An Invited Talk/Presentation
Cloud Computing Technology & Strategy
for
Construction Industry
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Presented at
Building Contractors Association of NE Indiana
by
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Topics of Presentation

- Cloud Computing 101: Systems and Enabling Technologies
- How Cloud Computing is Transforming Business
- Challenges, Cost Models and benefits
- Cloud Computing Deployment Models and Examples of Cloud Services and Platforms for Construction Industry
- Creating your Enterprise Cloud Computing Strategies to Increase Competitiveness and Sustain Company Growth
Cloud Computing 101: Systems and Enabling Technologies

The Evolution of Computer Systems and Applications

  - Early computer companies
  - Analog computers
  - Mainframe computers
    - Time-sharing
    - Real-time computing
  - Supercomputers
  - Minicomputers
  - Networking
  - Personal computers
  - Mobile computing

Cloud Computing 101: Systems and Enabling Technologies

The Evolution of Computer Systems and Applications

- Client-Server Computing
- Distributed Computing
- Virtualization and data centers
- Utility Computing
- Grid Computing
- Internet computing
- Web services
- Service-Oriented Computing (SOA)
- Mobile Computing
- Cloud Computing
Traditional IT Infrastructure (Microsoft-based)

Data Center: Blade Computer & Wiring
Cloud Service Data Centers: Cost Distribution

<table>
<thead>
<tr>
<th>Amortized Cost</th>
<th>Component</th>
<th>Sub-Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>~45%</td>
<td>Servers</td>
<td>CPU, memory, storage</td>
</tr>
<tr>
<td>~25%</td>
<td>Infrastructure</td>
<td>Power distribution &amp; cooling</td>
</tr>
<tr>
<td>~15%</td>
<td>Power draws</td>
<td>Electrical utility costs</td>
</tr>
<tr>
<td>~15%</td>
<td>Network</td>
<td>Links, transmit, equipment</td>
</tr>
</tbody>
</table>

Datacenter and server cost distribution

![Graph showing customer spending versus millions of installed servers from 1996 to 2013, with categories for physical server, logical server, power & cooling, management, and server spending. The graph highlights a virtualization management gap.]

1. Cloud Service Data Centers: Cost Distribution
2. Datacenter and server cost distribution
Cloud Computing ≈ Scalable Internet-based Computing

- **General Computing Trend**
  - Leverage shared web resources
  - Massive amount of data over the Internet
- **High Performance Computing (HPC)**
  - Supercomputers (massively parallel processors, MPP)
  - Clusters of cooperative computers; share computing resources
  - Physically connected in close range to one another
- **High Throughput Computing (HTC)**
High Performance Computing (Cray) at IPFW

Cloud Computing ≈ Scalable Internet-based Computing

- High Throughput Computing (HTC) & Applications
  - Peer-to-peer (P2P) networks – distributed file sharing and content delivery applications
  - Web service platforms
  - Cloud computing

- HTC Technologies
  - Improved batch processing speed
  - Address acute problems at many data and enterprise computing centers
    - Cost, Energy saving, Security, Reliability
Cloud Computing 101: Enabling Technologies

- **Cloud Computing - Convergence of Technologies**
  1) Hardware virtualization and multi-core chips
  2) Utility and grid computing
  3) SOA (Service-Oriented Architecture), Web 2.0, and WS mashups (Web services)
  4) Atonomic computing and data center automation

Cloud Computing: 101
Basic Concept of Internet Clouds

Berkeley NOS (Network of Workstations) Project

- Clustered machines connected via high-speed switched networks, 1995, http://now.cs.berkeley.edu/
- NOW-2 (1997) 105 Ultra-1 workstations
- Each with a 167 MHz UltraSPARC Microprocessor, 128 MB of memory, and 2 Seagate Hawk 2 GB 5400 RPM 3.5 inch disks
- Myrinet switch system area network with each link operating at 160 Mbytes/second

Cloud Computing ≈ Scalable Internet-based Computing

- HPC for Science and HTC for Business Applications

(Courtesy of Raj Buyya, University of Melbourne, 2011)
Cloud and Internet of Things (IOT)

The NIST Cloud Computing Services Definitions

- “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. This cloud model is composed of five essential characteristics, three service models, and four deployment models.”

