Cloud Computing Tutorial 1/2

Peter Mell, Tim Grance
NIST, Information Technology Laboratory

Dongwon Lee, Ph.D.
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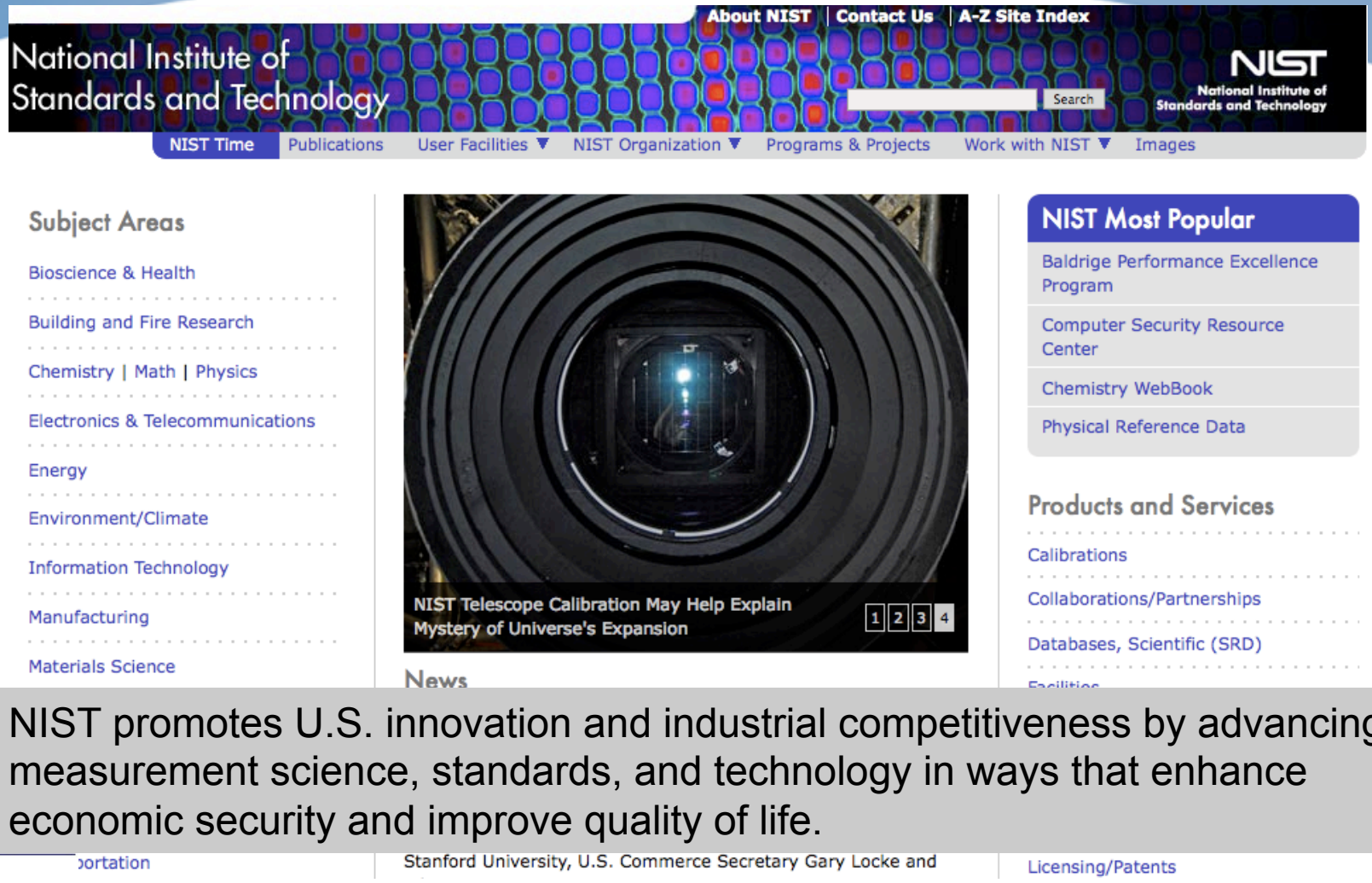
NIST View of Cloud Computing



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Origin of the term "Cloud Computing"

- "Comes from the early days of the Internet where we drew the network as a cloud… we didn't care where the messages went… the cloud hid it from us" – Kevin Marks, Google
- First cloud around networking (TCP/IP abstraction)
- Second cloud around documents (WWW data abstraction)
- The emerging cloud abstracts infrastructure complexities of servers, applications, data, and heterogeneous platforms
  - ("muck" as Amazon's CEO Jeff Bezos calls it)

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A Working Definition of Cloud Computing

- Cloud computing: 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**.

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Salesforce.com's CC Video

http://youtu.be/ae_DKNwK_ms

5 Essential Cloud Characteristics

- On-demand self-service
- Broad network access
- Resource pooling
  - Location independence
- Rapid elasticity
- Measured service

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3 Cloud Service Models

- Cloud Software as a Service (SaaS)
  - Use provider's applications over a network
- Cloud Platform as a Service (PaaS)
  - Deploy customer-created applications to a cloud
- Cloud Infrastructure as a Service (IaaS)
  - Rent processing, storage, network capacity, and other fundamental computing resources

- To be considered "cloud" they must be deployed on top of cloud infrastructure that has the key characteristics

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Eg, SaaS

Apple iCloud

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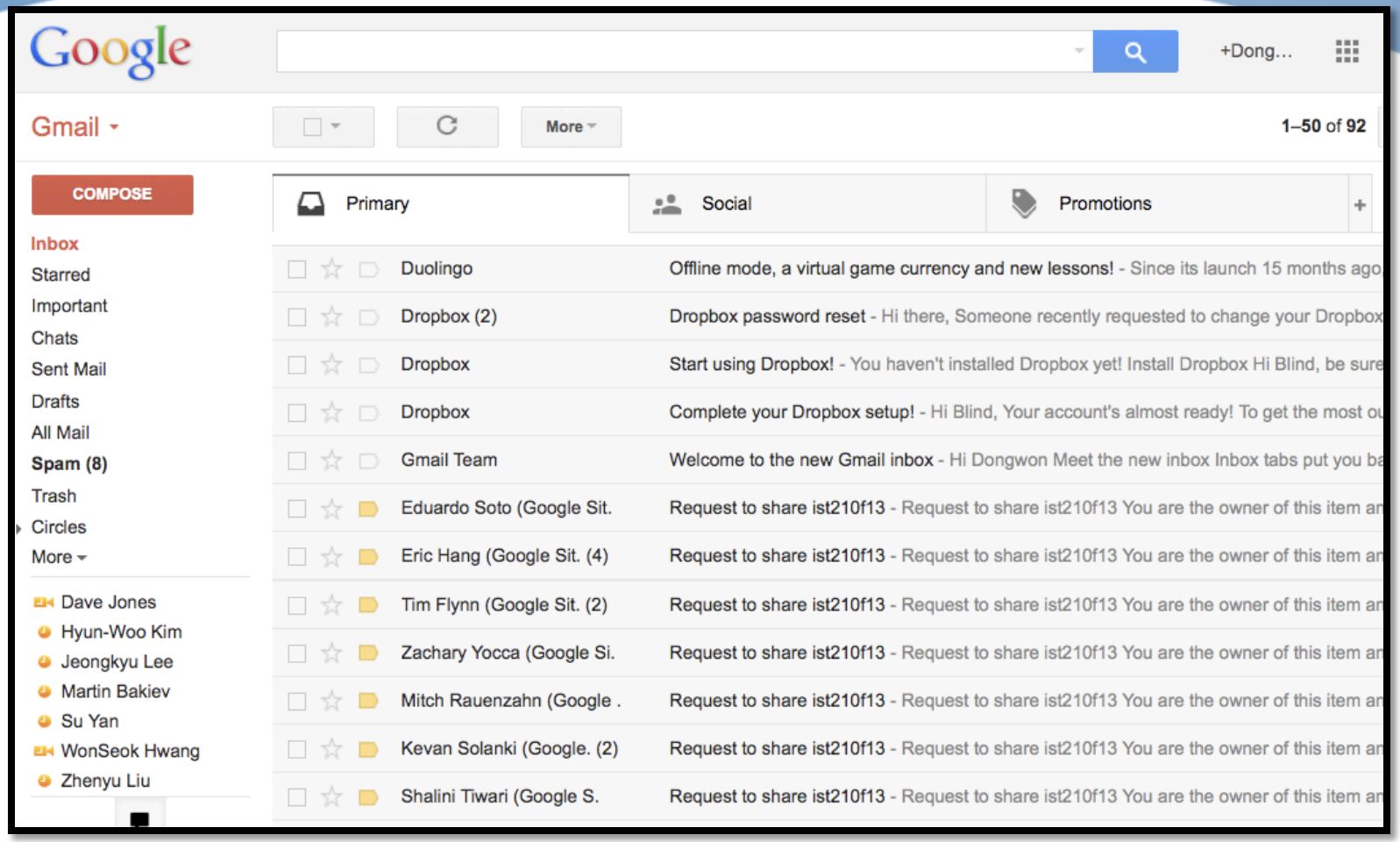
Eg, SaaS



