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Introduction to Cloud Computing and Service Models

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Pokok Bahasan

- Introduction to Cloud Computing
  - Motivation
  - Characteristics
  - Advantages & Disadvantages
  - Opportunities & Challenges
- Cloud Architecture & Service Models
  - IaaS, PaaS, SaaS
  - Sedang Trend: FaaS
- Cloud Service Provider: Amazon Web Services
- Cloud Economics

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Introduction to Cloud Computing

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Quick Survey: Consumer PoV

- For each the following statements, please raise your hands if you:
  - Own a Gmail/Yahoo/Outlook email account
  - Use Google Drive/Dropbox/Onedrive cloud storage
  - Use Microsoft Office 365/Google Docs office suite
  - Share pictures via Instagram/Flickr/imgur
  - Watch videos via YouTube/Vimeo
- Do you notice any similarity across each mentioned online services?

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Similarities – Consumer PoV

- All services are delivered via the Internet
  - Usually, no Internet means no service ☹
- You do not have to know where your data is actually stored
  - It is somewhere.. "***in the cloud***"
- You have to read and agree on Terms & Conditions before you can use the services
- You do not have to install additional software in your PC to use those services
  - Most services are usable via Web browser

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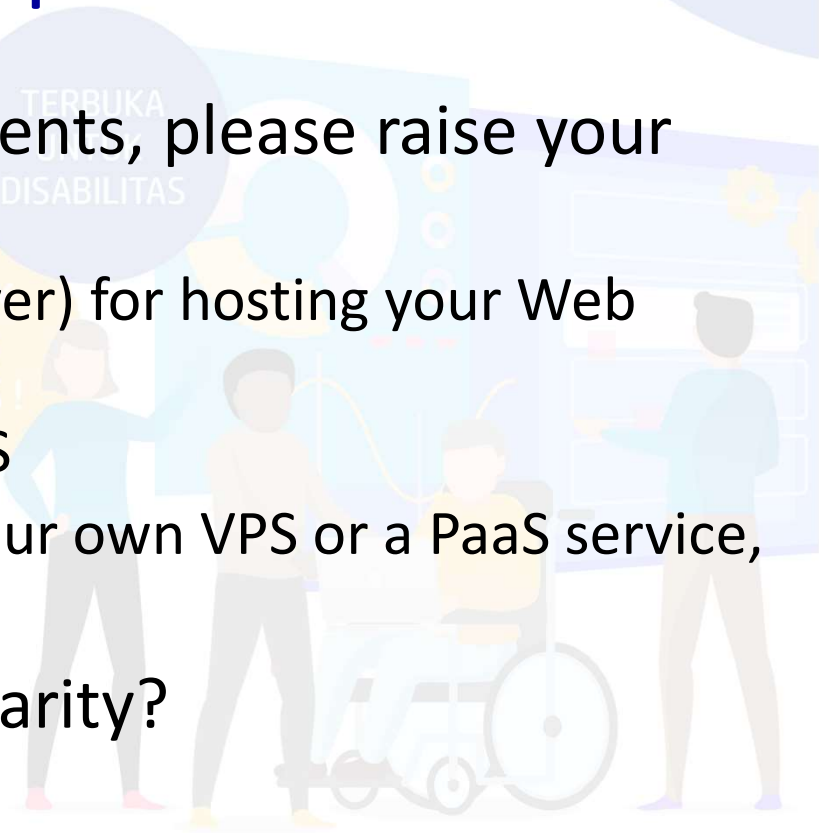
Quick Survey: Developer PoV

- For each the following statements, please raise your hands if you:
  - Rent a VPS (Virtual Private Server) for hosting your Web site/blog/seedbox
  - Use cPanel to manage your VPS
  - Deploy a Web application to your own VPS or a PaaS service, such as Heroku
- Again, do you notice any similarity?



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Similarities – Developer PoV

- There is some form of computing resource management
  - Example: resource provisioning via Web interface
- You might know where the computing resources are located, but do not necessarily have physical access to them
- You have to read and agree on Terms & Conditions before you can use the services

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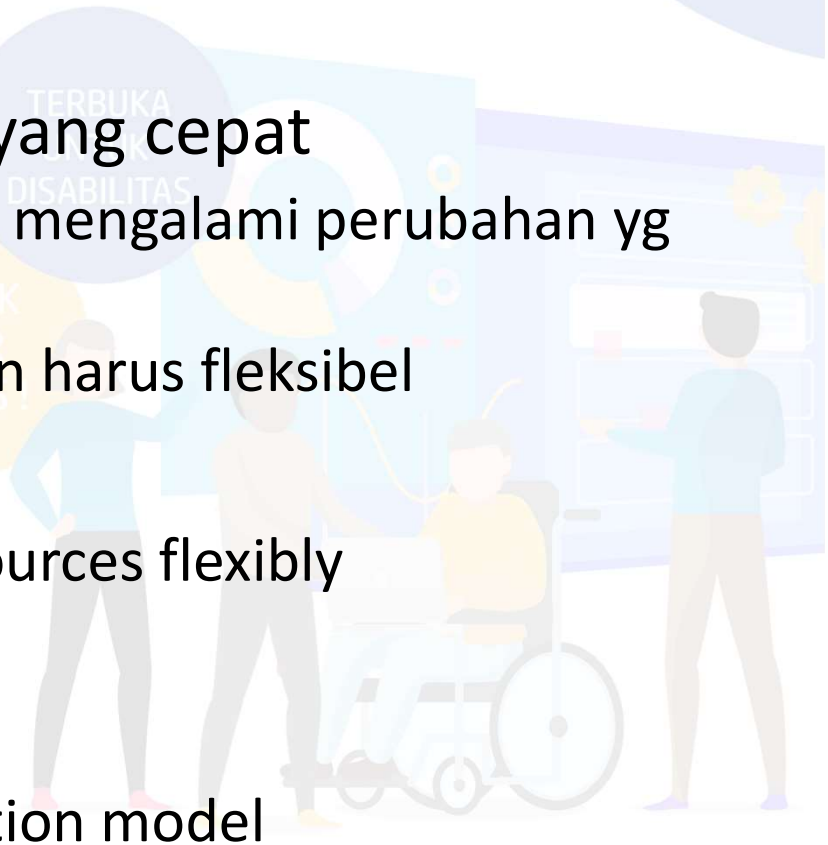
Motivation

- Perubahan lingkungan bisnis yang cepat
  - Ketentuan/persyaratan produk mengalami perubahan yg cepat
  - Pengembangan produk/layanan harus fleksibel
- Elastisitas
  - Scale up/down computing resources flexibly
    - Avoid Slashdot effect
- Cost Savings
  - Pay-as-you-go, or use subscription model



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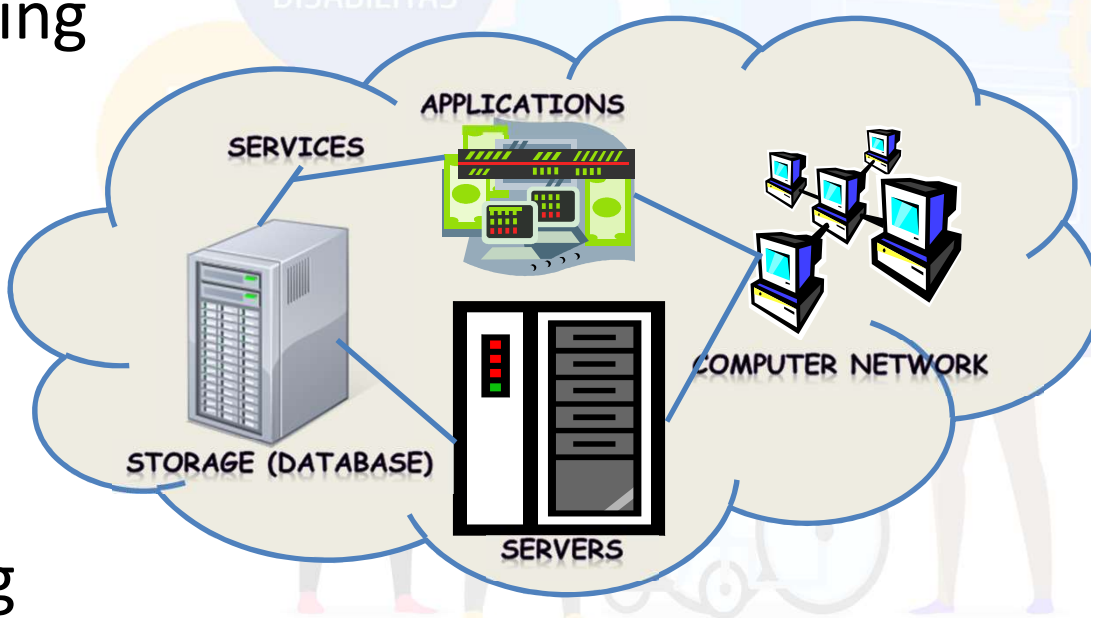
What is Cloud Computing?

- Shared pool of configurable computing resources
- On-demand delivery through internet
- Provisioned by the service provider
- Pay-as-you-go pricing



Adopted from (Mell, 2009)

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History

- Evolusi cloud computing dimulai dari tahun 1950an -> mainframe computing
- Tahun 1970an -> konsep virtual machines -> virtualisasi
- Tahun 1990an -> virtualized private network connections (oleh beberapa perusahaan telekomunikasi)
- Tahun 1997 -> muncul istilah Cloud Computing "*computing paradigm, where the boundaries of computing will be determined by economic rationale, rather than technical limits.*"
- Tahun 1999 -> Salesforce.com (menggunakan internet untuk mengirim software on demand ke klien)
- Tahun 2006 -> Amazon membuka AWS (Amazon Web Service)

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CC's Characteristics

Common Characteristics

- Skala massive
- Homogenitas
- Low cost software
- Virtualization
- Robust computation
- Geographic distribution
- Service orientation
- Advanced security

Essential Characteristics

- On-demand self service
- Broad network access
- Rapid elasticity
- Resource pooling
- Measured service

Adopted from (Mell, 2009)

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Basic Cloud Characteristics (Mell, 2009)

- The “no-need-to-know” in terms of the underlying of the infrastructure, applications interface with the infrastructure via the APIs
- The “flexibility-and-elasticity” allows these systems to scale up/down at will utilizing the resources of all kinds (CPU, storage, load balancing, etc.)
- The “pay-as-much-as-used-and-needed” type of utility computing and the ubiquitous (anywhere) type of network-based computing
- Cloud are transparent to users and applications, they can be built in multiple ways
- In general, they are built on clusters of PC servers and off-the-shelf components plus open-source software combined with in-house applications and/or system software

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Advantages (Mell, 2009)

- 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

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Disadvantages (Mell, 2009)

- Requires a constant Internet connection
- Does not work well in a slow Internet connection
- Can be slow in terms of throughput
- Stored data might be not secure
- Stored data can be lost
- Vendor (cloud service provider) lock-in

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Opportunities & Challenges (Mell, 2009)

- Enables services to be used without any understanding of their infrastructure
- Data and services are stored remotely but accessible from anywhere
- Works using economies of scale
- Dependence on certain service provider could possibly limit flexibility and innovation
- Issues with policy and access regarding to the data in the cloud
- It is still unclear how safe out-sourced data is and when using these services ownership of data is not always clear

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Cloud Architecture & Service Models

