

An Invited Talk/Presentation
Cloud Computing Technology & Strategy
for
Construction Industry

March 2, 2016

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

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Cloud Computing 101: Systems and Enabling Technologies

■ The Evolution of Computer Systems and Applications

■ Computer History Museum, <http://www.computerhistory.org/>

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



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Cloud Computing 101: Systems and Enabling Technologies

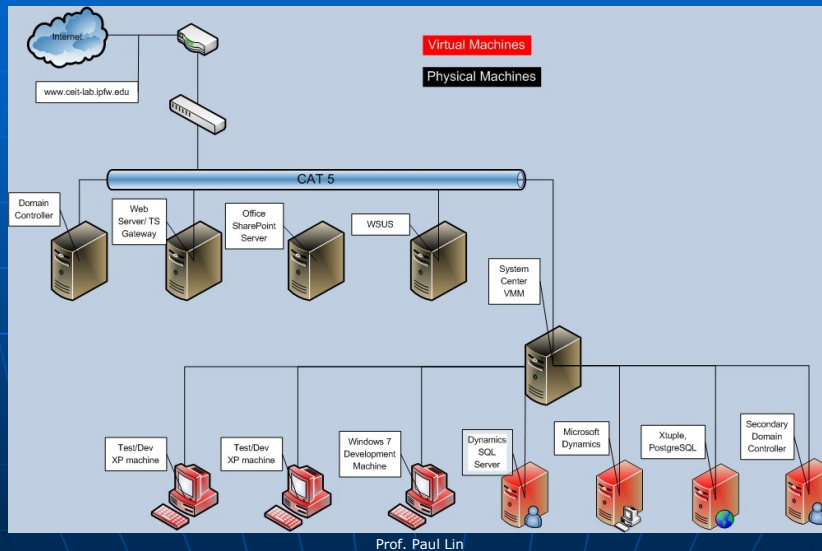
The Evolution of Computer Systems and Applications

- 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

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Traditional IT Infrastructure (Microsoft-based)



Data Center: Blade Computer & Wiring



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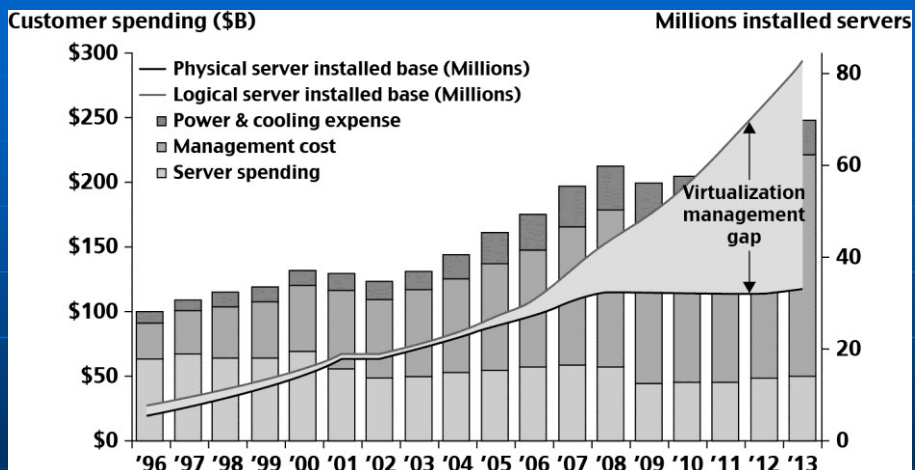
Cloud Service Data Centers: Cost Distribution¹

Amortized Cost	Component	Sub-Component
~45%	Servers	CPU, memory, storage
~25%	Infrastructure	Power distribution & cooling
~15%	Power draws	Electrical utility costs
~15%	Network	Links, transmit, equipment