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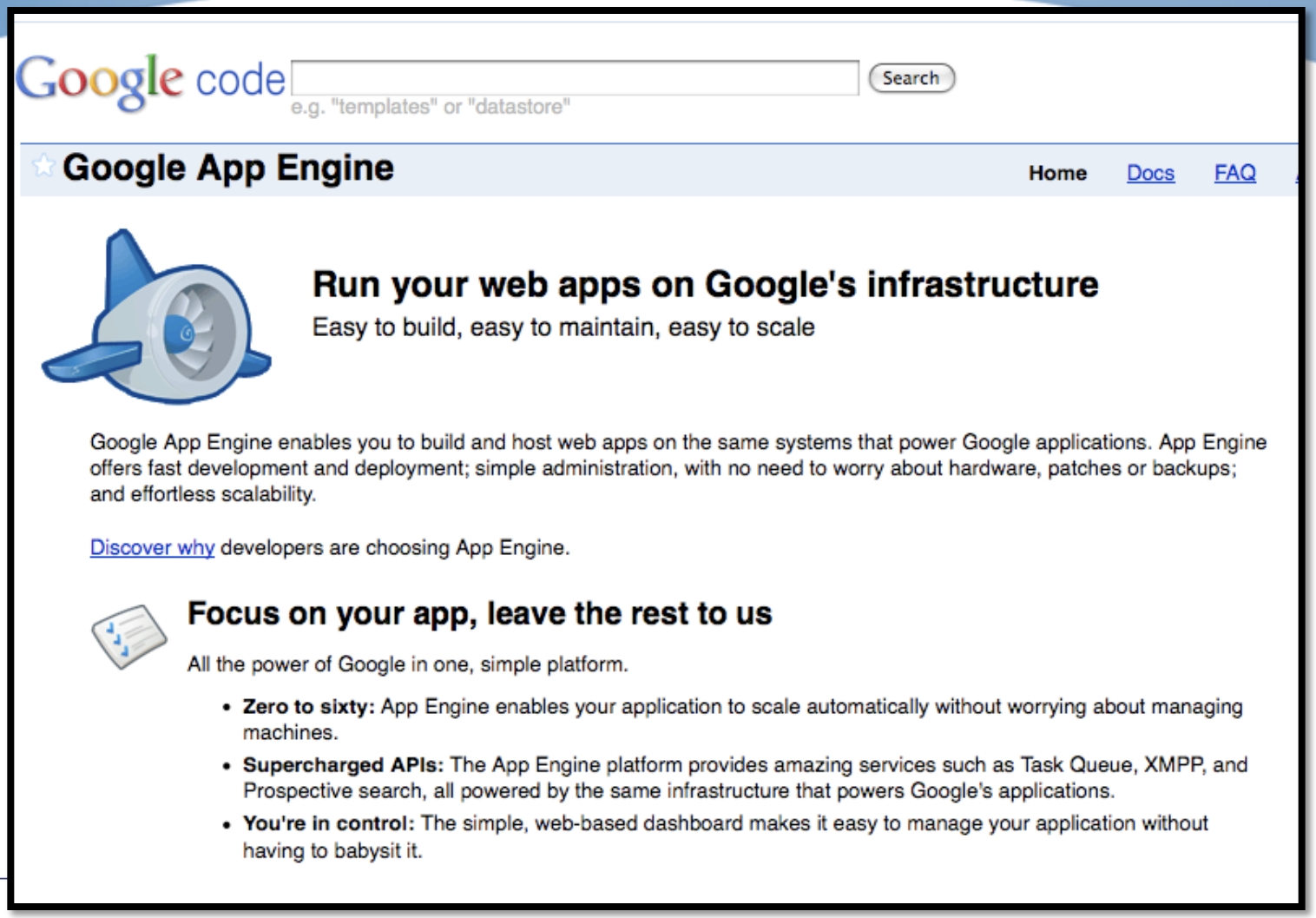
Eg, PaaS



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Google App Engine (GAE)

- Google's approach to CC
  - "Google as the web platform"
- A platform to deploy and host web applications in Google-managed data centers
- GAE delivers a platform and solution stack (as a service) → PaaS
- GAE virtualizes apps across multiple servers and data centers
- Beta service since 2008

