

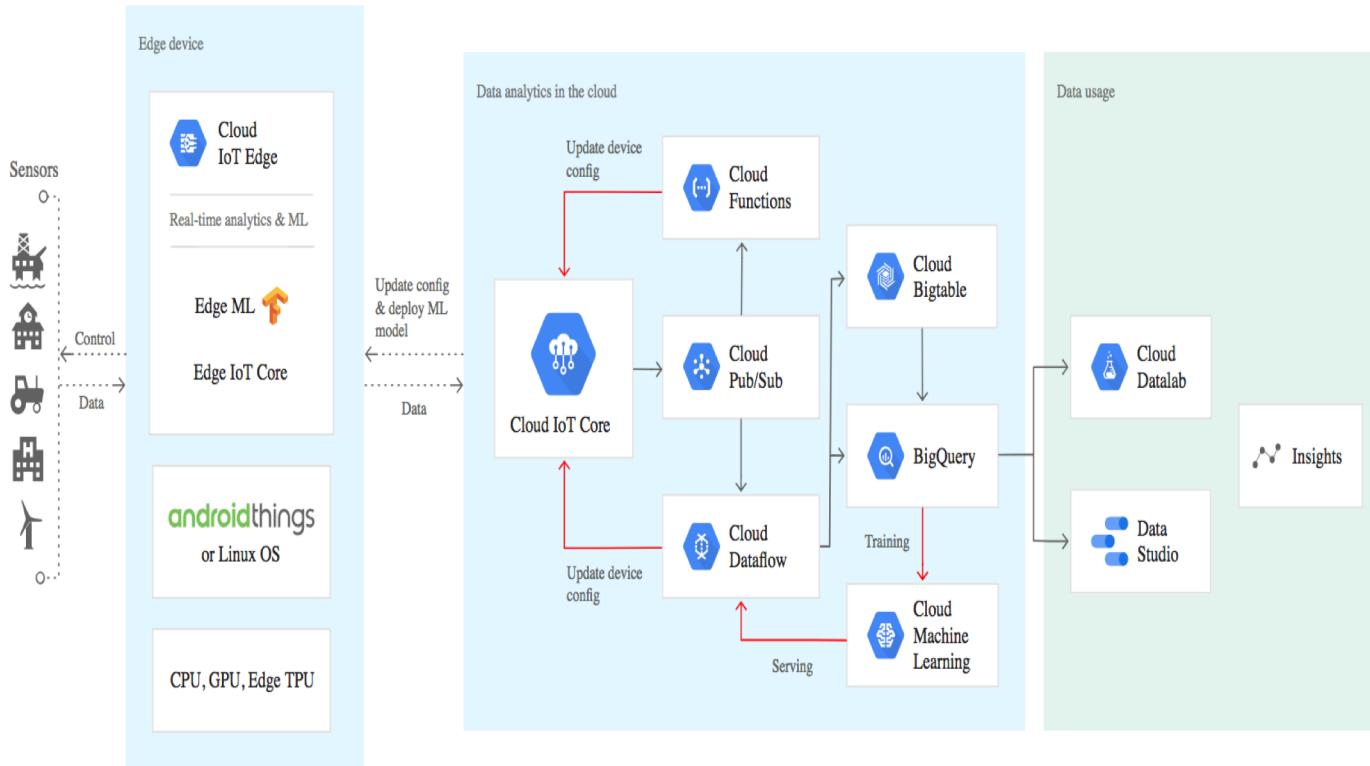
Cloud Computing

Foundations

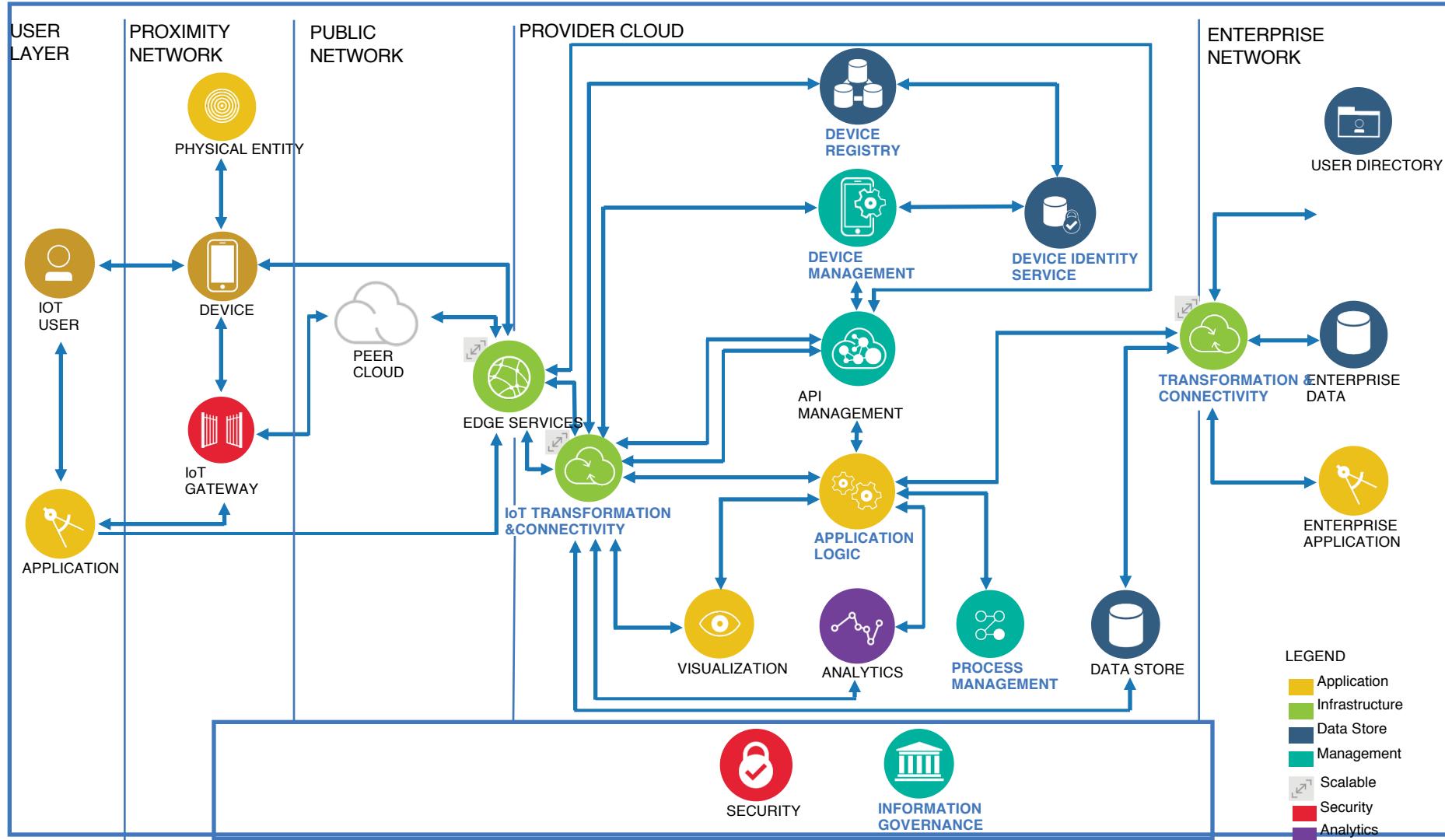
Marin Litoiu, York University
mlitoiu@yorku.ca