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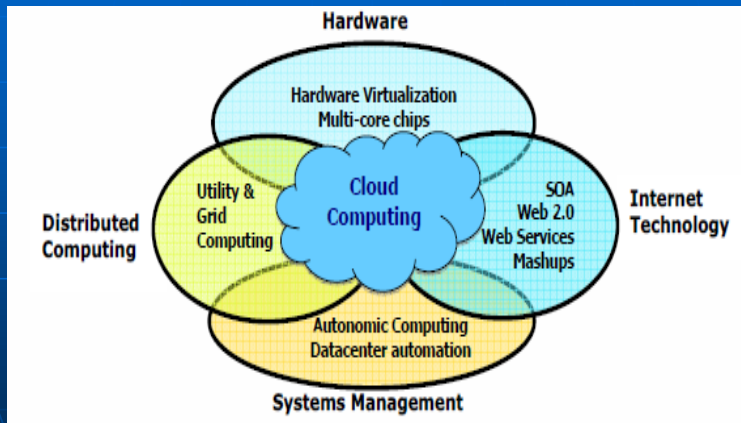
Datacenter and server cost distribution²



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Cloud Computing Enabling Technologies



(Courtesy of Judy Qiu, Indiana University, 2011)

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Cloud Computing $\approx$ 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)**

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High Performance Computing (Cray) at IPFW



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Cloud Computing $\approx$ 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

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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) Atomic computing and data center automation

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Cloud Computing: 101 Basic Concept of Internet Clouds



Source: Distributed and Cloud Computing, by K. Hwang, G C. Fox, and J.J. Dongarra, published Elsevier/Morgan Kaufmann, 2012.

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Berkeley NOS (Network of Workstations) Project

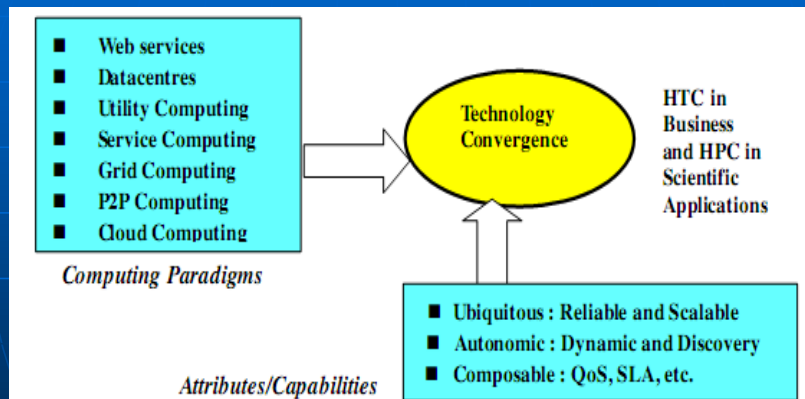
- Clustered machines connected via high-speed switched networks, 1995, <http://now.cs.berkeley.edu/>
- NOW-2 (1997) 105 Ultra-1 workstations
- Each with a 167 MHz UltraSPARC Microprocessor, 128 MB of memory, and 2 Seagate Hawk 2 GB 5400 RPM 3.5 inch disks
- Myrinet switch system area network with each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



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Cloud Computing $\approx$ Scalable Internet-based Computing

- HPC for Science and HTC for Business Applications

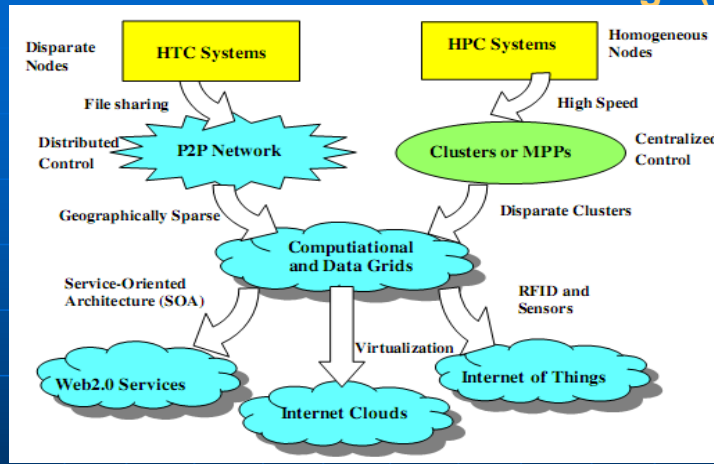


(Courtesy of Raj Buyya, University of Melbourne, 2011)