The NIST Cloud Computing Definitions\textsuperscript{4} (cont.)

- **Five Essential Characteristics**
  - On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, Measured service

- **Three Service Models**
  - Software as a Service (SaaS)
  - Platform as a Service (Paas)
  - Infrastructure as a Service (IaaS)

- **Four Deployment Models**
  - Private cloud
  - Community cloud
  - Public cloud
  - Hybrid cloud

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Three Cloud Services\textsuperscript{2}

- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS)
- Software as a Service (SaaS)

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*Figure 1.10*

Three cloud service models in a cloud landscape of major providers.

(Courtesy of Dennis Gannon, keynote address at Cloud.Com2010 (19))
Cloud Computing Challenges: Dealing with too many issues (courtesy of R. Buyya)

- Virtualization
- QoS
- Service Level Agreements
- Provisioning on Demand
- Security
- Privacy
- Legal & Regulatory
- Trust
- Billing
- Pricing
- Scalability
- Reliability
- Energy Efficiency
- Utility & Risk Management
- Software Eng. Complexity
- Programming Env. & Application Dev.

Cost Models: Traditional IT vs. Cloud Computing

(a) Traditional IT cost model
(b) Cloud computing cost model
Cloud Computing Services

Cloud Service Provider

Activities:
- Service Deployment
- Service Orchestration
- Cloud Service Management
- Security
- Privacy

Application, Ecommerce, Database, Email, Storage Servers, etc.

Worldwide Public Cloud Service Forecast

<table>
<thead>
<tr>
<th>Types of Cloud Services</th>
<th>2015</th>
<th>2015 Growth (%)</th>
<th>2016</th>
<th>2016 Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud business process services (Bpass)</td>
<td>39.2</td>
<td>2.7</td>
<td>42.6</td>
<td>8.7</td>
</tr>
<tr>
<td>Cloud application services (SaaS)</td>
<td>31.4</td>
<td>15.5</td>
<td>37.7</td>
<td>20.3</td>
</tr>
<tr>
<td>Cloud application infrastructure services (PaaS)</td>
<td>3.8</td>
<td>16.1</td>
<td>4.6</td>
<td>21.1</td>
</tr>
<tr>
<td>Cloud system infrastructure services (IaaS)</td>
<td>16.2</td>
<td>31.9</td>
<td>22.4</td>
<td>38.4</td>
</tr>
<tr>
<td>Cloud management and Security Services</td>
<td>5.0</td>
<td>20.7</td>
<td>6.2</td>
<td>24.7</td>
</tr>
<tr>
<td>Cloud Advertisement</td>
<td>79.4</td>
<td>15.4</td>
<td>90.3</td>
<td>13.6</td>
</tr>
<tr>
<td><strong>Total Market</strong></td>
<td><strong>175.0</strong></td>
<td><strong>13.7</strong></td>
<td><strong>203.9</strong></td>
<td><strong>16.5</strong></td>
</tr>
</tbody>
</table>
First Movers in Public Cloud

- Amazon
- Google
- Microsoft

Transparent Cloud Computing Environment

Figure 3: Transparent computing that separates the user data, application, OS, and hardware in time and space – an ideal model for future Cloud platform construction.
Cloud Computing Benefits

- **Scalability**
  - Size, Software, Applications, and Technology Scalability
- **On-Demand**
- **System Availability/Fault Tolerance**
- **Security**
- **Lower Total Cost of Ownership**

Cloud Strategy for Tech-Based Enterprises

- **SWOT Analysis** (Strength-Weaknesses, Opportunities-Threat)
  - IT-based Enterprise, Healthcare Industries, Service-Oriented Industry, Technology & Engineering Firms, Educational Institutional, etc
- **Learning & Trying Cloud Services & Technologies**
- **Put Cloud Technology into Corporate Planning**
  - Technology & Business Competitive Strategy
  - Product Technological Change
  - Business and/or Manufacturing Process Technological Change
Cloud Strategy for Tech-Based Enterprises (cont.)

