4. Cloud Computing (4/4)

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Agenda

- What is Cloud Computing ?
  - Different perspectives
  - Properties and characteristics
  - Benefits from cloud computing
- Service and deployment models
  - Three service models
  - Four deployment models

Infrastructure as a Service

Platform as a Service

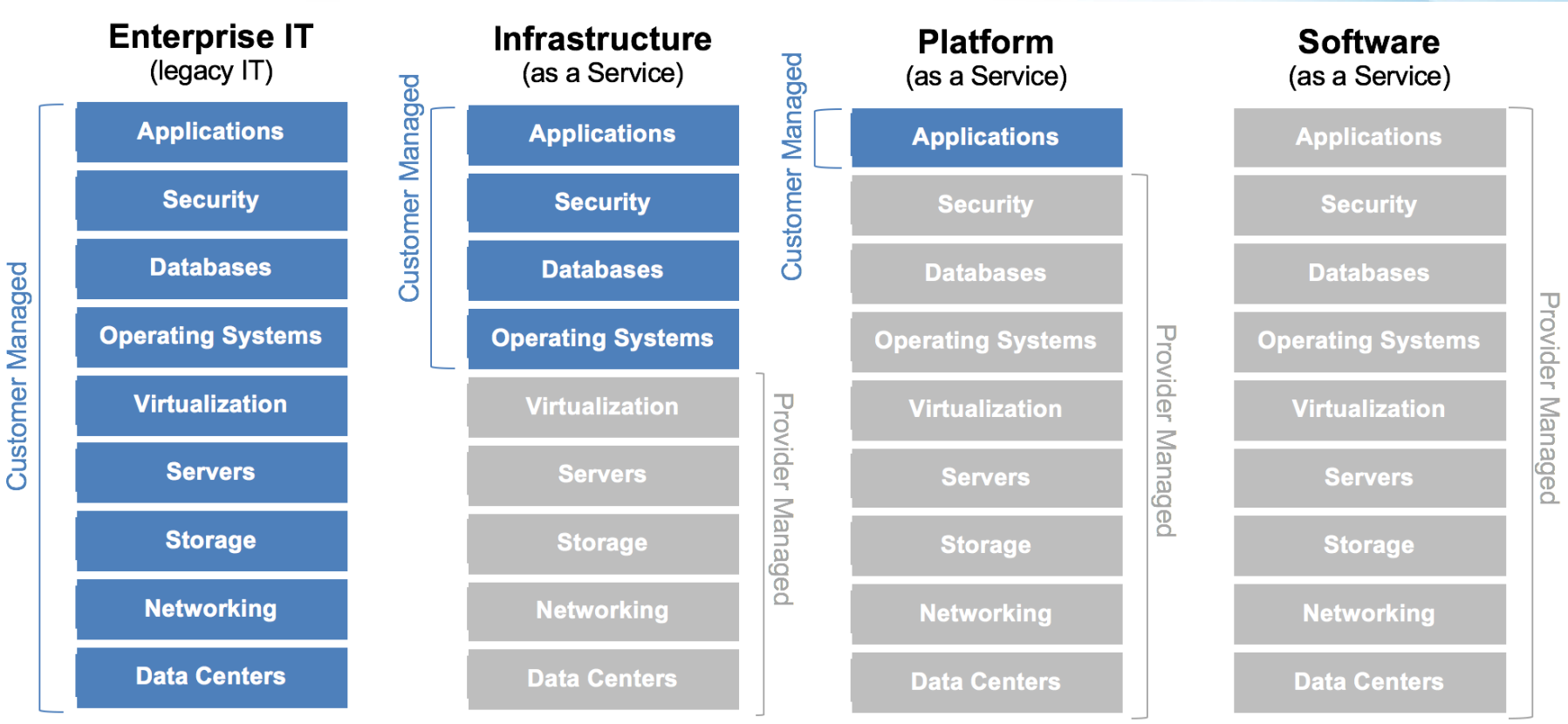
Software as a Service

SERVICE MODELS

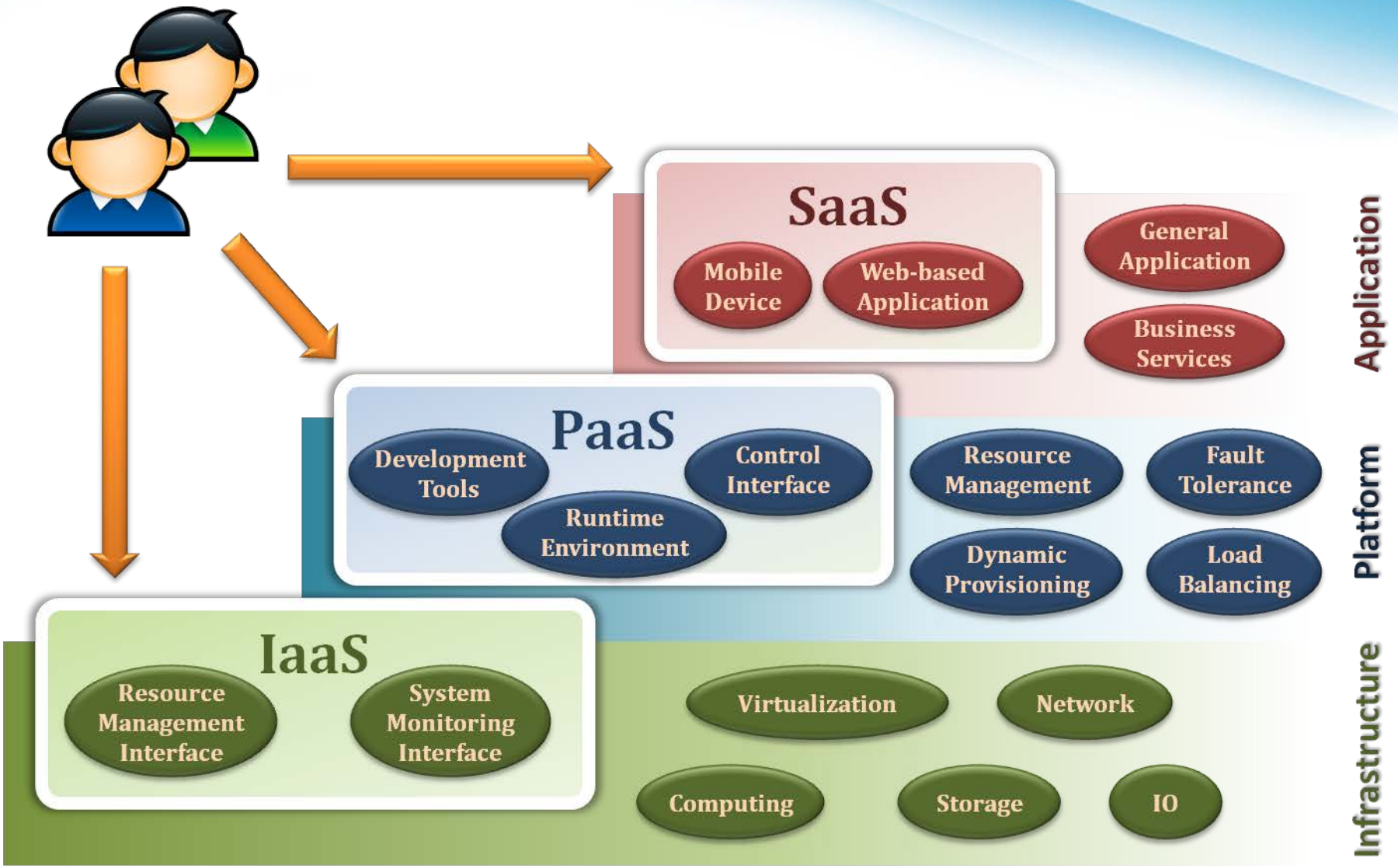
Service Models Overview

- What if you want to have an IT department ?
  - Similar to ***build a new house*** in previous analogy
    - You can rent some virtualized infrastructure and build up your own IT system among those resources, which may be fully controlled.
    - Technical speaking, use the ***Infrastructure as a Service (IaaS)*** solution.
  - Similar to ***buy an empty house*** in previous analogy
    - You can directly develop your IT system through one cloud platform, and do not care about any lower level resource management.
    - Technical speaking, use the ***Platform as a Service (PaaS)*** solution.
  - Similar to ***live in a hotel*** in previous analogy
    - You can directly use some existed IT system solutions, which were provided by some cloud application service provider, without knowing any detail technique about how these service was achieved.
    - Technical speaking, use the ***Software as a Service (SaaS)*** solution.