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Cloud and Internet of Things (IoT)



HPC: High-Performance Computing

HTC: High-Throughput Computing

P2P: Peer to Peer

MPP: Massively Parallel Processors

Source: K. Hwang, G. Fox, and J. Dongarra, *Distributed and Cloud Computing*, Morgan Kaufmann, 2012.

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The NIST Cloud Computing Services Definitions⁴

- “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.”

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The NIST Cloud Computing Definitions⁴ (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 Services²

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

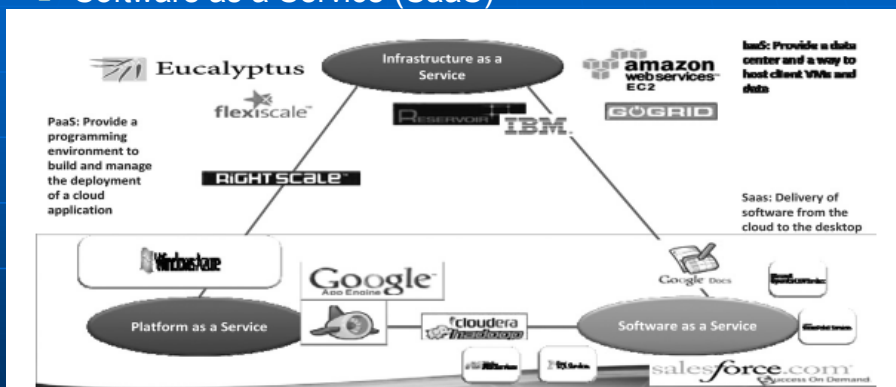


FIGURE 1.19

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

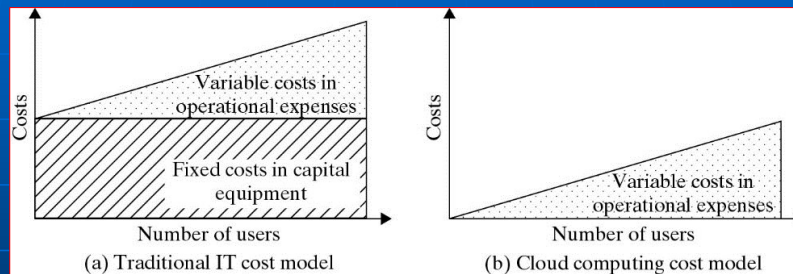
(Courtesy of Dennis Gannon, keynote address at Cloudcom2010 [19])

Cloud Computing Challenges: Dealing with too many issues (courtesy of R. Buyya)



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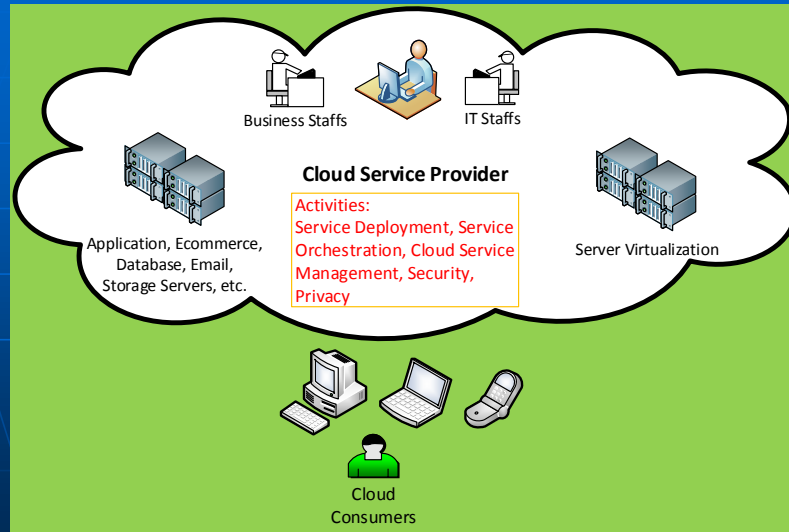
Cost Models: Traditional IT vs. Cloud Computing²