- Integrating & Migrating to the Cloud
  - Resource Allocation for Innovative Activities
  - Your Enterprise Cloud: Private Cloud, Public Cloud, Hybrid Cloud
  - Establishing a Baseline and Metrics Tools
  - Finding the Right Vendors
  - Phase In and Get Ready

Cloud Strategy for Tech-Based Enterprises (cont.)

- Profiting from Cloud Strategy
  - **Operational Benefits:**
    - Reduced IT Cost, Increased Storage, Automation, Flexibility, Better Mobility, Better Use of IT Staff
  - **Economic Benefits:**
    - Staffing Benefits
      - No software installation or maintenance
      - Shorter Deployment Time
      - World Availability
    - SLA
    - Upgrades
    - Hardware (Leasing vs. Buying)
    - On Demand Pay as You Need,
    - Time to Market (Apps)
### SaaS for Construction Industry

- Business/Office Operation
- Construction Project Management and Process Automation
- File storage, Sharing
- Collaboration
- Communication & Network Infrastructure at Remote Job site

### Top Construction Management Software,
http://www.capterra.com/construction-management-software/

- Procore
- HeavyJob
- SiteMMAx
- BuilderTREND
- Premier
- Jonas Enterprise
- BuildTools Construction Mgmt
- Co-construct
- and more ..
SaaS for Construction Industry

- Procore – Construction Management Software: Integrating Sage for accounting, Box for collaboration and file sharing, MS Project for project management, https://www.procore.com/
- Synchroteam
- Corecon V7

SaaS for Construction Industry

- Construction Project Management and Process Automation
  - Project management, Estimating, Job cost control, Scheduling, Contract Admin, Change Management, Time Tracking, Collaboration, Reporting, etc
SaaS for Construction Industry

- File sharing, Cloud Backup:
  - Box
  - ShareFile
  - Google Drive
  - DropBox

Cloud Project Example 1


The XYZ Construction Inc., (located in Fort Wayne, Indiana) with less than 100 employees is in the business on highway expansion and/or repair projects, construction of commercial and industrial building in other cities or states. There is a need to expand the IT supports (in the areas of smartphones, Tablet and others mobile cloud service) for their staffs who work on remote job sites. As the CIO (Chief Information Officer) of the company, yourself, **you need to** form a small project team to address the problems/issues (Productivity and efficiency):

- Improving productivity and efficiency for those staffs working at remote sites which include (1) communications and networking infrastructure, (2) selection and configuration for end user devices (smartphone, tablet, PC, etc), (3) remote access to Home office CAD, project management, and other design tools from the job sites.
Mobile Technology Evaluation, Assessment, and Planning for a Construction Company

- Proposed system drawing by Justin M. Hagan and Judith Sobotie, CPET 565 Mobile Computing Technology

Mobile Technology Evaluation, Assessment, and Planning for a Construction Company

- Proposed system drawing by Kurt Bender & Aungar Long, CPET 565 Mobile Computing Technology
Mobile Technology Evaluation, Assessment, and Planning for a Construction Company

- Mobile Cloud Architecture drawing by Abid Latif & Roba Sobotie, CPET 565 Mobile Computing Technology

Cloud Project Example 2


Enterprise Mobility and Safety Wearable Device: Pilot Project

After the XYZ company’s strategic planning meeting, top administration approves a funding of $60,000 for an Enterprise Mobility Pilot Project to explore adoption of “Wearable Devices for Safety, Health, and Productivity Monitoring” for the company’s high-way construction department so that the company can stay innovative, competitive and possibly increase their capabilities, revenue/sales, and expand their global markets.
Cloud Project Example 2

- The major tasks during the kick-off phase of this Enterprise Mobility project are listed below. Each team
- Choose/made an initial list of “Wearable devices for safety, health, and productivity monitoring,” their purposes, advantages, ROI, etc
- Study, document, and recommend the desired wireless connectivity and protocols (Bluetooth, Bluetooth Low Energy, PWAN, NEC, etc) that are widely adopted or used in Wearable devices. It is expected that these new wearable devices can be easily integrated into company’s Android smartphones/devices that is current used by company’s employee.

