



Cloud Computing: Technology and Implementation

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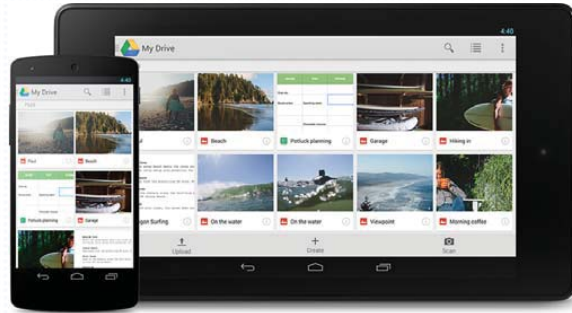
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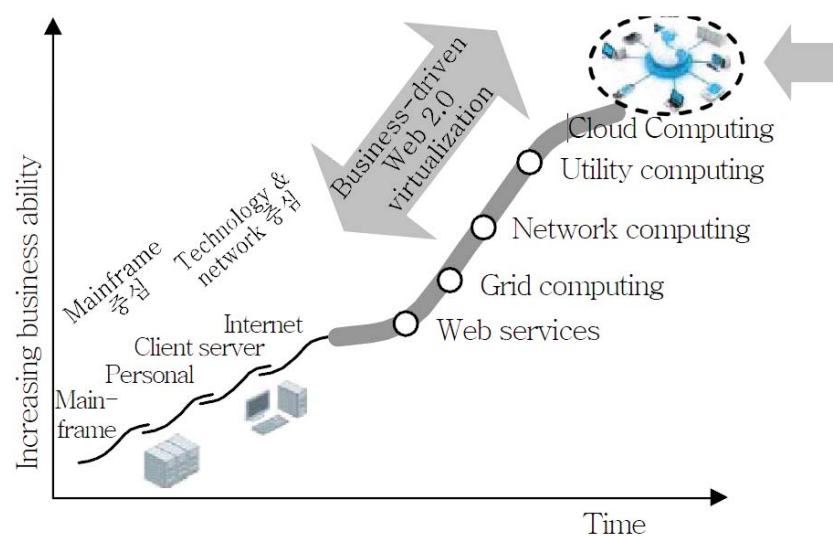
Intuitive Understanding on Cloud Computing

- Delivery of computing service over the Internet
 - Cloud can provide services over network
- Instead of running an e-mail program on your computer, you log in to a Web e-mail account remotely
- The software and storage for your account does not exist on your computer, but they are on the cloud
- Distributed computing on Internet
 - Cloud is something, which is present at remote location

Why Cloud Computing?

- No need to buy software and the computing power
- Cloud service providers that have specialized in a particular service can bring advanced services that an individual company might not be able to afford or develop
- Scalability, reliability, and efficiency
 - Whenever the user wants, he/she could expand the storage or the computing power
 - Information at cloud are not easily lost
 - The user could expect the quality of service at the reasonable cost

History on Information Technology (1)

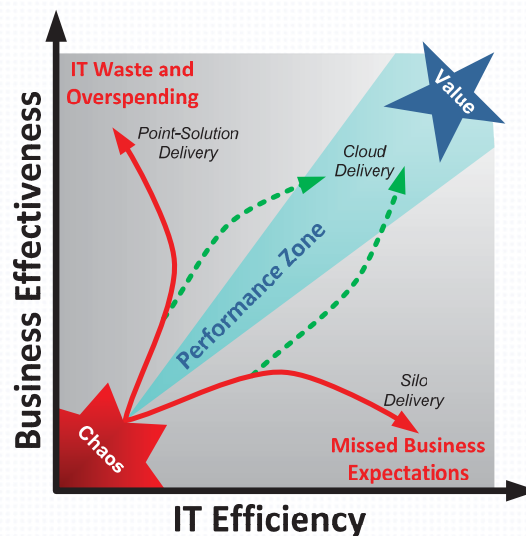


History on Information Technology (2)



Management Backgrounds on Cloud Computing

- *Outsourcing*
- Cost management: Business effectiveness vs. IT efficiency



Technical Backgrounds on Cloud Computing

- **Internet**
 - We could access anything remote any time in a reliable manner
- **Software technology**
 - We could provide any service on local device using remote resources as if they are local
- **Hardware pools**
 - We could maintain a pool of hardware resources which are always available

Definition of Cloud Computing

From NIST Definition of Cloud Computing
<http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc>

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.

