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1. History of Computing
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History of Computing

- **Main Frame**
  - 1980

- **Client-Server**
  - 1990

- **Web Computing**
  - 2000

- **Clouding computing**
  - 2010

Revising a bad tube meant checking among ENIAC's 19,000 possibilities.
The Evolution of Computing

ENIAC - Electronic Numerical Integrator and Computer

1946 the World’s 1st General Purpose Computer
History of Computing

- Mainframe
- Technology & network
- Internet
- Client server
- Personal
- Mainframe

Increasing business ability

Time

- Business-driven
- Web 2.0
- Virtualization

- Cloud Computing
- Utility computing
- Network computing
- Grid computing
- Web services
We already live in Cloud world!
“Cloud computing is 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.”

Source: NIST 2009
Why Cloud Computing?

“CLOUD COMPUTING”

On-demand Outsourcing

“Pay-as-You-Go”
Why Cloud Computing?

Benefits of Cloud Computing?

Private Car

Rental or Public Vehicle

Cheap Price

Easy-to-use

Pay-as-you-go

Whatever-you-want

Buying it with expensive price

Just Rental with cheap price
Why Cloud Computing

Benefits of Cloud Computing

- **Reduced Cost**
  - Cloud technology is paid incrementally, saving organizations money.

- **Increased Storage**
  - Organizations can store more data than on private computer systems.

- **Highly Automated**
  - No longer do IT personnel need to worry about keeping software up to date.
Why Cloud Computing

Benefits of Cloud Computing

- **Flexibility**
  - Cloud computing offers much more flexibility than past computing methods.

- **More Mobility**
  - Employees can access information wherever they are, rather than having to remain at their desks.

- **Allows IT to Shift Focus**
  - No longer having to worry about constant server updates and other computing issues, government organizations will be free to concentrate on innovation.
# Cloud Today

Government is Moving to the Cloud

<table>
<thead>
<tr>
<th>Federal</th>
<th>State</th>
<th>Local</th>
<th>Non-profit</th>
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<td>Department of Defense</td>
<td>New York State</td>
<td>Arlington VA</td>
<td>Chicago Housing Authority</td>
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<td>Homeland Security</td>
<td>NJ Transit</td>
<td>Wyoming Bus. Council</td>
<td>City of Littleton</td>
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<td>NASA</td>
<td>DIR</td>
<td>METROLINK</td>
<td>American Red Cross</td>
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<td>U.S. Department of State</td>
<td></td>
<td>North Carolina</td>
<td>United Way</td>
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<td>FSA San Francisco</td>
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<td></td>
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<td>Katrina List.net</td>
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Cloud Today
Across Segments

- Economic Development
- Environment & Natural Resources
- Transportation
- General Government
- Public Safety & Justice
- Health & Human Services
- Science & Tech
- Education
Cloud Today
Promising Technologies

<table>
<thead>
<tr>
<th>Technologies You Can't Afford to Ignore</th>
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<tr>
<td><strong>Top 10 Strategic Technology Areas for 2009</strong></td>
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<td>1. Virtualization ..........................</td>
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<td>2. Business Intelligence ..............</td>
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<td>3. Cloud Computing .....................</td>
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<td>4. Green IT ...............................</td>
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<td>5. Unified Communications ..........</td>
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<tr>
<td>6. Social Software and Social Networking ........................................</td>
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<tr>
<td>7. Web-Oriented Architecture ..</td>
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<td>8. Enterprise Mashups ...............</td>
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<tr>
<td>9. Specialized Systems ..........</td>
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<td>10. Servers — Beyond Blades .......</td>
</tr>
<tr>
<td><strong>Top 10 Strategic Technology Areas for 2010</strong></td>
</tr>
<tr>
<td>1. Cloud Computing</td>
</tr>
<tr>
<td>2. Advanced Analytics</td>
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<tr>
<td>3. Client Computing</td>
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<td>4. IT for Green</td>
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<td>5. Reshaping the Data Center</td>
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<td>6. Social Computing</td>
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<tr>
<td>7. Security — Activity Monitoring</td>
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<tr>
<td>8. Flash Memory</td>
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<tr>
<td>9. Virtualization for Availability</td>
</tr>
<tr>
<td>10. Mobile Applications</td>
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</tbody>
</table>

Source: Gartner (July 2009)
Cloud Today
Market Expectation

More than 30% growth

World CC Market

2008
590
CAGR 34.2%

2013
2,563

(100 M$)

Korea CC Market

2008
19,525

4,773
CAGR 32.5%

2013

(100M WON)


Cloud Today

Basic CC Models

- Infrastructure as a Service
- Platform as a Service
- Service as a Service

Applications Built by The cloud consumers

Services Provided by the Cloud

Cloud Today

Expansion of CC Models

**SaaS** – Service as a Service

**PaaS** – Platform as a Service

**IaaS** – Infrastructure as a Service

**BPaaS** – Business Process as a Service

**APaaS** – Application Platform as a Service

**AIaaS** – Application Infrastructure as a Service

**DaaS** – Desktop as a Service

**NaaS** – Network as a Service

**CaaS** – Communication as a Service

Cloud Today

Cloud Provider – Service Orchestration

- Service Layer
  - SaaS
  - PaaS
  - IaaS

- Resource Abstraction and Control Layer
- Physical Resource Layer
  - Hardware
  - Facility