Other Cloud Project Examples

- “Challenges of the Deployment of Advanced Metering Infrastructure (AMI) within U.S. Smart Power Grid,” MS. Directed Project by Peter Muchai, Advisor Paul Lin, May 2014
Other Cloud Project Examples

- “Challenges of the Deployment of Advanced Metering Infrastructure (AMI) within U.S. Smart Power Grid,” MS. Directed Project by Peter Muchai, Advisor Paul Lin, May 2014
MS Technology Course Projects


- “Implementing Remote Desktop Computing Services using Amazon EC2 – An IaaS Example," by Hemchand Lallad, Gregory Scalet, and Meng-Wei Li, Course Project for CPET 581 Cloud Computing: Technologies and IT Strategies, Course Instructor, Paul Lin, May 9 2013

Other Cloud Project Examples


*College of Engineering, Technology, and Computer Science
Purdue University Fort Wayne Campus

**U.S. Army Construction Engineering Research Laboratory
Other Cloud Project Examples

- Design and Evaluation of Hybrid Wire and Wireless Sensor Networks with Cloud Services for Monitoring of Early-Stage Environmental Corrosion

Corrosion Monitoring Sensor System

Packaging and Cabling
Corrosion Monitoring Sensor System – Installation (May 2013)

Thermal Electric Cooler (200 BTU)

Central Monitoring Computer (Windows XP, embedded)

Power Supplies

Six Sensor Connection Sockets and Cabling

Corrosion Monitoring Sensor System Installation – May 2013

Thermal Electric Cooler

Central Monitoring Computer (Windows XP, embedded)

Six Sensor Connection Sockets and Cabling

Power Supplies
Deployment and Testing: Corrosion Sensors and Wired Sensor Network at RIA Bridge, IL

- Sensor #1 (coal tar epoxy coated sol-gel sensor)
- Sensor #2 (coal tar epoxy coated sol-gel sensor)
- Sensor #3 (sol-gel sensor)
- Sensor #4 (sol-gel sensor)
- Sensor #5 (stainless steel cylindrical sensor, coal-tar epoxy coated)
- Sensor #6 (A36 cylindrical sensor, coal-tar epoxy coated)

References


Dual Wireless WiFi Adapters
RS-485 Link #1
RS-485-1
RS-232

CMS Arsenal Bridge Monitoring System
Ethernet/RJ45 Wireless Internet Gateway
Server/Programs/Scripts
Local Sensor Data File
Dropbox at Local Storage
LogMeIn Remote Access

Corrosion Sensor Electronics Box #1
Address #1
Corrosion Sensor Electronics Box #2
Address #2
Corrosion Sensor Electronics Box #3
Address #3
Corrosion Sensor Electronics Box #4
Address #4
Corrosion Sensor Electronics Box #5
Address #5
Corrosion Sensor Electronics Box #6
Address #6

Adapted AD-416-16 Digital Output x 2
RS-485-16

Impactful Current Connection Setup
Sprint Cell Tower
Internet on the Go
3G Mobile Hot Spot
(Sprint)
3G Signal

Corrosion Sensor #1
Analog Signal Processing Unit
RS-485

Address #1
Address #2
Address #3
Address #4
Address #5
Address #6

CMS Networking and Communication Subsystem
Redundant WiFi Hotspots and LAN Adapters

Arsenal Bridge, Rock Island, IL
Sprint Cell Tower
INTERNET

Internet on the Go
3G Mobile Hot Spot
(Sprint)
WiFi Signal
NINTEGRIS N300 ARMY Corrosion Monitoring Server
TP-LINK Wireless-N USB Adapter

Current Connection Setup
Smart Phone
Computer
Laptop
 влиывающий

Arsenal Bridge Control Tower
Second Generation CMS System: Wired & Wireless Sensor Nodes and Network

- Wired Star Network: RS-485, Wireless Mesh Network

- Wireless Sensor Nodes and Network to enhance the system reliability
  - Redundant measurement using an extra wireless sensor node running ZigBee-based (XBee) sensor network protocol
  - Mesh sensor network to provide maximum reachability and data routing for each sensor