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Cloud Computing Services



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Worldwide Public Cloud Service Forecast³

Types of Cloud Services	2015	2015 Growth (%)	2016	2016 Growth (%)
Cloud business process services (Bpass)	39.2	2.7	42.6	8.7
Cloud application services (SaaS)	31.4	15.5	37.7	20.3
Cloud application infrastructure services (PaaS)	3.8	16.1	4.6	21.1
Cloud system infrastructure services (IaaS)	16.2	31.9	22.4	38.4
Cloud management and Security Services	5.0	20.7	6.2	24.7
Cloud Advertisement	79.4	15.4	90.3	13.6
Total Market	175.0	13.7	203.9	16.5

First Movers in Public Cloud

- Amazon
- Google
- Microsoft

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Transparent Cloud Computing Environment²



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

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Cloud Computing Benefits

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

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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

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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

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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)

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SaaS for Construction Industry

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

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- **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 ..

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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
- Sage, <http://www.sage.com/us>

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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
- Corecon V7, <http://www.corecon.com/products/coreconv7>

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SaaS for Construction Industry

- File sharing, Cloud Backup:

- Box
- ShareFile
- Google Drive
- DropBox

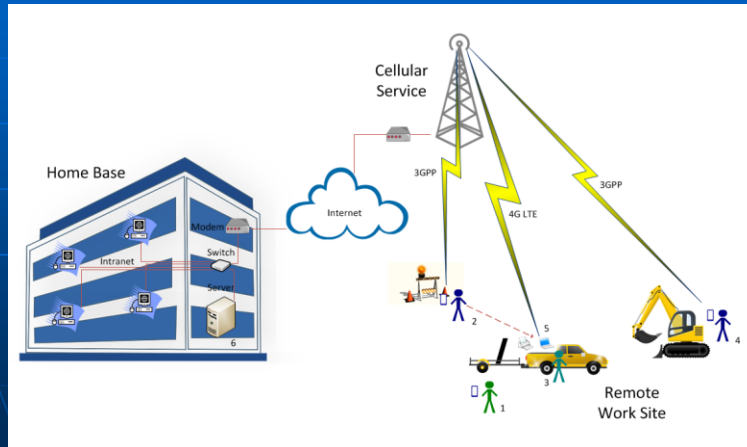
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Cloud Project Example 1

- 1. Mobile Technology Evaluation, Assessment, and Planning for a Construction Company, prepared by Prof. P.I. Lin, Jan. 16, 2016
- The XYZ Construction Inc., (located in Fort Wayne, Indiana) with less than 100 employees is in the business on high way 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

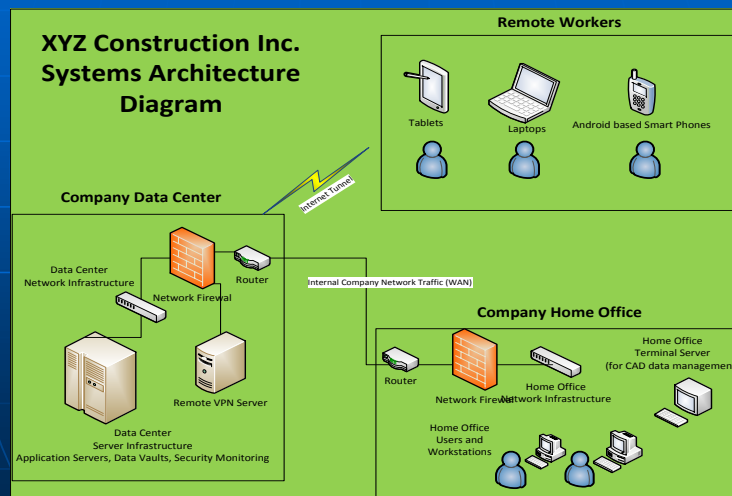


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Mobile Technology Evaluation, Assessment, and Planning for a Construction Company