인터넷 기술을 기반으로 기업, 공공기관, 개인과 같은 외부 사용자에게 IT로 구현된 ‘as a service’로 제공되는 컴퓨팅 환경

패러다임의 변화 (1)

전기산업 사례

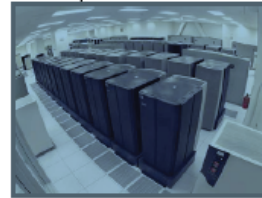
Burden Iron Works



Edison Power Plant & Power Grid

정보산업 사례

Corporate Data Center



Cloud Computing Center & Internet

패러다임의 변화 (2)

컴퓨팅 자원 소유 방식의 변화

기업내 IT 자원 및
서비스의 아웃소싱 확대

분업화와 규모의
경제 실현

인터넷 기반의 서비스 변화

소프트웨어와 콘텐츠의
온라인 서비스화

초고속망을 통한 안정적인
서비스 전송가능



데이터 센터

서비스
통합 플랫폼

유/무선
통합 인프라

사용자 편의 중심의
서비스 제공

Cloud computing

Cloud Computing의 특징

Common Characteristics:

Massive Scale

Resilient Computing

Homogeneity

Geographic Distribution

Virtualization

Service Orientation

Low Cost Software

Advanced Security

Essential Characteristics:

On Demand Self-Service

Broad Network Access

Rapid Elasticity

Resource Pooling

Measured Service

Cloud Computing의 특징

- **On-Demand Self Service**
 - 서비스를 원하는 시점에 서비스를 제공 받음
- **Broad Network Access**
 - 시간과 장소에 구애받지 않고 네트워크 기반으로 서비스에 접속 가능
- **Rapid Elasticity**
 - 빠른 시간내의 필요에 따른 자원의 확장과 감소에 대한 처리 가능
- **Resource Pooling**
 - 물리적 자원이나 가상화된 자원을 pool로 관리
 - 자원의 물리적인 위치, 크기 등에 대한 추상화
- **Commodified Measurable Service**
 - 자원의 사용에 대한 정보 모니터링 및 수집
 - 사용자에게 대한 과금정책, 자원에 대한 추가 요청 대처

Advantages of Cloud Computing

- Lower computer costs
- Improved performance
- Reduced software costs
- Instant software updates
- Improved document format compatibility
- Unlimited storage capacity
- Increased data reliability
- Universal document access
- Latest version availability
- Easier group collaboration
- Device independence