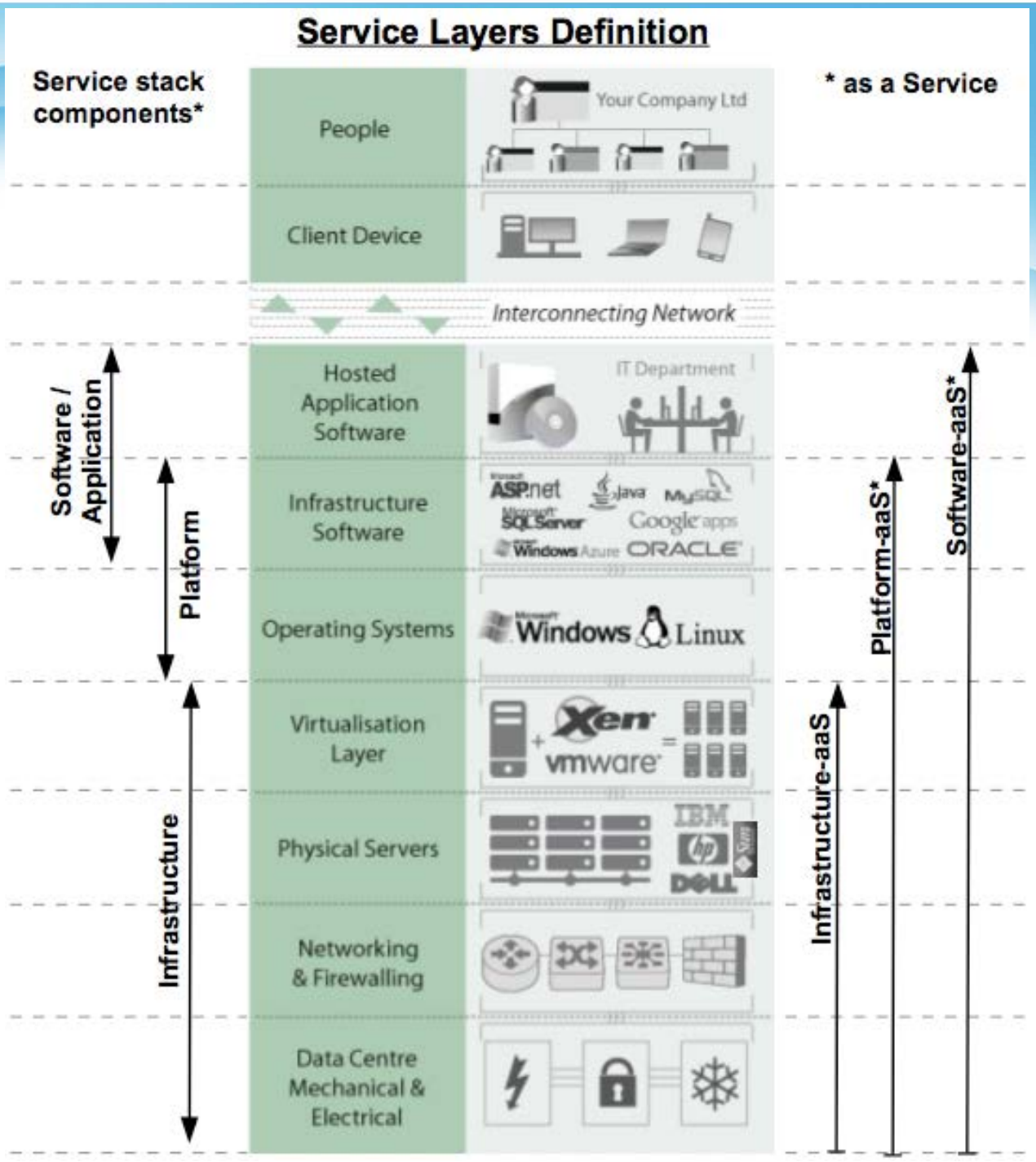
SW Stacks of Service Models



Service Model Overview



Service Layers Definition

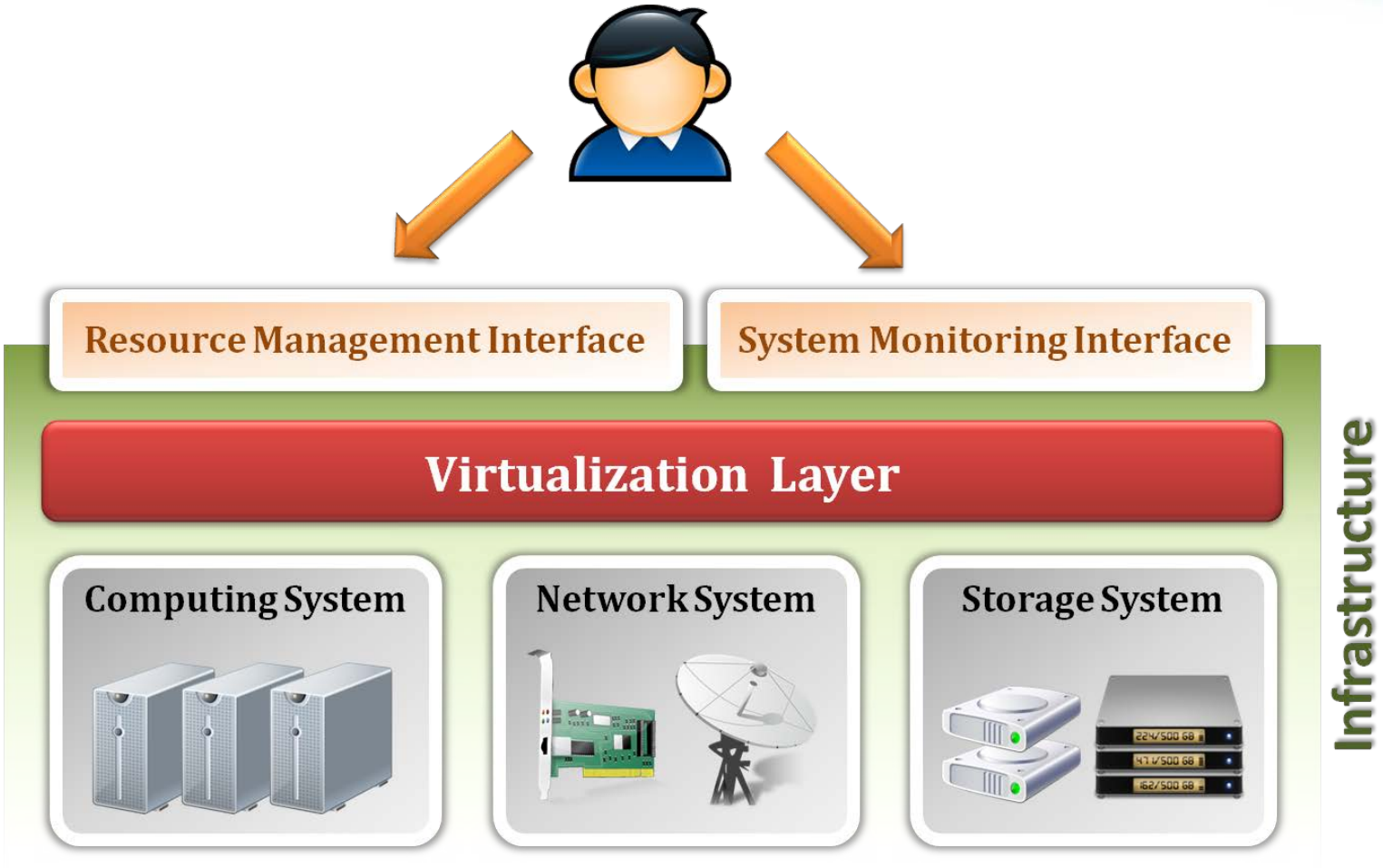


Infrastructure as a Service

- Infrastructure as a Service - IaaS
  - The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications.
  - The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components .
- Examples :
  - Amazon EC2
  - Eucalyputs
  - OpenNebula
  - … etc

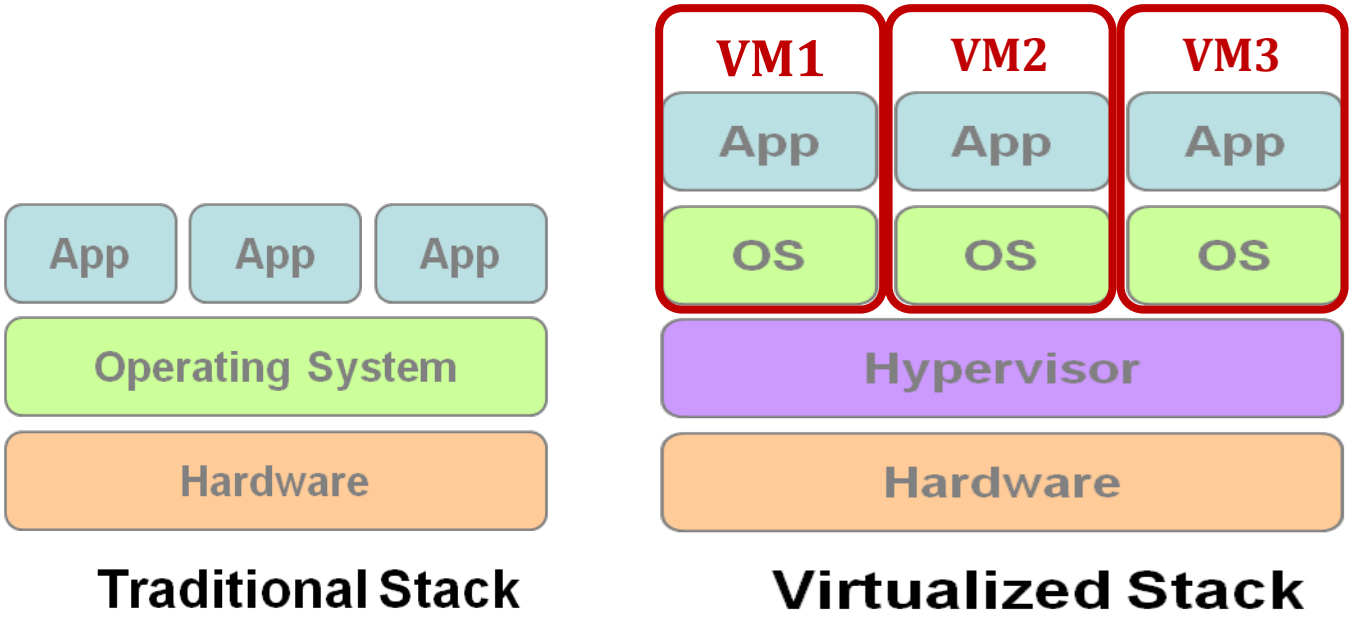
Infrastructure as a Service

- System architecture :



Infrastructure as a Service

- Enabling technique - ***Virtualization***
  - Virtualization is an abstraction of logical resources away from underlying physical resources.
    - Virtualization technique shift OS onto hypervisor.
    - Multiple OS share the physical hardware and provide different services.
    - Improve utilization, availability, security and convenience.



Infrastructure as a Service

- Properties supported by virtualization technique :
  - Manageability and Interoperability
  - Availability and Reliability
  - Scalability and Elasticity

Infrastructure as a Service

- Provide service **–Resource Management Interface**
  - Several types of virtualized resource :
    - ***Virtual Machine*** – As an IaaS provider, we should be able to provide the basic virtual machine operations, such as *creation*, *suspension*, *resumption* and *termination*, …etc.
    - ***Virtual Storage*** – As an IaaS provider, we should be able to provide the basic virtual storage operations, such as *space allocation*, *space release*, *data writing* and *data reading*, …etc.
    - ***Virtual Network*** – As an IaaS provider, we should be able to provide the basic virtual network operations, such as *IP address allocation*, *domain name register*, *connection establishment* and *bandwidth provision*, …etc.

Infrastructure as a Service

- Provide service **– System Monitoring Interface**
  - Several types of monitoring metrics :
    - ***Virtual Machine*** – As an IaaS provider, we should be able to monitor some system states of each virtual machine, such as *CPU loading*, *memory utilization*, *IO loading* and *internal network loading*, …etc.
    - ***Virtual Storage*** – As an IaaS provider, we should be able to monitor some storage states of each virtual storage, such as *virtual space utilization*, *data duplication* and *storage device access bandwidth*, …etc.
    - ***Virtual Network*** – As an IaaS provider, we should be able to monitor some network states of each virtual network, such as *virtual network bandwidth*, *network connectivity* and *network load balancing*, …etc.