https://developers.google.com/appengine/

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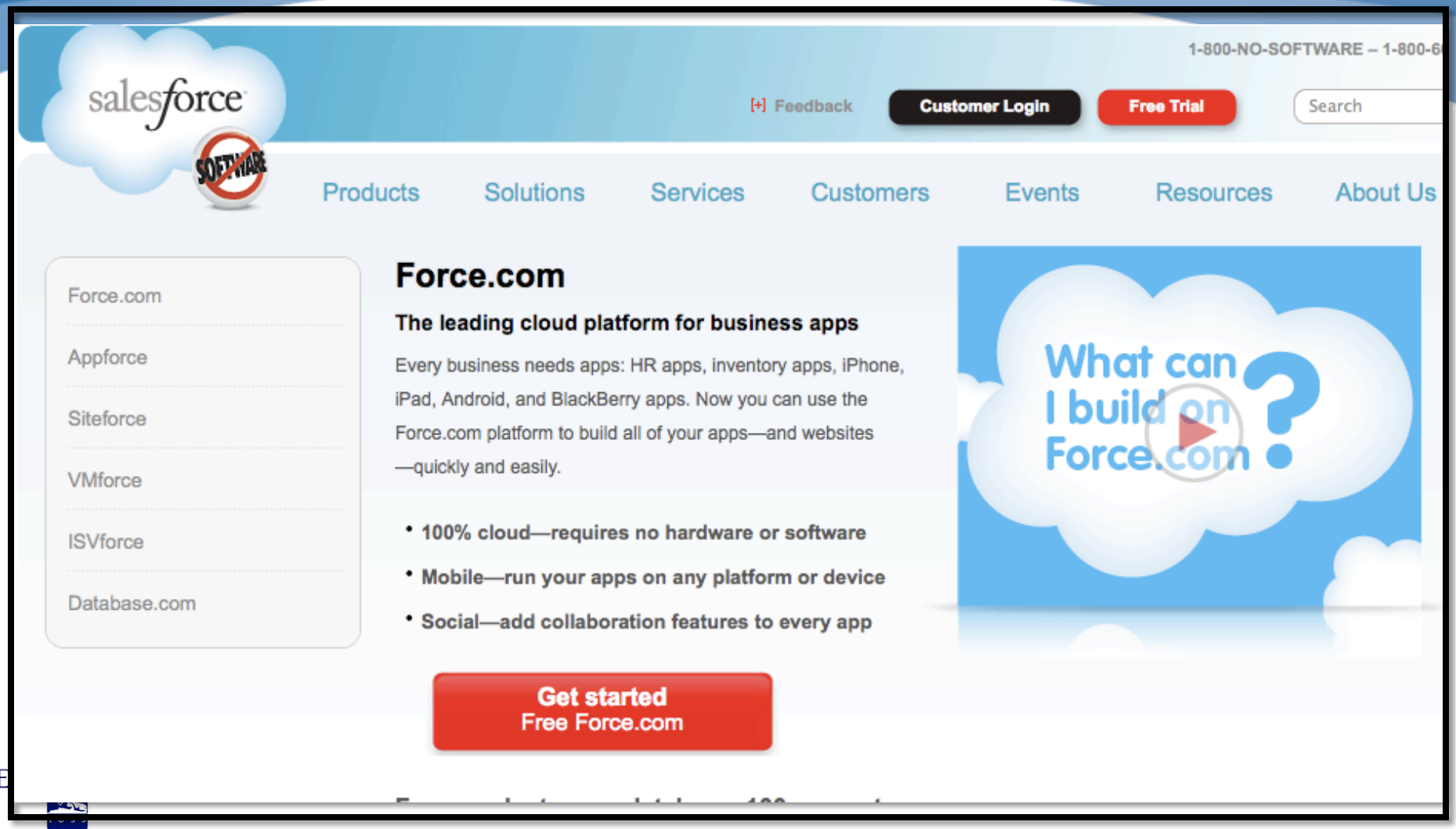
Eg, PaaS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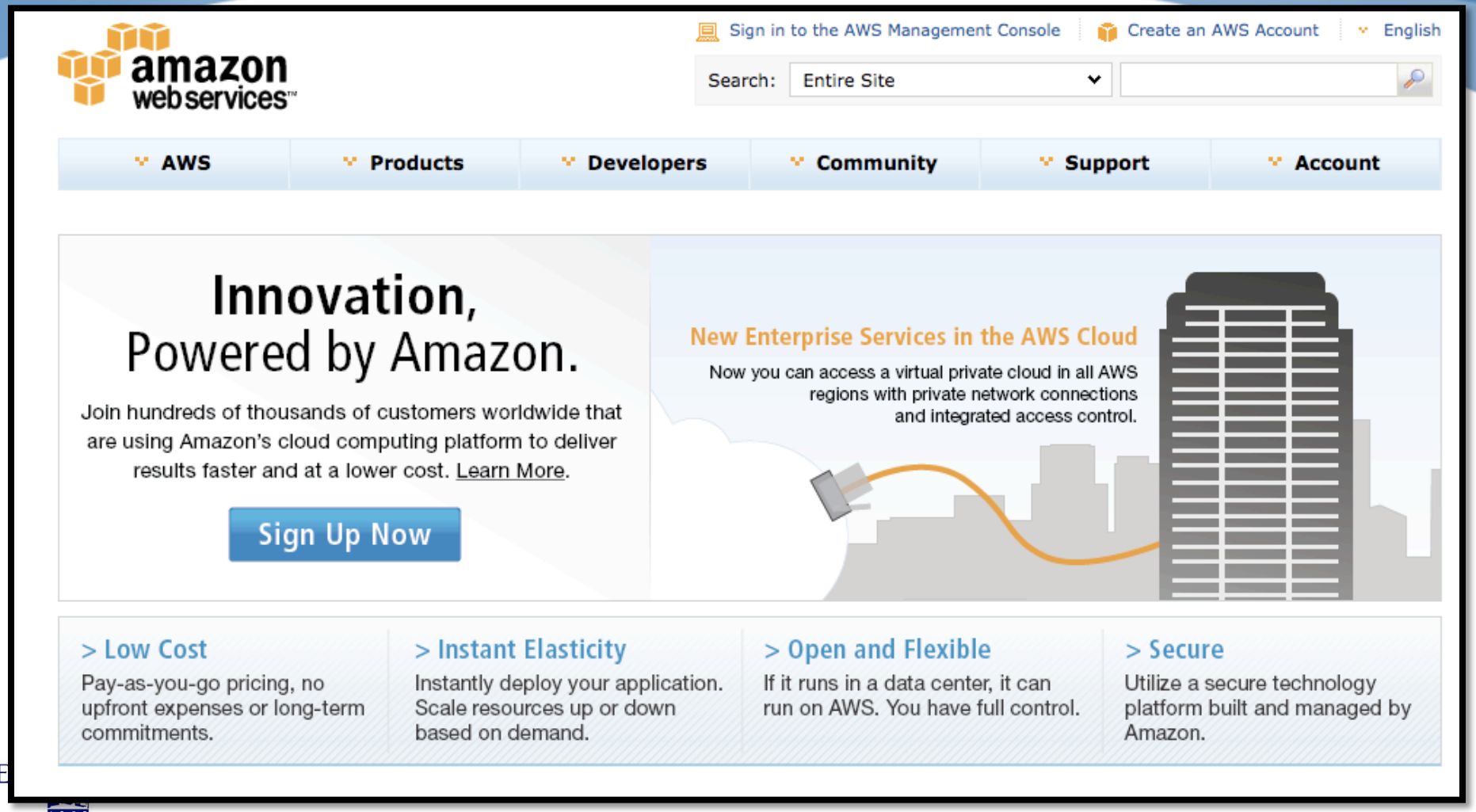
Eg, IaaS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Sign Up Now
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Now you can access a virtual private cloud in all AWS regions with private network connections and integrated access control.
> Low Cost
Pay-as-you-go pricing, no upfront expenses or long-term commitments.
> Instant Elasticity
Instantly deploy your application. Scale resources up or down based on demand.
> Open and Flexible
If it runs in a data center, it can run on AWS. You have full control.
> Secure
Utilize a secure technology platform built and managed by Amazon.

GAE vs. AWS

- GAE is PaaS
  - Abstract OS-independent platform is pre-built and provided
  - Users have to create a web app and deploy it to the abstract platform
- AWS is IaaS
  - Users can build their own platform within CC, called AMI → "Infrastructure as a Service"
  - Users can create a web app and deploy it to their own platform (AMI)

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♪

Eg, IaaS


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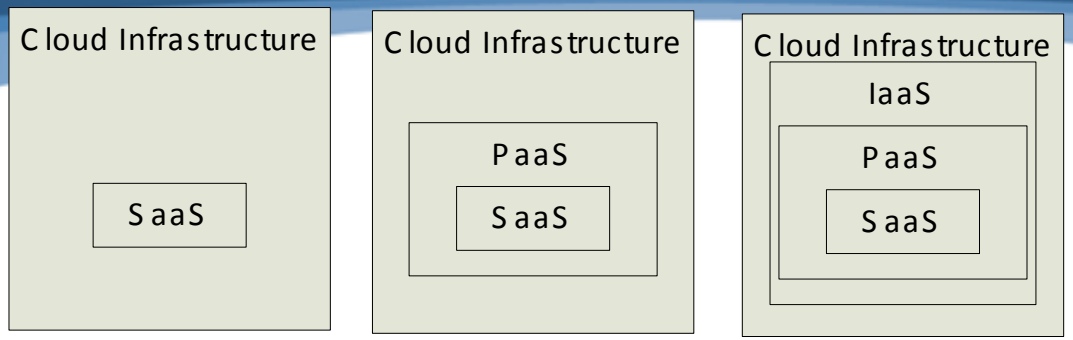
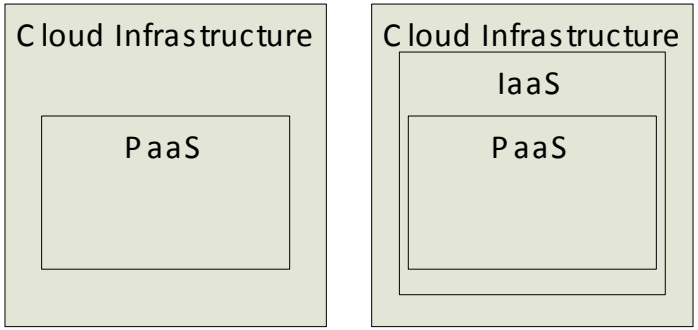
GoGrid positioned in the "Visionaries" Quadrant of the Magic Quadrant for Cloud Infrastructure as a Service and Web Hosting.
READ THE REPORT
East Coast