Google IoT Infrastructure

- Google: <https://cloud.google.com/solutions/iot/>



IBM IoT Infrastructure



Content

- **Cloud motivation and drivers**
- **Type of Clouds and Deployments**
- **Cloud landscape**
- **Conclusions**

Content

- **Lecture 1: Overview of Cloud**

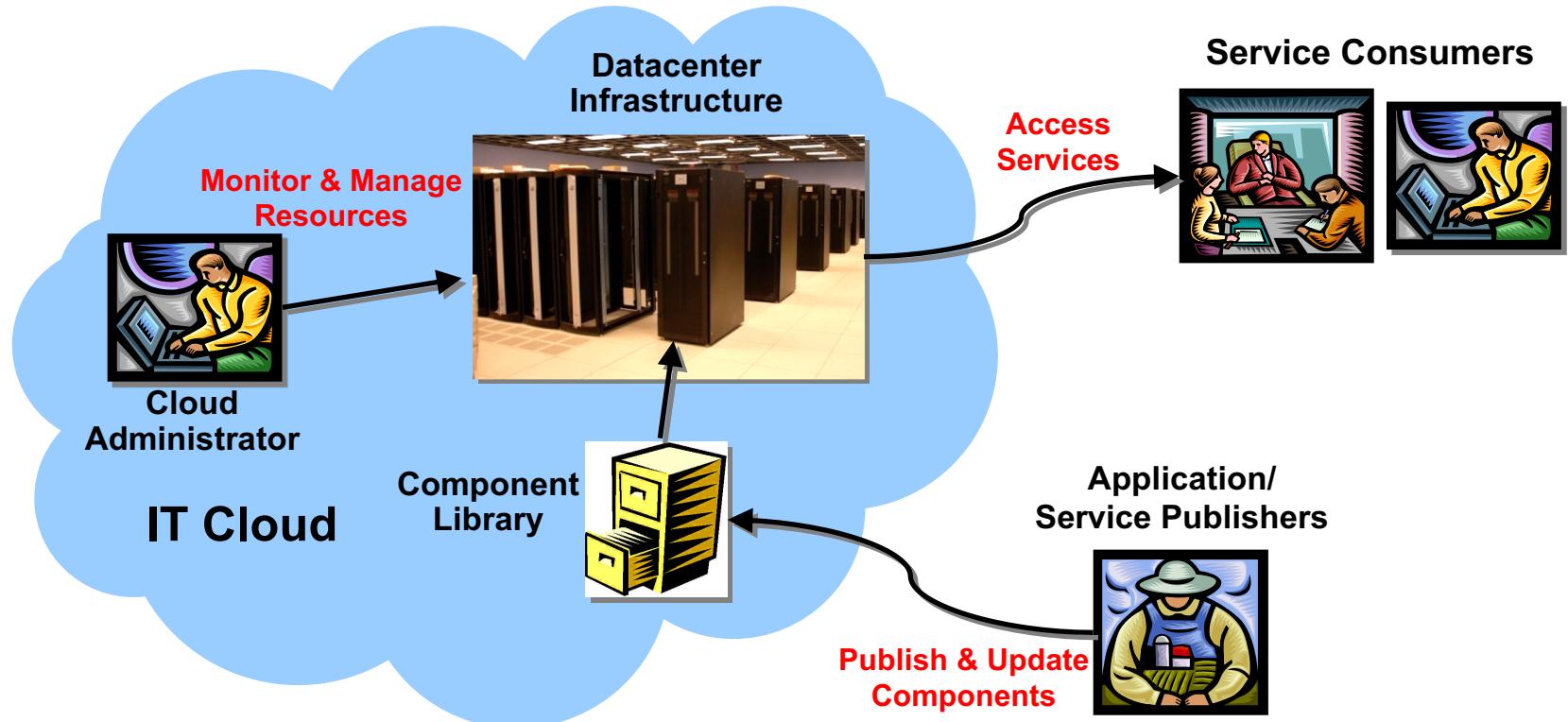
- Cloud Motivation
- Types of Clouds
- Cloud Structure
- Public Clouds
- Big Data
 - HDFS
 - Map Reduce Programming Model (Hadoop and Spark)
 - Hbase, Big Table

- **Lecture 2: Smart/Adaptive Applications on Clouds**

- Reactive and Proactive Adaptation
- Performance, Cost Optimization
- Hybrid Clouds Issues
- Development and Deployment for Hybrid Clouds

View from Above: “IT Cloud”

- **Definition:** *Cloud computing is an emerging style of computing in which applications, data, and IT resources are provided as services to users over the web.*



- **Characteristics:** *on demand self-service, broad network access, resource sharing(multi-tenancy), Everything as a Service, pay as you go.*

Forces: Technology Push and Business Pull

Alternate Client Devices:
Explosion of form factors, mobility, connectedness,

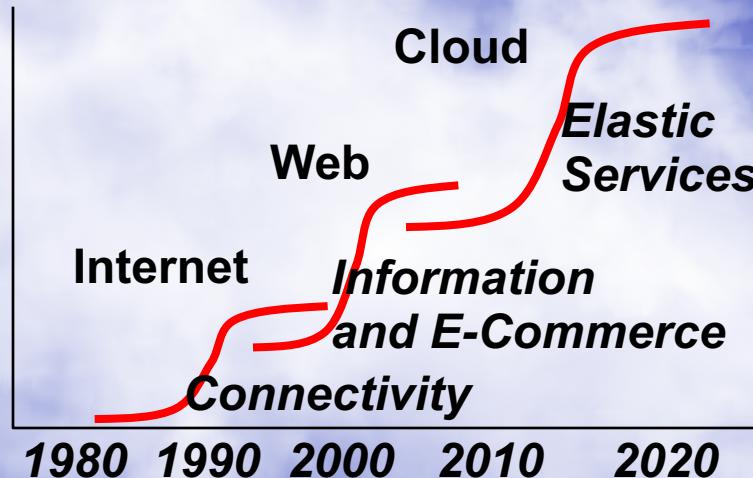
Internet of Things, Cyber Physical Systems

Web Platforms and Applications:
Elastically scalable global class infrastructure and mashable services built on WOA (e.g., REST, RSS/Atom)

Infrastructure Technologies:
Virtualization and automation

Industrialization of IT:
Standardization and commoditization (e.g., e-mail), open source

