

# Week 8

## Cloud Computing

- Delivers on-demand IT-related capabilities services incl. data storage, servers, databases, networking & software thru the internet
- A group of networked elements providing services
- Features Advanced Virtualization, Large Data Centres, Broadband Networks, Mobile Clients

## Benefits

- Flexibility
- Elasticity
- Cost efficiency
- Unlimited data storage
- Backup & recovery
- Easy deployment

## Pay-per-use / Pay-as-you-go

Users charged accordingly to amt. of resources consumed

## Virtualization

- Hides physical characteristics of computing resources from their users, supporting different apps/services on top of them

## Benefits

- Encapsulation & Isolation
- Hardware Utilisation (Elastic)
- Flexibility (Easy set-up/config/deployment)
- Replication for Recovery
- Cost Reduction
- Energy Saving (Inactive VM can off)
- No Hardware/Software Lock-in (Diff OS support)
- Quick Server Provisioning (Templates for easy set-ups)

## Hypervisor

- A software that creates & runs VMs
- One host computer to support multiple guest VMs by sharing its resources such as memory & processors

## Types

- 1: Efficient & Secure but need separate mgmt. machine
- 2: Quick & easy for end-user productivity but got lag :: need access resources from host OS, & got potential security risks

## Virtual Machines (VM)

- Created based on Server Virtualization Tech which divides a physical server into multiple unique & isolated virtual machines

## Containers

- Created based on Operating System Virtualization which enables apps to run in their own isolated partitions on top of a shared OS
- Lightweight & fast to bootup, unlike common VMs

## Virtualisation Technology

- Evolved in response to biz needs
- Basic computing resources e.g. network/storage all got abstraction so got a lot of diff cloud services

## Serverless Functions

- Small unit of codes
- Smaller & faster than containers

## Deployment of Cloud Services

- Public cloud
- Private "
- Hybrid " : ≥ 1 public + ≥ 1 pvt
- Multi " : ≥ 2 cloud infrastructures