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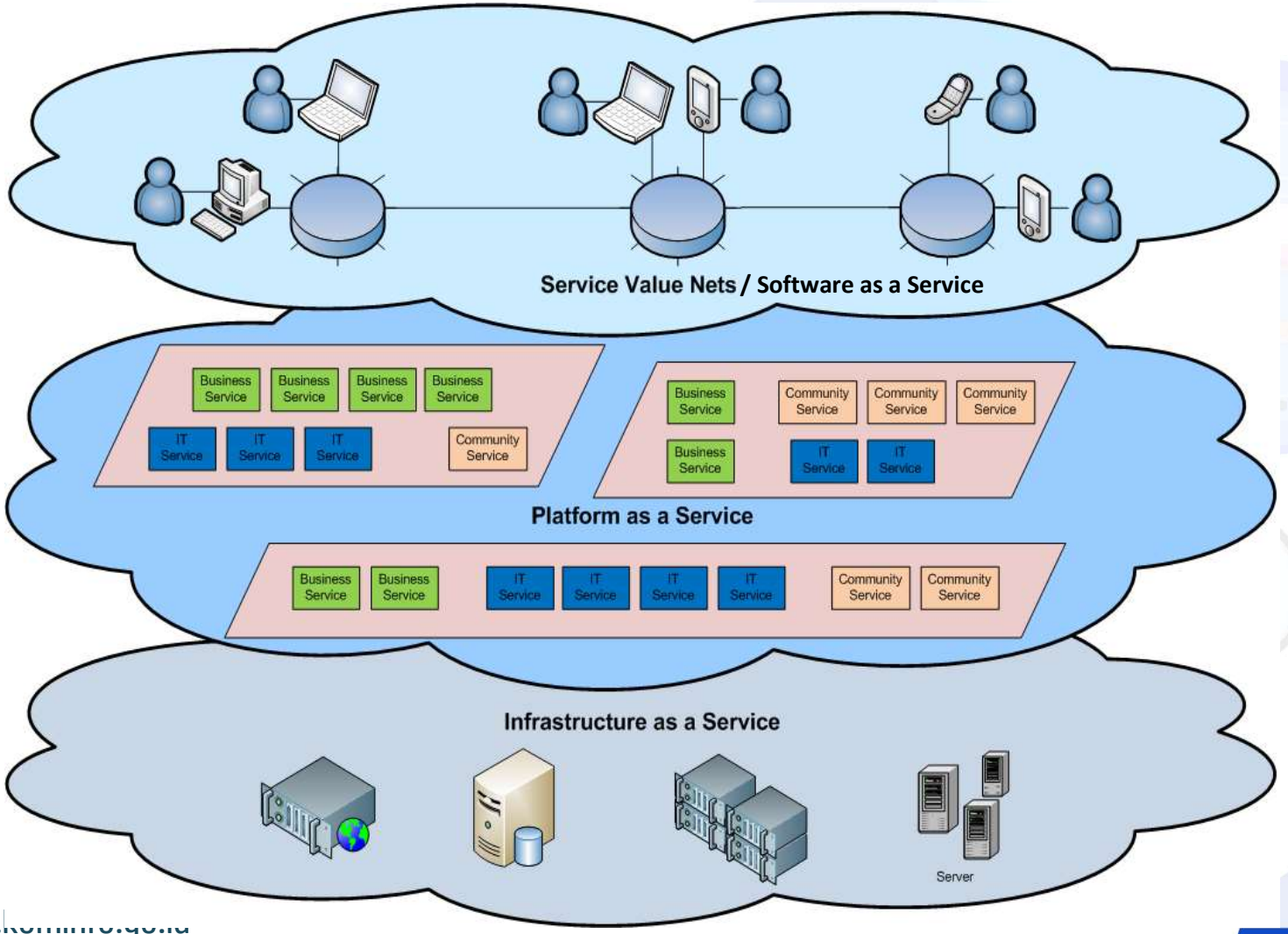
Cloud Architecture (Mell, 2009)



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Cloud Service Models

SalesForce CRM

LotusLive

Google App Engine

Windows Azure
The Future Made Familiar

amazon web services™

rackspace HOSTING

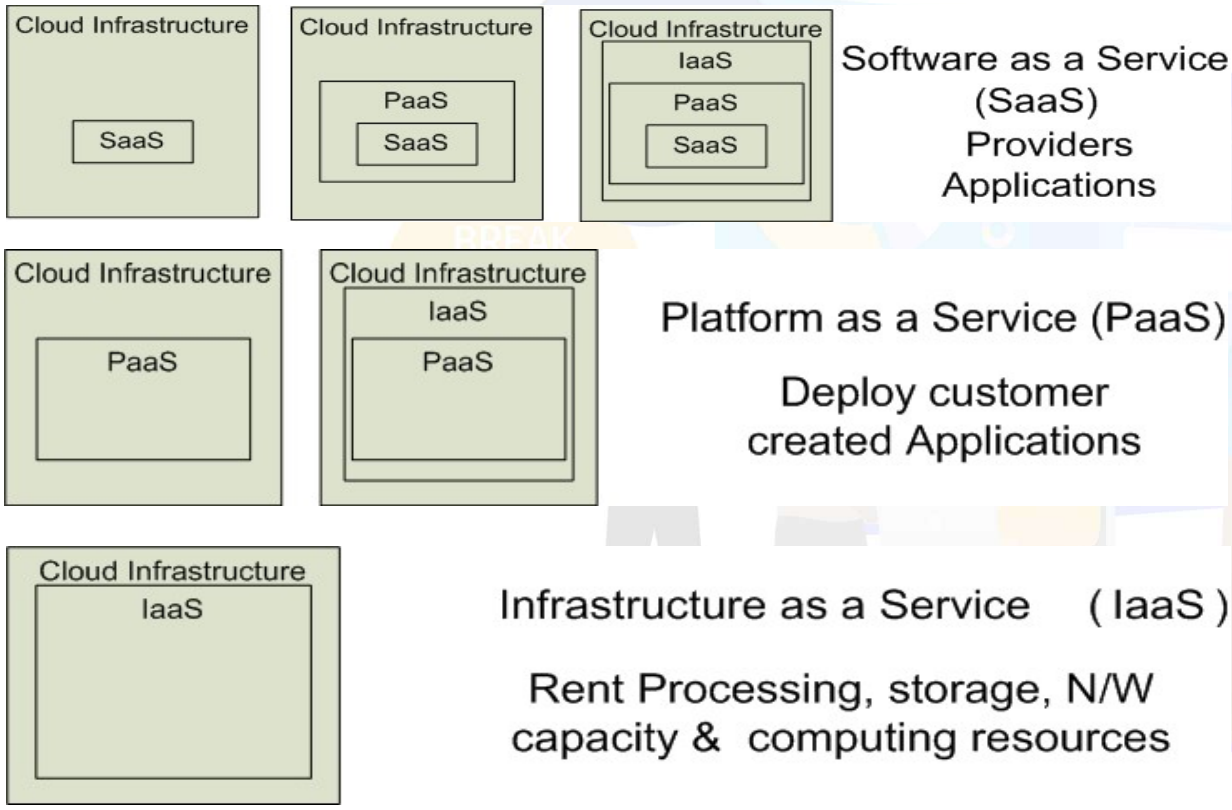

Figure modified from (Mell, 2009)

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Cloud Service Models (another view)

SaaS

PaaS

IaaS

Hosted applications /apps

Development tools, database management, business analytics

Operating system

Server and storage

Networking
Firewalls
Security

Data center physical plant /building

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Infrastructure-as-a-Service (IaaS)

- *"Contains the basic building blocks for cloud IT and typically provide access to networking features, computers (either virtual or on dedicated hardware), and data storage service"* – Amazon AWS
- Examples:
  - Amazon Lightsail
  - Amazon EC2 (finer-grained than Lightsail, e.g. more flexible on customizing the VM's specs)

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IaaS

- IaaS adalah layanan dari Cloud Computing sewaktu kita bisa “menyewa” infrastruktur IT (unit komputasi, storage, memory, network, dsb). Dapat didefinisikan berapa besar unit komputasi (CPU), penyimpanan data (storage), memory (RAM), bandwidth, dan konfigurasi lainnya yang akan disewa.

- Keuntungan: tidak perlu membeli komputer fisik, dan konfigurasi komputer virtual tersebut dapat diubah (scale up/scale down) dengan mudah.

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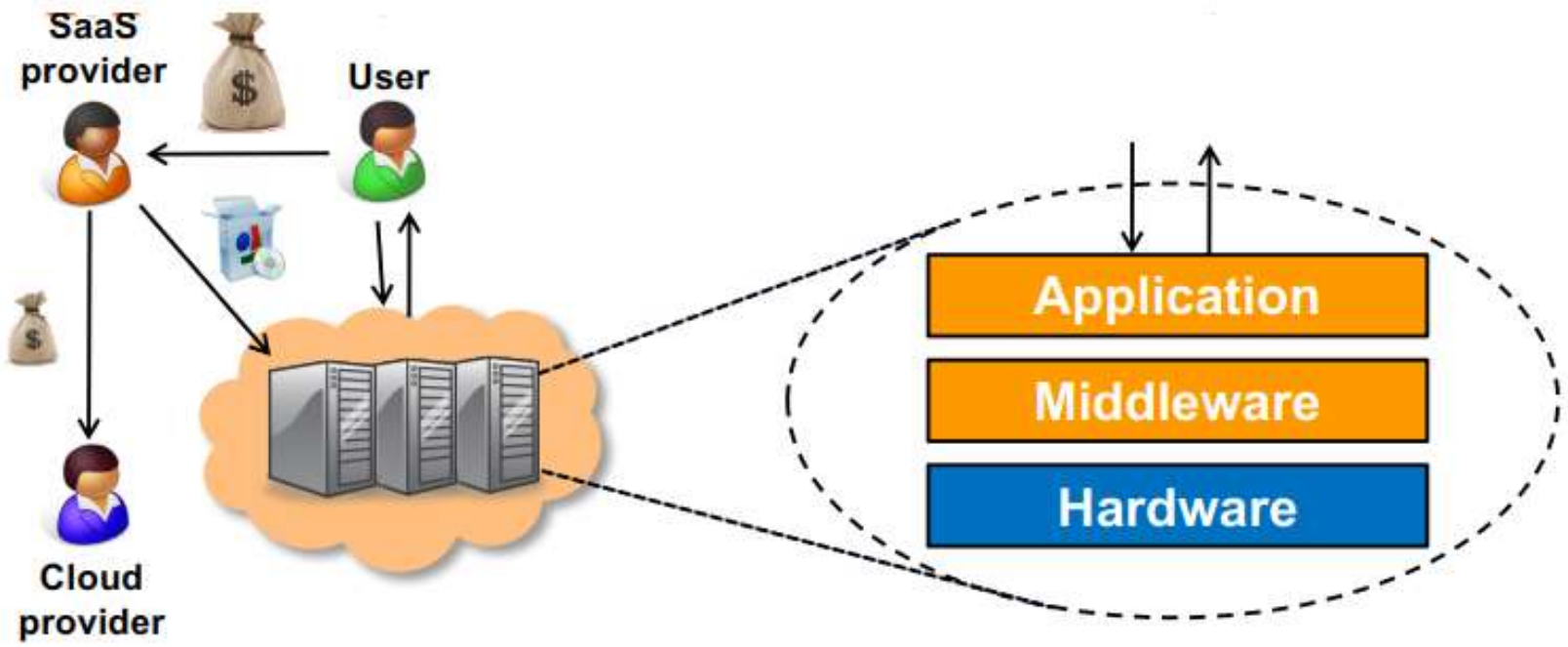
Infrastructure as a Service (IaaS)



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IaaS Examples

STORAGE

- **Amazon S3**
- Zetta
- CTERA Portal
- Mosso Cloud Files
- **Nirvanix**

CLOUD BROKERS

- RightScale
- enStratus
- Kaavo
- Elastra
- CloudKick
- CloudSwitch

COMPUTE

- **Amazon EC2**
- **Serve Path GoGrid**
- Elastra
- **Mosso Cloud Servers**
- **Joyent Accelerations**
- AppNexus
- Flexiscale
- Elastichosts
- Hosting.com CloudNine
- Terremark
- GridLayer
- ITRICITY
- LayeredTech

SERVICE MANAGEMENT

- Scale
- CohesiveFT
- Ylastic
- Dynect
- CloudFoundry
- NewRelic
- Cloud42

BACKUP & RECOVERY

- JungleDisk
- Mosy
- Zmanda Cloud Backup
- OpenRSM
- Syncplicity

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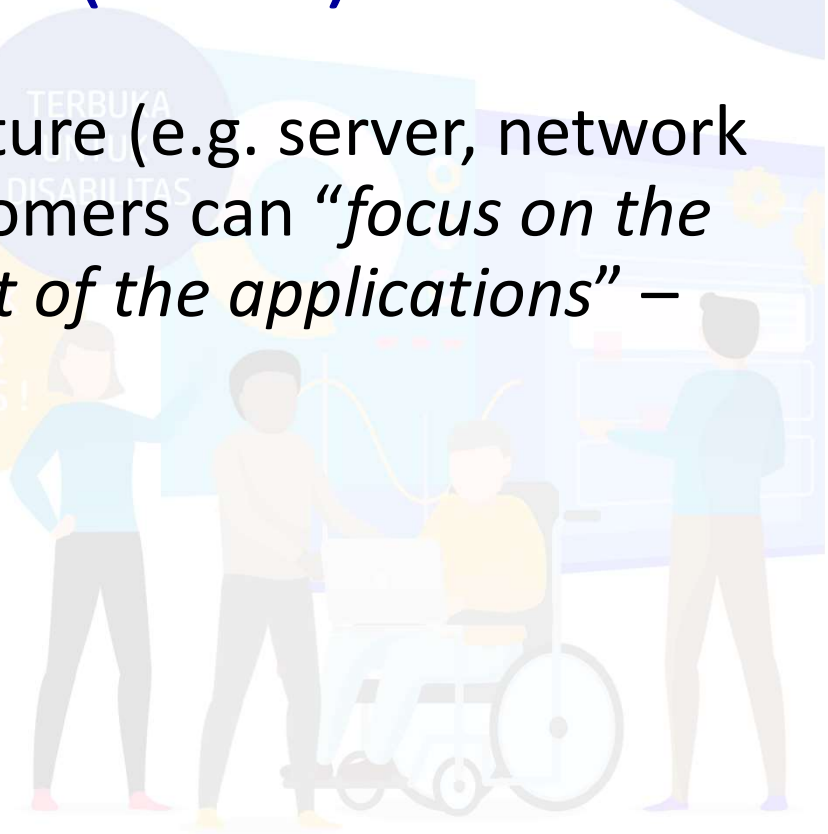
Platform-as-a-Service (PaaS)

- Abstracts away the infrastructure (e.g. server, network connectivity) so that the customers can "*focus on the deployment and management of the applications*" – Amazon AWS
- Examples:
  - AWS Elastic Beanstalk
  - Heroku



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PaaS Cloud

- PaaS adalah layanan dari Cloud Computing kita bisa menyewa “rumah” berikut lingkungannya, untuk menjalankan aplikasi yang telah dibuat. Pelanggan tidak perlu pusing untuk menyiapkan “rumah” dan memelihara “rumah” tersebut.