Data Center Pressures:
Growing costs of power and space, server sprawl

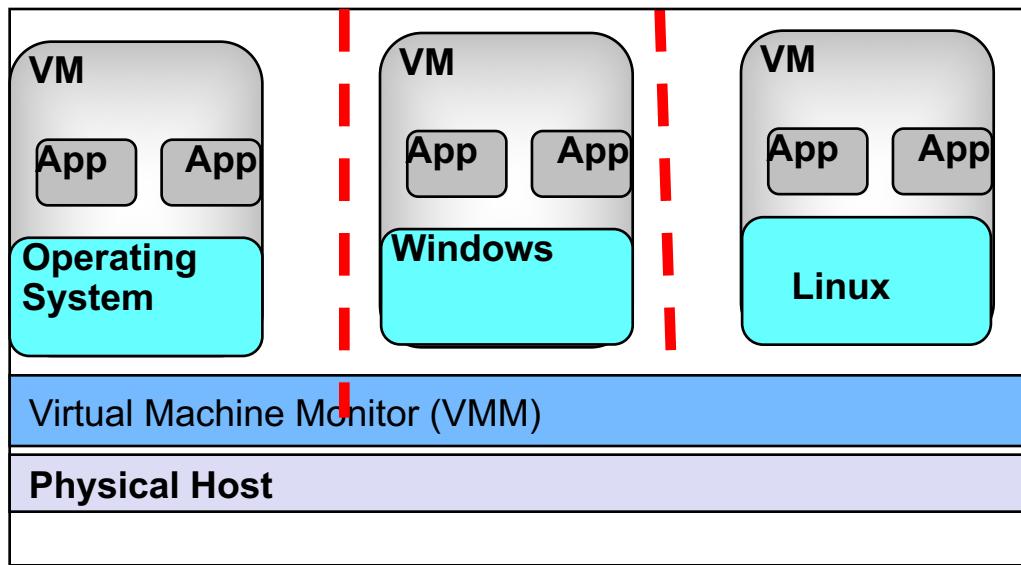


Business Model:
Advertising subsidized, venture funding for service model

Application Technologies:
From parallel processing (grid, MapReduce, Hadoop) to Web 2.0, SOA

Networking:
Growth in connectivity and bandwidth through the Internet

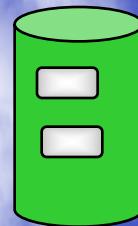
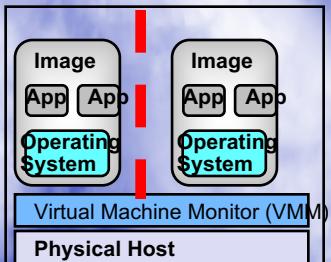
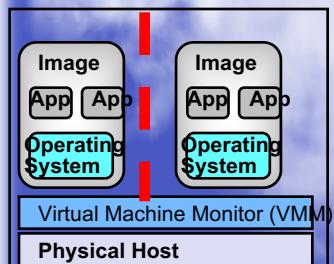
Virtualization: a mechanism to share hardware



With Vbox you can virtualize your computer
<https://www.virtualbox.org/>

Cloud Software: self-serving portal

Cloud Software (Eucalyptus, OpenStack
Amazon EC2, IBM SmartCloud, etc.)



Virtual Images
(Linux, Windows,
mySQL, DB2,
WAS, RAD, etc..)

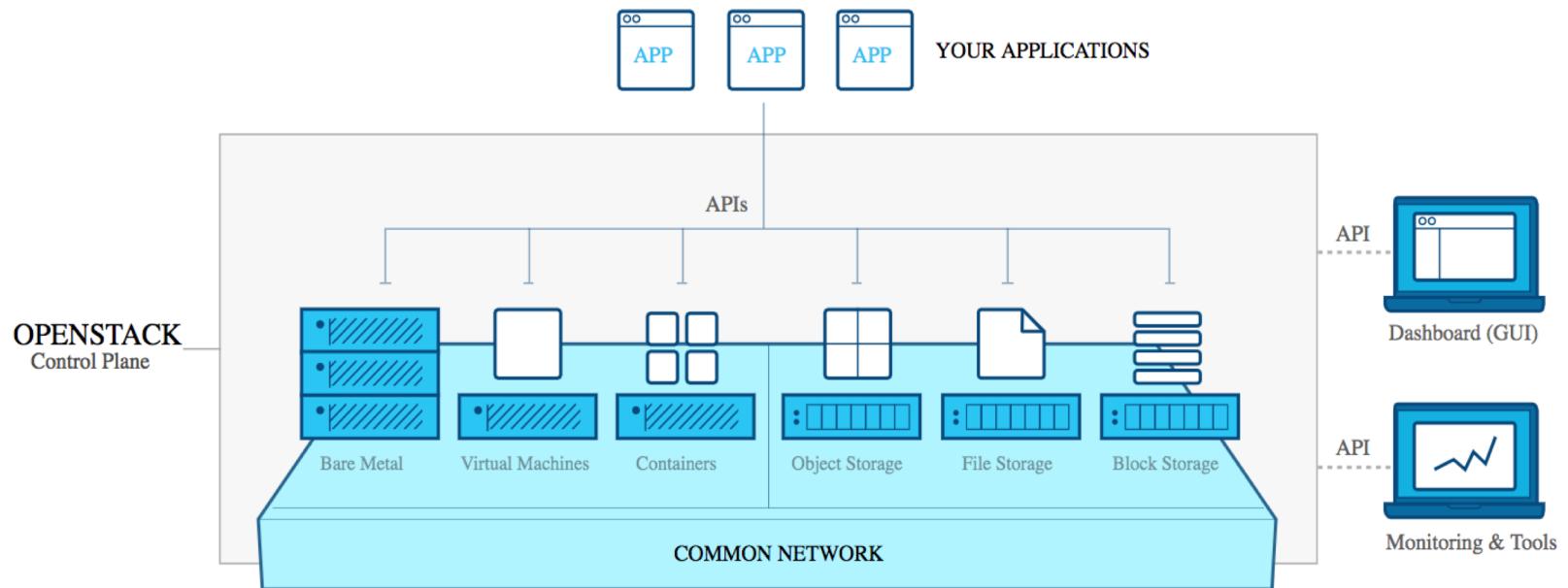
- **VMM (hypervisor) -virtualizes one physical host (one machine)**
 - Xen, VMware, KVM
- **Virtual Images (OS+Applications) can be instantiated(provisioned) in seconds as Virtual Machines**
- **Virtual Machines can be started, stopped, migrated, as any service**
- **Cloud software aggregates multiple physical hosts and manages the lifecycle of the VM, connectivity and IP addresses(EC2 de facto standard)**
 - Eucalyptus (open source)
 - OpenStack (open source)
 - IBM, HP (commercial)
 - Amazon (public cloud)

Amazon Cloud Demo(aws)

- **Amazon has a free tier (you still need to provide the credit card)**
- **Different types of VMs**
- **Pay as you go**
- **Provisioning in minutes**

OpenStack (<http://openstack.org>)

What is OpenStack?



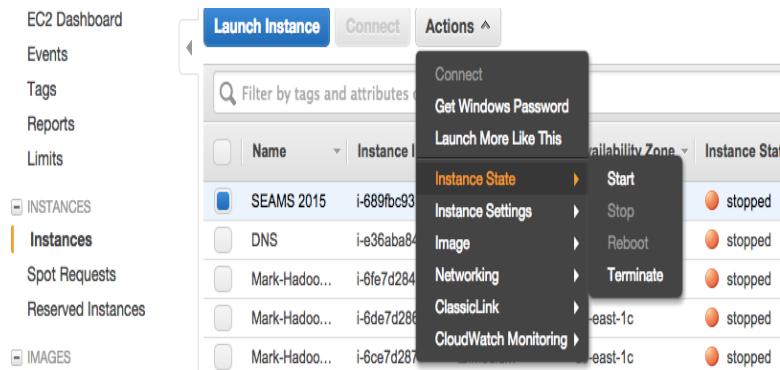
OpenStack is a cloud operating system that controls large pools of compute, storage, and networking resources throughout a datacenter, all managed through a dashboard that gives administrators control while empowering their users to provision resources through a web interface.

