processes through a cloud service model
- Software as a Service (SaaS)
  - Using provider’s applications over a network
- Platform as a Service (PaaS)
  - Deploying customer applications to a cloud
- Infrastructure as a Service (IaaS)
  - Lease processing, storage, network, and other computing resources
- Services above are all deployed on a cloud infrastructure
Global Cloud Market Growth

- Global cloud computing market to expand from $40.7 billion in 2011 to $241 billion in 2020.
- Global public cloud market growth
  - IaaS peaking in 2014 at about $5.9 billion
  - PaaS growing to around $12 billion by 2017, then leveling off.
  - SaaS growing to around $133 billion by 2020.
  - BPaaS growth to about $10 billion by 2020.
  - Newer technologies replacing virtualization.

(Forrester Research, as cited in Dignan, 2011)
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Federal Government Cloud Strategy

- Federal Cloud Computing Strategy
  - Adopting cloud 1st policy, ¼ of $80 B IT budget to clouds
  - 30% reduction in data centers
- DoD CIO’s 10-Point Plan for IT Modernization
  - IT Modernization Strategy
  - Requires Partnerships Across DoD to achieve
- GSA launched Info.apps.gov to provide cloud computing information and services to federal agencies
Federal Cloud Computing Initiative

• Federal Cloud Computing Initiative (FCCI)
  – FCCI focuses on implementing cloud computing solutions for the Federal Government that increase operational efficiencies, optimize common services and solutions across organizational boundaries and enable transparent, collaborative and participatory government.
  – Improve agency access to cloud technology
  – Federal Data Center Consolidation Initiative (FDCCI), a collaborative approach for data center consolidation
  – Federal Risk and Authorization Management Program (FedRAMP) provides standard approach for cloud security assessment
  – Cloud computing definition (NIST)
Info.apps.gov

- http://info.apps.gov/by GSA for federal agencies
  - Federal CIO - Promoting President’s agenda to modernize Federal IT
- Business applications
- Productivity applications
- Cloud IT services
- SaaS, IaaS, PaaS
Air Force Cloud Computing

- Air Force Research Laboratory/Information Directorate
  - University Center of Excellence (UCoE) in Assured Cloud Computing
  - High Performance Cloud Auditing and Applications book scheduled to be published
  - Innovative Approaches to On-Demand Cloud Computing over Ad-Hoc Wireless Networks
  - Cloud/Grid/Virtualization Architecture for AF Weather SBIR
  - Secure, cloud-based information sharing framework
  - Secure Cloud Computing Environment for Infrared Data
  - HPC facility operates like cloud computing
NASA Nebula Platform

- Cloud computing pilot program at NASA Ames
- Integrated open-source components into seamless, self-service platform
- Provided high-capacity computing, storage, and network connectivity
- Virtualized, scalable approach
- Cost and energy efficient
- Mission support
- Education and public outreach
- Nebula and Open Stack transitioning toward more commercial cloud usage

(NASA Nebula, 2010)
NSF Supported Cloud Research

  - Emphasis on research in the following areas:
    - Computer Systems
    - Computer Networks
    - Security and Privacy
    - Algorithms and Data Management
    - Applications and Software Engineering
    - Computer Science Education
Cloud Comparison to DoD HPCMP

- DoD High Performance Computing Modernization Program (HPCMP) has supported:
  - Grid Computing
  - Centralized computing resources
  - Centralized authentication and security
- DoD HPCMP currently emphasizes support for parallel computing jobs with users knowledgeable about parallel processing
- DREN/SDREN network support
University Center of Excellence in Assured Cloud Computing

• EQUAL co-sponsorship between AFOSR and the Information Directorate (RI)

• Awarded to the University of Illinois at Urbana-Champaign for $1M per year, 6 years

• Information Assurance research for cloud computing in a secure, timely and effective manner

• Assess and influence the predictability and performance of heterogeneous Air Force Networks

• Assured computing in dynamic, hostile, contested and high interference environments

• Responsive to Operational Needs; AFSPC Capability Need “Cyber Cloud Computing Infrastructure”

Center of Excellence Vision

Collaborators

University CoE A

University CoE B

Industry

On-Site Contractors

Government Researchers

Visiting Scientists
Government Cloud Strategy

• Meet growing computational needs
• Enhance reliability
• Centralize security
• 24/7 availability
• Adaptable to changing needs
Distributed Test Events