- Keuntungan: pengembang dapat fokus pada aplikasi yang sedang dikembangkan tanpa harus memikirkan “rumah”

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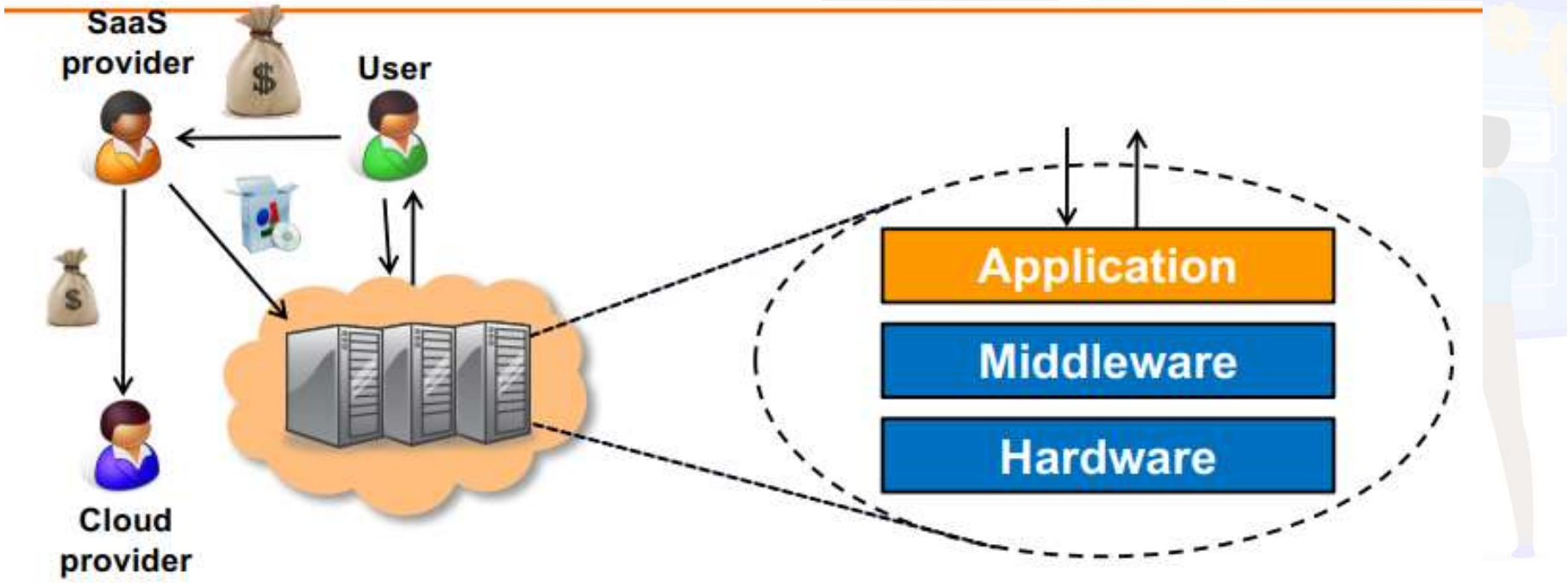
Platform as a Service (PaaS)



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PaaS Examples

GENERAL PURPOSE
- Force.com
- Etelos
- LongJump
- AppJet
- Rollbase
- Bungee Labs Connect
- **Google App Engine**
- Engine Yard
- Caspio
- Qrimp
- **MS Azure Services** Platform
- Mosso Cloud Sites

BUSINESS INTELLIGENT
- Aster DB
- Quantivo
- Cloud9 Analytics
- Blink Logic
- K2 Analytics
- Oco
- Panorama
- PivotLink
- Clario Analytics
- CloudLight Neuron
- Infobright
- Vertica

INTEGRATION
- Amazon SQS
- MuleSource Mule OnDEmand
- Boomi
- SnapLogic
- Opsource Connect
- Cast Iron
- Microsoft BizTalk Service
- Gnip
- Snaplogic SaaS Solution Packs
- Appian Anywhere
- HubSpan
- Informatica On-Demand

DEVELOPMENT & TESTING
- Keynote Systems
- Mercury
- SOASTA
- SkyTap
- Aptana
- LoadStorm
- Collabnet
- Dynamsoft

DATABASE
- Google Big Table
- Amazon SimpleDB
- FathomDB
- Microsoft SDS

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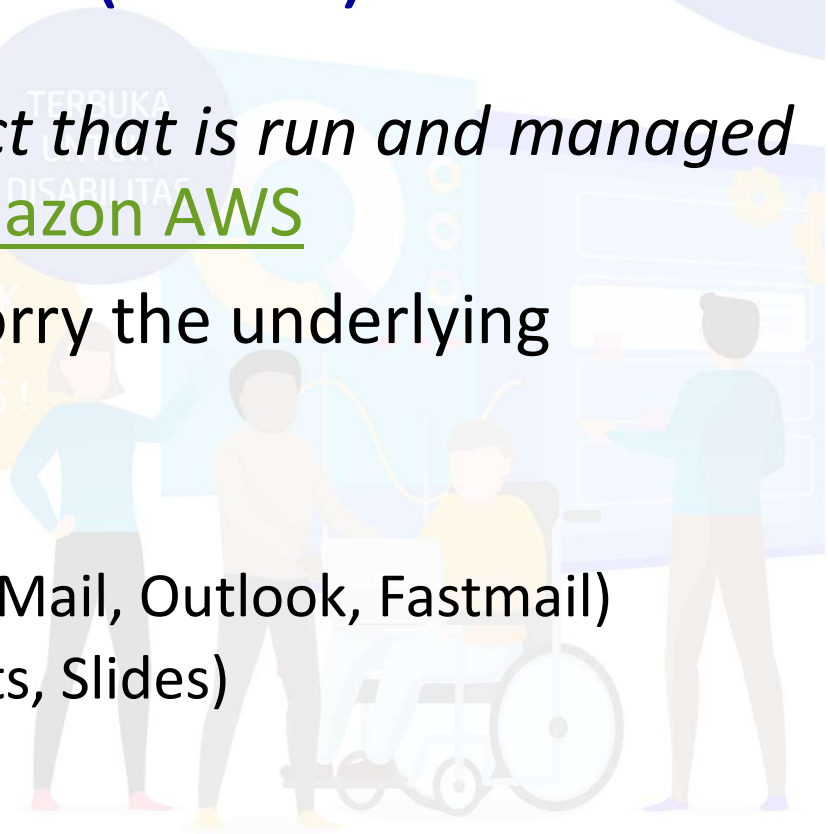
Software-as-a-Service (PaaS)

- *"Provides a completed product that is run and managed by the service provider."* – Amazon AWS
- The user does not need to worry the underlying infrastructure and platform
- Examples:
  - Web-based email (e.g. Google Mail, Outlook, Fastmail)
  - Google Docs Suite (Docs, Sheets, Slides)



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SaaS Cloud

- SaaS adalah layanan dari Cloud Computing dimana pelanggan dapat menggunakan software (perangkat lunak) yang telah disediakan oleh cloud provider.
- Contoh
  Layanan produktivitas: Office365, GoogleDocs, Adobe Creative Cloud
  Layanan email: Gmail, YahooMail, LiveMail
  Layanan social network: Facebook, Twitter

- Keuntungan: tidak perlu membeli lisensi software (system langganan), fully updated

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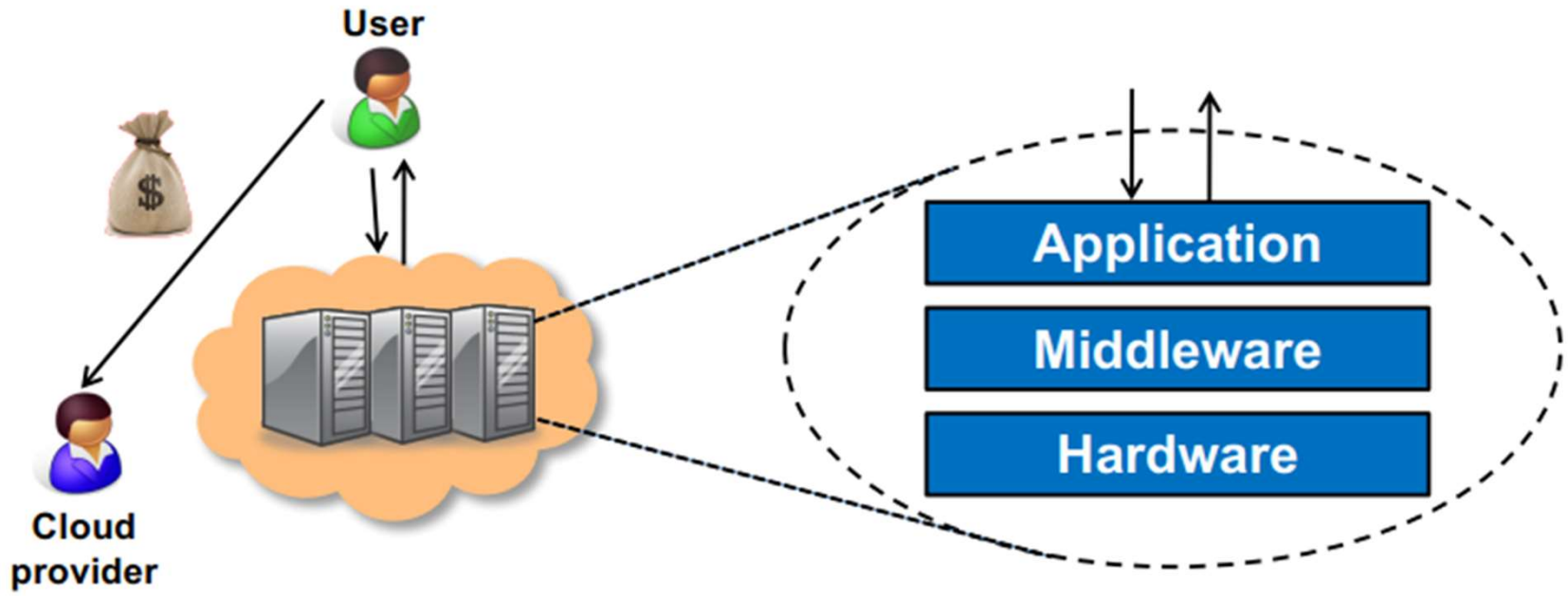
Software as a Service (SaaS)



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Saas Examples

BILLING
- Aria Systems
- eVapt
- OpSource
- Redi2
- Zuora

FINANCIAL
- Concur
- Xero
- Workday
- Beam4d

LEGAL
- DirectLaw
- Advologix
- Fios
- Sertifi

SALES
- Xactly
- LucidEra
- StreetSmarts
- Success Metrics

PRODUCTIVITY
- Zoho
- IBM Lotus Live
- **Google Apps**
- HyperOffice
- **Microsoft Live**
- ClusterSeven

HUMAN RESOURCE
- Taleo
- Workday
- ICIMSe

CONTENT MANAGEMENT
- Clickability
- SpringCM
- CrownPoint

CRM
- **NetSuite**
- **Salesforce**
- Parature
- Responsys
- Rightnow
- Sales.com
- LiveOps
- MSDynamics
- Oracle On Demand

DOCUMENT MANAGEMENT
- NetDocuments
- Questys
- DocLanding
- Aconex
- Xythos
- Knowledge TreeLive
- SpringCM