OpenStack main components (<http://openstack.org>)

- Compute - Nova
- Networking - Neutron
- Object Storage - Swift
- Block Storage - Cinder
- Identity - Keystone
- Image Service - Glance
- Dashboard - Horizon
- Telemetry - Ceilometer
- Orchestration - Heat
- Data Processing - Sahara

Cloud: Everything as a Service

- Accessed over the web, through browser

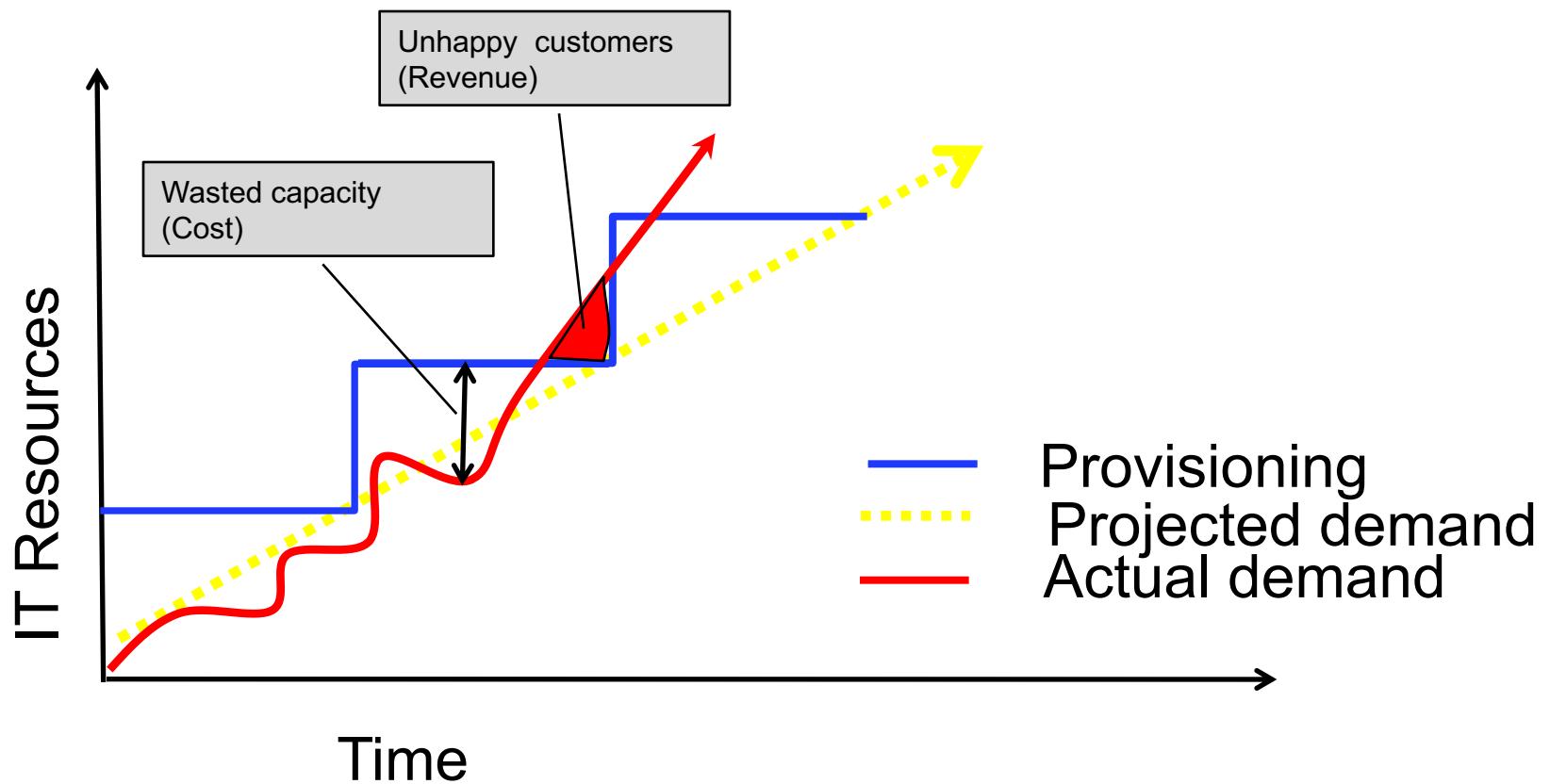


- Accessed Using SOAP, REST web services protocol
- The requests, at the client site are wrapped by programming languages

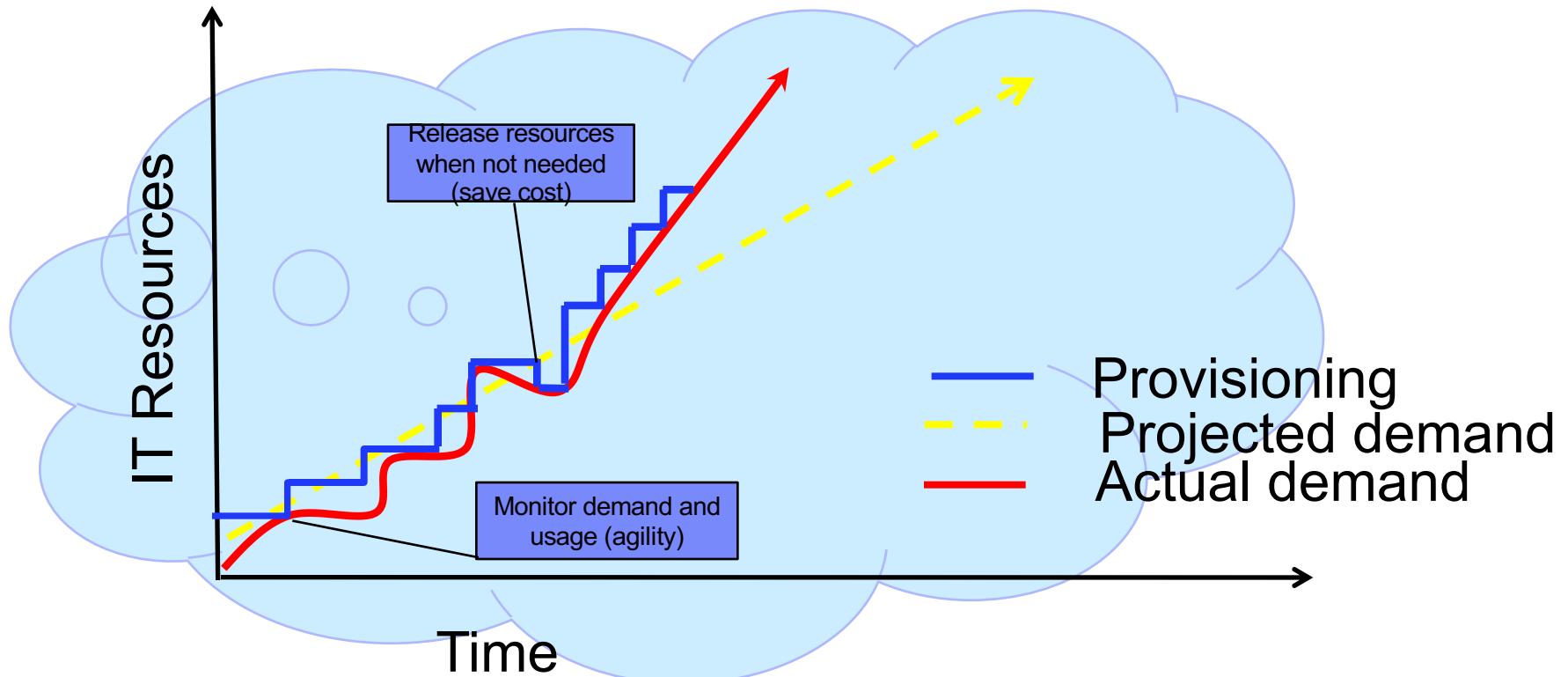
Ex. Java API

```
StartInstanceRequest.  
withInstanceId(java.lang.String instanceId)
```