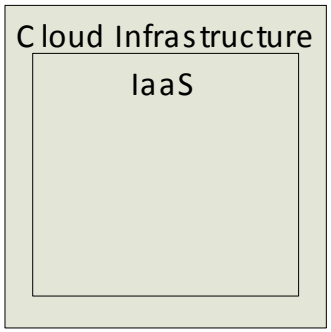
Service Model Architectures



Software as a Service (SaaS) Architectures



Platform as a Service (PaaS) Architectures



Infrastructure as a Service (IaaS) Architectures

4 Cloud Deployment Models

- Private cloud
  - enterprise owned or leased
- Community cloud
  - shared infrastructure for specific community
- Public cloud
  - Sold to the public, mega-scale infrastructure
- Hybrid cloud
  - composition of two or more clouds

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Eg, Community Cloud

Google's "Gov Cloud"

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Eg, Hybrid Cloud

OpenNebula.org

The Open Source Toolkit for Cloud Computing

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Most Flexible and Innovative Enterprise-class IaaS Cloud Software

Fully open source (not open core), **thoroughly tested**, **customizable**, **extensible** and with **unique features and excellent performance and scalability** to manage hundreds of thousands of VMs:

- Private cloud with **Xen**, **KVM** and **VMware**,
- Hybrid cloud (**cloudbursting**) with **Amazon EC2**, and other providers through **Deltacloud** (from ecosystem),
- Public cloud supporting **EC2 Query**, **OGF OCCI** and **vCloud** (from ecosystem) APIs,... and much more.

Designed to Implement Cloud Computing Use Cases from Leading IT Organizations

1 Download OpenNebula

2 Read the Documentation

3 Engage the Community

Quick links

- About the Project
- What is OpenNebula?
- Who is behind?
- Who uses OpenNebula?
- Why OpenNebula?
- Key Features

Featured Quotes

"...out of the five researched platforms OpenNebula is best for SurfNet"
Cloud Computing Solutions, SURFnet

Meet Us at

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Common Cloud Characteristics

- Cloud computing often leverages:
  - Massive scale
  - Homogeneity
  - Virtualization
  - Resilient computing
  - Low cost software
  - Geographic distribution
  - Service orientation
  - Advanced security technologies

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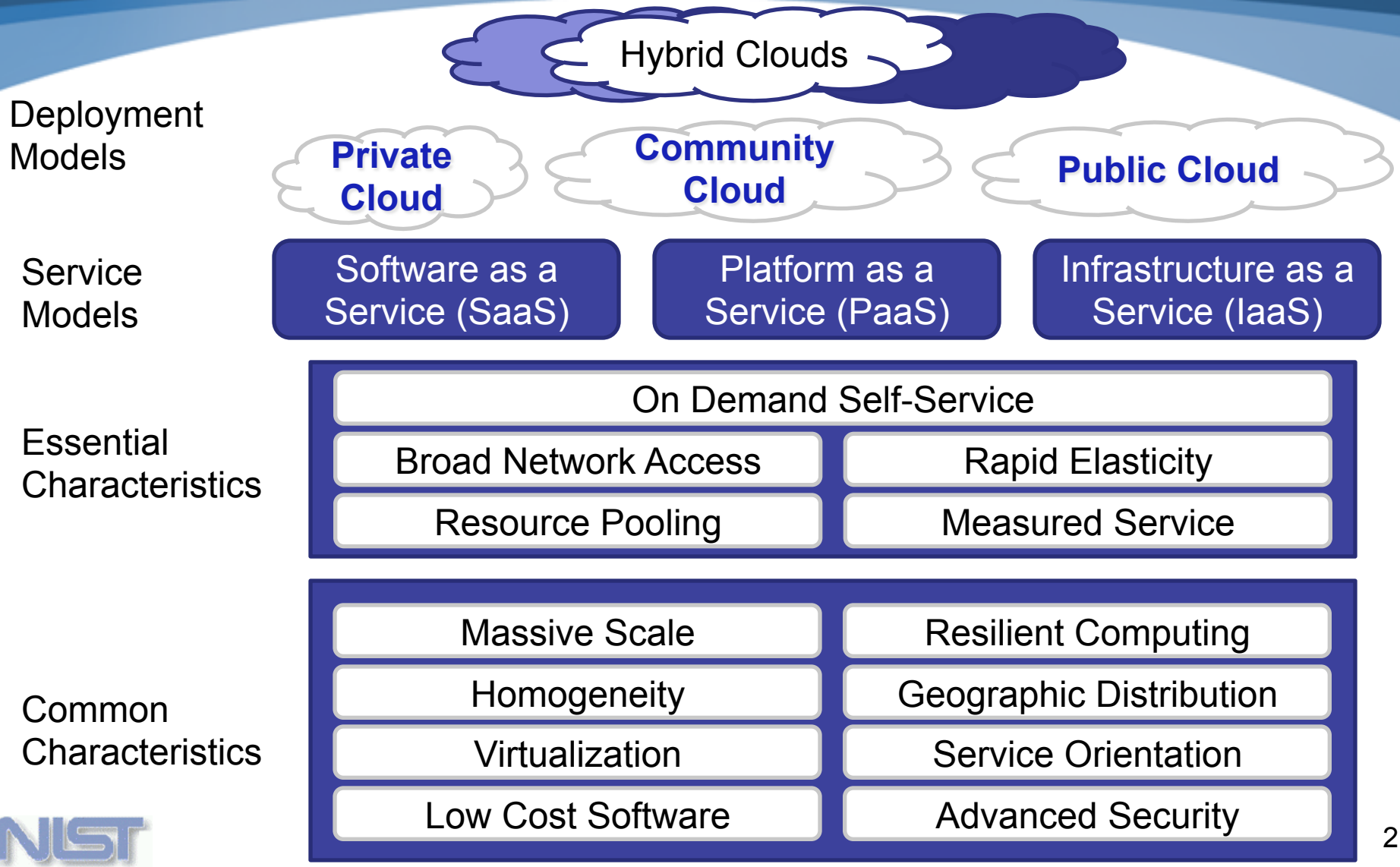
The NIST Cloud Definition Framework



Putting All Together

- Most clouds will require very strong security controls
- All models of cloud may be used for differing tradeoffs between threat exposure and efficiency
- There is no one “cloud”. There are many models and architectures.
- How does one choose?