- Infrastructure as a Service
- Platform as a Service
- Software as a Service

Biz Process/Operations
Application Development
IT Infrastructure/Operation

Cloud Provider
Cloud Today

Cloud Provider – Cloud Service Management

Cloud Service Management

- Business Support
  - Customer Mgmt
  - Contract Mgmt
  - Inventory Mgmt
  - Accounting & Billing
  - Reporting & Auditing
  - Pricing & Rating

- Provisioning /Configuration
  - Rapid Provisioning
  - Resource Change
  - Monitoring & Reporting
  - Metering
  - SLA Management

- Portability /Interoperability
  - Data Portability
  - Copy Data To-From
  - Bulk Data Transfer
  - Service Interoperability
  - Unified Management Interface
  - System Portability
  - VM Images Migration
  - App/Svc Migration

Cloud Consumers

Cloud Brokers
Cloud Today

The Combined Conceptual Reference Diagram
### Cloud Today

#### Available Solutions

<table>
<thead>
<tr>
<th>Network Device Layer</th>
<th>Kindle</th>
<th>Android</th>
<th>Win Mo</th>
<th>J2ME</th>
<th>IPAQ</th>
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<tr>
<td>SaaS</td>
<td>Alexa</td>
<td>Google Apps</td>
<td>Live</td>
<td>Java Consumer Space</td>
<td>Partner Strategy</td>
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<tr>
<td>PaaS</td>
<td>Simple DB</td>
<td>APP Engine</td>
<td>Azure</td>
<td>Caroline</td>
<td>Web Sphere Potential</td>
</tr>
<tr>
<td>IaaS</td>
<td>EC2, S3</td>
<td>APP Engine</td>
<td>Azure</td>
<td>Caroline</td>
<td>On Demand</td>
</tr>
<tr>
<td>Bare Metal, People Process based, Hardware Provisioning</td>
<td>Amazon, Google, Microsoft, Sun Micro, IBM, HP, Salesforce.com</td>
<td></td>
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</tbody>
</table>

Ref.: A Walk in the Clouds - Niraj Juneja (webscale solution)
Cloud Today

Cloud Deployment Models

Emerging Cloud
Mobile cloud

- How to develop Mobile Cloud App?
- How to reuse the resources on Mobile Device?
Emerging Cloud
Media cloud

Multimedia processing in a cloud
- Multimedia and service heterogeneity
- QoS heterogeneity
- Network heterogeneity
- Device heterogeneity

CPU: Central Processing Unit, GPU: Graphic Processing Unit

Emerging Cloud
Moving to the media cloud

A shift to the edge
- the shift of intelligence away from the network core and toward the network edge
- a similar movement of storage and some functionality away from the home and toward the network edge.

Ref) HP, “Moving to the Media Cloud” November 2010
Emerging Cloud
Trend of CC: context-aware computing

Precontext

Simple, Closed, Targeted & Isolated

Complex, Open, Federated & Interoperable

Presence, Personalization
Ad-serving
Reactive

2010

2011-2013

2014-2018

Location, social network
Identity management
Simple augmented reality
Simple proactive alerts
Adjacent devices, people

Complex context brokers
Context-enriched content
Context delivery architecture
Complex anticipatory behavior
Ensemble programming,
Conclusions and Recommendations

**Advantage:**
- Improved performance
- Reduced software costs
- Lower computer costs
- Instant software updates
- Unlimited storage capacity
- Increased data reliability
- Universal access (services & applications)
- Easier group collaboration
- Device independence

**Disadvantage:**
- Requires a constant Internet connection
- Requires Broadband Infrastructure
- Can be slow & Features might be limited
- Stored data might not be secure and lost
Conclusions and Recommendations

No unique single solution and business model
Identify objectives and proper position
Multimedia Storage Requirements

Real-time Storage and Retrieval

- Recording
  - CM recording devices generate continuous stream of media quanta that must be stored in realtime.
- Playback - Reverse operation of recording
  - Media Quanta must be presented using the same timing sequence with which they were captured.

High Data Transfer Rate and Large Storage Space

- HDTV quality - 81Mbytes/sec
- NTSC quality - 27Mbytes/sec
Cloud Options for Multimedia Application

- **Microsoft AZURE**
  - Blob Storage Server
  - Table Storage Server
  - SQL database Server

- **Amazon RDS (Relational Database Service)**
  - https://aws.amazon.com/rds/
Buffering Strategies in Client Server Systems

- In client-server systems
  - flow of information is from server to client
  - In any application, preset movement of media streams as application progresses with execution
  - There is always a window available to plan movement of further bits
    - At any point in execution, the number of bits in transit equals the buffer size at the client plus the bits equivalent of the channel, in between the client and server.

- Buffer management strategies
  - balance the bits in transit (buffer size and bits in channel)
  - can be fixed (non-adaptive) or dynamic (adaptive)
Increasing Server Capacity

**Batching**
- Group clients requesting the same video object that arrive within a short duration of time or use adaptive piggybacking

**Caching**
- **Interval Caching**
  - Exploits sequential nature of MM access
  - Cache only interval between temporally spaced clients
  - Order the intervals based on increasing space, smaller interval implies smaller time to reaccess.
- **Frequency Caching**
  - 80-20 rule for video accesses
  - Cache most frequently accessed video objects
  - Large buffer required
  - Not dynamic - based on past history, future estimates