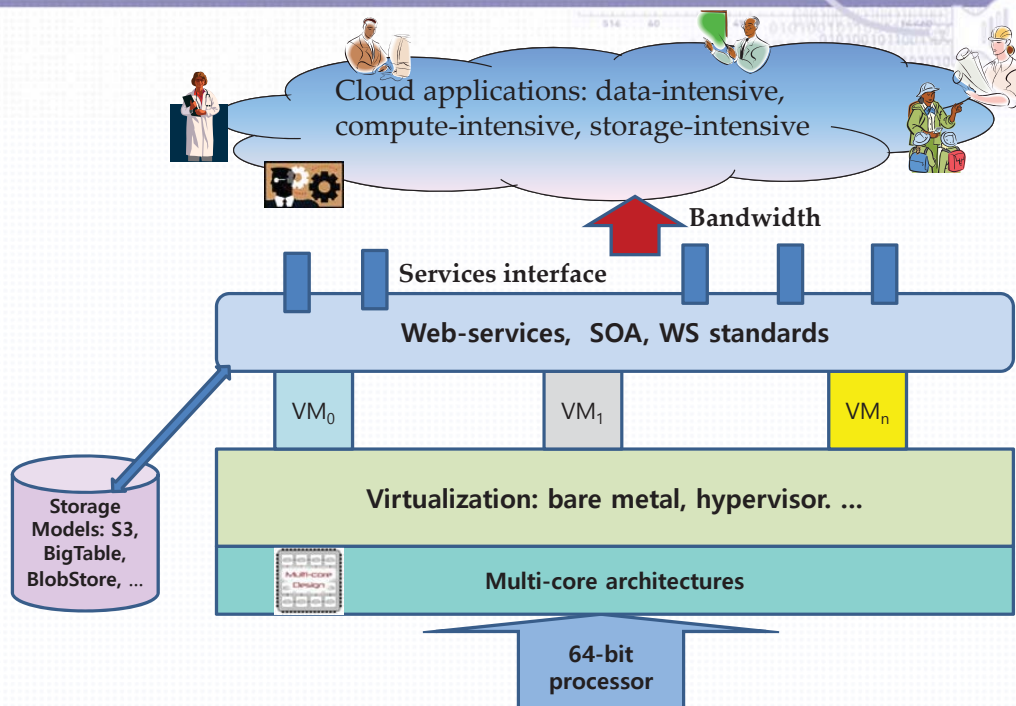
Disadvantage of Cloud Computing

- Requires a constant and fast Internet connection
 - Does not work well with low-speed connections
- Features might be limited
- Can be slow
- Stored data can be lost
- Stored data might not be secure

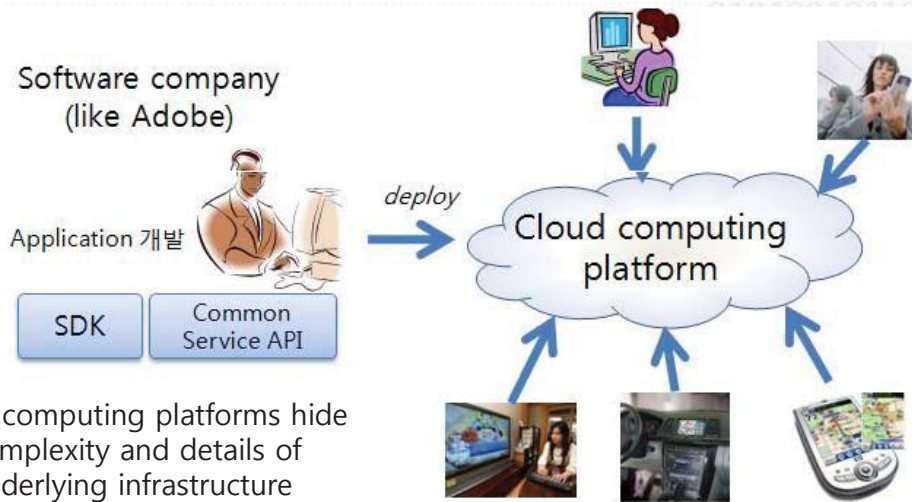
Cloud Components

- **Client computers**
 - Device that the end user interact with cloud
 - Mobile, Thick or thin device
- **Distributed servers**
 - Servers are in geographically different places
 - But servers act as if they are working next to each other
- **Datacenters**
 - Collection of servers where application is placed and is accessed via Internet

