CLOUD 101
Introduction to Cloud Computing & Potential Broadcast Applications

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Objective and Outline

Provide an introduction to cloud computing technologies and discuss some potential applications for public broadcasting

• Part I: The cloud computing model
• Part II: Potential broadcasting applications
Part I

Introduction to Cloud Computing
Is Cloud real or is it just hype?

Cloud Computing to Slice Data Center Energy Consumption by 2020
by ANURACHA on September 20, 2011 at 6:57 AM in BUSINESS, CASE STUDY, CLOUD COMPUTING, COMPUTING, GREEN COMPUTING/ CLEAN TECH, IT, NEWS, SAAS, SECURITY, STORAGE, TECHNOLOGY, TRENDS

Cloud Computing Done the Netflix Way
What can Netflix teach enterprises about data center operations and always-on reliability? Netflix is a consumer-facing Web shop with only a few applications—a completely different infrastructure challenge, right? Wrong. CIO.com's Bernard Golden explains the lessons to be learned from Netflix's data center transformation.

By Bernard Golden
Thu, April 05, 2012

Add a comment

Cloud Computing Calls for Rebuilding Enterprise IT
For all of the buzz about cloud computing, there remains confusion about its real implications for an IT organization. CIO.com's Bernard Golden argues that to take full advantage of the cost savings and efficiency improvements of the cloud, CIOs have to rethink their approach to IT.

By Bernard Golden
Wed, March 21, 2012

14 Comments

CDW Report: Work Imitates Life in Cloud Computing Adoption
Study Finds Personal Use of Cloud Influencing Decisions at Work; More Than Half of Organizations Are Migrating or Planning to Move Services to The Cloud
Press Release: CDW LLC – Mon, Feb 11, 2013 8:00 AM EST

Demystifying cloud computing
By Rhonda Betten, Mount Vernon News
March 1, 2013 9:19 am EST

MOUNT VERNON — Last year a survey by Citrix Systems revealed that only 16 percent of Americans could accurately define cloud computing and approximately half of the U.S. population would say they've never used cloud computing while actually 95 percent of them have. For example, Netflix, Facebook, and even email, are cloud-based operations. So, what is cloud computing?
It’s real!

iCloud, cloud computing services promise to change the way we use computers.
Demand Driving the Cloud

...business demand is outpacing budgets and resources – as well as traditional means of delivery

Source: CA Technologies

Previous Steady State

Recession & Credit Crisis

2003 - 2008
2008 - 2009
New Normal

Business IT Demand
Growing alignment gap
IT Budgets & Resources

Source: CA Technologies
Evolution of Cloud Computing

• Industry survey (2011):
  • 80% of enterprises surveyed had deployed at least one cloud service.
  • Over 50% have deployed six or more cloud services, while maintaining legacy infrastructures.

Source: CA Technologies
Defining Cloud Computing

The National Institute of Standards and Technology (NIST) Cloud Computing Model

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*. 
Defining Cloud Computing

Cloud computing is more than just “doing stuff in the cloud”
Four Deployment Models

- **Public Cloud**: Service over Internet
  - Utility Computing Model
  - Uses OpEx
  - Multiple tenants

- **Community Cloud**: Public, Private or Hybrid
  - Federated Clouds
  - OpEx (Users), CapEx (Community)
  - Resource Portability

- **Private Cloud**: Service over Internet
  - Grid Computing Model
  - Uses CapEx
  - Solo Tenant

- **Hybrid Cloud**: 2 or more Public, Private or Community
  - Combination OpEx & CapEx
  - Resource portability
  - Federated Clouds

- **Private/Internal**: The Cloud
  - On Premises/Internal

- **Public/External**: Off Premises/Third Party
  - The Cloud

"Cloud in a Box" – Azure for Enterprise – MS+HP
- IBM Cloudburst
- Eucalyptus cloud SW ~private AWS