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Migration Paths for Cloud Adoption

- Use public clouds
- Develop private clouds
  - Build a private cloud
  - Procure an outsourced private cloud
  - Migrate data centers to be private clouds (fully virtualized)
- Build or procure community clouds
  - Organization wide SaaS
  - PaaS and IaaS
  - Disaster recovery for private clouds
- Use hybrid-cloud technology
  - Workload portability between clouds

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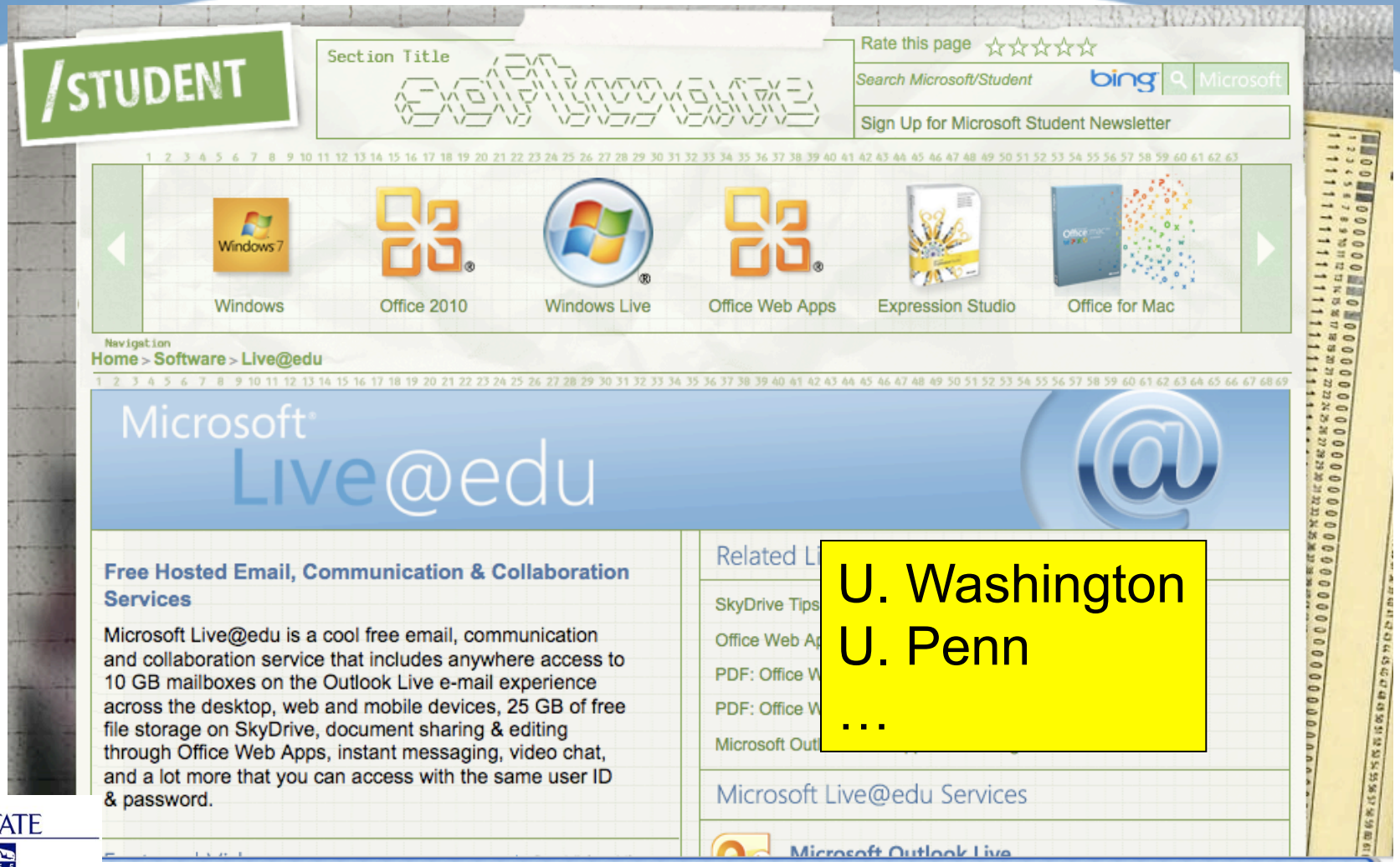
Eg, Using Public Cloud



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Possible Effects of Cloud Computing

- Small enterprises use public SaaS and public clouds and minimize growth of data centers
- Large enterprise data centers may evolve to act as private clouds
- Large enterprises may use hybrid cloud infrastructure software to leverage both internal and public clouds
- Public clouds may adopt standards in order to run workloads from competing hybrid cloud infrastructures

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Potential Issues of Cloud Computing

- Privacy
- Security
- Legal Issue
- Compliance
- Availability
- Performance
- …

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Eg, Security Problem

Major University Dumps Gmail Over Security Concerns

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Like | 499 likes. Sign Up to see what your friends like.

The University of California, Davis has stopped using Gmail for its 30,000-member staff and faculty body. The university was trying Gmail for faculty and staff with plans to roll out service to the entire campus. But school officials say the e-mail system isn't secure or private enough to meet their standards.

CIO Peter Siegel, Academic Senate IT Chair Niels Jensen and Campus Council IT Chair Joe Kiskis said the plug was pulled on Gmail because members of the faculty were concerned that it wouldn't keep their correspondence private enough. Many privacy experts also say that Gmail's social component, Google Buzz, is a source of privacy and security vulnerabilities

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Eg, Availability Problem

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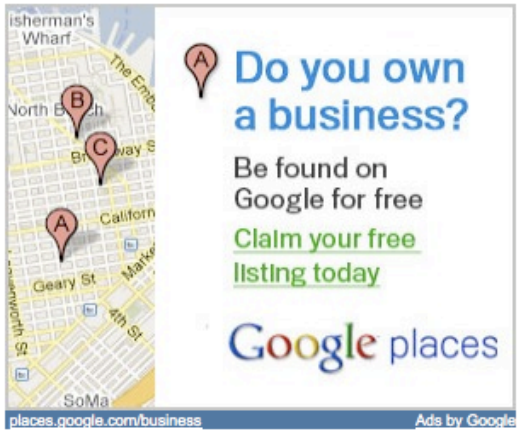
Tuesday, December 14th, 2010 | Posted by N Harrison

Yahoo Account Yahoo Mail Sign In Server Goes Down



Many users of Yahoo services are taking notice of their email and other Yahoo products and services not functioning. The servers that Yahoo uses have been

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Archives

- January 2011
- December 2010
- November 2010
- October 2010

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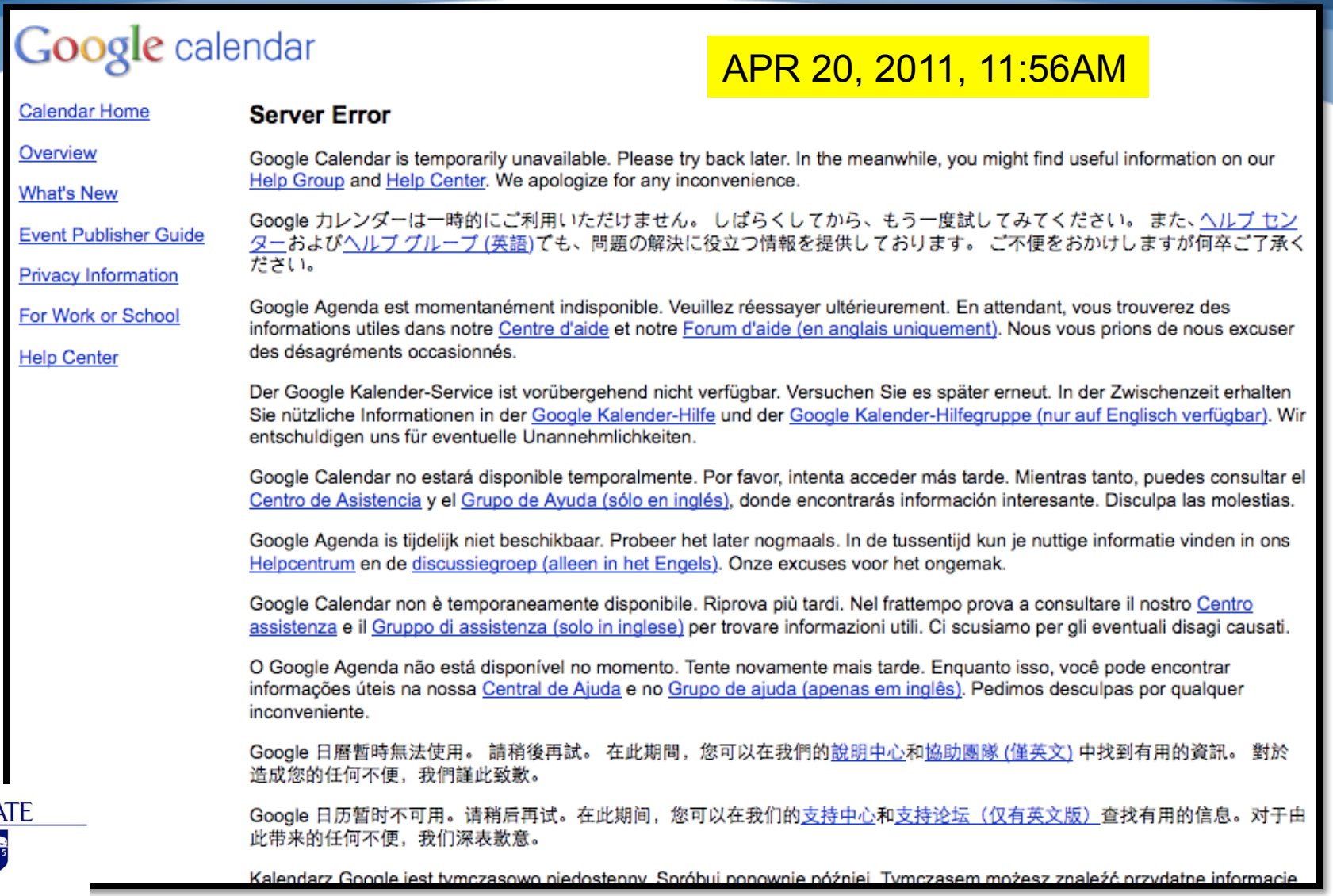
Eg, Availability Problem