IaaS - Summary

- **IaaS is the deployment platform that abstract the infrastructure.**

- IaaS enabling technique
  - Virtualization
    - Server Virtualization
    - Storage Virtualization
    - Network Virtualization

- IaaS provided services
  - Resource Management Interface
  - System Monitoring Interface

Infrastructure as a Service

Platform as a Service

Software as a Service

SERVICE MODELS

Platform as a Service

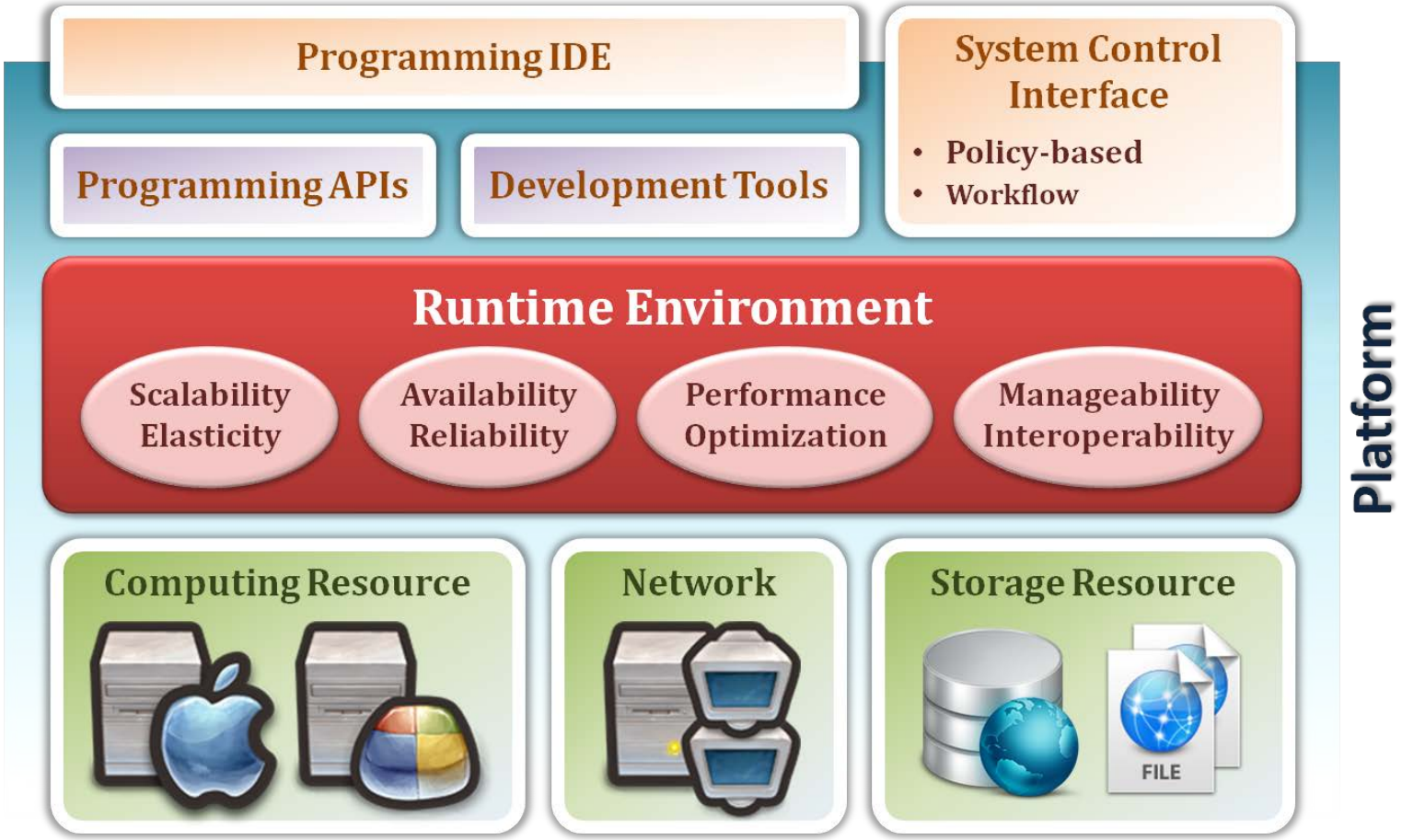
- Platform as a Service - PaaS
  - The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider.
  - The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.
- Examples :
  - Microsoft Windows Azure
  - Google App Engine
  - Hadoop
  - … etc

PaaS Services

서비스 구분	서비스 내용	활용사례
확장 플랫폼 (Software Platform)	· 시스템 소프트웨어를 완성한 형태 (pre-built)로 필요한 기관에 제공 · 재정 여력이 부족한 중소기업의 경우, 시스템 개발에 필요한 표준 환경을 저렴한 비용으로 단기간 내에 제공 받는 것이 가능	· Amazon : EC2 · WuXi의 클라우드 · IBM : TAP
구축 플랫폼 (Development Platform)	· 개발자가 손쉽게 프로그램 개발 및 테스트할 수 있는 개발 프레임워크를 제공 · 어플리케이션 소프트웨어의 개발을 위한 실행환경 (Java, NET 등) 및 프레임워크를 함께 제공	· Google App Engine · Amazon : EC2 · Hadoop
운영 플랫폼 (Delivery Platform)	· IaaS 서비스 제공을 위한 운영환경 제공의 기반 (운영플랫폼이 없다면 서버 위에 운영체제, 실행환경, 관리환경, 네트워크 구성 등의 작업을 수작업으로 진행하여나 하나 이를 바로사용할 수 있는 형태로 제공	· Google App Engine · 세일즈포스 : CRM S/W 변경 및 확장 API 제공

Platform as a Service

- System architecture :



Platform as a Service

- Enabling technique – **Runtime Environment Design**
  - Runtime environment refers to collection of software services available. Usually implemented by a collection of program libraries.
- Common properties in Runtime Environment :
  - Manageability and Interoperability
  - Performance and Optimization
  - Availability and Reliability
  - Scalability and Elasticity

Platform as a Service

- Provide service – **Programming IDE**
  - Users make use of programming IDE to develop their service among PaaS.
    - This IDE should integrate the full functionalities which supported from the underling runtime environment.
    - This IDE should also provide some development tools, such as profiler, debugger and testing environment.
  - The programming APIs supported from runtime environment may be various between different cloud providers, but there are still some common operating functions.
    - Computation, storage and communication resource operation

Platform as a Service

- Provide service – **System Control Interface**
  - Police-Based Control
    - Typically described as a principle or rule to guide decisions and achieve rational outcome(s)
    - Make the decision according to some requirements
  - Workflow Control
    - Describe the flow of installation and configuration of resources
    - Workflow processing daemon delivers speedy and efficient construction and management of cloud resources

PaaS - Summary

- **PaaS is the development platform that abstract the infrastructure, OS, and middleware to drive developer productivity.**

- PaaS enabling technique
  - Runtime Environment

- PaaS provide services
  - Programming IDE
    - Programming APIs
    - Development tools
  - System Control Interface
    - Policy based approach
    - Workflow based approach