COLLABO RATION
- Box.net
- DropBox

SOCIAL NETWORKS
- Ning
- Zembly
- Amitive

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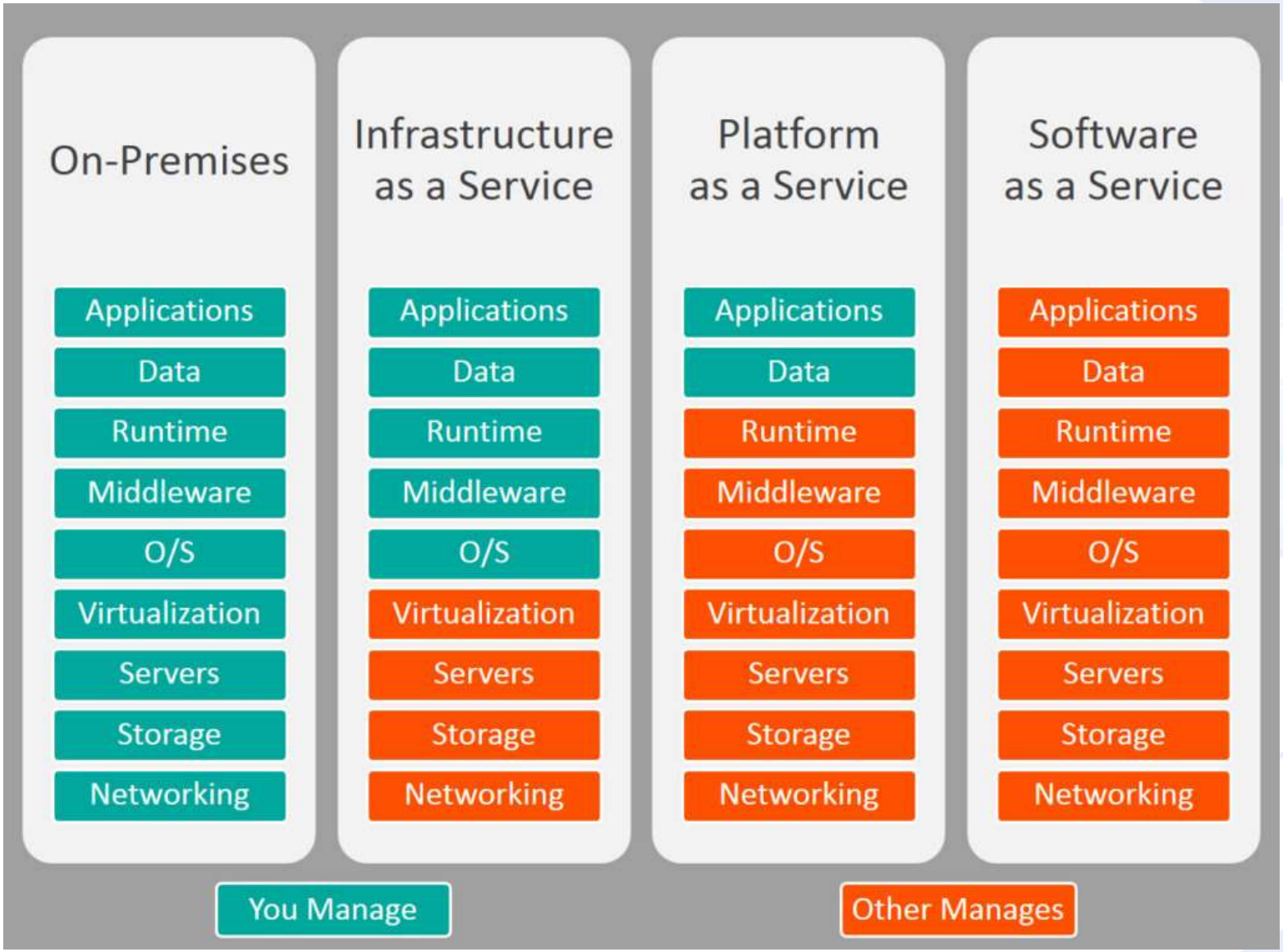

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X-as-a-Service

- Software-as-a-Service can be generalized to “X-as-a-Service”
- Meaning?
  - X can be any computing resource that managed by the cloud service provider and offered to the users for a price
- Examples:
  - Database-as-a-Service: provides managed database (e.g. Amazon Aurora, Google Cloud Firestore)
  - Email-as-a-Service: provides ability to send/receive email (e.g. Amazon Simple Email Service, Postmark)

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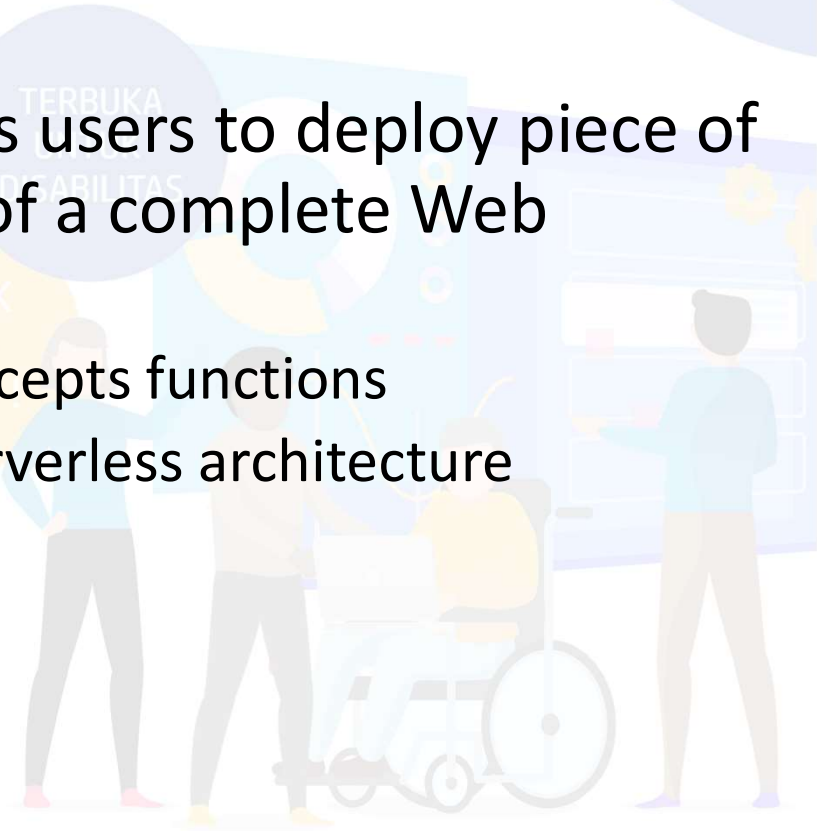
Emerging Trend: Function-as-a-Service (FaaS)

- The cloud service provider lets users to deploy piece of code (i.e. a function) instead of a complete Web application
  - It is similar to PaaS, but only accepts functions
  - Major part in implementing serverless architecture
- Examples:
  - Amazon Lambda
  - Google Cloud Functions



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Cloud Computing: Deployment Model

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Deployment Model

- **Private Cloud**
  The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). premises
- **Community Cloud**
  The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns
- **Public Cloud**
  The cloud infrastructure is provisioned for open use by the general public
- **Hybrid Cloud**
  The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public)

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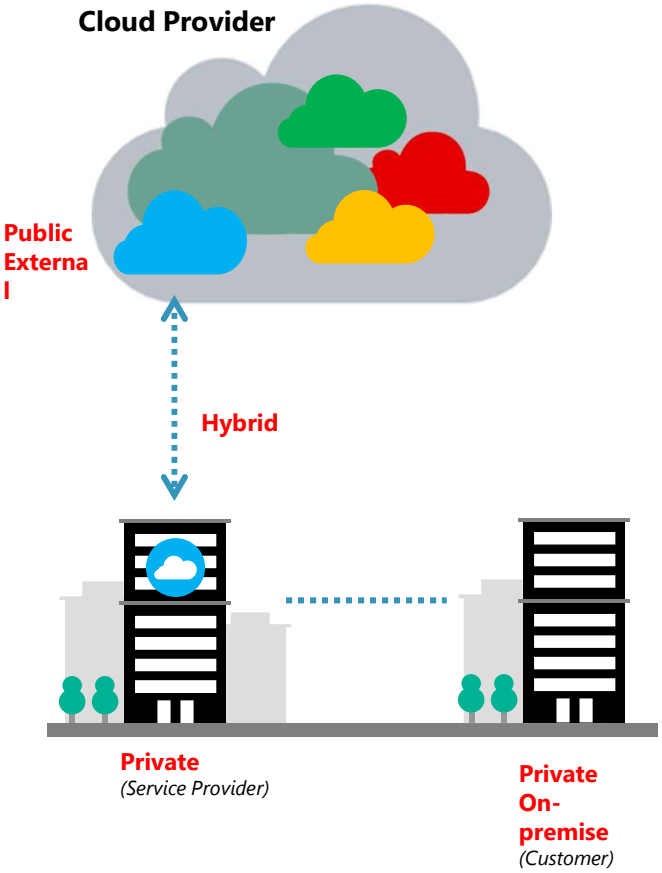
Deployment Model



public
Cost
★★★

Service & infrastructure provided publlicly for multiple client. Most economical solution, but security and compliance concerns.

- Share infrastructure accross different users
- Inexpensive and easy to setup

private
Control
★★★

The hosting infrastructure is provided exclusively for one customer (either locally or at en external provider). Most expensive solution for security requirements.

- Does not share infrastructure
- Mission critical workload, security, uptime, etc

hybrid
Both
★★★

Customized combination of private and public cloud services. Most flexible system, but difficult to implement.

- Data residence based on classificaiton
- Dynamic and highly changeable workload

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Deployment Model: Private Cloud

Adalah layanan cloud computing yang disediakan untuk memenuhi kebutuhan internal dari organisasi/perusahaan.

- Contoh layanannya:
  - SaaS: Web Application, Mail Server, Database Server untuk keperluan internal.
  - PaaS: Sistem Operasi + Web Server + Framework + Database yang untuk internal
  - IaaS: Virtual machine yang bisa di-request sesuai dengan kebutuhan internal

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Deployment Model: Private Cloud

- **Keuntungan:** Keamanan data terjamin, karena dikelola sendiri, Menghemat bandwith internet ketika layanan itu hanya diakses dari jaringan internal, proses bisnis tidak tergantung dengan koneksi internet, tapi tetap saja tergantung dengan koneksi jaringan lokal (intranet).

- **Kerugian:** Membutuhkan Investasi besar untuk menyiapkan infrastrukturnya dan untuk biaya pemeliharaannya.

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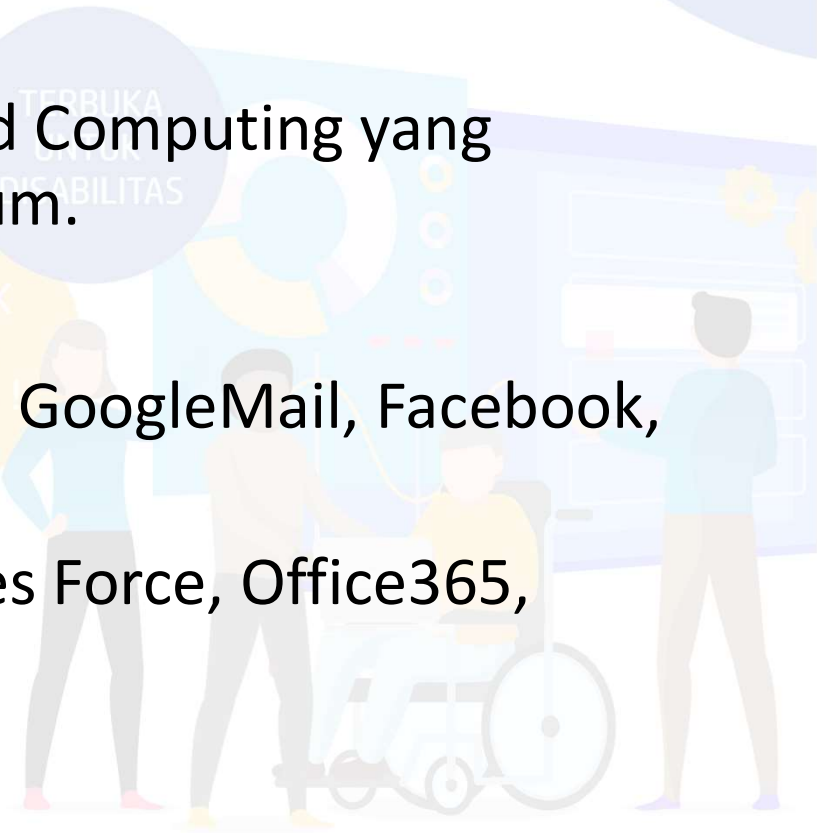
Deployment Model: Public Cloud

Public Cloud Adalah layanan Cloud Computing yang disediakan untuk masyarakat umum.