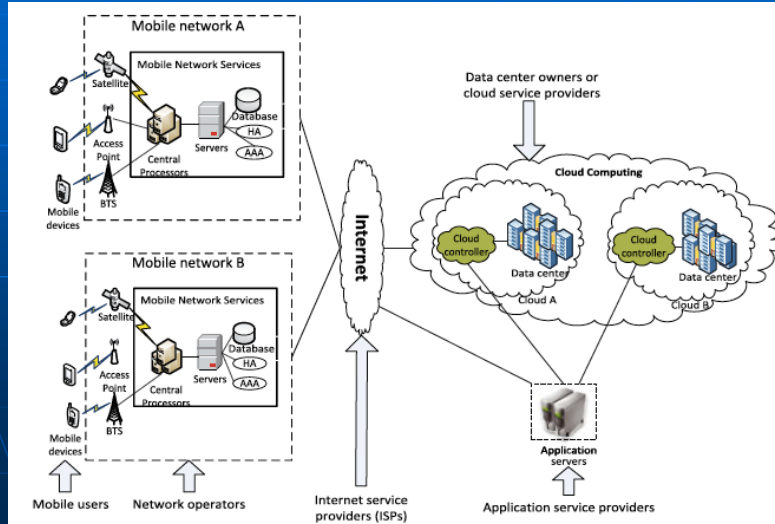
- Proposed system drawing by Kurt Bender & Aungar Long, CPET 565 Mobile Computing Technology



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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

- 2. Enterprise Mobility Pilot Project: Safety, Health, and Productivity Monitoring using Smart Wearable Device, prepared by Prof. P.I. Lin, Feb. 23, 2016
- 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

- **2. Enterprise Mobility Pilot Project: Safety, Health, and Productivity Monitoring using Smart Wearable Device**, prepared by Prof. P.I. Lin, Feb. 23, 2016
- 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.

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Other Cloud Project Examples

- “Design and Evaluation of Hybrid Wire and Wireless Sensor Networks with Cloud Services for Monitoring of Early-Stage Environmental Corrosion,” by Paul I. Lin**, Max. Yen**, Dong Chen**, Richard Lampo*, Michael McInenerny*, and Jerry Ryan*, International Computer Symposium, Taiwan, Dec. 14, 2014
- “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
- “Data Security Issues in Cloud Computing,” MS. Directed Project by Vicky Hogge, Advisor Paul Lin May 2012

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- **“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
- **“An Evaluation of Document Management and Business Process Improvement Using Cloud Computing,”** MS. Directed Project by Kevin Locascio, Advisor Paul Lin, May 2013

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Other Cloud Project Examples

- **“Design Issues for Electronics Health Record Using Cloud Computing Technologies,”** MS. Directed Project by Sayed Nayab Hassan, Advisor Paul Lin, May 2013
- **“Cloud Computing Adoption Concerns and Challenges,”** MS. Directed Project by Hemchand Lallad, Advisor Paul Lin, Oct. 2013
- **“Radical Standardization Approach in Cloud Computing,”** MS. Directed Project by Stephen Chike Obioma, Advisor Paul Lin, Oct. 2013
- **“Data Security Issues in Cloud Computing,”** MS. Directed Project by Vicky Hogge, Advisor Paul Lin May 2012

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MS Technology Course Projects