The Elasticity Argument: Traditional IT Scaling



The Elasticity Argument: Cloud IT Scaling



The Cost Argument

- Economies of scale bring the cost of admin down(Medium size versus large size data centres(2006)***

Technology	Cost in Medium-sized DC	Cost in Very Large DC	Ratio
Network	\$95 per Mbit/sec/month	\$13 per Mbit/sec/month	7.1
Storage	\$2.20 per GByte / month	\$0.40 per GByte / month	5.7
Administration	≈140 Servers / Administrator	>1000 Servers / Administrator	7.1

- Balancing the load across data centres reduces cost***
 - It is cheaper to transport the data than power**

Price per KWH	Where	Possible Reasons Why
3.6¢	Idaho	Hydroelectric power; not sent long distance
10.0¢	California	Electricity transmitted long distance over the grid; limited transmission lines in Bay Area; no coal fired electricity allowed in California.
18.0¢	Hawaii	Must ship fuel to generate electricity

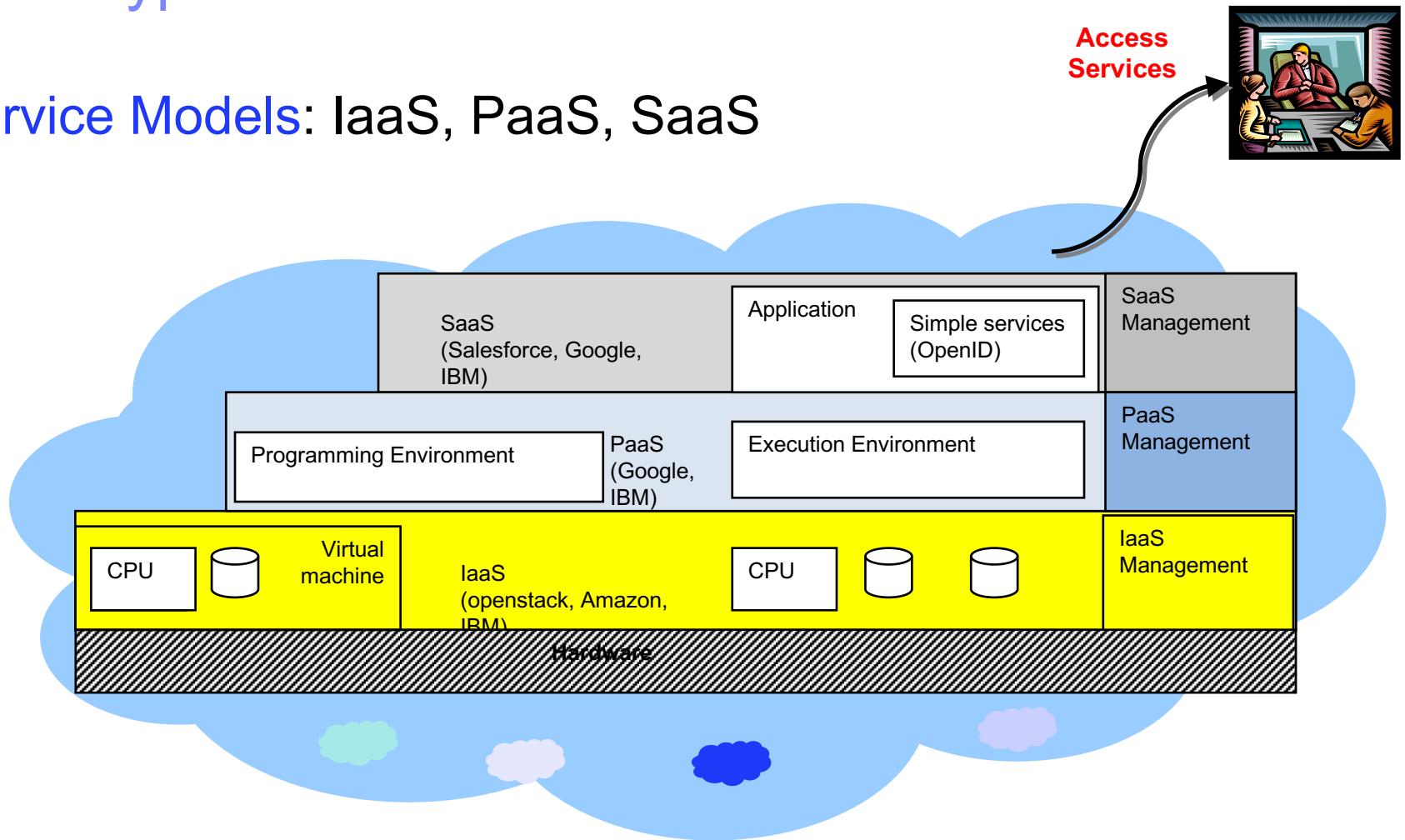
- Green data centres (powered by solar, wind..)**

*James Hamilton, <http://perspectives.mvdirona.com>.

*Armando Fox et al., Berkley Technical Report

Cloud Types

Service Models: IaaS, PaaS, SaaS



Deployment Models: private, community, hybrid, public

Amazon Cloud: IaaS (<http://aws.amazon.com>)

- **Amazon Web Services (AWS):**
 - Compute Capacity (Elastic Cloud Computing)
 - Storage (Simple Storage Service),
 - Databases
 - Simple Queue Service
 - Virtual Private Clouds
- **Business model: charges per usage**

Standard Instances	Linux/UNIX	Windows
Small (Default)	\$0.1 per hour	\$0.125 per hour
Large	\$0.40 per hour	\$0.50 per hour
Extra Large	\$0.80 per hour	\$1.00 per hour

Google Cloud: SaaS and PaaS

g Welcome to Google Apps × +

http://www.google.com/apps/

Google™ Web applications for communication and collaboration

Stay connected and be more productive

For personal use

Keep in touch and share with friends and family. Free, intuitive tools you can access anywhere with a single account.

- Gmail**
Fast, searchable email with less spam
- Google Talk**
IM and call your friends through your computer
- Google Calendar**
Organize your schedule and share events with friends
- Google Docs**
Share online documents, presentations, and spreadsheets
- Google Sites**
Create websites and secure group wikis

And [much more...](#)

For businesses and schools

Put Google's web-based communication, collaboration and security apps to work for your company or school.

- Business IT managers**
Not an IT manager?
Start collaborating with [coworkers](#) or [classmates](#).
- School IT managers**


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Microsoft Cloud

- **SaaS: MS Office, Exchange**
- **Subscription base business model**
- **Platform as a Service: Azure**



A screenshot of a Microsoft news article titled "Ozzie details Azure, Microsoft's cloud version of Windows". The article is dated Oct 27, 08 by Elizabeth Montalbano. It discusses Microsoft's Azure technology, which is described as a cloud computing version of its operating system. The screenshot shows the Microsoft news website interface with a blue header and navigation menu.