Google calendar

APR 20, 2011, 11:56AM

Calendar Home

Overview

What's New

Event Publisher Guide

Privacy Information

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Help Center

Server Error

Google Calendar is temporarily unavailable. Please try back later. In the meanwhile, you might find useful information on our Help Group and Help Center. We apologize for any inconvenience.

Google カレンダーは一時的にご利用いただけません。しばらくしてから、もう一度試してみてください。また、ヘルプ センターおよびヘルプ グループ (英語)でも、問題の解決に役立つ情報を提供しております。ご不便をおかけしますが何卒ご了承ください。

Google Agenda est momentanément indisponible. Veuillez réessayer ultérieurement. En attendant, vous trouverez des informations utiles dans notre Centre d'aide et notre Forum d'aide (en anglais uniquement). Nous vous prions de nous excuser des désagréments occasionnés.

Der Google Kalender-Service ist vorübergehend nicht verfügbar. Versuchen Sie es später erneut. In der Zwischenzeit erhalten Sie nützliche Informationen in der Google Kalender-Hilfe und der Google Kalender-Hilfegruppe (nur auf Englisch verfügbar). Wir entschuldigen uns für eventuelle Unannehmlichkeiten.

Google Calendar no estará disponible temporalmente. Por favor, intenta acceder más tarde. Mientras tanto, puedes consultar el Centro de Asistencia y el Grupo de Ayuda (sólo en inglés), donde encontrarás información interesante. Disculpa las molestias.

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O Google Agenda não está disponível no momento. Tente novamente mais tarde. Enquanto isso, você pode encontrar informações úteis na nossa Central de Ajuda e no Grupo de ajuda (apenas em inglês). Pedimos desculpas por qualquer inconveniente.

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Eg, Availability Problem

Amazon says some data unrecoverable after restoring cloud service

April 27, 2011 | Dean Takahashi

2 Comments

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Amazon said that about 0.07 percent of the data storage in its restored eastern cloud service isn't fully recoverable. The company's cloud-based web services suffered an outage that lasted for three-and-a-half days last week and service was restored for the most part on Monday.

But some of the data — 0.07 percent of the eastern region — hasn't been recovered, and the company is contacting the limited number of customers who have lost data. One of the lessons being learned here is that backup sometimes isn't enough, and customers who web services may have to use multiple d vendors in the future.

http://venturebeat.com/

Thoughts on Cloud Computing

- Galen Gruman, InfoWorld Executive Editor, and Eric Knorr, InfoWorld Editor in Chief
  - "A way to increase capacity or add capabilities on the fly without investing in new infrastructure, training new personnel, or licensing new software."
  - "The idea of loosely coupled services running on an agile, scalable infrastructure should eventually make every enterprise a node in the cloud."

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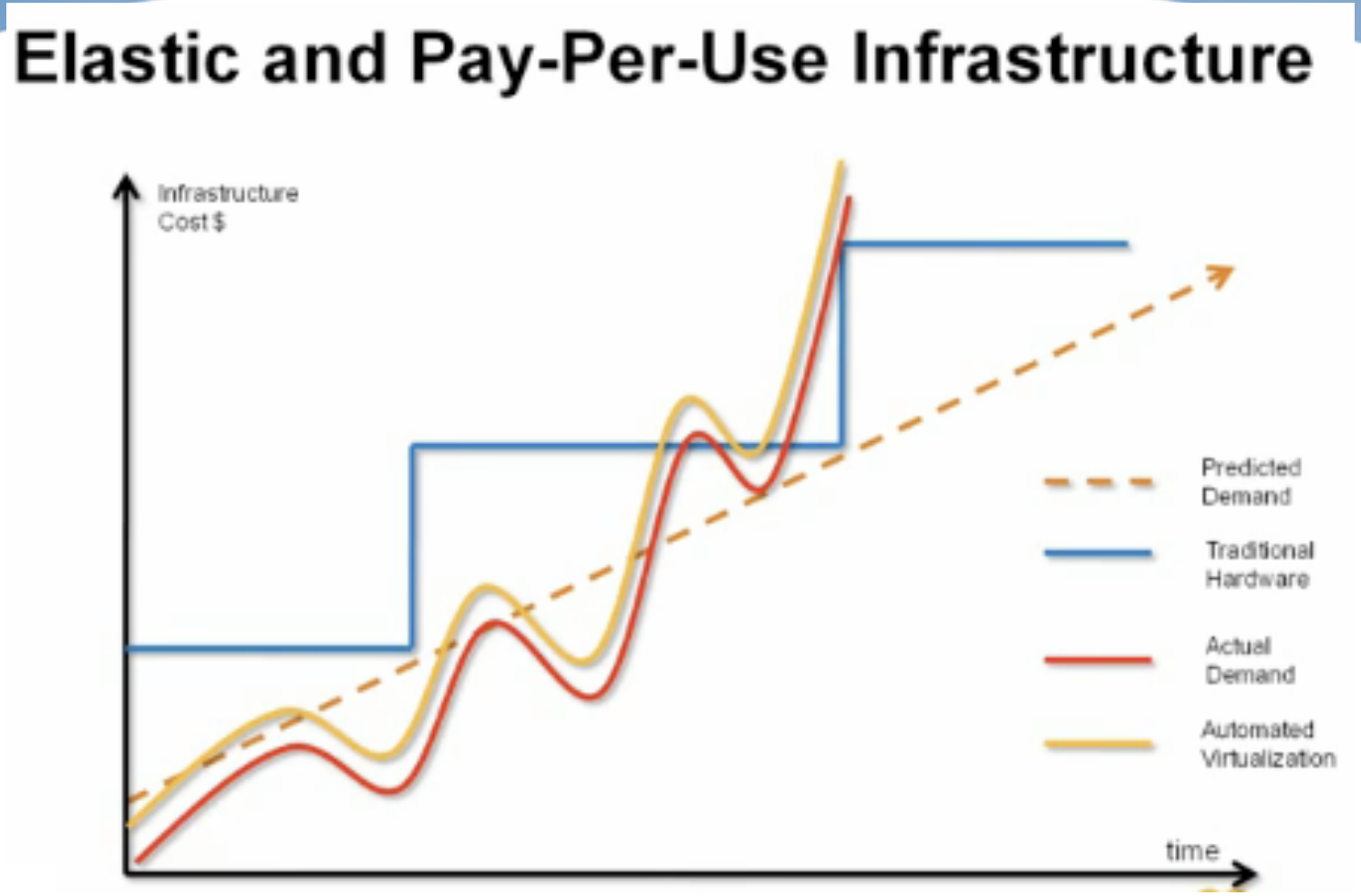
Meeting Demands using CC



http://youtu.be/yW79SIVZV0g

Thoughts on Cloud Computing

- Tim O' Reilly, CEO O' Reilly Media
- "I think it is one of the foundations of the next generation of computing"
- "The network of networks is the platform for all computing"
- "Everything we think of as a computer today is really just a device that connects to the big computer that we are all collectively building"