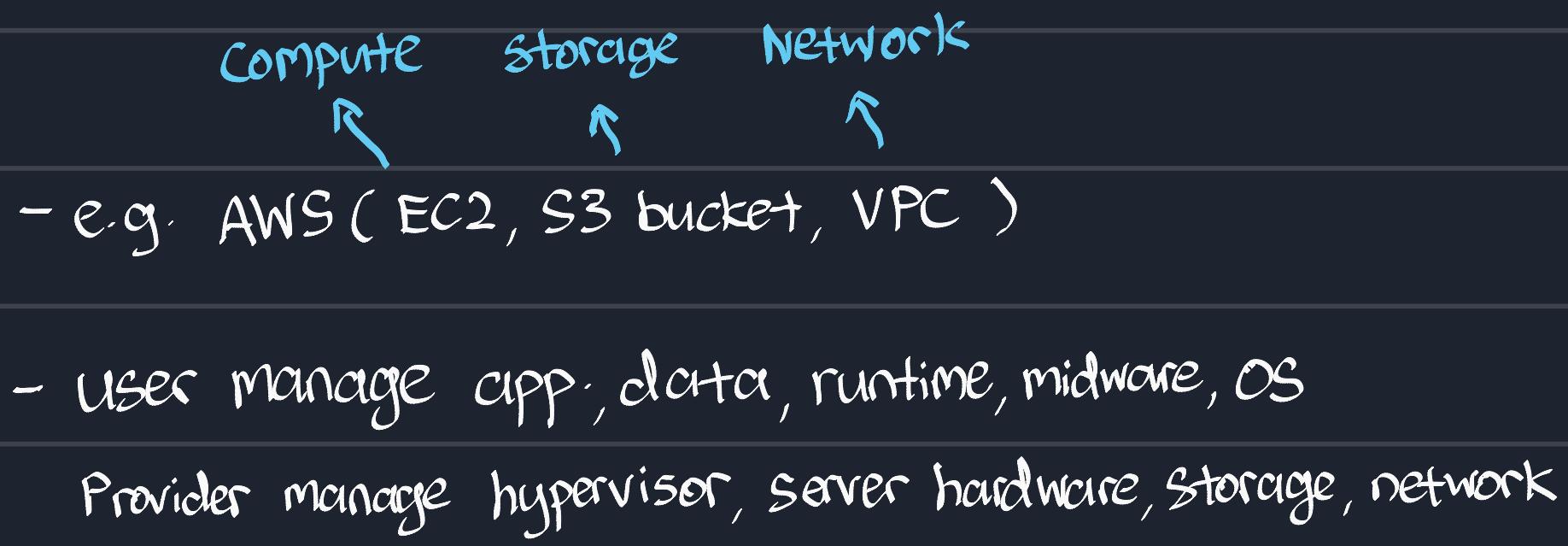
## Microservices

- Architectural & Org. approach
- Small independent services which enables fast app. dev. & innovation
- More faster & scalable than Monolithic
- But more complex

# Week 9

## Infrastructure - as - a - Service (IaaS)

- Provides on-demand services of computing infras. such as servers, storage, & networking resources that users can config & use via internet



### Benefits

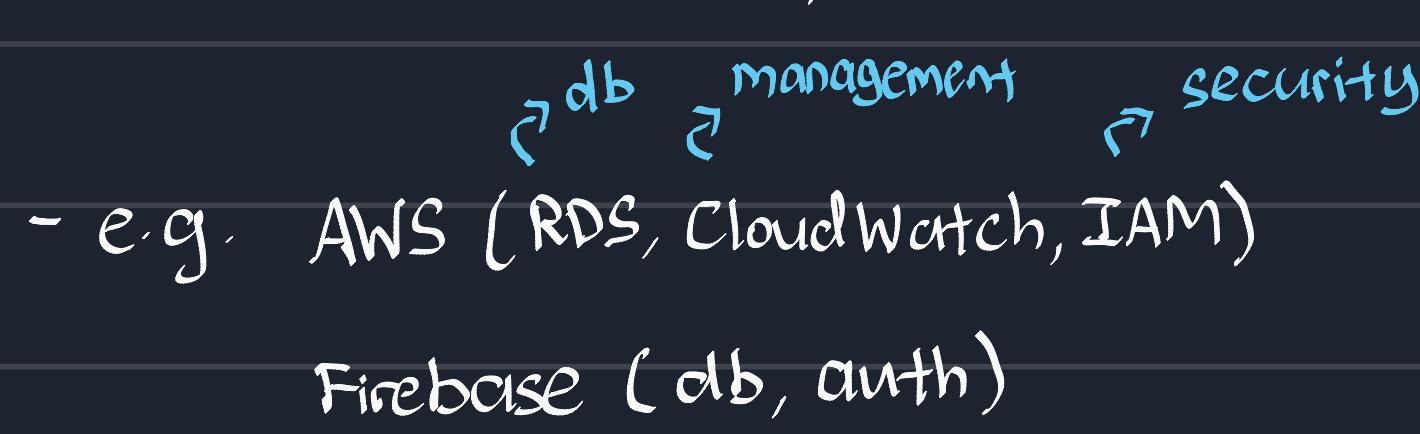
- Scalable & Elastic by demand
- Redundancy & Reliability  
Impt. data & resource can copy to all ur sites
- Pay-per-use

### Cons

- Security risk
- Need internet connection
- Complexity (mafen to learn)

## Platform - as - a - Service (PaaS)

- Provides cloud platform that manages dev. tools for app. dev. such as db, middleware, runtime, frameworks, security, OS, soft. upg., back-ups



- User can manage app. & data  
Provider handle the rest

### Benefits

- Collab. Dev.  
needed tools all there to use
- Add. Dev. capabilities  
can buy/leverage extra framework, tools, pkg
- Auto testing & deployment  
can automate dev., test & prod.