Ozzie details Azure, Microsoft's cloud version of Windows

Oct 27, 08 by Elizabeth Montalbano

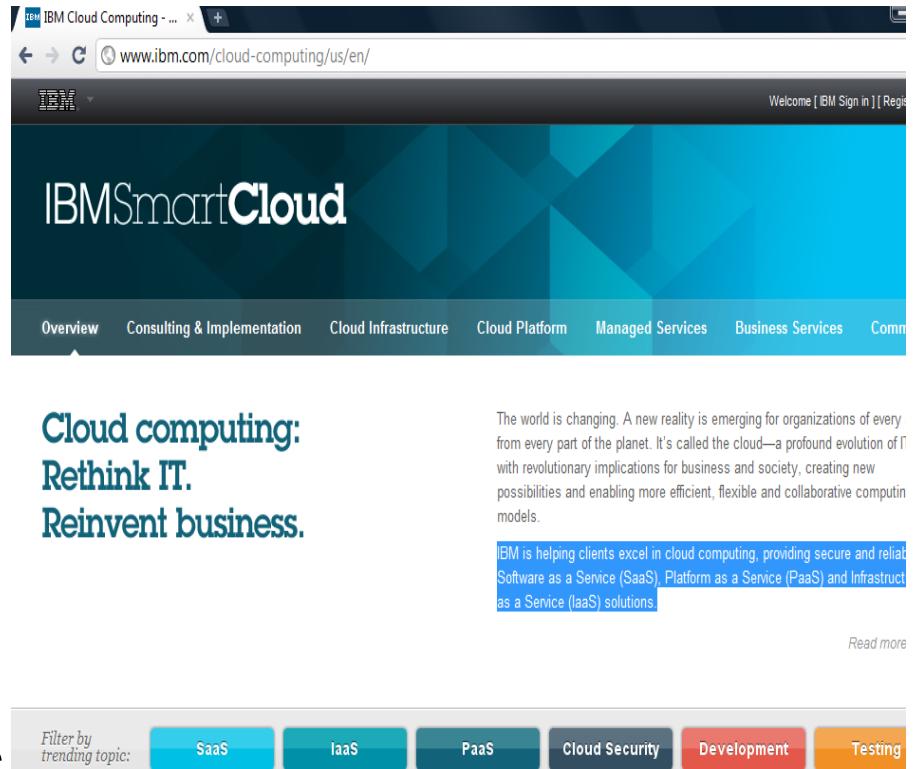
<http://www.computerworld.com> — Microsoft targets Amazon's EC2 service with Azure technology, Ray Ozzie says at PDC show.

Ray Ozzie, Microsoft Corp.'s chief software architect, today detailed Windows Azure, a cloud computing version of its operating system that the software vendor says will enable developers to build and host online services on a Windows-based IT infrastructure.

Continue reading at <http://www.computerworld.com>

IBM Smart Cloud

- **Public IaaS cloud for development and testing**
- **SaaS public cloud: IBM Lotus Live**
- **Hardware, IaaS and PaaS stack for private cloud**
- **IBM BlueMix as a PaaS**



The screenshot shows the IBM Cloud Computing website at www.ibm.com/cloud-computing/us/en/. The page features a large banner with the text "IBMSmartCloud". Below the banner is a navigation bar with links: Overview, Consulting & Implementation, Cloud Infrastructure, Cloud Platform, Managed Services, Business Services, and Community. A prominent blue callout box contains the text: "Cloud computing: Rethink IT. Reinvent business." followed by a paragraph about the changing reality of cloud computing and a link to "Read more". At the bottom, there is a filter bar with buttons for "Filter by trending topic:" and categories: SaaS, IaaS, PaaS, Cloud Security, Development, and Testing.

IBM BlueMix

Starters // Choose a package of sample code and services, or start from scratch

Boilerplates

Get started with a new app, now



Internet of Things
Foundation Starter
IBM



Java Cache Web Starter
IBM



Java Cloudant Web
Starter
IBM



Java DB Web Starter
IBM



Mobile Cloud
IBM



MobileFirst Services
Starter
IBM



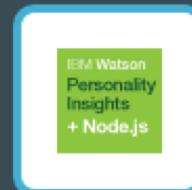
Node.js Cache Web
Starter
IBM



Node.js Cloudant DB
Web Starter
IBM



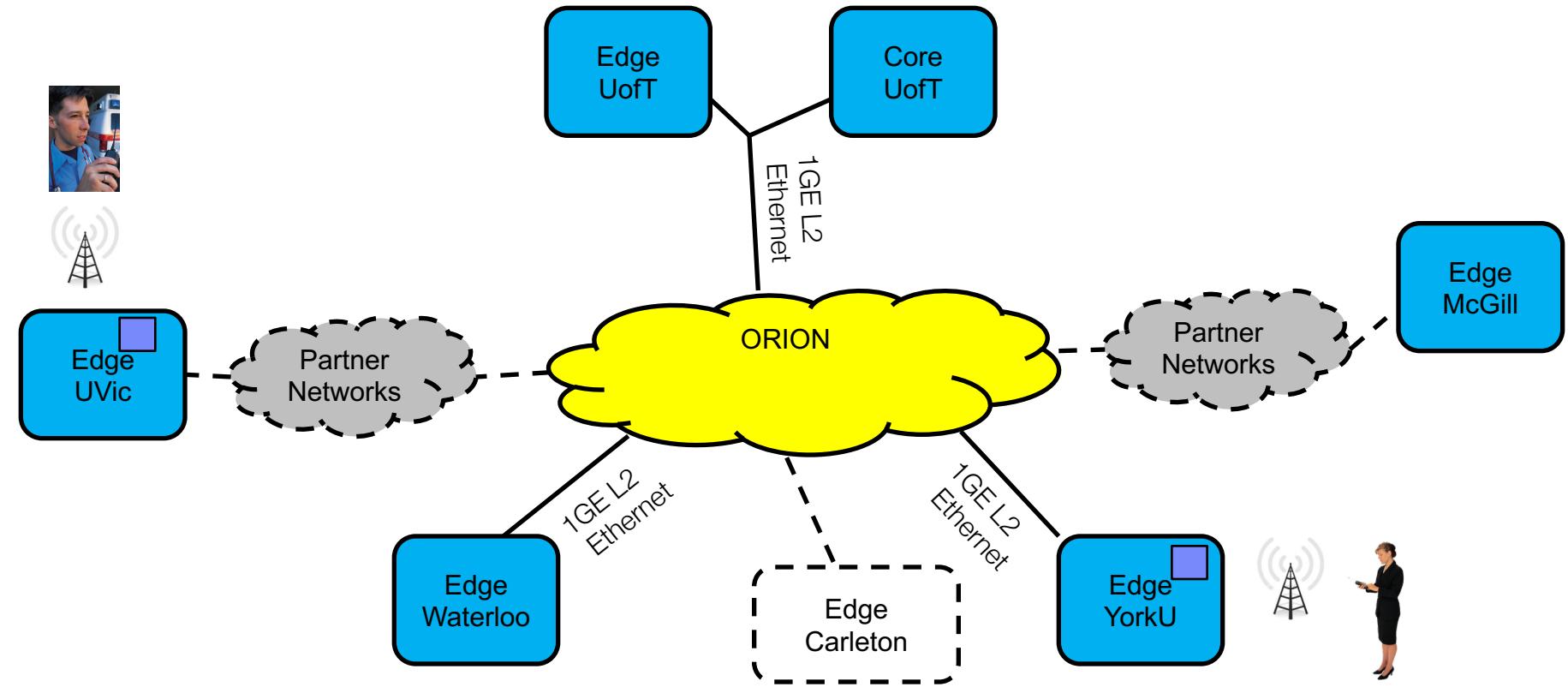
Personality Insights Java
Web Starter
IBM