Infrastructure as a Service

Platform as a Service

Software as a Service

SERVICE MODELS

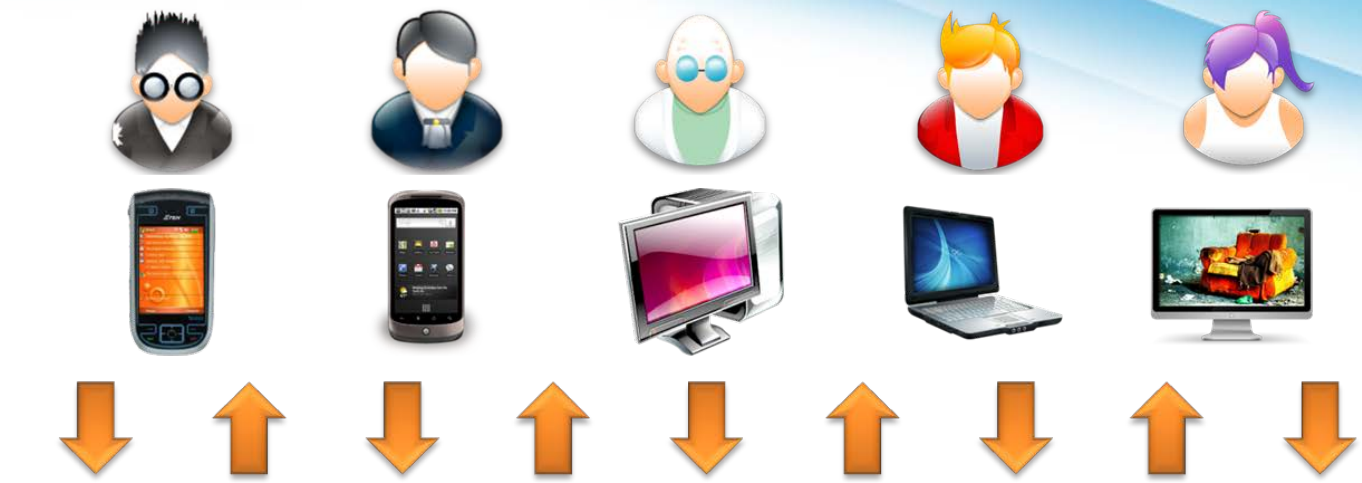
Software as a Service

- Software as a Service - SaaS
  - The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email).
  - The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.
- Examples :
  - Google Apps (e.g., Gmail, Google Docs, Google sites, …etc)
  - SalesForce.com
  - EyeOS
  - … etc

SaaS Services

구 분	내 용	예 시	사업자
단순 사무 자동화기능	데이터 계산, 워드 프로세싱 등 단순사무를 위한 소프트웨어	· 사무자동화 · 자료 관리	· 구글(구글 독스) · 싱크프리 웹 오피스
기업 단일기능	회계, 급여, 재고 관리와 같은 단일 기능을 처리하기 위한 소프트웨어	· 회계 패키지 · 고객관리 · 재고관리 · 생산관리 · 영업관리	· 세일즈포스닷컴 영업 자동화 · 오라클 시벨 고객관계 관리 · 영업 자동화 고객관계 관리 세일즈
기업내 통 합	회계, 급여, 고객 관리 등의 기능을 연계 처리할 수 있는 통합 솔루션	· 그룹웨어 · 전사적 자원 관리	· 마이크로소프트 라이브 미팅 · 넷스위트 전사적 자원 관리
기업간 통 합	공급사슬 관리, 연구개발 등 기업 간 협업 및 공동 거래를 처리할 수 있는 솔루션	· 공급사슬관리 · 자동 주문 및 납품	

Software as a Service



Web-base Applications

Web Portal

General Applications

Business Applications

Scientific Applications

Government Applications

Commercial Platform

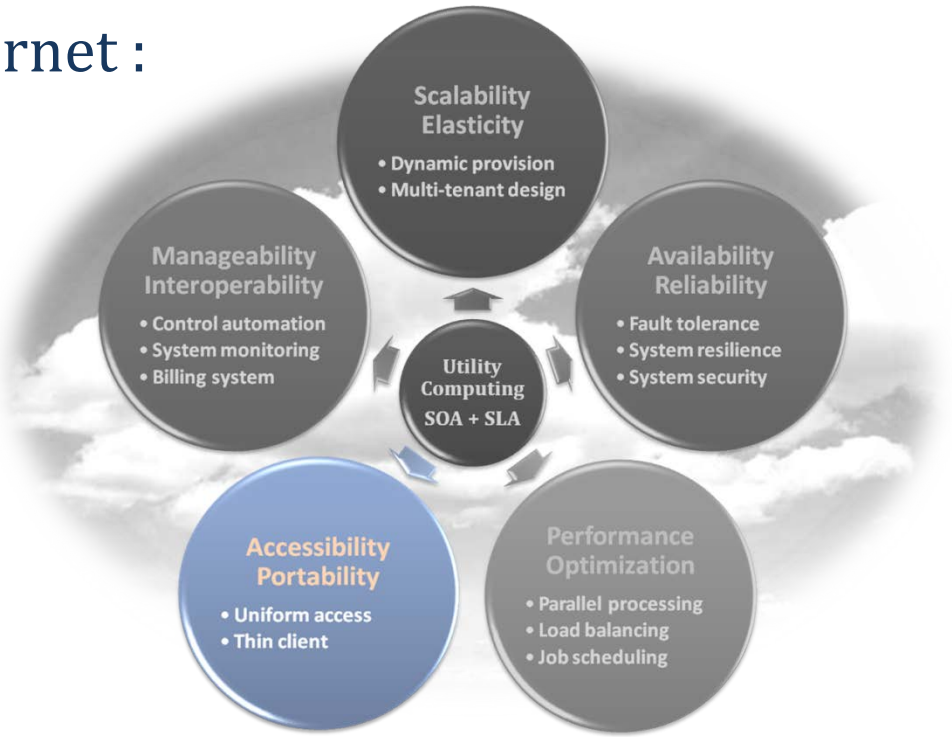
Open Source Platform

Other

Application

Software as a Service

- Enabling Technique – **Web Service**
  - Web 2.0 is the trend of using the full potential of the web
    - Viewing the Internet as a computing platform
    - Running interactive applications through a web browser
    - Leveraging interconnectivity and mobility of devices
    - Enhanced effectiveness with greater human participation
- Properties provided by Internet :
  - Accessibility and Portability



Software as a Service

- Provide service **– Web-based Applications**
  - Conventional applications should translate their access interface onto web-based platform.
  - Applications in different domains
    - ***General Applications*** – Applications which are designed for general propose, such as office suit, *multimedia* and *instant message*, …etc.
    - ***Business Applications*** – Application which are designed for business propose, such as *ERP*, *CRM* and *market trading system*, …etc.
    - ***Scientific Applications*** – Application which are designed for scientific propose, such as *aerospace simulation* and *biochemistry simulation*, …etc.
    - ***Government Applications*** – Applications which are designed for government propose, such as *national medical system* and *public transportation system service*, …etc.