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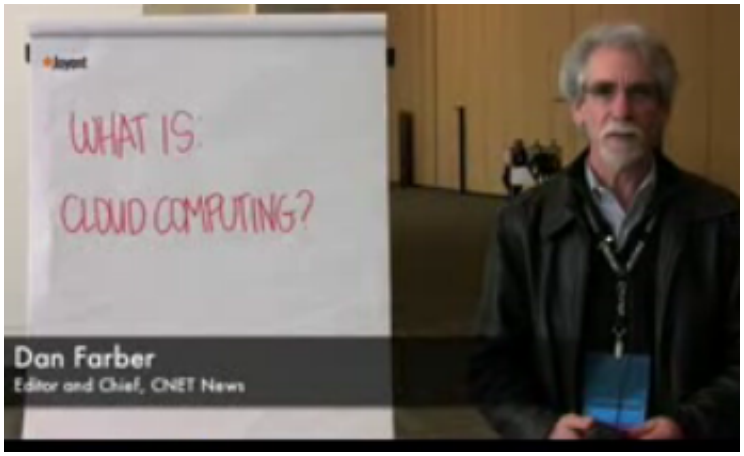
Thoughts on Cloud Computing

- Dan Farber, Editor in Chief CNET News
- "We are at the beginning of the age of planetary computing. Billions of people will be wirelessly interconnected, and the only way to achieve that kind of massive scale usage is by massive scale, **brutally efficient** cloud-based infrastructure."



Core objectives of Cloud Computing

- Amazon CTO Werner Vogels
- Core objectives and principles that cloud computing must meet to be successful:
  - Security
  - Scalability
  - Availability
  - Performance
  - Cost-effective
  - Acquire resources on demand
  - Release resources when no longer needed
  - Pay for what you use
  - Leverage others' core competencies
  - Turn fixed cost into variable cost

Amazon CTO Werner Vogels
(Credit: Dan Farber)

A "sunny" vision of the future

- Sun Microsystems CTO Greg Papadopoulos
  - Users will "trust" service providers with their data like they trust banks with their money
  - "Hosting providers [will] bring 'brutal efficiency' for utilization, power, security, service levels, and idea-to-deploy time" –CNET article
  - Becoming cost ineffective to build data centers
  - Organizations will rent computing resources

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Criticisms on Cloud Computing

- Richard Stallman (GNU, FSF, Emacs)
  - cloud computing was simply a trap aimed at forcing more people to buy into locked, proprietary systems that would cost them more and more over time
- Larry Ellison (Oracle CEO)
  - “everything that we already do" and that it will have no effect except to "change the wording on some of our ads”

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Case Study: Facebook's Use of Open Source and Commodity Hardware (8/08)

- Jonathan Heiliger, Facebook's vice president of technical operations
- 80 million users + 250,000 new users per day
- 50,000 transactions per second, 10,000+ servers
- Built on open source software
  - Web and App tier: Apache, PHP, AJAX
  - Middleware tier: Memcached (Open source caching)
  - Data tier: MySQL (Open source DB)
- Thousands of DB instances store data in distributed fashion (avoids collisions of many users accessing the same DB)
- "We don't need fancy graphics chips and PCI cards," he said. "We need one USB port and optimized power and airflow. Give me one CPU, a little memory and one power supply. If it fails, I don't care. We are solving the redundancy problem in software."

Case Study: Amazon Cloud

- Amazon cloud components
  - Elastic Compute Cloud (EC2)
  - Simple Storage Service (S3)
  - SimpleDB
- New Features
  - Availability zones
    - Place applications in multiple locations for failovers
  - Elastic IP addresses
    - Static IP addresses that can be dynamically remapped to point to different instances (not a DNS change)

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Amazon Cloud Users: New York Times and Nasdaq (4/08)

- Both companies used Amazon's cloud offering
- New York Times
  - Didn't coordinate with Amazon, used a credit card!
  - Used EC2 and S3 to convert 15 million scanned news articles to PDF (4TB data)
  - Took 100 Linux computers 24 hours (would have taken months on NYT computers
- Nasdaq
  - Uses S3 to deliver historic stock and fund information
  - Millions of files showing price changes of entities over 10 minute segments
  - "The expenses of keeping all that data online [in Nasdaq servers] was too high." – Claude Courbois, Nasdaq VP
  - Created lightweight Adobe AIR application to let users view data