- **“Microsoft Office 365 for Enhancing Engineering Design Collaboration and Service Productivity – A SaaS Example”, by Stephen C. Obioma and Luis Morales, Course Project** for CPET 581 Cloud Computing: Technologies and IT Strategies, Course Instructor, Paul Lin, May 9 2013
- **“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

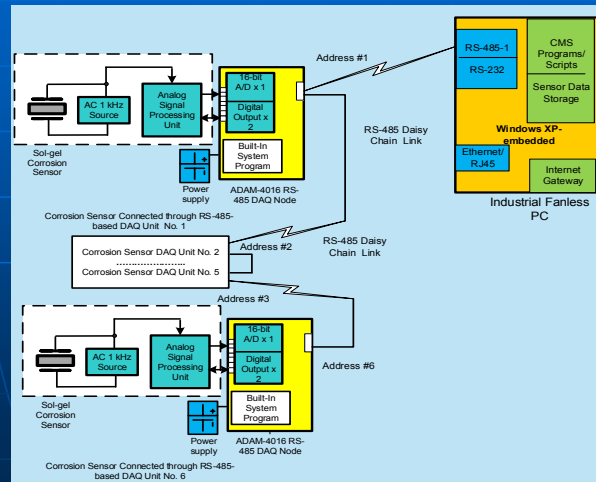
- **“Design and Evaluation of Hybrid Wire and Wireless Sensor Networks with Cloud Services for Monitoring of Early-Stage Environmental Corrosion,”** by Paul I. Lin**, Max. Yen**, Dong Chen**, Richard Lampo*, Michael McInenerny*, and Jerry Ryan*, International Computer Symposium, Taiwan, Dec. 14, 2014

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

****U.S. Army Construction Engineering Research Laboratory**

Other Cloud Project Examples

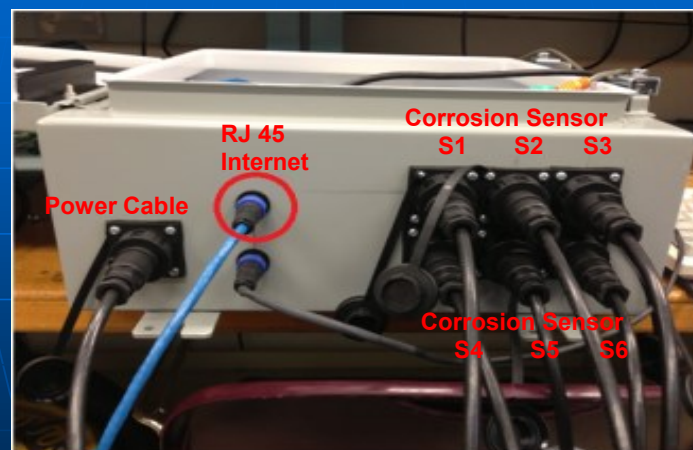
- Design and Evaluation of Hybrid Wire and Wireless Sensor Networks with Cloud Services for Monitoring of Early-Stage Environmental Corrosion



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Corrosion Monitoring Sensor System

Packaging and Cabling



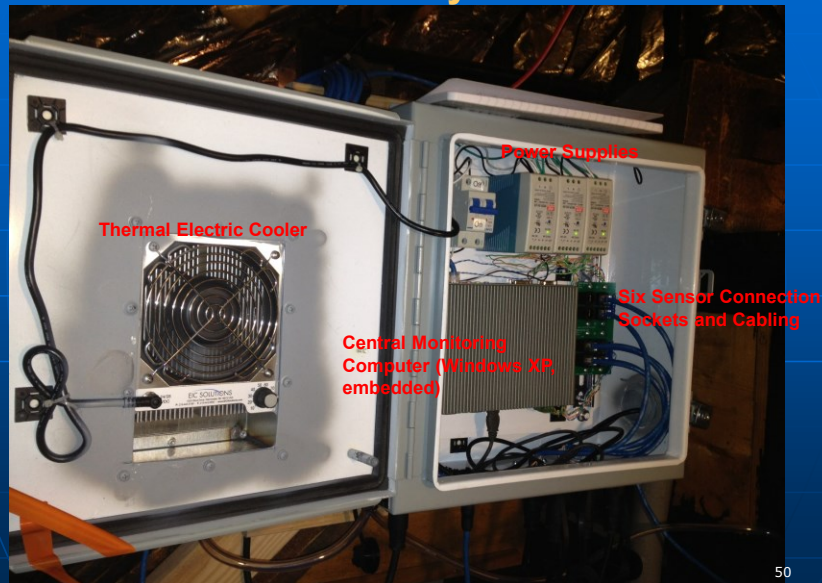
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Corrosion Monitoring Sensor System – Installation (May 2013)