Software as a Service

- Provide service – **Web Portal**
  - Apart from the standard search engine feature, web portals offer other services such as e-mail, news, stock prices, information, databases and entertainment.
  - Portals provide a way for enterprises to provide a consistent look and feel with access control and procedures for multiple applications and databases, which otherwise would have been different entities altogether.
  - Some examples :
    - iGoogle
    - MSNBC
    - Netvibes
    - Yahoo!

SaaS - Summary

- **SaaS is the finished applications that you rent and customize.**
- SaaS enabling technique
  - Web Service
- SaaS provide services
  - Web-based Applications
    - General applications
    - Business applications
    - Scientific applications
    - Government applications
  - Web Portal

How to deploy a cloud system ?

DEPLOYMENT MODELS

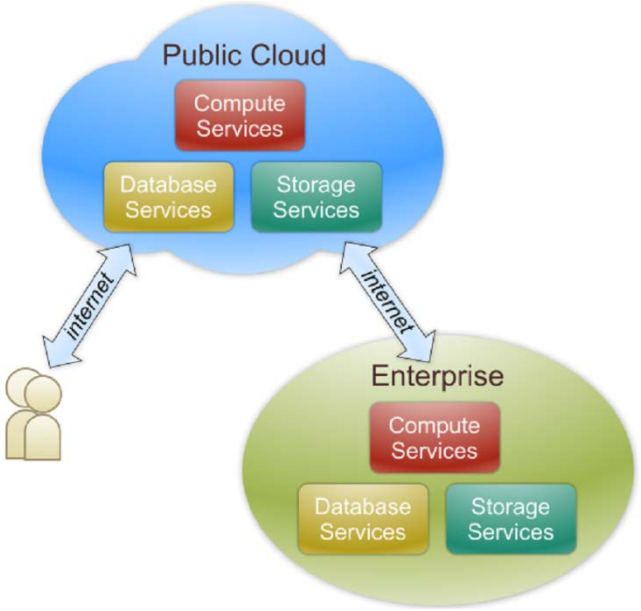
Deployment Model

- There are four primary cloud deployment models :
  - Public Cloud
  - Private Cloud
  - Community Cloud
  - Hybrid Cloud

- Each can exhibit the previously discussed characteristics; their differences lie primarily in the scope and access of published cloud services, as they are made available to service consumers.

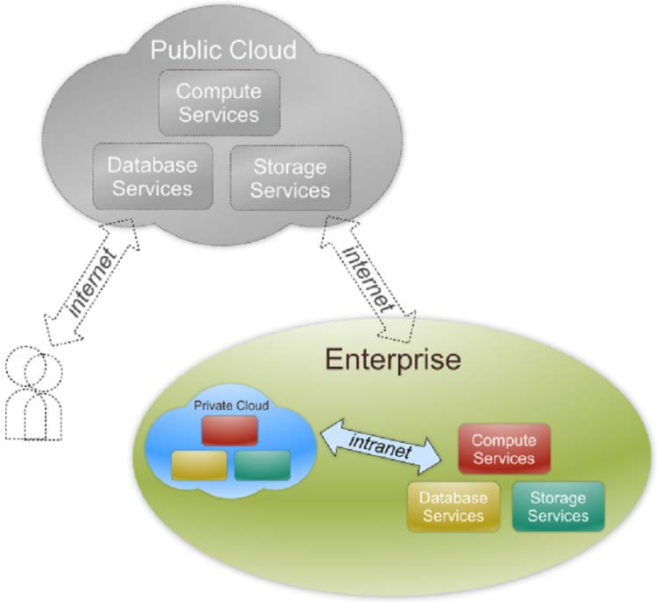
Public Cloud

- Public cloud definition
  - The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
  - Also known as external cloud or multi-tenant cloud, this model essentially represents a cloud environment that is openly accessible.
  - Basic characteristics :
    - Homogeneous infrastructure
    - Common policies
    - Shared resources and multi-tenant
    - Leased or rented infrastructure
    - Economies of scale



Private Cloud

- Private cloud definition
  - The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.
  - Also referred to as internal cloud or on-premise cloud, a private cloud intentionally limits access to its resources to service consumers that belong to the same organization that owns the cloud.
  - Basic characteristics :
    - Heterogeneous infrastructure
    - Customized and tailored policies
    - Dedicated resources
    - In-house infrastructure
    - End-to-end control



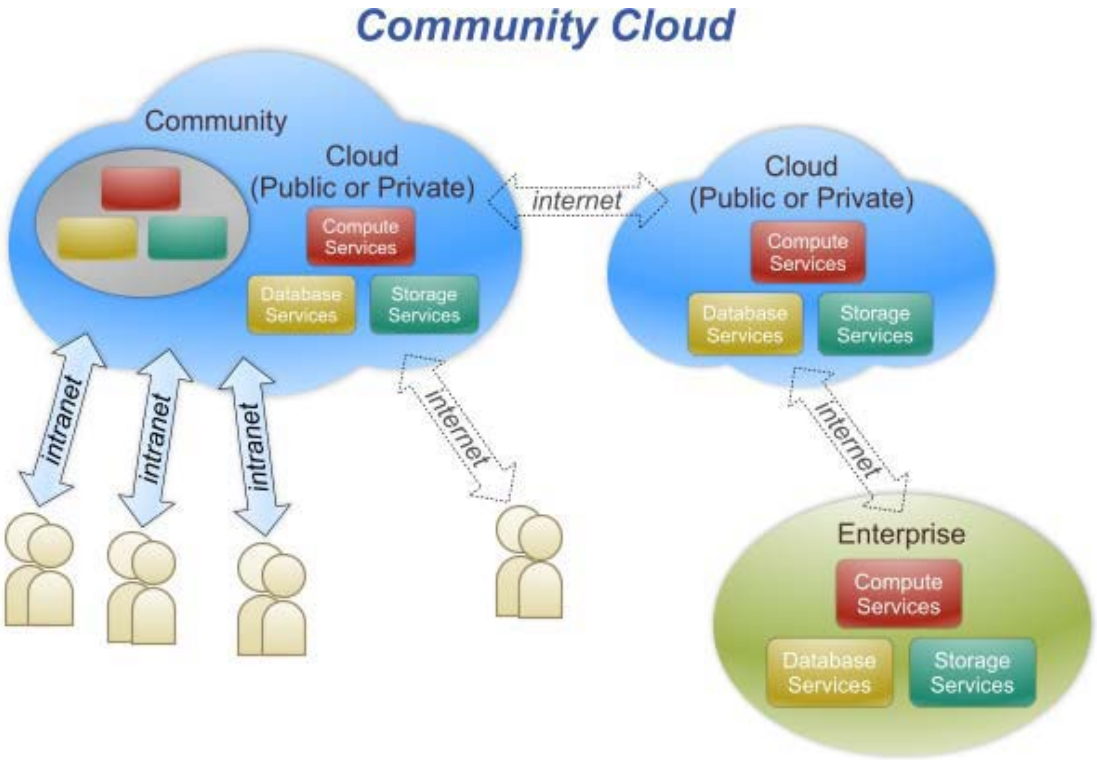
Public vs. Private

- Comparison :