• Joint Mission Environment Test Capability (JMETC) provides infrastructure to link distributed facilities
• Incorporates Test and Training Enabling Architecture (TENA)
• Provides corporate infrastructure to capitalize on:
  – Network connections
  – Security agreements
  – Integration software
  – Interface definitions
  – Distributed test tools
  – Reuse repository  (Hudgins, 2012)
Cloud Computing Advantages

• Support for data intensive computing
  – Index and Parallelize large data sets
  – Support low BW transmission by data preformatting
• Ease of use – transfer complexity to cloud host
• Multi-user data access from large distributed cloud databases
• Default backup and cost effective archival for large data sets.
• Accessible any time, anywhere at low cost
Programming Models
What’s the right fit for DoD?

<table>
<thead>
<tr>
<th>App-components-as-a-service</th>
<th>Software-platform-as-a-service</th>
<th>Virtual-Infrastructure-as-a-Service</th>
<th>Physical infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google App Engine</td>
<td>Azure</td>
<td>Amazon Elastic Compute Cloud (Amazon EC2) - Beta</td>
<td>Amazon Web Services</td>
</tr>
<tr>
<td>Engine Yard</td>
<td></td>
<td>Data Intensive</td>
<td>MOSSO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amazon Hadoop, Public Data Sets, Simple DB</td>
<td>RACE</td>
</tr>
</tbody>
</table>

Hardware Resources
- Compute
- Storage
- Networking
- Content Delivery

(Greenfield, 2009, p 20)
### Storage data charges of cloud computing providers (SaaS)

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Usage out</th>
<th>Data transfer in</th>
<th>Data transfer out</th>
<th>Data transfer in</th>
<th>No of requests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon S3</td>
<td>$0.15/GB</td>
<td>No restrictions</td>
<td>$0.17/GB</td>
<td>No restrictions</td>
<td>$0.01/1000 requests</td>
</tr>
<tr>
<td>AT&amp;T Synaptic</td>
<td>$0.25/GB</td>
<td>$0.1/GB</td>
<td>$0.1/GB</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>GoGrid</td>
<td>$0.15/GB</td>
<td>No restrictions</td>
<td>No restrictions</td>
<td>No restrictions</td>
<td>No restrictions</td>
</tr>
<tr>
<td>Rackspace</td>
<td>$0.15/GB</td>
<td>No restrictions</td>
<td>No restrictions</td>
<td>No restrictions</td>
<td>No restrictions</td>
</tr>
</tbody>
</table>

- Prices shown for lowest usage tier and reduce with higher usage.

Source:
http://www.thecloudtutorial.com/cloudcomparison.html
Cost Savings

- Centralized resources and management yield economy of scale
- Cost reduction of 5-7x for power, network, operations, software, and hardware
- Reduced energy usage and higher utilization for green computing
- Capitalize on low cost locations
Need for Cloud Computing

- Provide resources not available to individual users
- Minimize up-front user expenses
- On demand availability, ability to handle surges
- Provider manages security
- Handle data intensive applications
- Mobile interactive applications
- Large parallel computing jobs
- Serve countries/organizations with limited resources
- Medical research
- Online gaming
Security Effectiveness

• Data integrity
• Commingling of data
• Virtualization
• Cost versus risk issues
• Multicore for data separation
• Social engineering and human error
• Remote access/authentication
• Strong, enforced security posture
Availability and Usability

- Proprietary software
- Portability between vendors
- Standards
- Software from open source community, such as OpenFabrics Alliance, can meet user needs
Cloud Adoption Study

Implications

• Non-technical issues influence cloud computing adoption decisions.

• Consideration of the overall organizational impact of cloud computing is important.

• A complex interaction between vendors and potential customers, considering factors such as security, need, reliability, and cost, could maximize customer benefit.

Ross, 2010
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• Cloud computing offers numerous potential benefits to the DoD and the broader computing community

• Adoption of an efficient shared software infrastructure, such as supported by the OpenFabrics Alliance, can enhance high efficiency computing over a multitenant computing infrastructure
References


References (continued)

• NASA Nebula (2010). Retrieved from nebula.nasa.gov
Thank You