- Contoh Public Cloud yang gratis: GoogleMail, Facebook, Twitter, Live Mail, dsb. Contoh
- Public Cloud yang berbayar: Sales Force, Office365, GoogleApps, dsb.



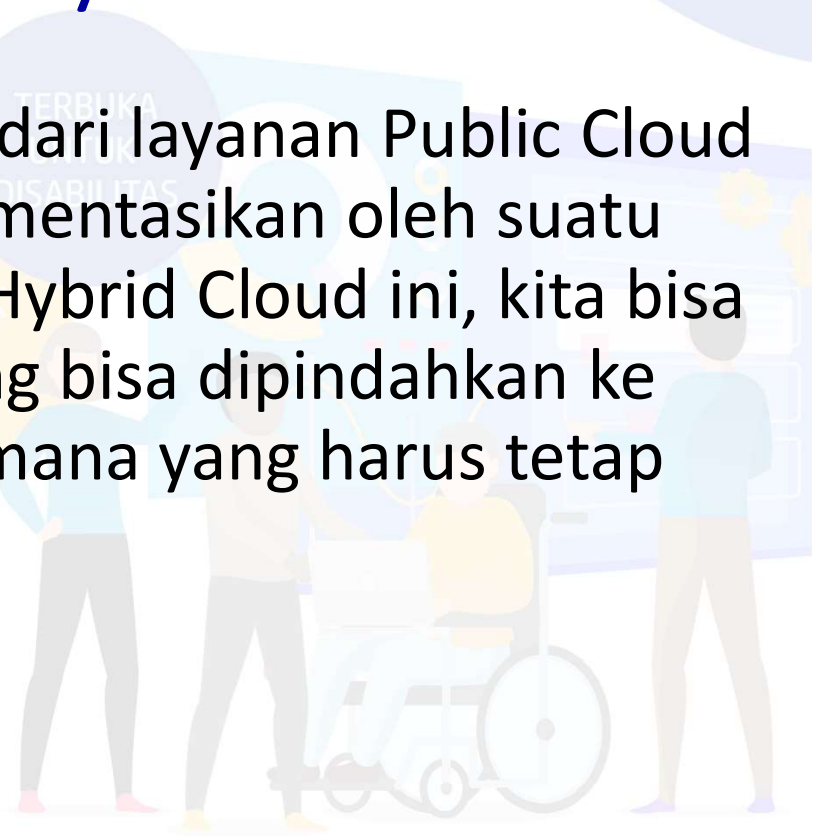
Deployment Model: Public Cloud

- **Keuntungan:** Pengguna tidak perlu berinvestasi untuk merawat serta membangun infrastruktur, platform, ataupun aplikasi.

- **Kerugian:** Sangat tergantung dengan kualitas layanan internet (koneksi) yang kita pakai. Jika koneksi internet mati, maka tidak ada layanan yang dapat diakses. Untuk itu, perlu dipikirkan secara matang infrastruktur internetnya.

Deployment Model: Hybrid Cloud

Hybrid Cloud Adalah gabungan dari layanan Public Cloud dan Private Cloud yang diimplementasikan oleh suatu organisasi/perusahaan. Dalam Hybrid Cloud ini, kita bisa memilih proses bisnis mana yang bisa dipindahkan ke Public Cloud dan proses bisnis mana yang harus tetap berjalan di Private Cloud.



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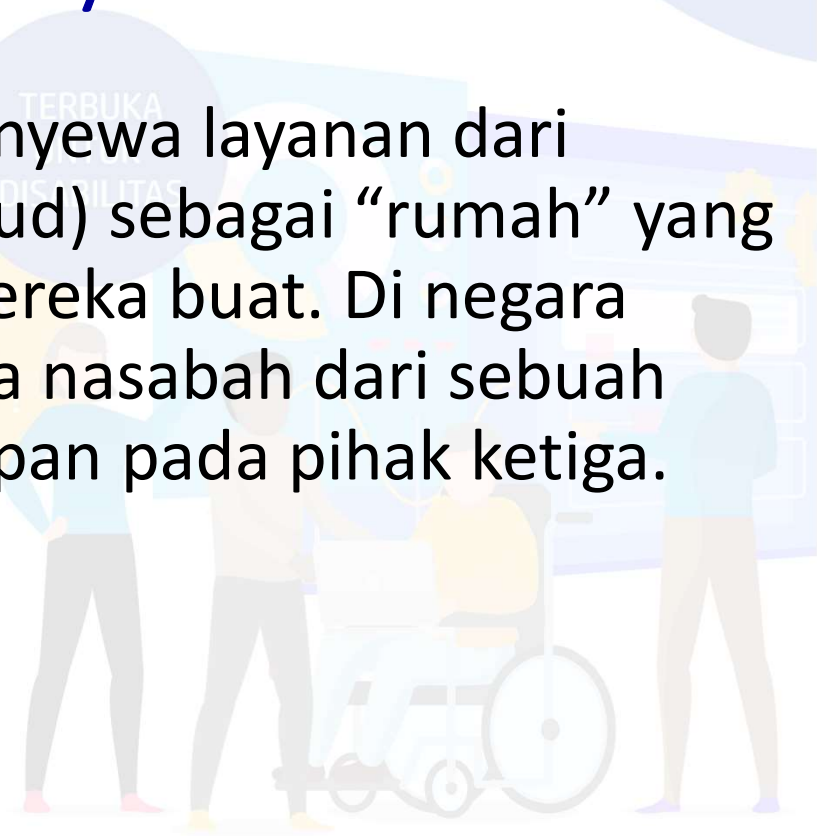
Deployment Model: Hybrid Cloud

- Contohnya: Perusahaan A menyewa layanan dari GoogleApp Engine (Public Cloud) sebagai “rumah” yang dipakai untuk aplikasi yang mereka buat. Di negara tersebut ada aturan kalau data nasabah dari sebuah perusahaan tidak boleh disimpan pada pihak ketiga.



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Deployment Model: Hybrid Cloud

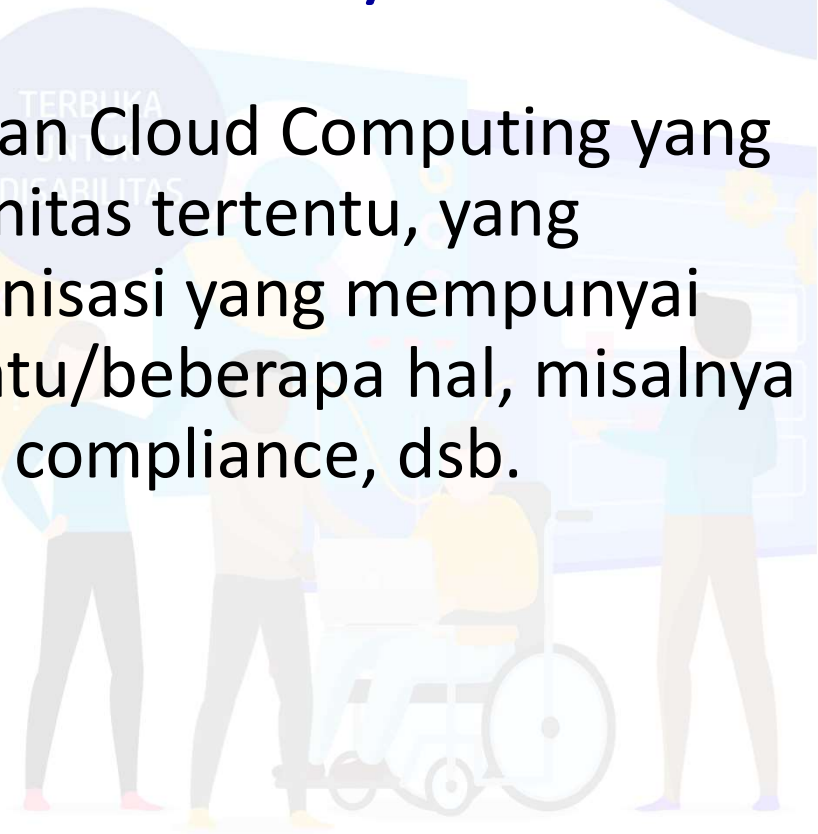
- **Keuntungan:** Keamanan data terjamin karena data dapat dikelola sendiri (hal ini TIDAK berarti penyimpan data di public cloud tidak aman, ya). Lebih leluasa untuk memilih mana proses bisnis yang harus tetap berjalan di private cloud dan mana proses bisnis yang bisa dipindahkan ke public cloud dengan tetap menjamin integrasi dari keduanya.

Deployment Model: Hybrid Cloud

- **Kerugian:** Untuk aplikasi yang membutuhkan integrasi antara public cloud dan private cloud, maka perlu dipikirkan infrastruktur internet untuk menunjang hal tersebut.

Deployment Model: Community Cloud

Community Cloud Adalah layanan Cloud Computing yang dibangun eksklusif untuk komunitas tertentu, yang consumer-nya berasal dari organisasi yang mempunyai perhatian yang sama atas sesuatu/beberapa hal, misalnya saja standar keamanan, aturan, compliance, dsb.



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Deployment Model: Community Cloud

- **Keuntungan:** Bisa bekerja sama dengan organisasi lain dalam komunitas yang mempunyai kepentingan yang sama. Melakukan hal yang sama bersama-sama tentunya lebih ringan daripada melakukannya sendiri.

- **Kerugian:** Ketergantungan antar organisasi jika tiap-tiap organisasi tersebut saling berbagi sumber daya.

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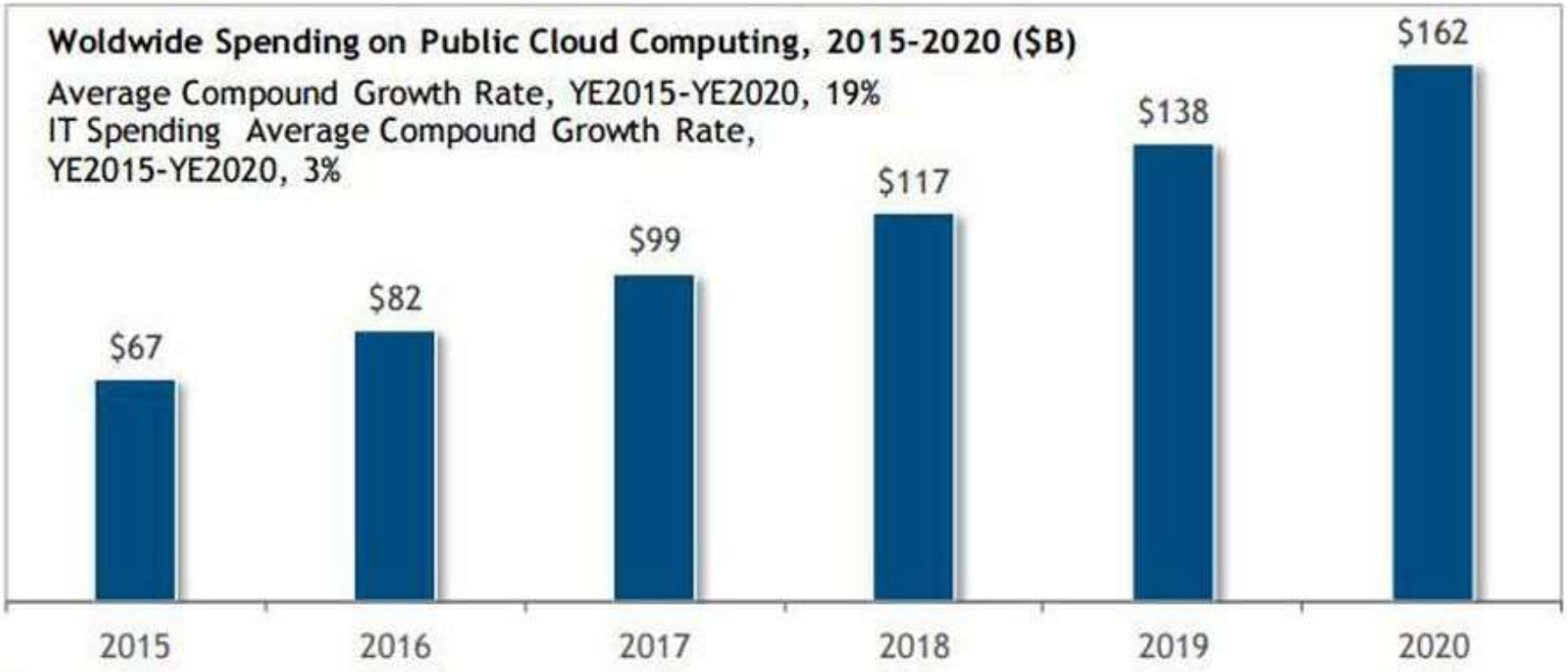
The Rapid Growth of Cloud Computing, 2015-2020