### Cons

- Security & Data privacy risk
- Platform/Vendor Lock in (mafen to change)
- Complexity (mafen to learn)

## Software - as - a - Service (SaaS)

- Provides on-demand software services by hosting apps. & make them available to end users over the internet

- e.g. Outlook, Google Docs/Drive, ERP, Twitter, Instagram, Discord
- Everything fully managed by provider

### Benefits

- Supports on-demand, variable, one-to-many workload
- Device Compatiblity, can use on browser
- Easy IT Maintenance

### Cons

- Security & Data privacy risk
- Need internet connection
- Limited customization

## Container - as - a - service (CaaS)

e.g. AWS EKS  
Google Kubernetes Engine

## Function - as - a - service (FaaS)

e.g. AWS Lambda  
Google Cloud Function

Higher level of abstraction  
for microservice deployment : CaaS & FaaS

# Week 10

## Cloud Deployment Models

### 1. Public Cloud

- open to general public

### 2. Private Cloud

- limited to within an org.

#### Benefits

- Availability & Accessibility  
got a lot of diff. svc.
- Scalability  
even got offer temp. burst cap.
- Pay-per-use

#### Cons

- Security & data privacy risk
- Integration & Migration  
(manaf to do)
- May be costly

#### Benefits

- Security & data privacy
- Performance  
due to dedicated infra.
- Easy support & troubleshooting

#### Cons

- No / Less Remote Access
- Lack of Scalability
- Cost & Maintenance  
(hardware/software/manpower)

### 3. Hybrid Cloud

- ≥ 1 public + ≥ 1 pvt.

### 4. Multi-Cloud

- ≥ 2 cloud infrastructures / providers

#### Benefits

- Security & data privacy
- Cost Optimization  
(can use pay-per-use)
- Support legacy applications

#### Cons

- Complexity  
(manaf to consider diff. types of infra.)
- Expertise  
(if diff. vndrs. how combine infra. then rip)

#### Benefits

- Prevent vendor lock-in
- Redundancy & Availability  
Impt. data & service can deploy to all ur sites
- Leverage Various Capabilities  
from diff. vendors

#### Cons

- More Security risk
- Complexity  
(manaf to consider diff. types of infra.)
- Expertise  
(if diff. vndrs. how combine infra. then rip)

## Cloud Architectures

### 1. Simple baseline (3-Tier)

Presentation Tier	UI
	HTML/CSS/JS
Logic Tier	Biz logic
	Python/Ruby/PHP
Data Tier	db
	MySQL/Oracle/DBA

### 2. Scalable w/ load balancer (delegates traffic across mult. servers)

Vertical scaling (up/down)	inc./dec. cap. of existing svc./instances e.g. upgrade t2 instance type
Horizontal scaling (in/out)	+/- amt. of resources e.g. inc. num of VM

### 3. Elastic w/ autoscaling

[ adaptable to dynamic workloads  
can recover from individual failures ]

Demand spike	Auto inc. cap./scale out to inc. performance
Demand low	Auto dec. cap./scale down to reduce costs

#### Benefits

- Simplicity
- Easy manage
- Fast dev.

#### Cons

- No Redundancy
- Low Scalability
- Less Flexibility

#### Benefits

- Reliability  
(can handle workload)
- Resiliency  
(if one serv. die still ok)
- Scalable  
(balanced workload)

#### Cons

- Complexity  
(manaf monitor/update)
- Inc. Cost
- Less Elastic  
(gg when got demand spike)

#### Benefits

- Cost saving
- Adaptive  
(resources)
- Scalable  
(for demand spikes)

#### Cons

- Complexity  
(manaf monitor/update)
- Security & Data privacy risk

# Week 11

## Cloud Data Storage

- Temporary :

Only stores data such as curr page

Any data on temp storage lost aft. redeployment

e.g. AWS instance storage

- Object :

- Entire object must be updated
- All objects got ID, metadata(desc), data
- Higher latency, but cheaper
- Network storage

- Persistent :

Stored data will be still available

after reboots / start / stop / lifecycle

events

e.g. AWS S3 (Object)

" EBS (Block)

- Block :

- Just update necessary indiv. blocks, no need update whole file
- Each block got their own ID
- Lower latency, but more ex
- Stored on HDD or boot vol.

## Benefits

- Accessibility & Redundancy (auto dupe for backup / recovery)
- Elastic volumes (storage space can expand on demand)
- On demand & pay-per-use (storage options is you yourself choose)
- Other service offering (Data encryption, auto-sync, etc.)

