



2013 OFA Developer Workshop

DoD Cloud Computing

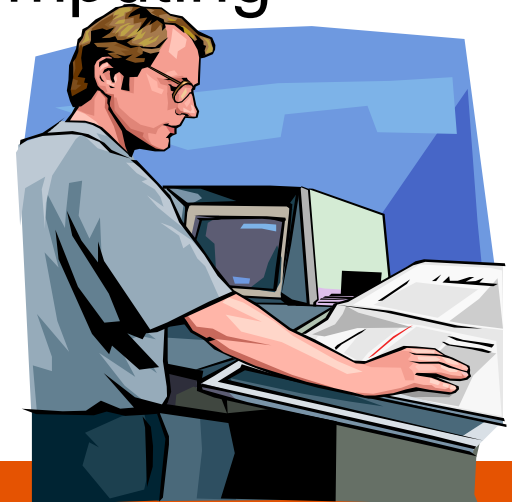
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Outline

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

- 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?

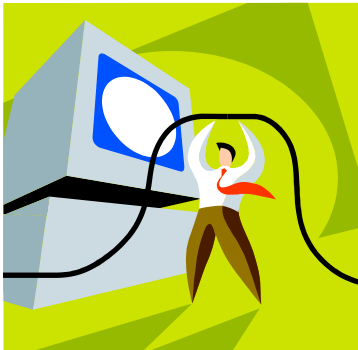
- Computing resources held by provider
- Internet access to resources via PCs, laptops, smart phones, and PDAs
- Access to programs, storage, processing, and applications development
- Precursors include:
 - Thin clients
 - Grid computing
 - Utility computing



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



- IBM effort to Design and Demonstrate Mission-Oriented Cloud Architecture for Cyber Security (2010)
- 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



- Support for Cloud Computing in response to America Competes Reauthorization Act of 2010, Cloud Computing Research Enhancement
 - 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

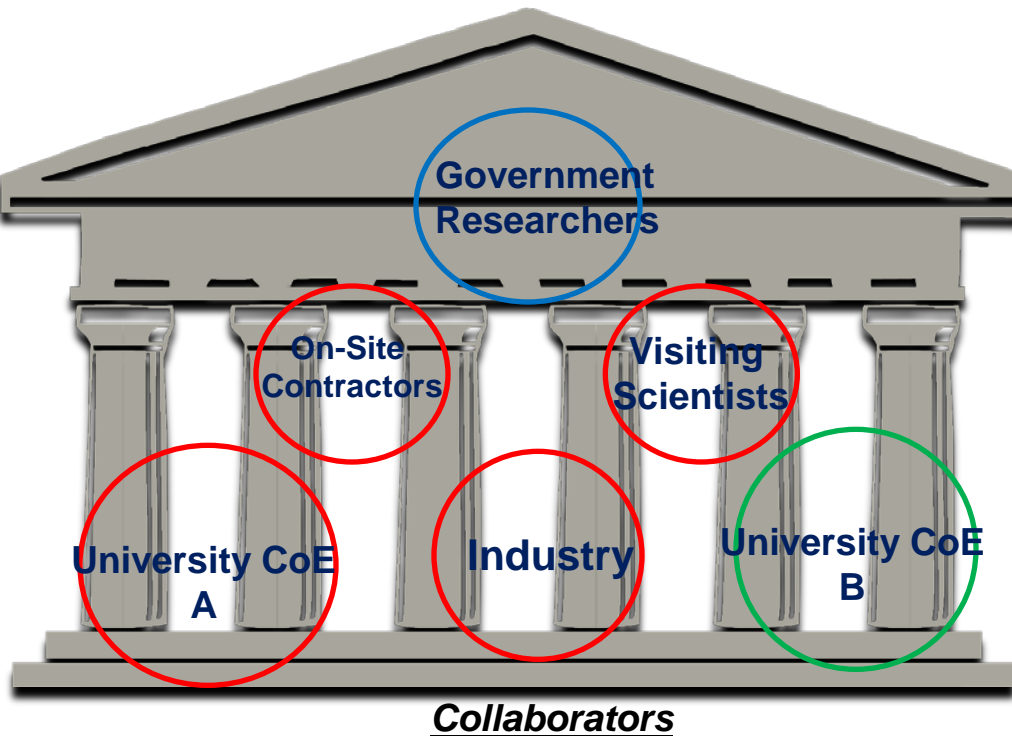
- DoD High Performance Computing Modernization Program (HPCMP) has supported:
 - Grid Computing
 - Centralized computing resources
 - Centralized authentication and security
- DoD HPCMP currently emphasizes support for parallel computing jobs with users knowledgeable about parallel processes
- DREN/SDREN network support



University Center of Excellence in Assured Cloud Computing



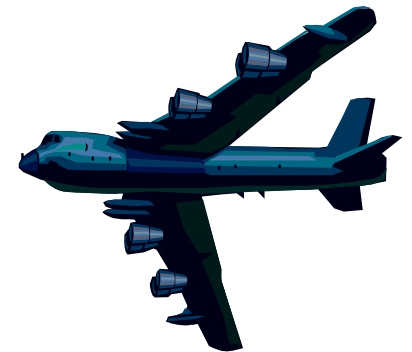
Center of Excellence Vision



- 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"

Government Cloud Strategy

- Meet growing computational needs
- Enhance reliability
- Centralize security
- 24/7 availability
- Adaptable to changing needs