Source: IDC, 2016

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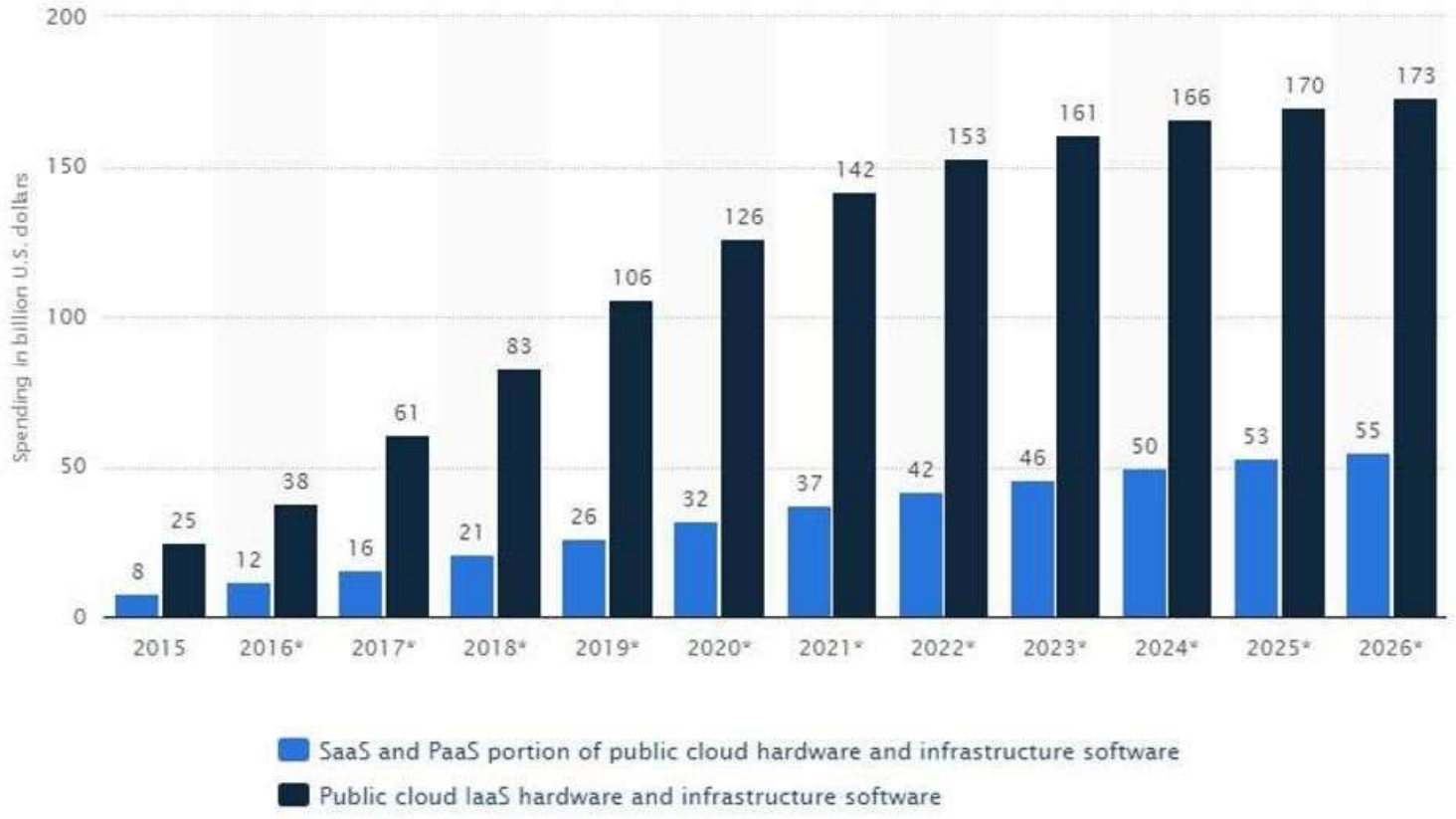
Public cloud Infrastructure as a Service (IaaS) hardware and software spending from 2015 to 2026, by segment (in billion U.S. dollars)



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AWS Technology Overview

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Introduction to the AWS Cloud

- Cloud Computing (Komputasi Cloud)
  - ✓On-demand delivery of IT resources and applications via the internet with pay-as-you-go pricing

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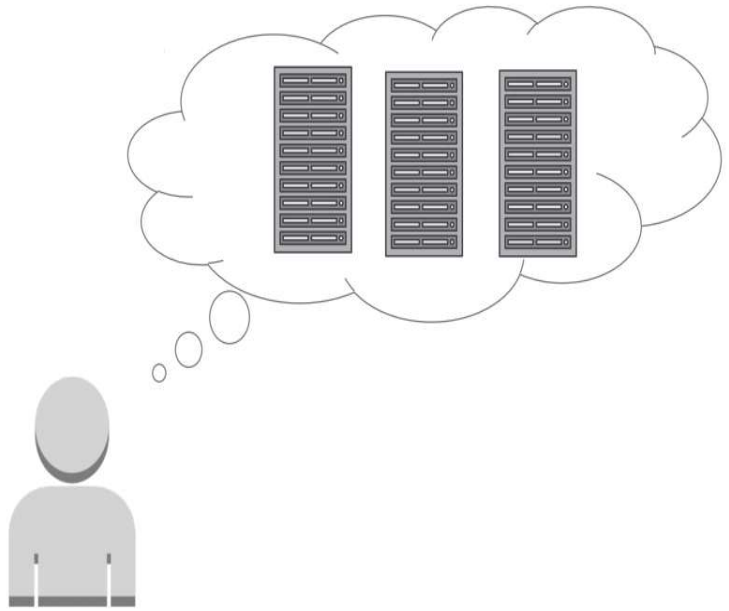
Before AWS

AWS Architecting

- Guessing theoretical maximum peaks?
  - ✓Is there enough resource capacity?
  - ✓Is this sufficient storage?



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With AWS

- **With AWS:**

✓Servers
✓Databases
✓Storage
✓Higher-level applications

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With AWS

- Resouces can be:
  - ✓Initiated within second
  - ✓Treated as “temporary and disposable”
- Free from the inflexibility and constraints

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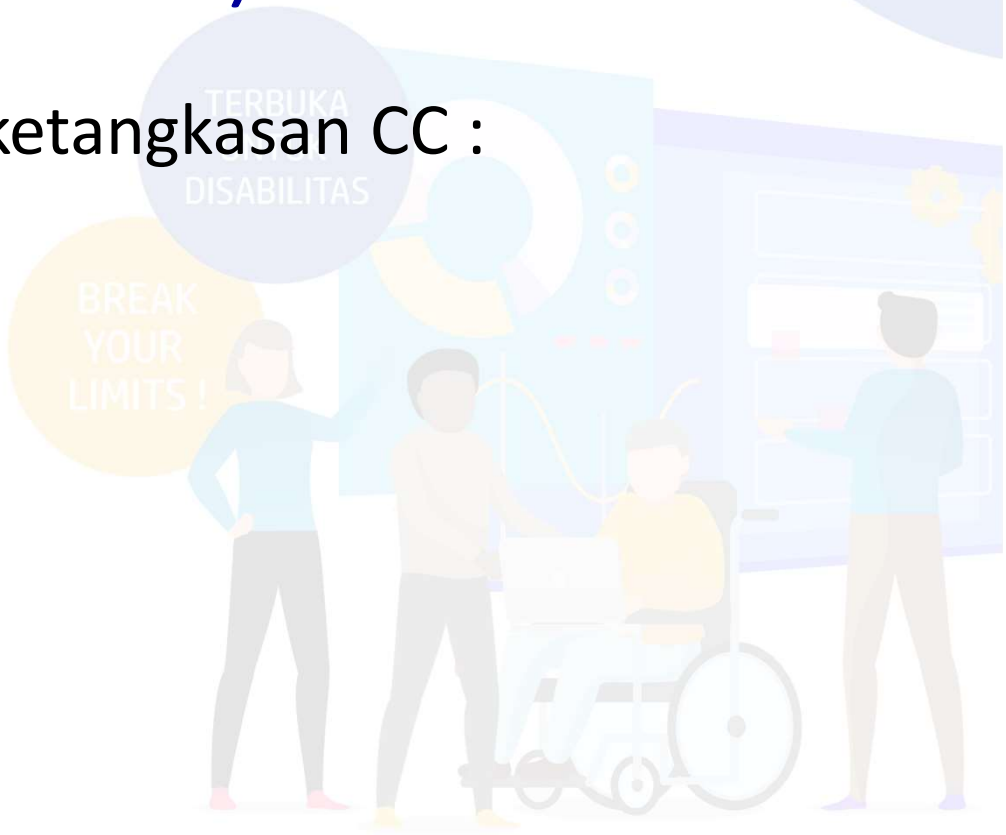
AGILITY (Ketangkasan)

3 Faktor mempengaruhi ketangkasan CC :

- Speed
- Experimentation
- Cultur of innovation



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Agility: Increase Speed and Global Reach

- Instant global reach
- Rapid availability of new resources

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Agility: Increase Experimentation

- AWS enables
  - ✓Operations as code
  - ✓Safe Experimentation
  - ✓Comparative testing

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Agility: Increase Innovation

- Quick experimentation with low cost/risk
- More experimentation and more often

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Agility: The AWS Infrastructure

- Instant elasticity-
- Scalability-
- Flexible
- Reliability
- Secure-

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Global Infrastructure : AWS Region

https://aws.amazon.com/about-aws/global-infrastructure/regions_az

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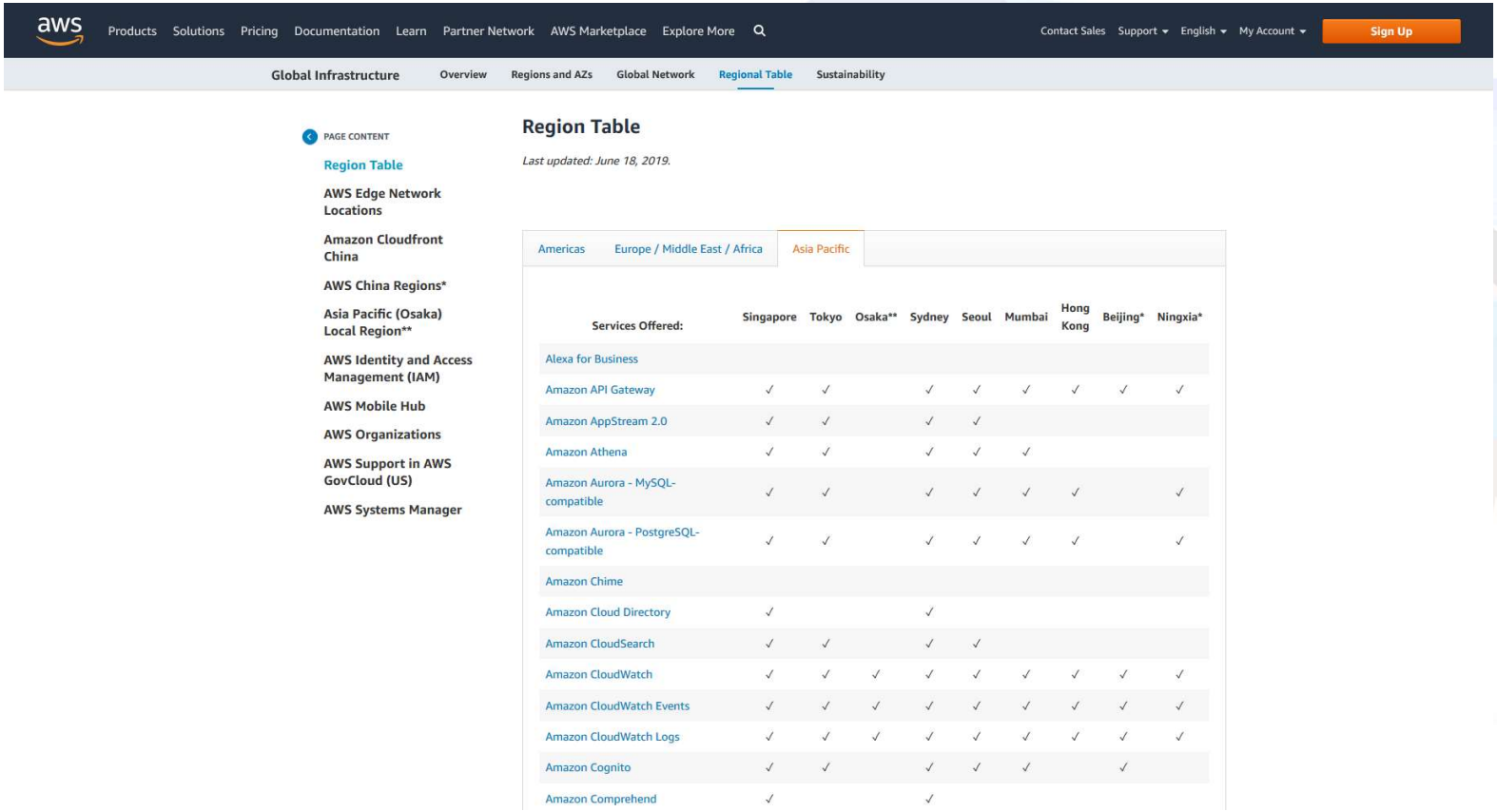
AWS Region