## Cloud Databases

(users can access/update data from cloud)

- Relational database service (RDS) :
- Use SQL
  - Store in row/col. table
  - Fixed schema
  - - Vertical scaling (inc. CPU/RAM of db machine)

- Non RDS :
- Use variety of query lang.
  - Stored in/with JSON/XML
  - Key-val / document / wide col. / graph
  - Flexible schema
  - Horizontal scaling (add more machines to store subsets of total data)

## Benefits

- Usability & Accessibility (got internet can use it, don't think so much)
- Scalability & Redundancy (auto scaling / version snapshots / dupe backups for redund.)
- On demand & pay-per-use
- Other svc offering (Encryption / migration / user friendly UI / version controls / etc.)

## Cloud AI & Data Analytics

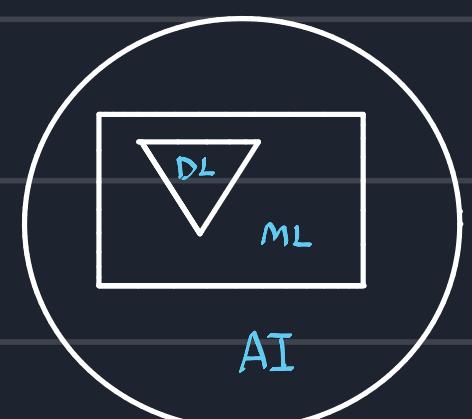
[ Data Mgt. → Descriptive/Diagnosis → Predictive → Prescriptive → Cognitive (AI) ]

- Data Analysis :
1. Data capture & store
  2. Xformation & integration
  3. Modelling & analysis
  4. Interpret & Report

Deep Learning (DL) : To analyze

Mach " (ML) : To predict / decide

Art. Int. (AI) : To Mimic human reason, learn, perceive



## Benefits

- Variety of integrated resources
- Scalability, reliability, optimize perf.
- On demand, pay-per-use
- Other svc offering (encryption/automation)

# Week 12

## Cloud Security

(protect cloud-based infras./apps/data)

### Shared Responsibility Model

- shared betw. provider & user
- resp. depend on which model chosen: IaaS, PaaS, SaaS

### Security Standards & Control Frameworks

- Cloud Security Alliance (CSA)
- They identified Notorious Nine Risks:
  - 1. Data breach
  - 2. " loss
  - 3. Acc/svc traffic hijack
  - 4. Insecure interface / API
  - 5. Denial of service
  - 6. Malicious insiders
  - 7. Abuse of cloud svc
  - 8. Insufficient due diligence
  - 9. Shared tech. vuln.

## Access Controls & Network Security

(IAM / VPC / Route Table)

### Identity & Access Management : (IAM)

- Fine grain control specifying who/what resources can access
- Manages identities across single/multiple AWS accs & refine access perms. w/ IAM policies

### Virtual Private Cloud : (VPC)

- VPC & subnets are logically isolated sections containing a pool of resources in a public cloud
- Users set inbound/outbound rules of traffic in Firewall / Sec. Grp & specify which route tables to control network access

### Route Table :

- Specify dest. to which network traffic is routed
- In cloud, dest. specified using Classless Inter-Domain Routing (CIDR) block as range of IP addresses in a subnet

## Data Security

(4 Essential Issues)

### 1. Data Confidentiality:

- Protect from unauth view / other access
- Use data encryption
  - Plaintext data encoded into ciphertext
  - Effective to protect data in transit / rest from attacks
  - e.g. Transit: SSH key pair
    - Rest: customer managed enc. key
    - consist of
      - public key (in cloud VM)
      - pvt. key (in user's comp)

### 2. Data Integrity:

- Protect from unauth changes
- e.g. use IAM & VPC

### 3. Data Availability:

- Auth users can access what they need
- e.g. use Firewalls & DDOS protection

### 4. Data Privacy:

- Individual can control what extent of personal info is collected / used
- Personal data protection regulations
  - SG Personal Data Protection Act (PDPA)
  - EU General " " Regulation (GDPR)
  - US California Consumer Privacy Act (CCPA)