Distributed Test Events

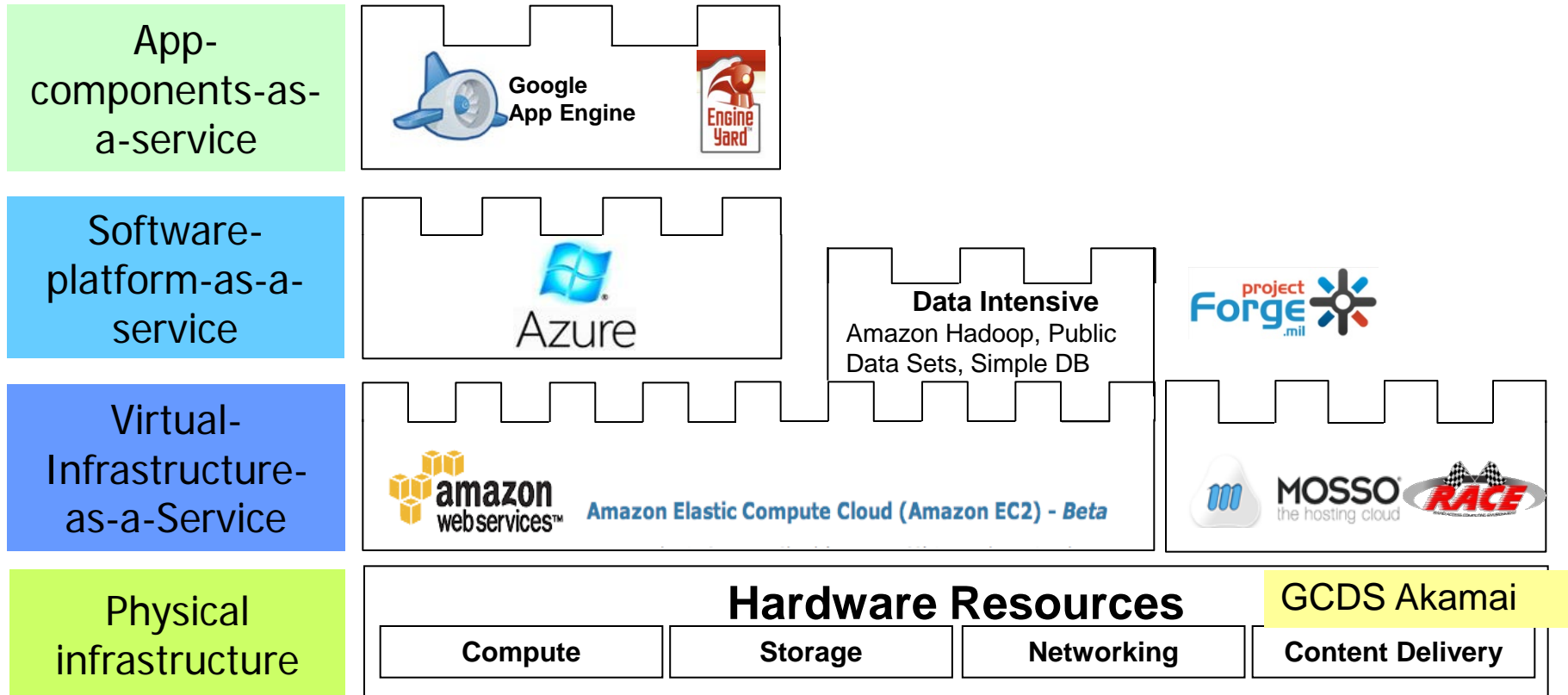
- Joint Mission Environment Test Capability (JMETC) provides infrastructure to link distributed facilities
- Incorporates Test and Training Enabling Architecture (TENA)
- Provides corporate infrastructure to capitalize on:
 - Network connections
 - Security agreements
 - Integration software
 - Interface 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?



Storage data charges of cloud computing providers (SaaS)

Vendor	Usage	Data transfer out	Data transfer in	No of requests
Amazon S3	\$0.15/GB	\$0.17/GB	No restrictions	\$0.01/1000 requests
AT&T Synaptic	\$0.25/GB	\$0.1/GB	\$0.1/GB	Nil
GoGrid	\$0.15/GB	No restrictions	No restrictions	No restrictions
Rackspace	\$0.15/GB	No restrictions	No restrictions	No restrictions

- 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

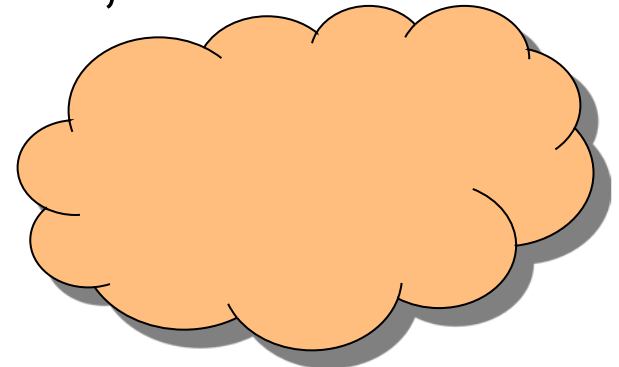
- Proprietary software
- Portability between vendors
- Standards
- Software from open source community, such as OpenFabrics Alliance, can meet user needs



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



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Thank You



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