Personality Insights
Node.js Web Starter
IBM

Academic Clouds: SAVI Cloud

<http://savinetwork.ca>



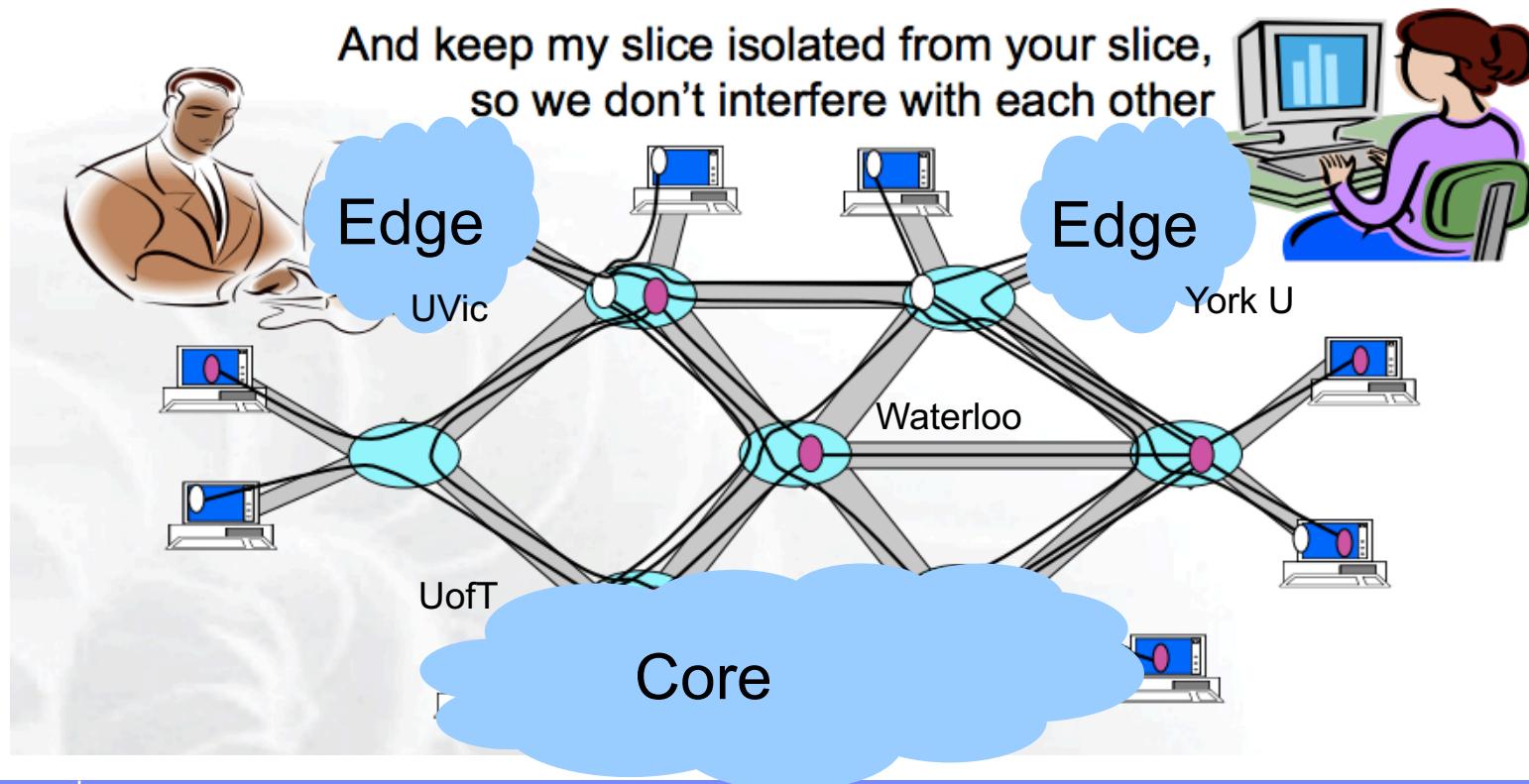
The cloud is at your fingertip...

SAVI Cloud: Software Defined Infrastructures (SDI)

- In SAVI, the network and the cloud converge, each cloud edge is both a cloud and a router (OpenStack and OpenFlow)

Install the software I want *throughout* my network slice
(into firewalls, routers, clouds, ...)

And keep my slice isolated from your slice,
so we don't interfere with each other

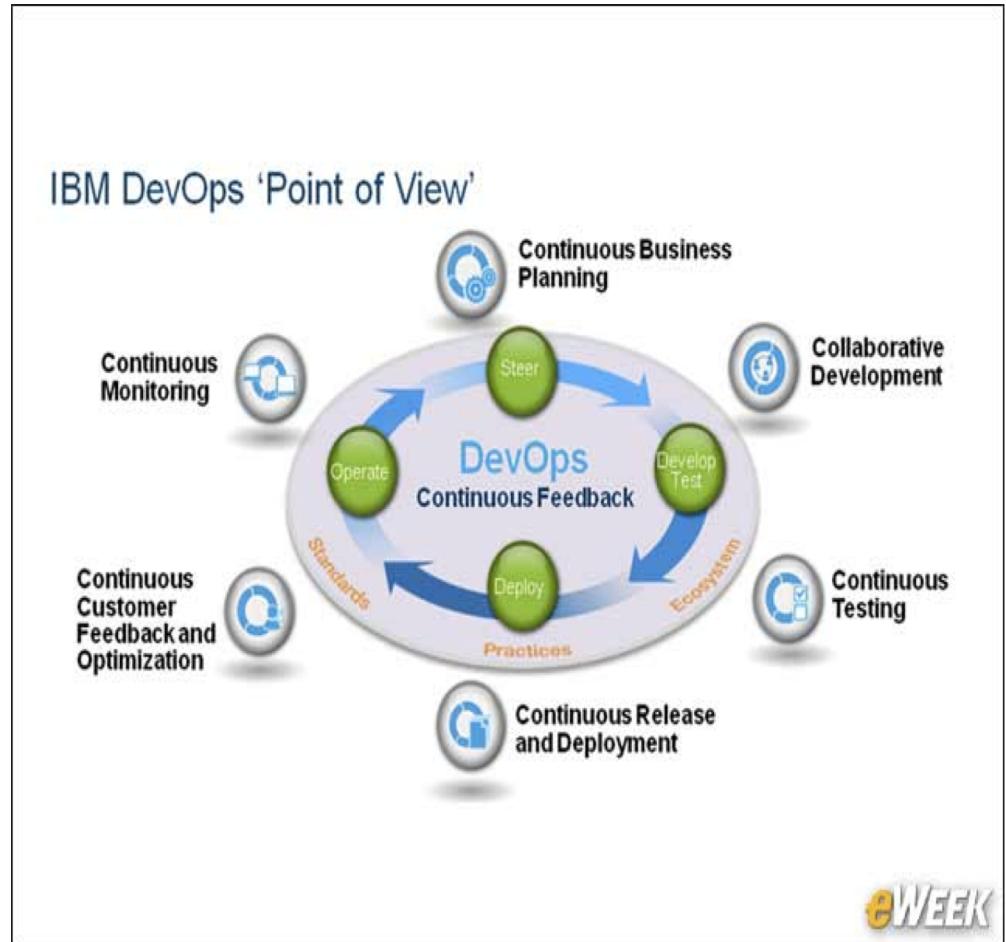


The Changing Development Landscape

- **Traditional IT duties**
 - Resource capacity planning
 - Security of both infrastructure and production applications
 - Long release cycle
- **Cloud Ecosystem**
 - Security responsibilities
 - Cloud provider → infrastructure
 - Application owner → application
 - Capacity planning: elasticity
 - Short release cycle
 - DevOps and Noops