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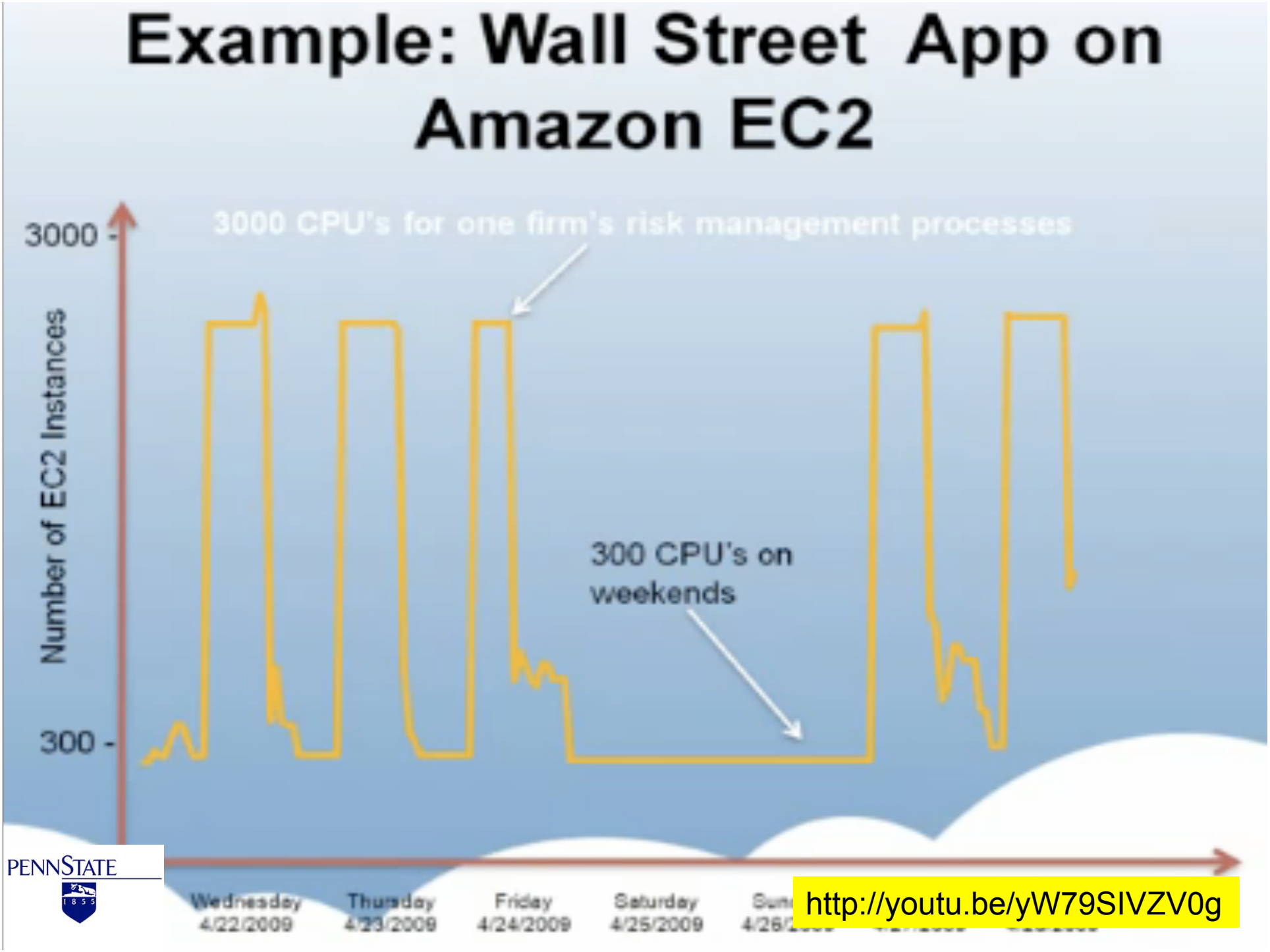
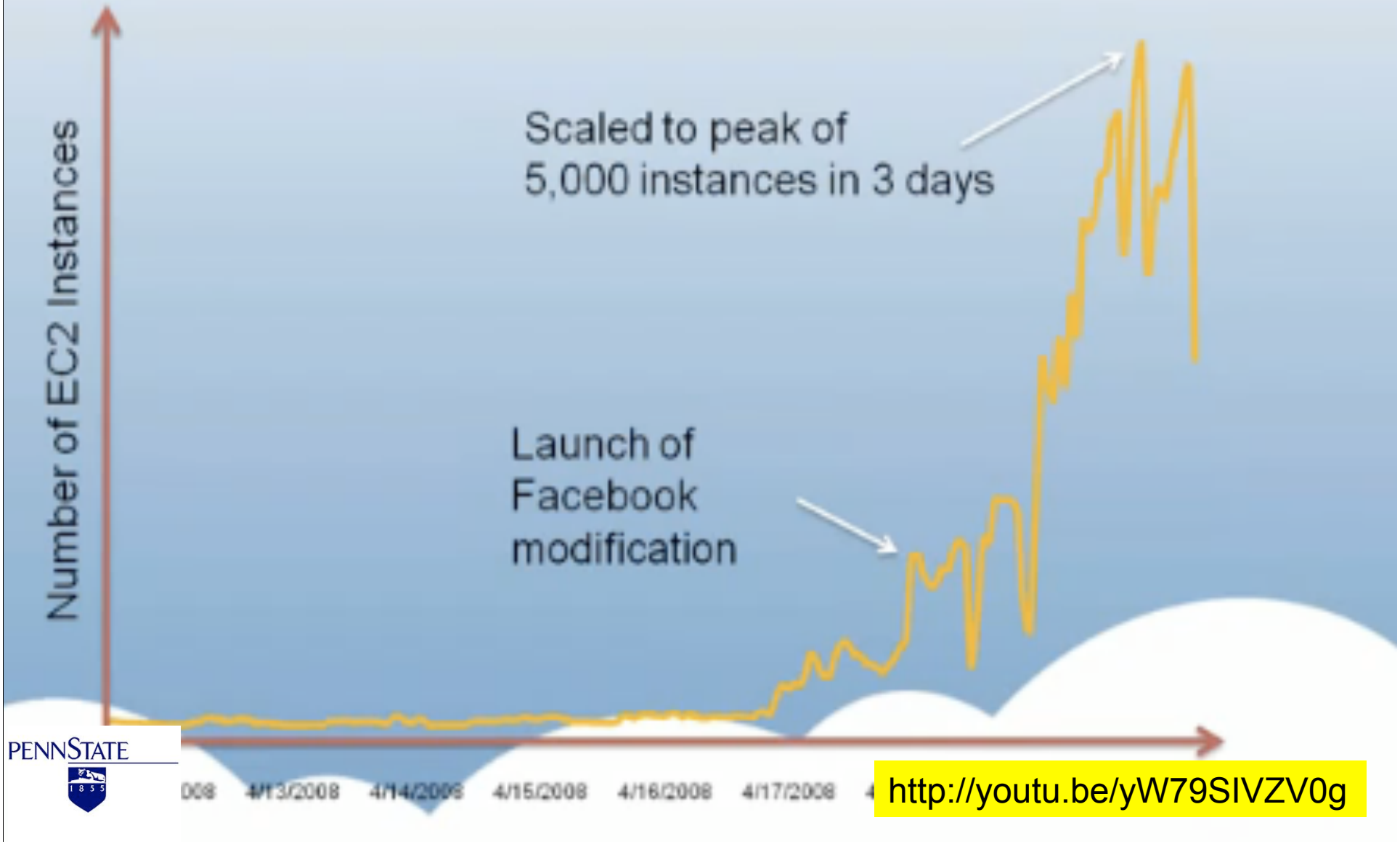
Example: Wall Street App on Amazon EC2



http://youtu.be/yW79SIVZV0g

Example: Video App on Amazon EC2



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http://youtu.be/yW79SIVZV0g

Case Study: Salesforce.com in Government

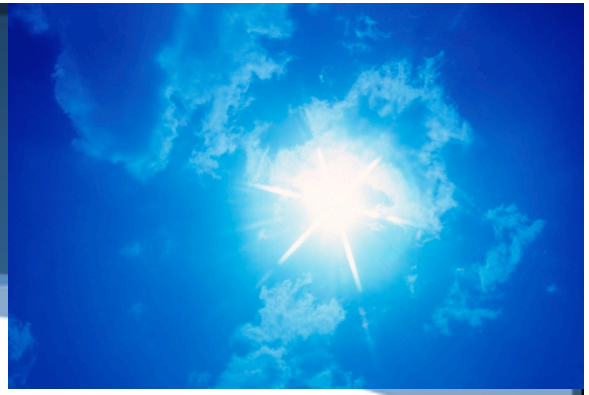
- **5,000+ Public Sector and Nonprofit Customers use Salesforce Cloud Computing Solutions**
- **President Obama's Citizen's Briefing Book Based on Salesforce.com Ideas application**
  - Concept to Live in Three Weeks
  - 134,077 Registered Users
  - 1.4 M Votes
  - 52,015 Ideas
  - Peak traffic of 149 hits per second
- **US Census Bureau Uses Salesforce.com Cloud Application**
  - Project implemented in under 12 weeks
  - 2,500+ partnership agents use Salesforce.com for 2010 decennial census
  - Allows projects to scale from 200 to 2,000 users overnight to meet peak periods with no capital expenditure

Case Study: Salesforce.com in Government

- **New Jersey Transit Wins InfoWorld 100 Award for its Cloud Computing Project**
  - Use Salesforce.com to run their call center, incident management, complaint tracking, and service portal
  - **600%** More Inquiries Handled
  - **0** New Agents Required
  - **36%** Improved Response Time

- **U.S. Army uses Salesforce CRM for Cloud-based Recruiting**
  - U.S. Army needed a new tool to track potential recruits who visited its Army Experience Center.
  - Use Salesforce.com to track all core recruitment functions and allows the Army to save time and resources.

Questions?



- Peter Mell
  - NIST, Information Technology Laboratory
  - Computer Security Division
- Tim Grance
  - NIST, Information Technology Laboratory
  - Computer Security Division

- Dongwon Lee, Ph.D.
  - Penn State University
  - All slides with PSU logo were newly added