Enabling Technologies

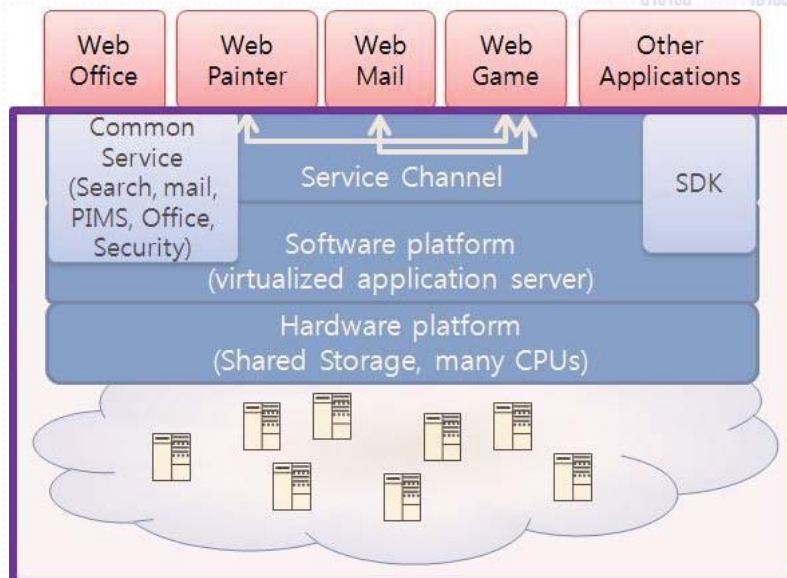


Cloud Computing Platform



Cloud computing platforms hide the complexity and details of the underlying infrastructure from users and applications by providing very simple graphical interface or API.

Cloud Computing Platform

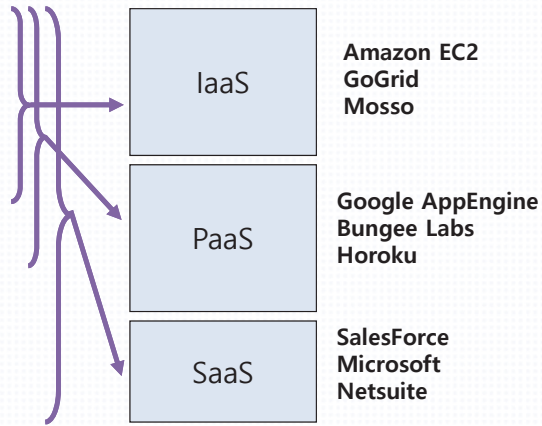


Classification

Mehta's 11 Layers + Robert Anderson's 3 Layers

1. Facilities (space, power, cooling)
2. Network
3. Hardware (e.g. Servers)
4. Hardware Virtualization (e.g. Xen)
5. O/S (e.g. Linux)
6. System Management
7. Application Middleware
8. Application Code
9. Application API
10. GUI for Application
11. GUI for Application Development

Mehta's 11 Layers

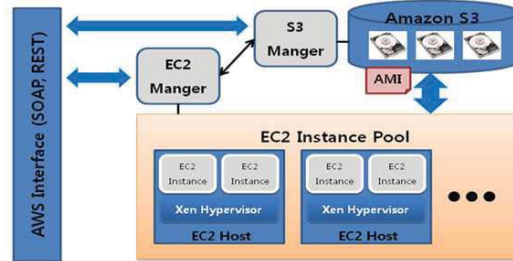
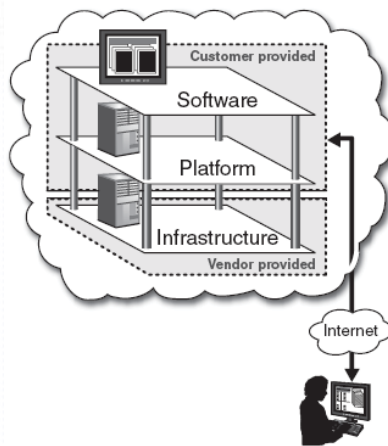


Robert Anderson's 3 Layers

Service Model

- Reference models on which the cloud computing is based
- **IaaS (Infrastructure as a Service)**
 - Provides access to fundamental resources such as physical machine, virtual machines, virtual storage, et al
- **PaaS (Platform as a Service)**
 - Provides the runtime environment for applications, development and deployment tools, et al
 - Provides all of the facilities required to support the complete life cycle of building and delivering web applications and services entirely
- **SaaS (Software as a Service)**
 - Provides licensed multi-tenant access to software and its functions remotely as a web-based service