DevOps and Noops

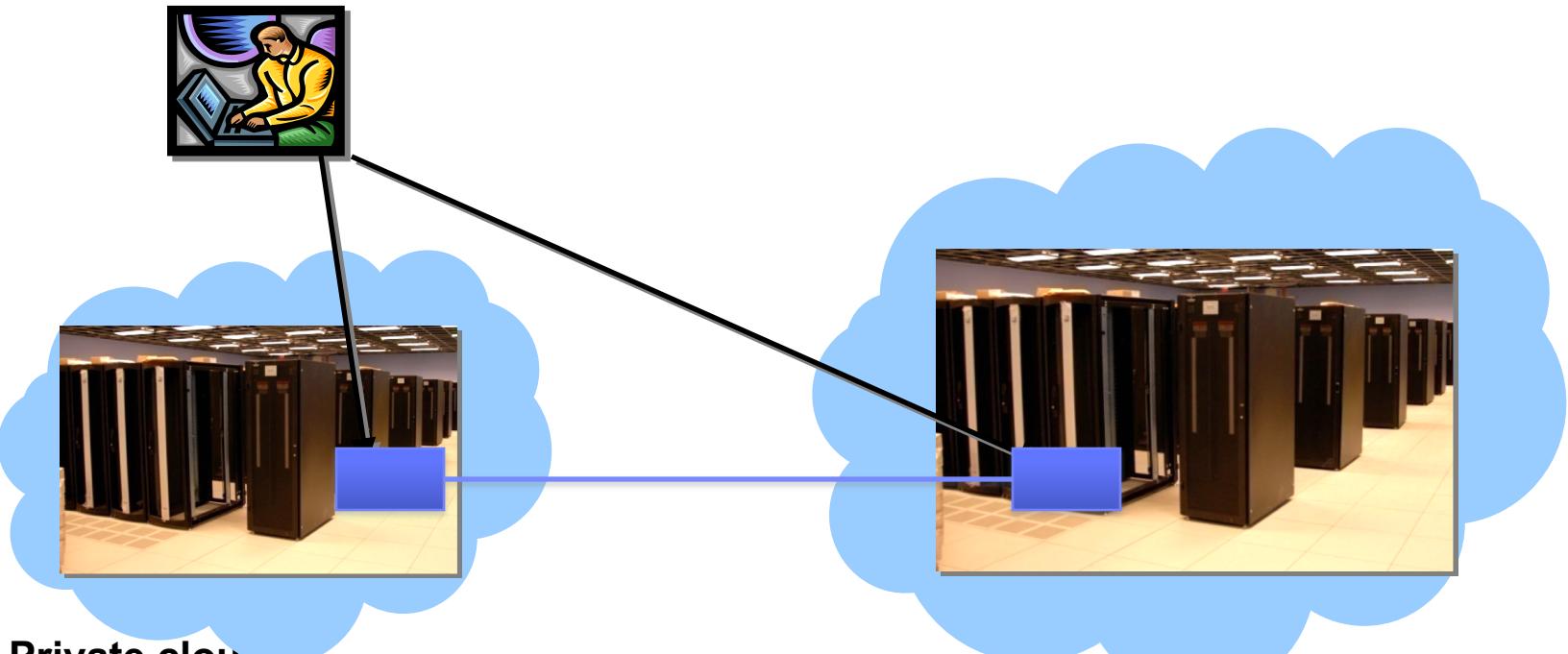
- **DevOps:** promotes the idea of strong collaboration among Development, QA and Operations teams
- **NoOps** means developers can code, deploy, manage and maintain the application
 - automated systems (PaaS like Cloud Foundry, XCAMP) manage app lifecycles; no Operations teams
- **Companies started to advertise their PaaS as NoOps**
- **Most probably, Operations will deal with business related issue rather than technical issues**



Discussion....

- **Development in cloud**
- **Migration to cloud**
- **Performance**
- **Cost**
- **Security**
- **Privacy**

Hybrid Clouds



- **Private cloud**

- Limited capacity
- High bandwidth
- Low latency
- Privacy

- **Public cloud**

- High capacity
- Low cost
- Lack of privacy
- High latency

We are interested in applications that run/migrate seamlessly across private and public cloud

Hybrid Clouds: Disaster Mitigation

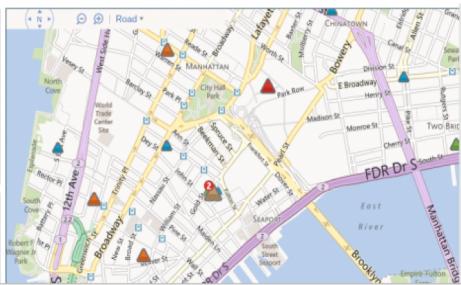
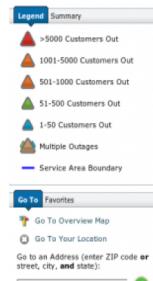
NYC Data Centers Struggle to Recover After Sandy

by Mark Hatchman | October 31, 2012



23

A number of facilities in lower Manhattan are racing to pump out flooded facilities to keep services up and running. Here's an update.



Slashdot Poll

Favorite U.S. Political Party

- Republican
- Democratic
- Libertarian
- Green
- Americans Elect
- Constitution



Summary so far: Clouds – Everything as a Service

- **The computing infrastructure is programmable, as a service**
 - Publish, discover, bind
 - Tune, migrate, dispose, etc.
- **The network is programmable**
- **The COST is first class citizen**
- **Cloud is not a centralized data centre**
 - Has “edges” and cores
 - Locality is important for applications and cloud

Issues....

- **Development in cloud**
- **Migration to cloud**
- **Performance**
- **Cost**
- **Security**
- **Privacy**

More readings...

- <http://Openstack.org>
- IBM Cloud
- Azure
- AWS Cloud
- **Above the Clouds: A Berkeley View of Cloud Computing(Tech report)**
- Babar, Muhammad Ali, and Muhammad Aufeef Chauhan. "A tale of migration to cloud computing for sharing experiences and observations." Proceedings of the 2nd International Workshop on Software Engineering for Cloud Computing. ACM, 2011.
- Tak, Byung Chul, Bhuvan Urgaonkar, and Anand Sivasubramaniam. "To move or not to move: The economics of cloud computing." Proceedings of the 3rd USENIX conference on Hot topics in cloud computing. USENIX Association, 2011.