SE4010 - Current Trends in Software Engineering

CLOUD COMPUTING

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About Me

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Lecture Objective

1. To Provide an Understanding to Cloud Computing
2. ?

Lecture Content

- Introduction to Cloud Computing - Week 1
  - What is Cloud Computing ?
  - History and Origins
  - Characteristics of Cloud Computing
- CapEX vs OpEx
  - Vertical Scalability
  - Horizontal Scalability
- Types of Cloud Deployment Methods
  - Private
  - Hybrid
  - Public
- Types of Cloud Computing Services
  - SAAS
  - PAAS
  - IAAS

Lecture Content Cont.

- introduction Amazon Web Services – Week 1
  - AWS Cloud History
  - AWS Global Infrastructure
  - AWS Regions
  - Choosing an AWS Region
  - AWS Availability Zones
  - Edge Locations
  - Global Services vs Regional Services
- Identity and Access Management – IAM
  - Users & Groups
  - Permissions & Policies
  - Password Policy & MFA
  - Access Methods of AWS

Lecture Content Cont.

- EC2 – Week 2
  - EC2 sizing & configuration options
  - EC2 Instance Storage Section
  - Security Groups
  - AMI Overview
- Simple Storage Service – S3
  - S3 Storage Classes
  - S3 Buckets and Objects
  - S3 Security
  - S3 Web Site – Demo
  - S3 Consistency Model
- Networking – VPC - Week 3
- Database – RDS Week 3
- Costing Management

Introduction

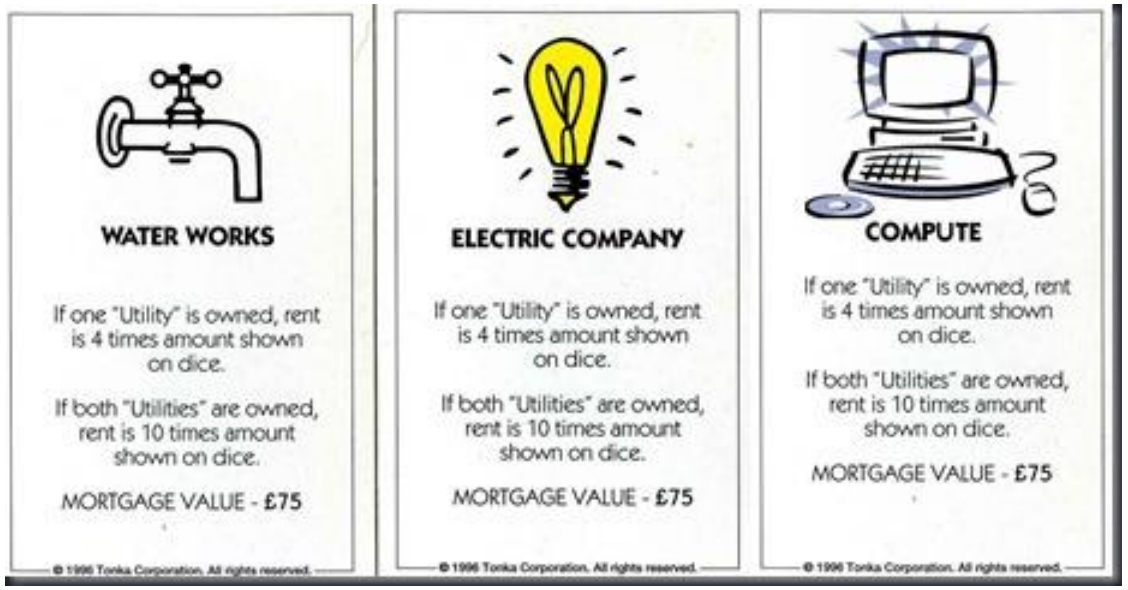
CLOUD COMPUTING

What is cloud computing?