Source: Wikipedia and Sam Johnston
Evolution of the Cloud

Traditional Virtualized Private Cloud Public Cloud

Distribution today

Distribution in 3-5 years

Source: Dell
Private Clouds: Government View

Benefits of Private Clouds for the Federal Government

- 72%: Control over physical security
- 61%: Compliance with Fed regs & specs
- 56%: Superior data protection
- 43%: Ability to share IT resources within agency and with other agencies
- 38%: Ability to respond to user req’ts

Source: Information Week Analytics/Information Week Government 2011
Three Service Models

- **Legacy**
  - Applications
  - Data
  - Runtime
  - Middleware
  - O/S
  - Virtualization
  - Servers
  - Storage
  - Networking

- **IaaS**
  - Applications
  - Data
  - Runtime
  - Middleware
  - O/S
  - Virtualization
  - Servers
  - Storage
  - Networking

- **PaaS**
  - Applications
  - Data
  - Runtime
  - Middleware
  - O/S
  - Virtualization
  - Servers
  - Storage
  - Networking

- **SaaS**
  - Applications
  - Data
  - Runtime
  - Middleware
  - O/S
  - Virtualization
  - Servers
  - Storage
  - Networking

= YOU provide & manage  = VENDOR provides & manages  Source: derived from Microsoft
Five Major Characteristics

- Broad Network Access
- Rapid Elasticity
- Measured Service
- On-Demand Self Service

Virtualization & Resource Pooling

- Virtual/Physical SW Stacks
- Stateless Compute
- Logically Configurable Network

Example: HP Blade Server
The Scalable/Elastic Cloud

Scalable Cloud Elasticity

Predicted Demand

Automated Trigger Actions

Actual Demand

Source: Multiple
Example Industry Structure

Cloud Migration Consultants
- e.g. CA Technologies, Fujitsu and many others

Service Providers
- e.g. Terremark, Amazon, OpSource, SHI, & many others

Cloud Management (multiple clouds)
- e.g. RightScale, Abiquo and others

Provisioning (single cloud)
- e.g. Cloud.com, RackSpace, Eucalyptus and many others

Virtualization – e.g. Hypervisor
- e.g. VMWare, Oracle, Xen, HP, Dell, and many others
Sample Cloud Vendors
## Example Cloud vendors

### Summary of Major Vendor Emphasis

<table>
<thead>
<tr>
<th></th>
<th>Build Private Services</th>
<th>Deliver Services</th>
<th>Services Delivered*</th>
<th>Private Offerings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IaaS</td>
<td>PaaS</td>
<td>SaaS</td>
<td>Enabling Tech.</td>
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<td>Amazon</td>
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<td>None</td>
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<td>salesforce.com</td>
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<td>None</td>
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<td>Google</td>
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<td>None</td>
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<tr>
<td>Microsoft</td>
<td></td>
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<tr>
<td>IBM</td>
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<tr>
<td>VMware</td>
<td></td>
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<tr>
<td>Oracle</td>
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<td></td>
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<td>None</td>
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<tr>
<td>SAP</td>
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<td></td>
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<tr>
<td>HP</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

*The provider may offer public, community or virtual private services

Note: This is not an evaluation of capabilities, but rather of emphasis.
Example Cloud Vendor Pricing