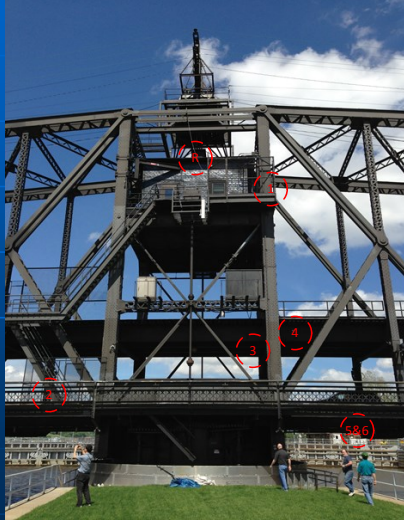
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Corrosion Monitoring Sensor System Installation – May 2013



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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)

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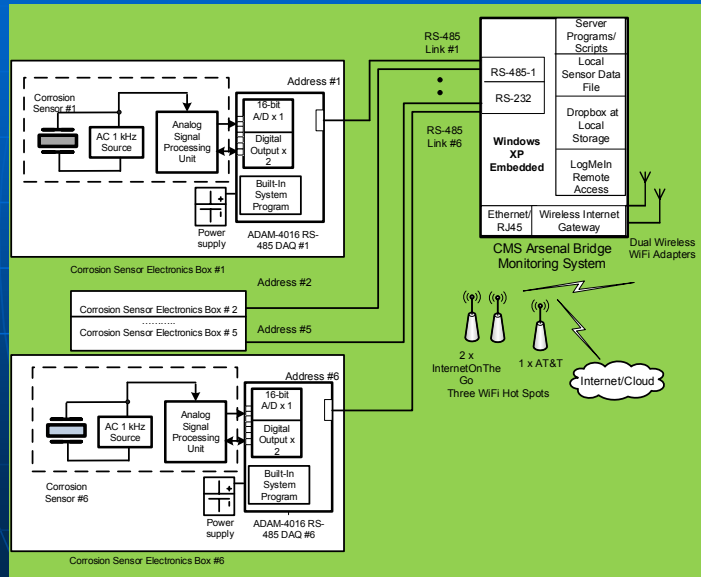
References

- [1] Greenberg, J. Hamilton, D. Maltz, and P. Patel, "The Cost of a Cloud: Research Problems in Data Center Networks," <http://research.microsoft.com/en-us/um/people/dmaltz/papers/DC-Costs-CCR-editorial.pdf>
- [2] K. Hwang, G. C. Fox, and J. J. Dongarra, ***Distributed and Cloud Computing***, by Morgan Kaufmann Publishers, www.mkp.com, 2012; **Text book** of CPET 581 Cloud Computing: Technologies and Strategies, Spring 2015, <http://www.etcs.ipfw.edu/~lin/CPET581-CloudComputing/2015-Spring/cpet581-CloudComputing-Homepage-2015S.html>
- [3] Gartner Says Worldwide Public Cloud Service Forecast to Reach \$204 Billion in 2016, <http://www.gartner.com/newsroom/id/3188817> : IaaS will remain the fastest-growing segment, SaaS to continue to have strong growth
- [4] NIST Definition of Cloud Computing, Special publication 800-145, by Peter Mell and Timothy Grance, Sept., 2011, U.S. Dept. of Commerce, <http://www.nist.gov/itl/csd/cloud-102511.cfm>