	Public Cloud	Private Cloud
Infrastructure	*Homogeneous*	*Heterogeneous*
Policy Model	*Common defined*	*Customized & Tailored*
Resource Model	*Shared & Multi-tenant*	*Dedicated*
Cost Model	*Operational expenditure*	*Capital expenditure*
Economy Model	*Large economy of scale*	*End-to-end control*

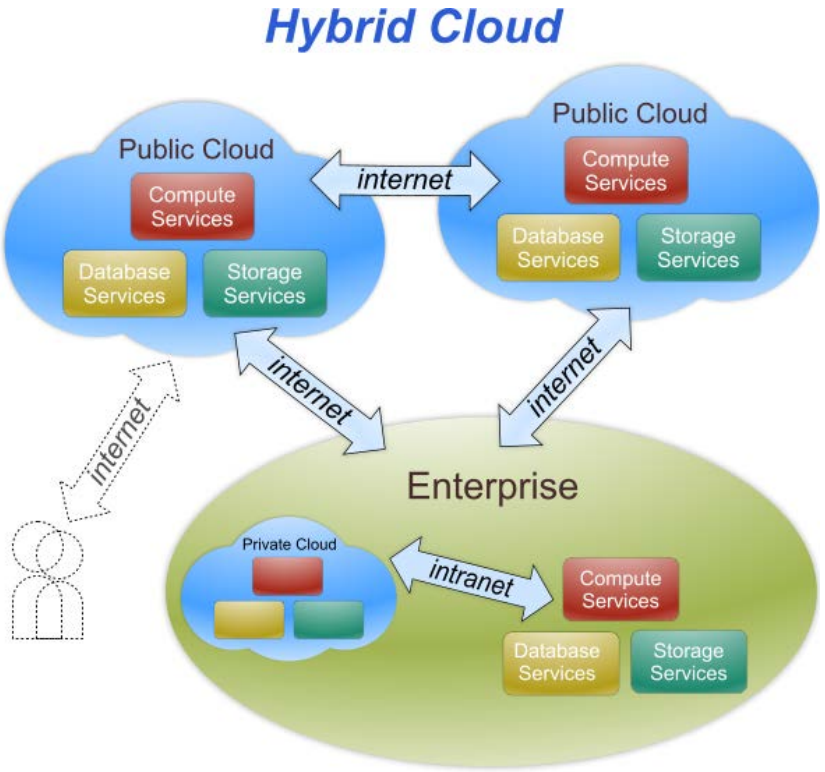
Community Cloud

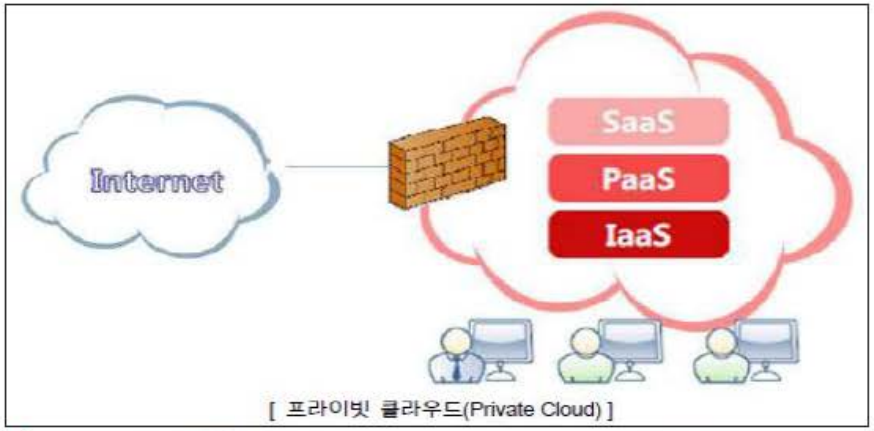
- Community cloud definition
  - The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations).



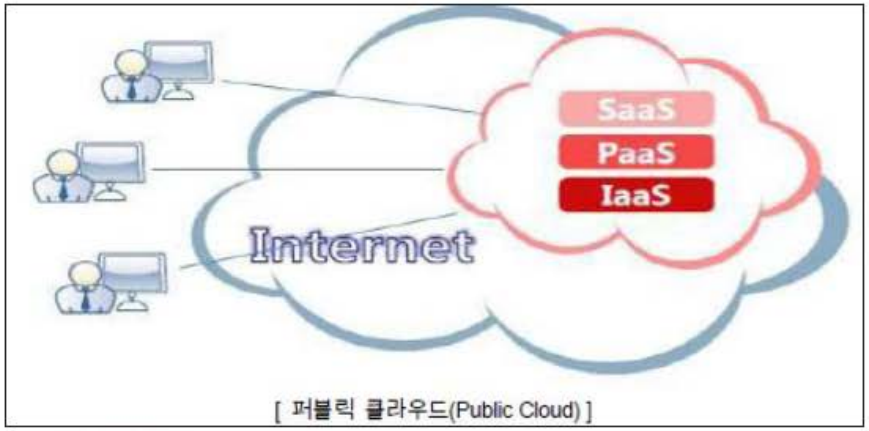
Hybrid Cloud

- Hybrid cloud definition
  - The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).



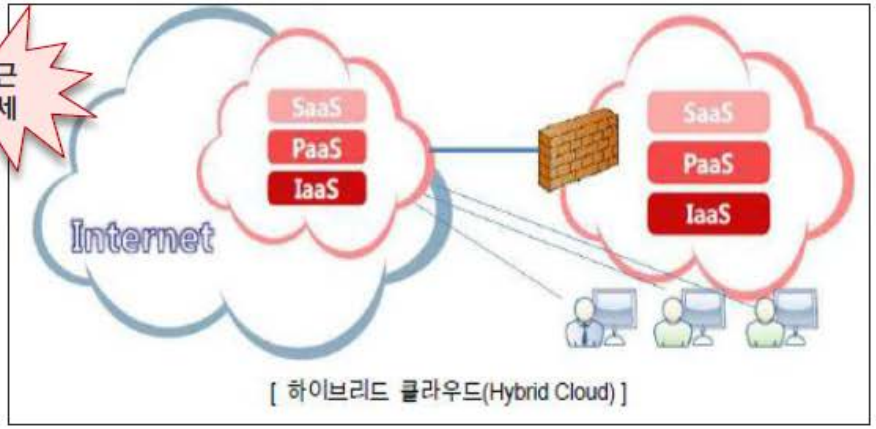


[프라이빗 클라우드(Private Cloud)]

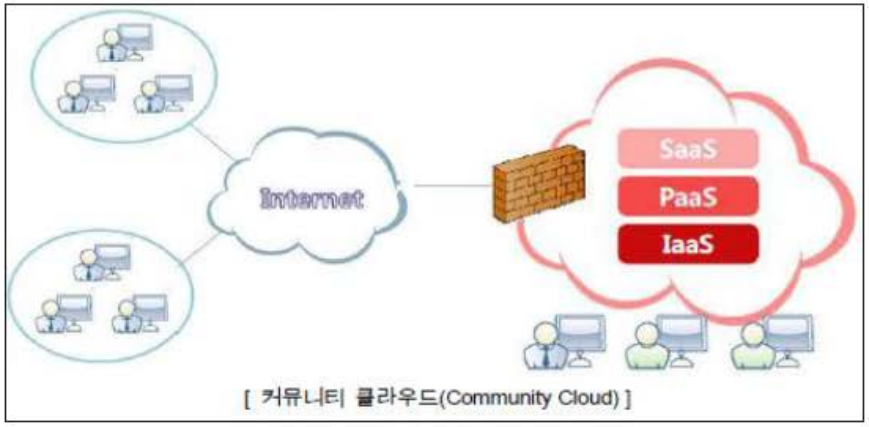


[퍼블릭 클라우드(Public Cloud)]