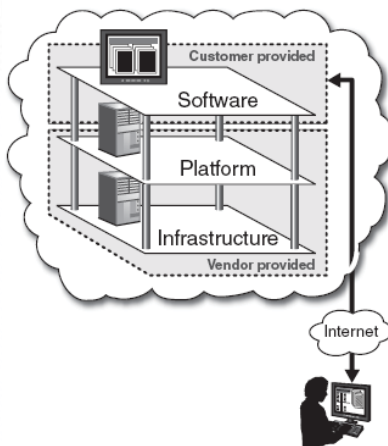
Infrastructure as a Service – Virtual Servers



- ✓ On-demand provisioning
- ✓ Standard "server" behavior
- ✓ Elastic resource assignments
- ✓ Metered usage
- ✓ High availability

- ⊗ Few unstructured or many homogeneous servers
- ⊗ Hard to manage many
- ⊗ No or limited network/storage infrastructure

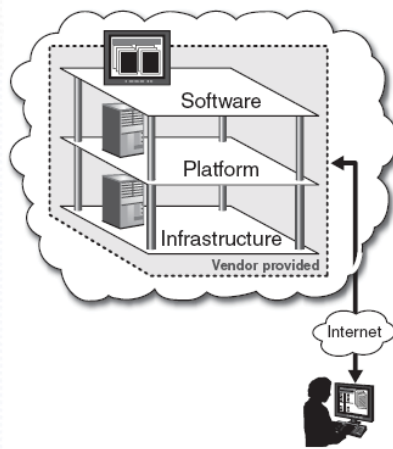
Platform as a Service – Ready Stacks



- ✓ Code + data → running service
- ✓ No infrastructure to manage
- ✓ Manual and automatic scaling
- ✓ Metered usage
- ✓ High availability

- ⊗ Limited stacks/options available
- ⊗ No control/visibility
- ⊗ "Good enough or not usable at all"

Software as a Service – Ready-to-use Apps



- ✓ Ready for use by consumer
- ✓ No infrastructure/code to deal with
- ✓ Instant one-step provisioning
- ✓ Safe code upgrade / rollback
- ✓ Automatic and manual scaling
- ✓ Built-in high availability

- ⊗ Fixed application functionality
- ⊗ No "one stop shop"
- ⊗ No control/visibility
- ⊗ Very limited customization

Old Story on Cloud Computing

The New York Times

- Cloud computing을 batch 작업에 적용
- 1851~1980년 사이의 1,100만건의 기사를 변환
 - TIFF 이미지 → PDF
 - 원본 TIFF 이미지 크기는 4 TB
 - 생성된 PDF 파일 크기는 1.5 TB
- Amazon EC2와 S3를 활용
 - 신규 장비 구입 불필요
 - Hadoop 플랫폼 활용
- 소요시간 및 경비
 - 24시간
 - \$600 for S3 (5.5 TB), \$240 for EC2 (100 instances)

Key Technical Issues

- 상시 접속할 수 있는 고속 네트워크 인프라 (**reliability**)
 - 사용자에게 안정적인 서비스를 상시 제공
 - 다양한 서비스를 실시간에 제공할 수 있도록 고속 전송 기술 필요
- Seamless computing을 실현하는 시스템 소프트웨어 기술 (**convenience**)
 - Local service와 같은 형태의 인터페이스 제공
 - 사용자에게 원격 자원을 투명하게 제공하기 위한 분산처리 기술 필요
- 보안 기술 (**security**)
 - 모든 작업이 온라인상으로 이루어지므로 보안의 중요성 증가
 - 시스템/서비스의 availability를 보장하기 위한 기술도 보안의 범주에 포함됨

Cloud Computing

“컴퓨터 네트워크는 이제 막 걸음마를 시작한 아기에 불과하다. 그렇지만 이것이 성장하면 우리는 ‘컴퓨터 유틸리티’의 확산을 통하여 전기나 전화기처럼 모든 가정과 사무실에서 서비스를 이용하게 되는 시대가 도래할 것이다.”

By Leonard Kleinrock (1969)