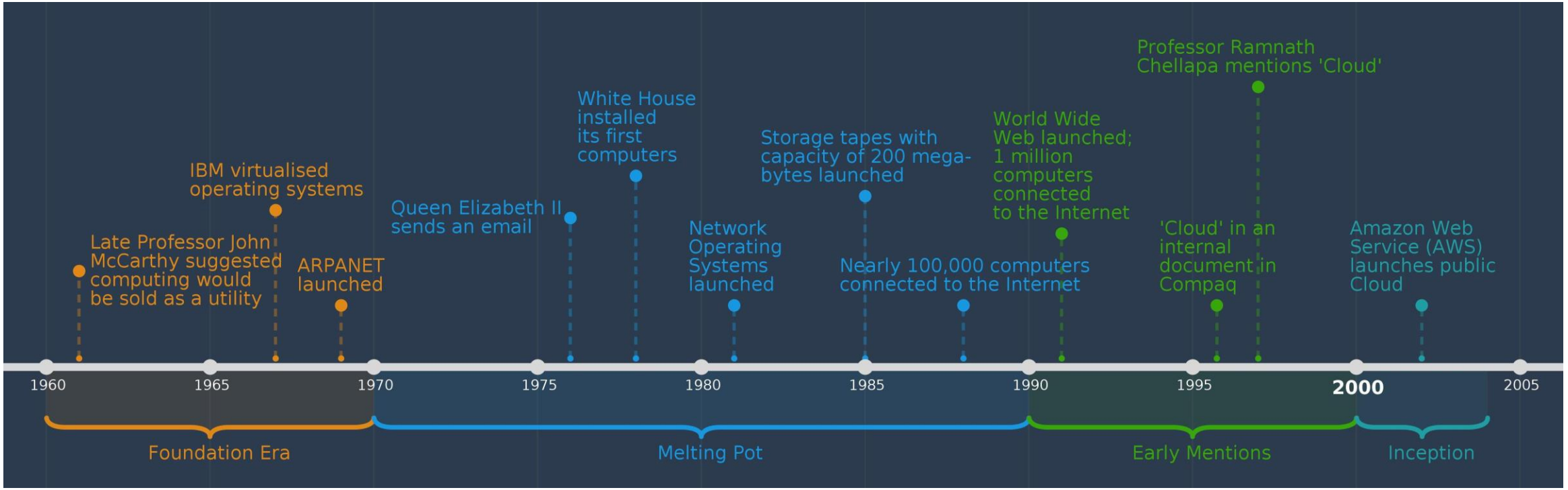
- Cloud Computing Is The Delivery of Computing Services including Servers, Storage, Databases, Networking, Software, Analytics, and Intelligence over The Internet

- Typically pay only for cloud services you use, helping to lower the operating costs

- Run the infrastructure more efficiently, and scale as your business needs change