<table>
<thead>
<tr>
<th>Cloud Provider</th>
<th>Cloud Server Summary</th>
<th>Price</th>
<th>Go to Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>atlantic.net</td>
<td>2 GB RAM / 2.4 GHz VCPU (Medium)</td>
<td>$49</td>
<td></td>
</tr>
<tr>
<td>M5</td>
<td>1.5 GB RAM / 1x 1% VCPU</td>
<td>$24</td>
<td></td>
</tr>
<tr>
<td>eApps</td>
<td>1.5 GB RAM / 20 CPU Shares</td>
<td>$29</td>
<td></td>
</tr>
<tr>
<td>ElasticHosts</td>
<td>1.5 GB RAM / 1x 0.5 GHz VCPUs</td>
<td>$35</td>
<td></td>
</tr>
<tr>
<td>CloudSigma</td>
<td>1.5 GB RAM / 1x 0.5 GHz VCPUs</td>
<td>$37</td>
<td></td>
</tr>
<tr>
<td>UltiCloud</td>
<td>2 GB RAM / 1 VCPU Instance (Micro)</td>
<td>$37</td>
<td></td>
</tr>
<tr>
<td>e24cloud.com</td>
<td>Standard 1 Core / 2 GB RAM</td>
<td>$38 PLN 122</td>
<td>Go to Provider</td>
</tr>
<tr>
<td>amazon web services</td>
<td>Standard Small + 10 GB EBS</td>
<td>$45</td>
<td></td>
</tr>
<tr>
<td>atlantic.net</td>
<td>2 GB RAM / 2.4 GHz VCPU (Medium)</td>
<td>$49</td>
<td></td>
</tr>
<tr>
<td>Storm</td>
<td>Storm Server 2GB (1.7GB RAM)</td>
<td>$50</td>
<td></td>
</tr>
<tr>
<td>bitrefinery</td>
<td>1.5 GB RAM / 1 VCPUs Instance</td>
<td>$53</td>
<td></td>
</tr>
</tbody>
</table>

source: cloudorado.com (a particular sample day)
Sample Cloud Applications

• Application Hosting
• Backup & Storage
• Content Delivery
• Databases
• E-Commerce
• Enterprise IT

• High Performance Computing
• On-Demand Workforce
• Media Hosting
• Search Engines
• Web Hosting
• Development
Examples: media in the Cloud
Example: media in the Cloud

Netflix Media Pipeline

EC2 → S3 → EC2 → S3 → FTP → EC2

aspera
Amazon web services
Lionsgate

Open Connect
Part II

Potential Broadcasting Applications
The Paradigm Shift

• The technology exists today to implement the complete broadcast workflow from ingest to transmission in the cloud

• There are many excellent public cloud options but for Broadcast, a private/hybrid community cloud configuration may be ideal (e.g. station groups)
Why Cloud and why now?

**M&E Market and Broadcast Industry Drivers/Trends**

- IP Connectivity & File Based Workflow
- OTT Content Delivery & Mobile devices
- TV Everywhere
- Emerging standards
- Move from legacy H/W to S/W
- Dedicated and virtualized server implementations
- Cloud services

**Cloud Solutions for Broadcasting**

**Cloud Computing Industry Trends**

- Second gen cloud computing technologies & standards
- Availability of mature private & hybrid cloud solutions
- Low cost terrestrial broadband connectivity
Typical Historical Media Workflow

ACQUIRE → PRODUCE → PREP → TRANSMIT

ARCHIVE (e.g. LTO)

Derived from: SMPTE and others
File-Based Workflow

Live Production

Audio

Work in progress

Graphics

Archive

News

Playout

P2
PD
SxS
CF

MXF, IMX, DV
AVC, J2K

MXF

AAF

NLE

Derived from: Broadcast Engineering & SMPTE

Live Production

Field Production

Work in progress

Graphics

Archive

News

Playout
Examples: Cloud Functionality

- Ingest & Transcoding
- Media asset management (MAM)
- Hosting for OTT delivery (linear and COD)
- File-based workflow
- Archival & Disaster recovery
- QC/test and verify all formats
- Developmental stress testing and simulation
The Ingest Challenge

OB/SNG/DSNG Feeds

Internet

STUDIOS

PRODUCTION

Affiliate & Syndicated Feeds

User Generated Content (UGC)

Other Content (e.g. Ads)

Various tape and hard drive formats
The Ingest Challenge

Ingest conversion to file based format for editing, archival and proxy access - real time as well as file based. Today’s ingest examples:

• Tape input from legacy sources and raw multi-year archives (Sony, DV, HD, HDSR, IMX)
• File formats (e.g. DNX-145, XD CAM 50, QTIME 45m, IMX-30/40/50, MXF, J2K)
• Web UGC: cell phone, QuickCam, Home
Brute Force Approach

Cloud Functionality

C0

C1

C2

C3

Ingest & Transcode

P1

P2

P3

P4

Common dBase

Production Workflow

“FAT PIPES!”