Services Offered:	Singapore	Tokyo	Osaka**	Sydney	Seoul	Mumbai	Hong Kong	Beijing*	Ningxia*
Alexa for Business									
Amazon API Gateway	✓	✓		✓	✓	✓	✓	✓	✓
Amazon AppStream 2.0	✓	✓		✓	✓				
Amazon Athena	✓	✓		✓	✓	✓			
Amazon Aurora - MySQL-compatible	✓	✓		✓	✓	✓	✓		✓
Amazon Aurora - PostgreSQL-compatible	✓	✓		✓	✓	✓	✓		✓
Amazon Chime									
Amazon Cloud Directory	✓			✓					
Amazon CloudSearch	✓	✓		✓	✓				
Amazon CloudWatch	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amazon CloudWatch Events	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amazon CloudWatch Logs	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amazon Cognito	✓	✓		✓	✓	✓		✓	
Amazon Comprehend	✓			✓					

https://aws.amazon.com/about-aws/global-infrastructure/regional-product-services/

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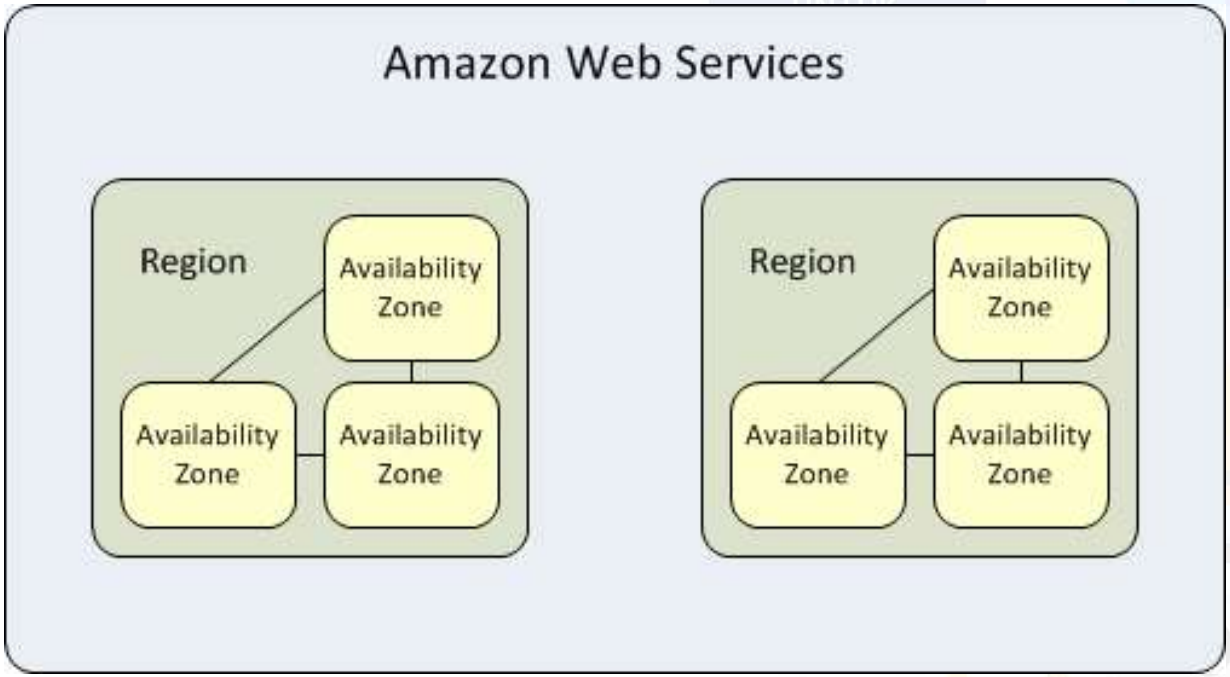
Availability Zones (AZ)



https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/using-regions-availability-zones.html

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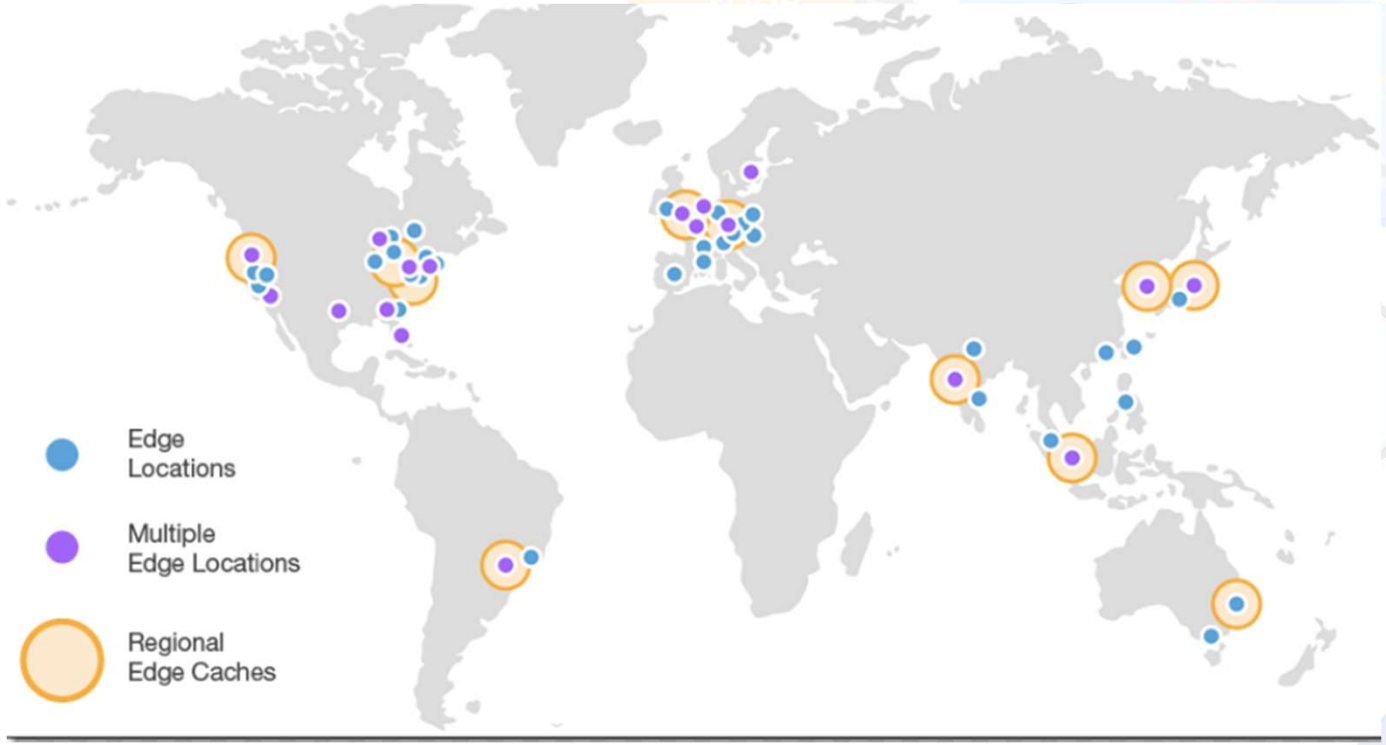
Edge Location

- An **edge location** is where end users access services located at AWS.
  - Implements caching concept here i.e. CDN, DNS



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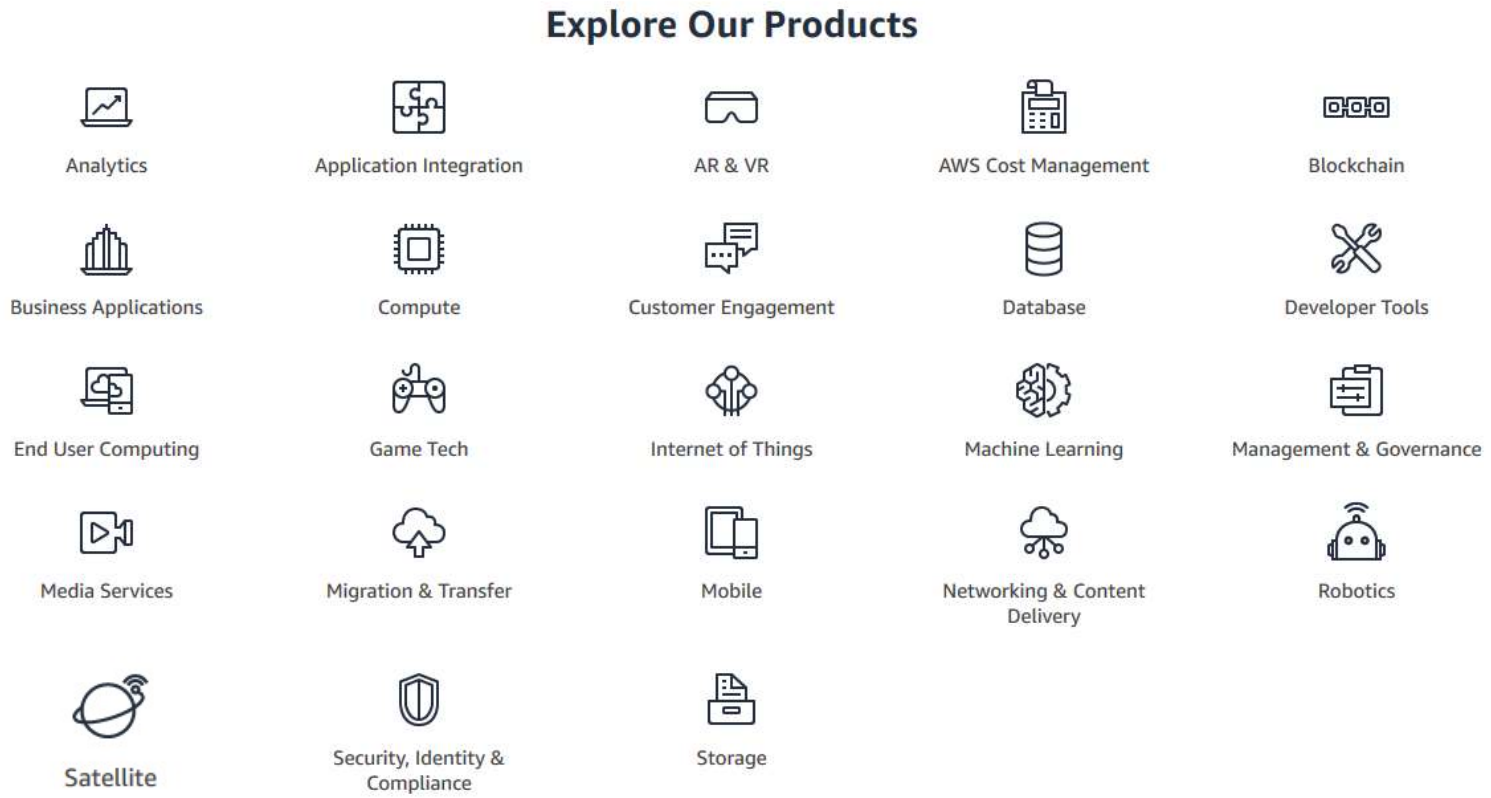
Services & Categories



https://aws.amazon.com/products/

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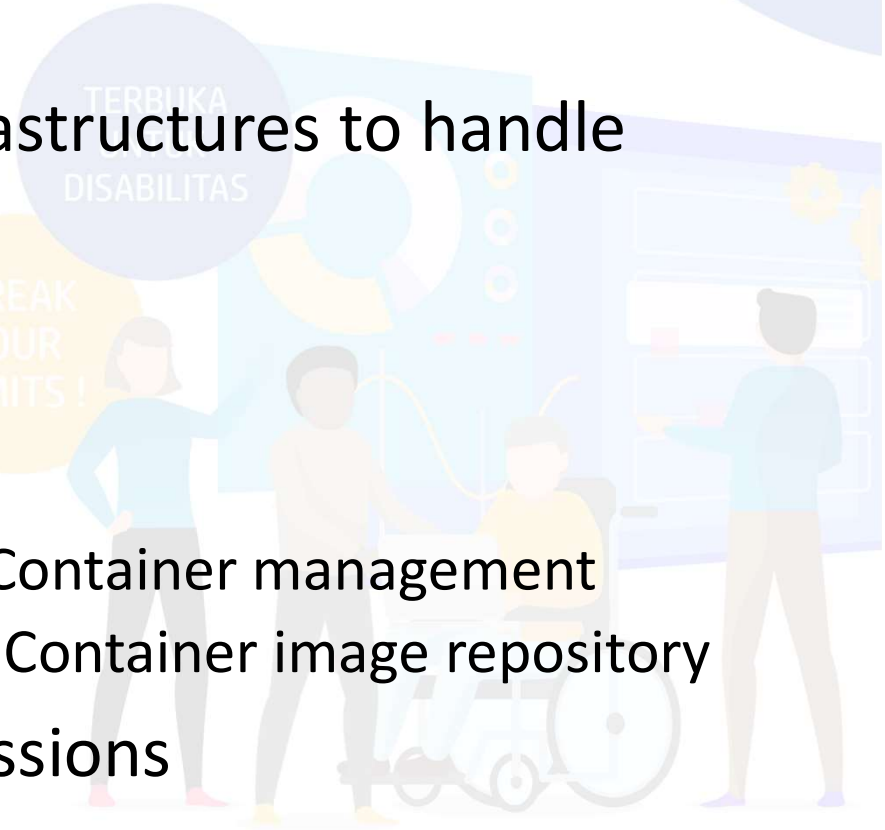
Compute