최근 추세



[하이브리드 클라우드(Hybrid Cloud)]



[커뮤니티 클라우드(Community Cloud)]

서비스 제공 형태

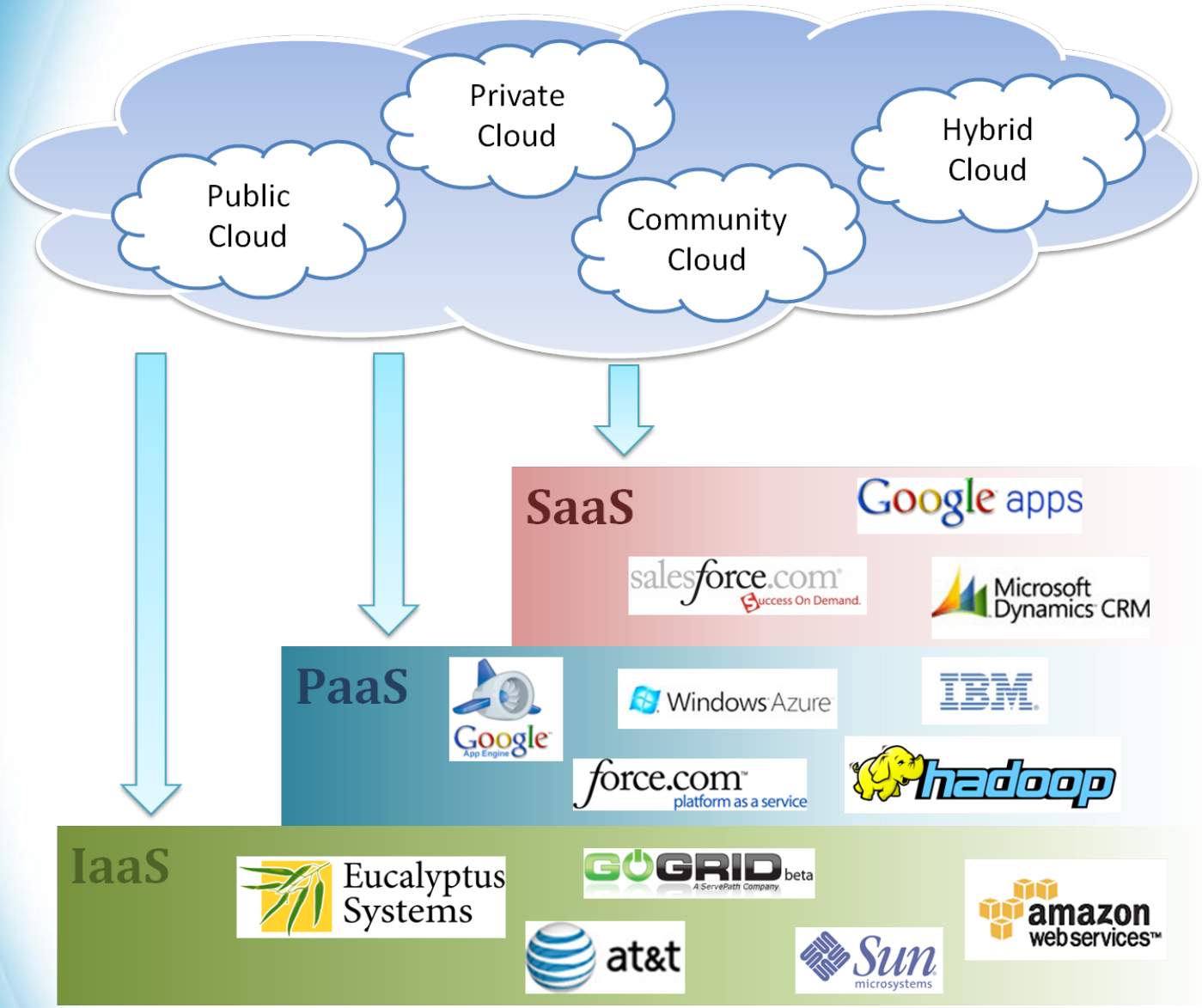
	Public cloud	Private cloud	Community cloud	Hybrid cloud
공급	클라우드 서비스 제공자	회사 전산실, CIO 조직	그룹 IDC, SI 회사	클라우드 서비스 제공자
고객	일반소비자/중소기업	대기업	대기업	대기업/중소기업
통신	인터넷을 통한 접근	Intranet (LAN) 접근	Extranet (전용선) 접근	Extranet (VPN) 접근
비고	규모의 경제	보안, 안정성 최우선	보안 + 투자효율	고객 투자 효율 최적화

Multi Cloud

- Definition
  - 2곳 이상의 클라우드 벤더가 제공하는 2개 이상의 퍼블릭 또는 프라이빗 클라우드로 구성된 클라우드 구성 방식
- 왜 multi-cloud 를 사용해야 하는가?
  - 완벽한 단일 솔루션은 없다: 클라우드 별로 고유한 기능을 제공하는 경우
  - Fail-over: 전부 다 AWS에 올려놨는데, AWS가 고장나면?
  - 근접성: 고객과 가까운 곳에 위치한 클라우드를 이용
- Hybrid 클라우드와의 차이점
  - 멀티: 여러 벤더를 걸쳐서 이용함
  - 하이브리드: 여러 배포 유형 사이에 통합이나 오케스트레이션이 이루어지는 경우

* https://www.redhat.com/ko/topics/cloud-computing/what-is-multicloud

Cloud Ecosystem



Summary

- What is cloud computing in your mind
  - Clear or Cloudy?

- Cloud computing is a new paradigm shift of computing
- Cloud computing can provide high quality of properties and characteristics based on essentially central ideas

- Service models and deployment models provide services that can be used to
  - Rent fundamental computing resources
  - Deploy and develop customer-created applications on clouds
  - Access provider's applications over network (wired or wireless)

References

- NIST (National Institute of Standards and Technology). http://csrc.nist.gov/groups/SNS/cloud-computing/
- M. Armbrust et. al., “Above the Clouds: A Berkeley View of Cloud Computing,” Technical Report No. UCB/EECS-2009-28, University of California at Berkeley, 2009.
- R. Buyya et. al., “Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility,” Future Generation Computer Systems, 2009.
- Cloud Computing Use Cases. http://groups.google.com/group/cloud-computing-use-cases
- Cloud Computing Explained. http://www.andyharjanto.com/2009/11/wanted-cloud-computing-explained-in.html
- From Wikipedia, the free encyclopedia
- All resources of the materials and pictures were partially retrieved from the Internet.