UGC

Other

"FAT PIPES!"
The Cloud Paradigm Shift

Production Workflow

UGC
Other

Common dBase(s)

Ingest & Transcode

C1 -> C2 -> C3 -> C4

"THIN PIPES!"
The Cloud Paradigm Shift

Inherently native multiplatform OTT delivery

Production Workflow
The Cloud Paradigm Shift

Native multi-cloud connectivity for backup, diversity, regulations, DRM etc..

Native multiplatform OTT delivery
**Example Cloud Transcoding**

Capture → 101010010111

Origin Encode → Cloud Encoding

<table>
<thead>
<tr>
<th>Input Format</th>
<th>Bit Rate</th>
<th>RTMP (Flash)</th>
<th>HTTP (iPAD, ROKU …)</th>
<th>RTSP (Android, BB …)</th>
</tr>
</thead>
<tbody>
<tr>
<td>720p</td>
<td>2.50 Mbps</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>540p</td>
<td>1.75 Mbps</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>480p</td>
<td>1.25 Mbps</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>360p</td>
<td>1.00 Mbps</td>
<td>X</td>
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<td>288p</td>
<td>0.75 Mbps</td>
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<tr>
<td>270p</td>
<td>0.50 Mbps</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>180p</td>
<td>0.25 Mbps</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Source: KulaByte
SaaS and Cloud-Based Outlook:

“Some of the biggest challenges to the SaaS model have traditionally been around security, robustness and infrastructure. Technological advances, declining storage costs and the proliferation of high-speed broadband have transformed the business landscape and the SaaS model is no longer seen as a risky option.”

Source: Frost and Sullivan
Cloud Archival Concepts

- Cache
- Manage Archival
- Manage LTO
- Ingest & Transcode
- Common dBase(s)
- C1, C2, C3, C4
- Production Workflow
- P1, P2, P3, P4
- LTO PRIMARY
- LTO BACKUP
- Example LTO tapes (Linear Tape Open)
- UGC
- Other

Production Workflow:
- Ingest & Transcode
- Common dBase(s)
- C1, C2, C3, C4
- Production Workflow
- P1, P2, P3, P4
- LTO PRIMARY
- LTO BACKUP
- Example LTO tapes (Linear Tape Open)
- UGC
- Other
Cloud Archival Concepts

Manage Archival

Manage LTO

Cache

OnNet Connectivity

Ingest & Transcode

Common dBase(s)

Production Workflow

LTO PRIMARY

LTO BACKUP

UGC

Other

P1

P2

P3

P4

Production Workflow
Cloud Archival Concepts

Low latency mid-term cache on demand

Note: Cloud spinning disk archival is catching up. See Cloud 102 for AWS Glacier discussion.
Cloud transmission – why not?

Production Workflow

It’s being done today!
Summary

• The technologies exist today to implement the complete end-to-end broadcast workflow using **cloud computing technologies**

• This is a natural migration from our legacy broadcast infrastructure and the way of the future
For further reading ...

**The Silver Lining**—Utilizing Cloud Computing in Broadcast Applications
By A. S. Davies
March 2011

**Story-Centric Workflows in the Cloud**
By Peter Defreyn, Luk Overmeire, Matthias De Geyter, Rik Van de Walle, and Wim Van Lancker
March 2012

**Service-Oriented Architecture and Cloud Computing in the Media Industry**
By John Footen and Mohan Ananthanarayanan
March 2012

**A Cloudspotter’s Guide to Migration**
Al Kovalick, Founder, Media Systems Consulting
October 2012

The Cloud and its potential role in the production and distribution of multi-screen enabled content
Jason Williamson, Deloitte Consulting
Hanish Patel, Deloitte Consulting

Leveraging the Cloud for File-based Workflows
Ron Quartararo, Director of Media and Entertainment Strategic Solutions, Verizon Enterprise Solutions
October 24, 2012

Delivering live multicam content to smart devices through cloud platforms
Werner Ramaekers – EVS - speaker
Johann Schreurs – EVS
Maher Khatib – EVS
Thank you for your time

Q&A?

(see also Cloud 102 tomorrow)

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