- Provides platforms and infrastructures to handle computational workload
- Examples:
  - Elastic Beanstalk → PaaS
  - EC2 → Virtual servers
  - Elastic Container Service → Container management
  - Elastic Container Registry → Container image repository
- Will have its own lecture sessions



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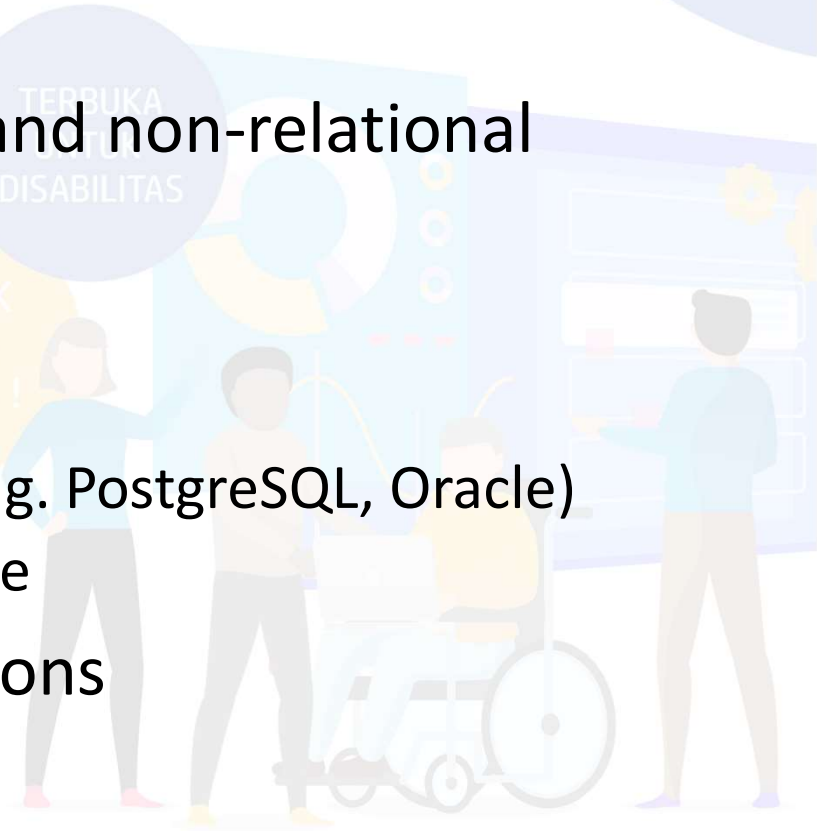
Database

- Provides managed relational and non-relational databases
- Examples:
  - DynamoDB → NoSQL database
  - RDS → Relational databases (e.g. PostgreSQL, Oracle)
  - ElastiCache → In-memory cache
- Will have its own lecture sessions



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Storage

- Provides data persistence for files and disks
- Examples:
  - Simple Storage Service (S3) → Cloud file storage
  - Elastic Block Storage → EC2 virtual disks
  - S3 Glacier → Cold archive storage
- Will have its own lecture sessions

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Networking & Content Delivery

- Provides network management to the cloud resources
- Examples:
  - Virtual Private Cloud (VPC) → Isolated cloud resources
  - CloudFront → Content Delivery Network (CDN)
  - Route 53 → DNS
  - Elastic Load Balancing (ELB) → Load balancer
- Will have its own lecture sessions

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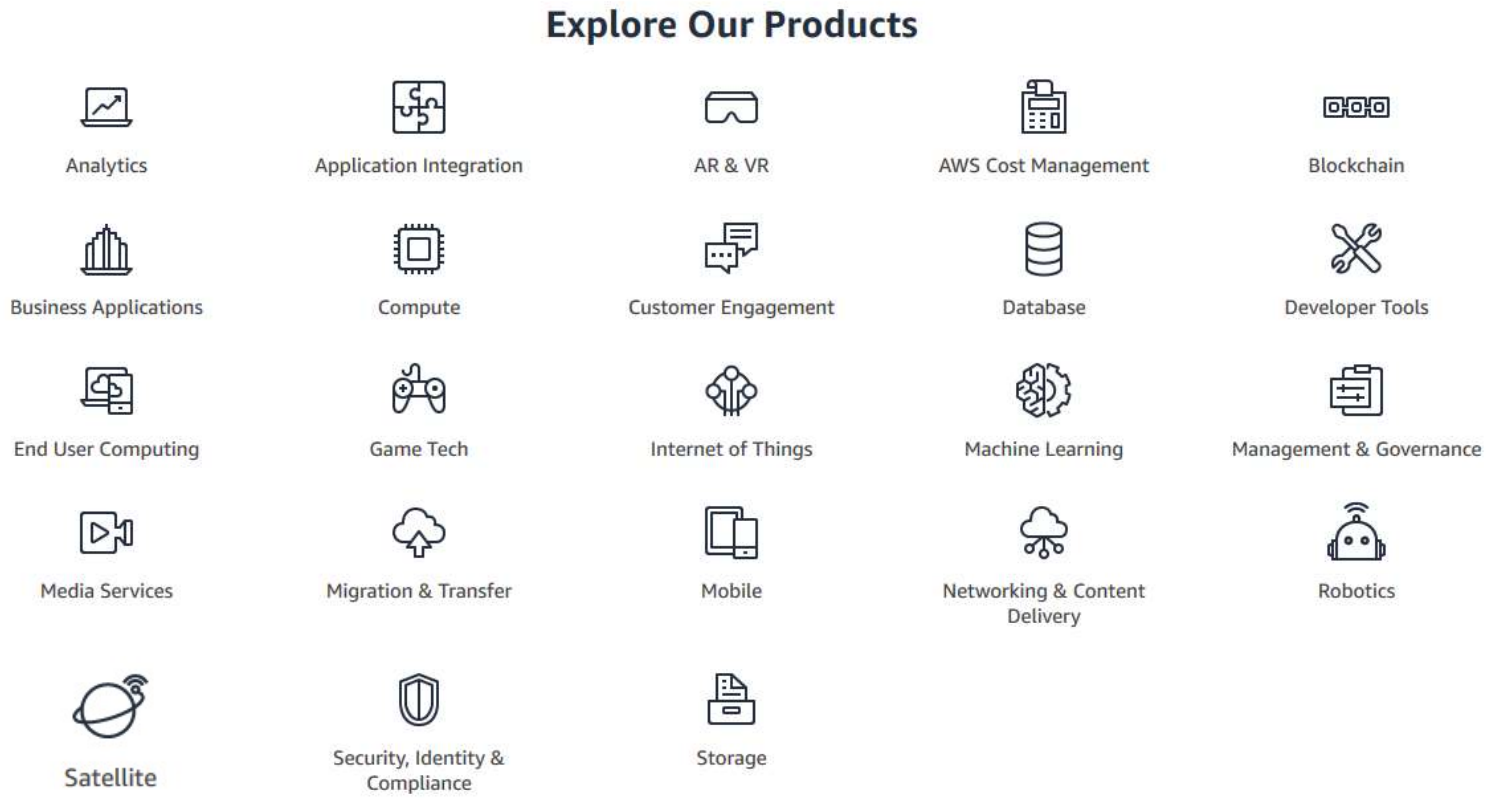
And many more …



https://aws.amazon.com/products/

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Cloud Economics

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Traditional IT Infrastructure vs. Cloud

Traditional

Equipment

Resources & Administration

Contracts

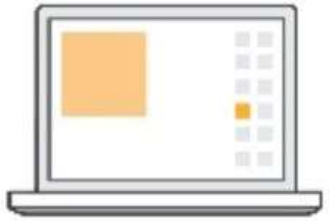
Cost

AWS Cloud

No upfront cost
Pay for what you use

Improve time & agility

Scale up & down



Self-service infrastructure

Redrawn from (Johnson, 2017)

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Total Cost of Ownership (TCO)

- "*Total cost of acquiring and operating for running an infrastructure environment*" – (Johnson, 2011)
- We need to estimate and compare the TCO both when setting up infrastructure "on premise" and "on the cloud"
  - Cloud-only or local-only is not necessarily cheaper
  - Mix-and-match/hybrid is possible (e.g. VPS on local datacentre, backup storage on the cloud)
- Why?

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Why Use TCO?

- Comparing the costs of running of an infrastructure environment or specific workload on-premises or in a co-location facility versus on AWS
  - Example: Operating a server locally in office vs. collocated in a datacentre vs. on AWS as EC2 instance
- Budgeting & building the business case for moving to the cloud
- Integrate an existing AWS workload with an on-premises or co-location setup

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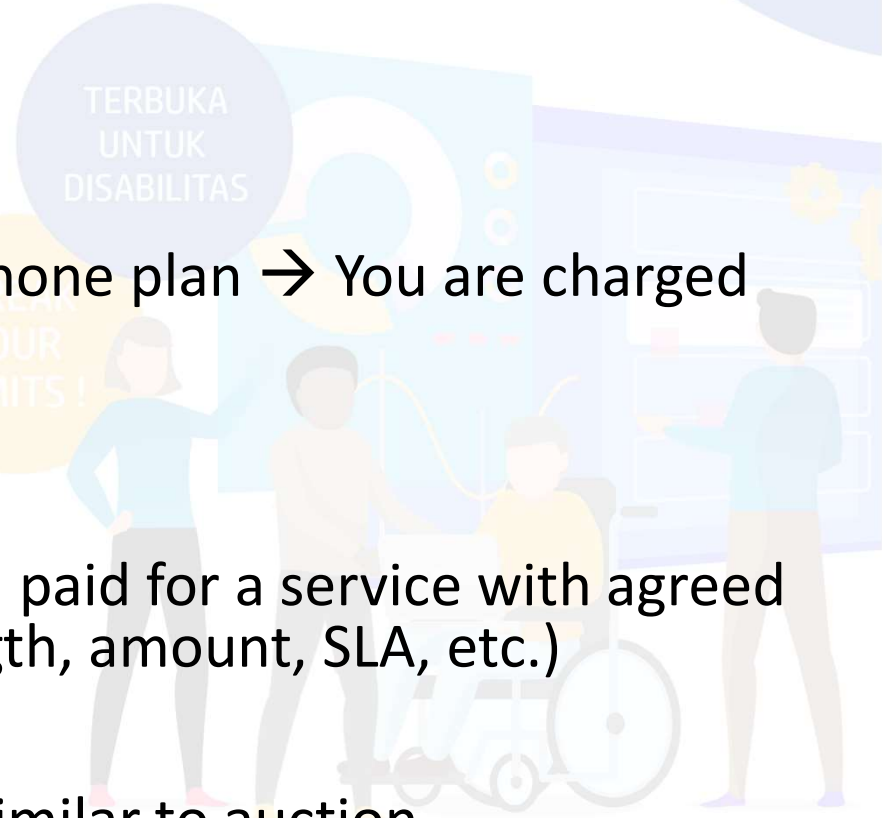
Pricing Models

- On-demand
  - Pay-as-you-go
  - Analogy: Post-paid mobile phone plan → You are charged based on your service usage
- Reserve
  - Upfront payment
  - Analogy: Subscription → You paid for a service with agreed terms & conditions (e.g. length, amount, SLA, etc.)
- Spot
  - Bid for a cloud resource → Similar to auction
  - Availability is not guaranteed



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