Cloud Computing

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*All notes are summarized from the lecture and tutorial materials provided by Prof. Michael Gerndt and his team. Images are retrieved from the lecture as well as tutorial slides.

Contents

1 Introduction

Different IT-trends boosts the need for cloud computing:

- Outsourcing, either infrastructure or management
- IT as a service: pay per use
- Re-centralization of data: similar to data centers, cloud be provided as a central place for data storage.
- Resource sharing instead of over-provisioning: same resource can be used for multiple purposes
- Server consolidation: instead of having multiple physical servers, with each dedicated to a certain service, servers are virtualized and put on one/reduced number of physical machines.
- Scalable computing
- Application dynamism: amount of request on web changes over time.
- Green computing, big data, stream processing, IoT, machine learning, etc.

Cloud Computing the definition is mainly divided by

- ubiquitous, convenient, on-demand network access to a **shared pool of configurable computing resources** (eg: networks, servers, storage, applications, services)
- resources can be **rapidly provisioned** and released with **minimal management effort** or service provider interaction
- cloud model is composed of
  - 3 service models
  - 4 deployment models
  - 5 essential characteristics

1.1 3 Service Models: IaaS, PaaS and SaaS

Three service models, ranking from outsourcing the least to the most: IaaS → PaaS → SaaS.

1.1.1 IaaS: Infrastructure as a Service

- Offering: provision processing, storage, networks, other fundamental computing resources
- Rights as consumer:
  - deploy and run **arbitrary** software, including **operating systems and applications**

  - control over OS, storage, deployed applications
  - limited control of select networking components

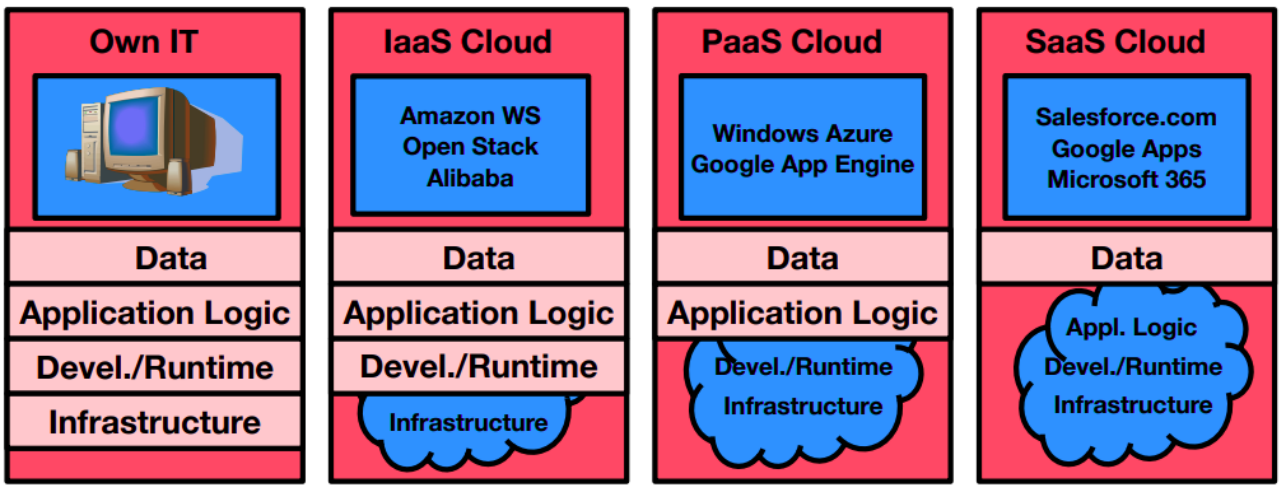
- No control as consumer:
  - underlying cloud infrastructure

1.1.2 PaaS: Platform as a Service

- Offering: application infrastructure services(eg: development platforms, libraries, tools, databases) through client interface
- Rights as consumer:
  - limited user-specific application configuration settings
- No control as consumer:
  - underlying cloud infrastructure
  - network, servers, storage, OS
  - individual application capabilities
- Example: MS Azure, Amazon FaaS, Google application engine

1.1.3 SaaS: Software as a Service

- Offering: provider's applications on cloud through client interface
- Rights as consumer:
  - limited user-specific application configuration settings
- No control as consumer:
  - underlying cloud infrastructure
  - network, servers, OS, storage
  - individual application capabilities



Service Model	IaaS	PaaS	SaaS
Service category	VM rental, online storage	online operating environment, online database, online message queues	application and software rental
Service customization	server template	Logic resource template	application template
Service provisioning	automation	automation	automation
Service accessing and using	remote console, web services	online development and debugging, integration of offline development tools and the cloud	Browser, web service interfaces, SDKs, apps

Service Model	IaaS	PaaS	SaaS
Service monitoring	physical resource monitoring	logic resource monitoring	application monitoring
Service level management	dynamic orchestration of physical resources	dynamic orchestration of logic resources	dynamic orchestration of applications
Service accounting	physical resource metering	logic resource usage metering	application usage metering
security	storage encryption and isolation, VM isolation, VLAN, SSL/SSH	data isolation, operating environment isolation, SSL	data isolation, application isolation, SSL, Web authentication and authorization

1.2 4 Deployment Models: Private, Community, Public, Hybrid

- Private Cloud:
  - service offered **via private network** for **single client**.
- Community Cloud:
  - service offered to **a specific group of clients**.
- Public Cloud:
  - service offered **over Internet via Web-application** or third-party provider for **everyone**.
- Hybrid Cloud: combination of public and private cloud.

1.3 5 Essential Characteristics

- **on-demand self-service**:
  - able to **provision computing capabilities** unilaterally(no interaction required with provider).
- **broad network access**:
  - capabilities can be available and accessed through by **diversely thin or thick client platforms** (mobile, tablets, cable, etc.)
- **resource pooling**:
  - **multi-tenant model** is used, multiple customers shares the computing capabilities at the same time, according to their self-customized demand. Specification of resource location can be possible at higher abstraction level.
- **rapid elasticity**:
  - computing capabilities can be **elastically provisioned and released** in any quantity at any time. The process can be automated or scaled according to dynamic demand.
- **measured service**:
  - automatically control and optimize resource use by **leveraging a metering capability**. Resource usage can be monitored, controlled and reported.

1.4 Pros & Cons of Clouds

- Advantages:
  - scalability, elasticity
  - rapid deployment
  - no capital investment for physical resources
  - outsourcing of infrastructure management
  - limited access to on-premise servers
  - fault tolerance: multiple servers have data replicas, if one node fails, other nodes will replace.
  - collaboration
- Disadvantages:
  - no control over security, based on ”trust”.
  - no control over hardware/infrastructure
  - vendor lockin: service is not standardized, not compatible to other vendors.
  - cost on monthly fees: if demand for same computational power is constant, fee may be higher than building own hardware. Only recommendable for dynamic demand.
  - breaking SLAs: your performance may be influenced by other tenants(multi-tenant model).