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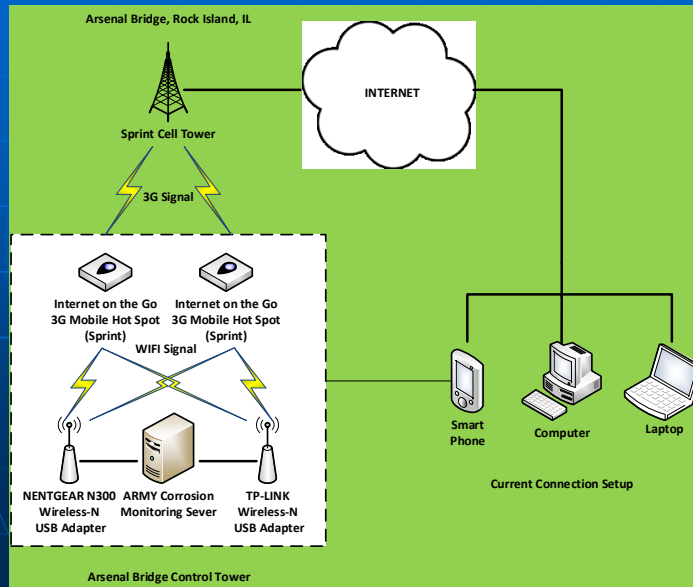
The Corrosion Monitoring System – Oct. 31, 2014



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CMS Networking and Communication Subsystem

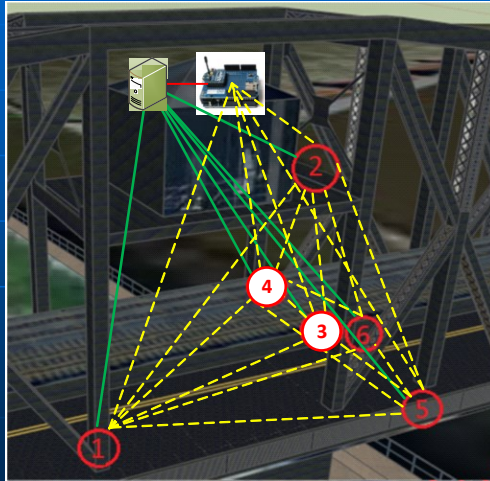
Redundant WiFi Hotspots and LAN Adapters



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Second Generation CMS System: Wired & Wireless Sensor Nodes and Network

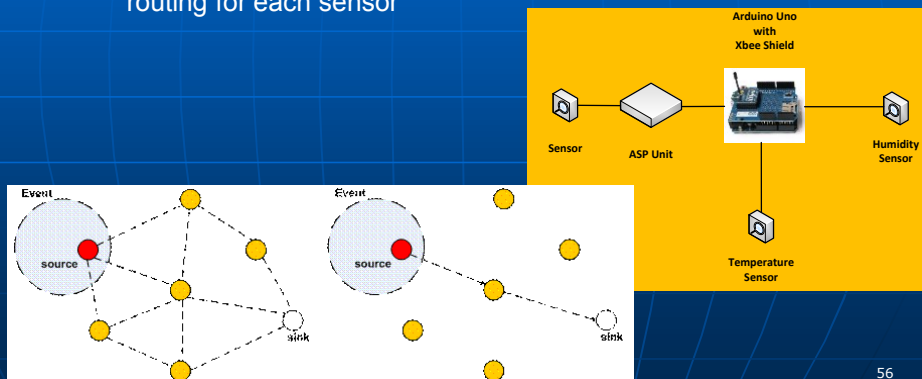
- Wired Star Network: RS-485, Wireless Mesh Network



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Second Generation CMS System: Wired & Wireless Sensor Nodes and Networks

- 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



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Summary & Conclusion

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