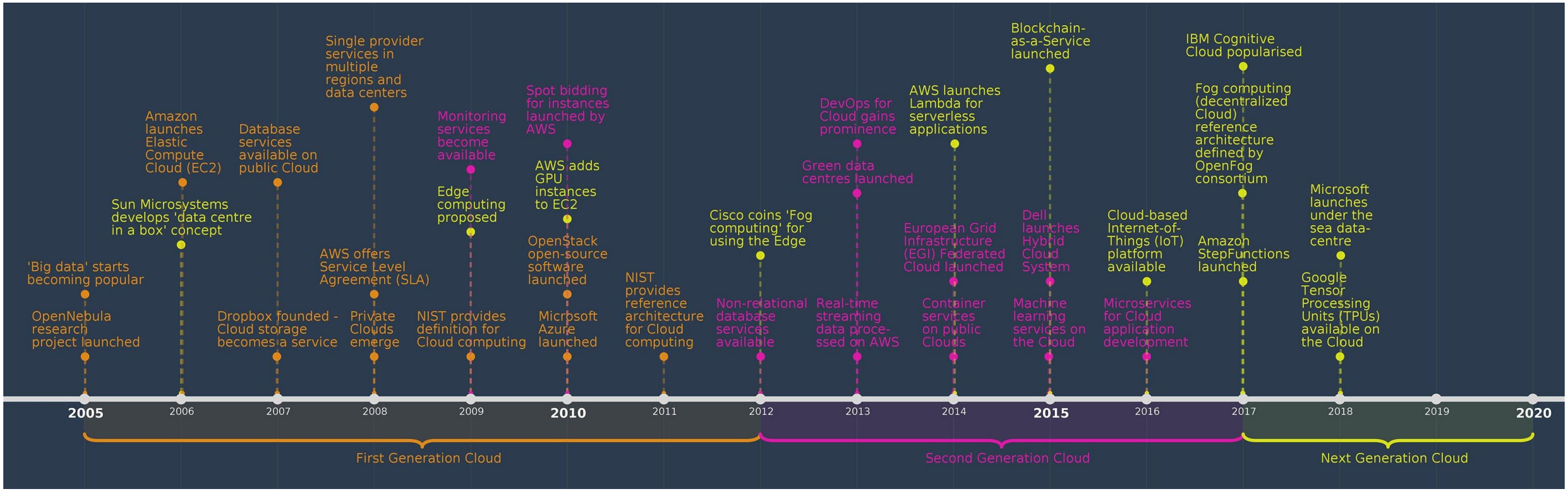


History and Origins



https://www.bcs.org/media/2416/cloud-timeline-1960-2005.jpg

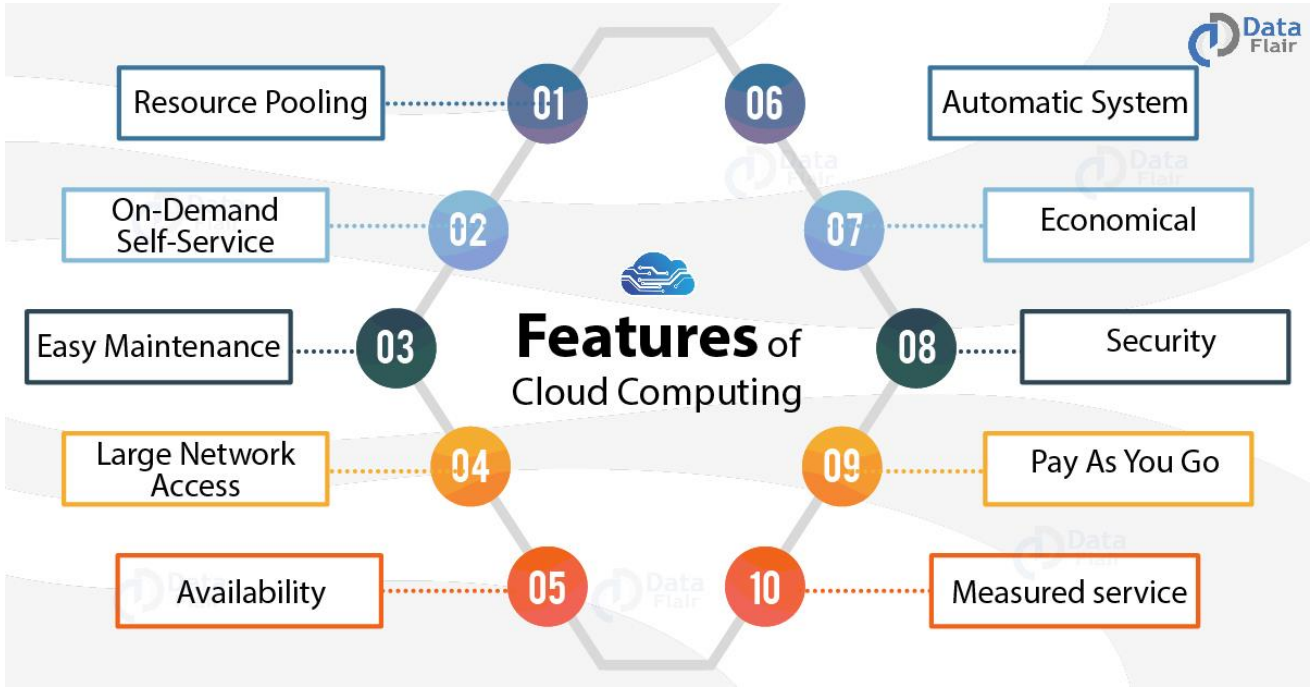
History and Origins



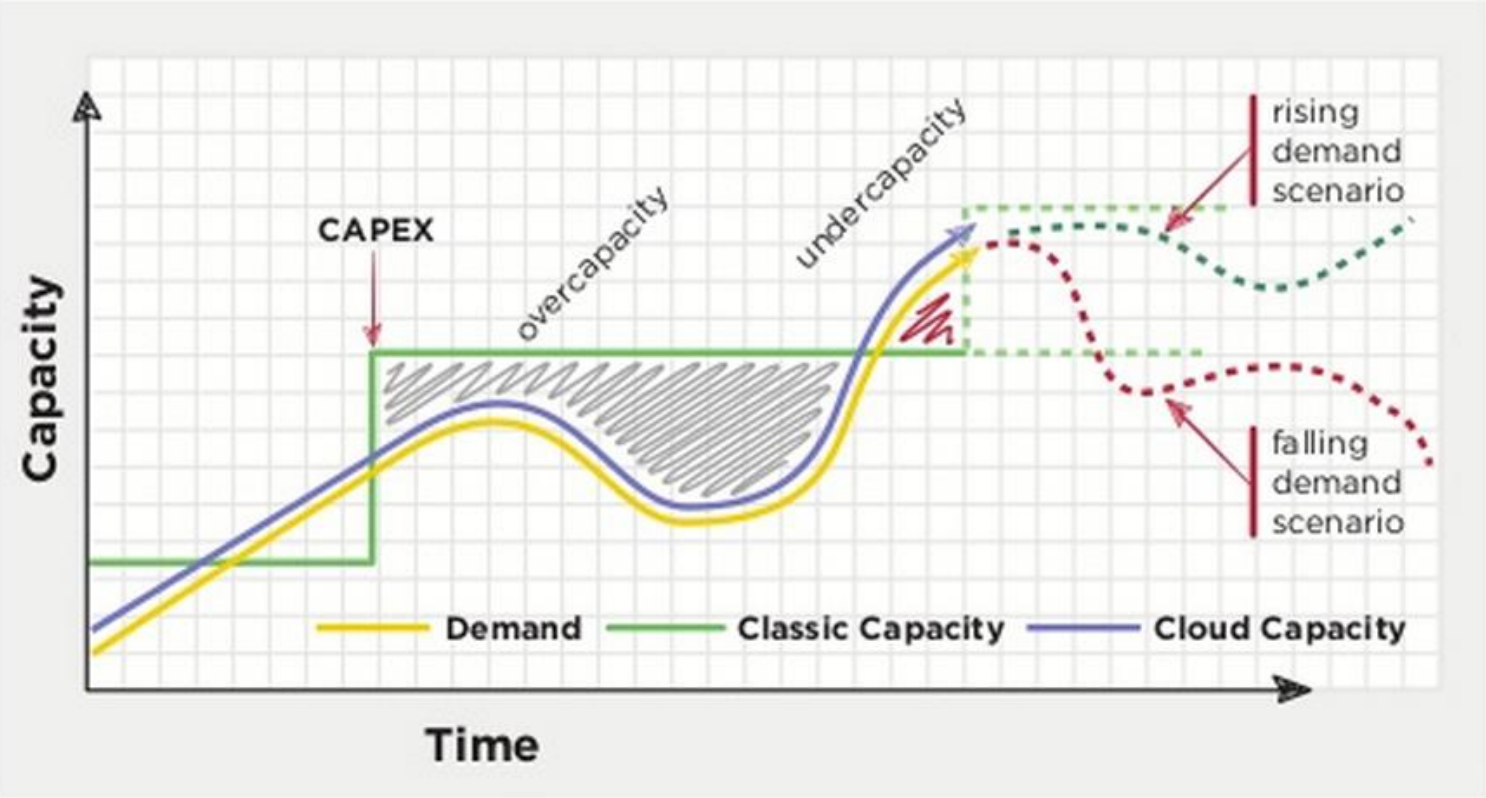
https://www.bcs.org/media/2417/cloud-timeline-2005-2020.jpg

Characteristics of Cloud Computing

- Resources Pooling
- On-Demand Self-Service
- Easy Maintenance
- Scalability And Rapid Elasticity
- Economical
- Measured And Reporting Service
- Security
- Automation
- Resiliency And Availability
- Large Network Access
- Work From Any Location
- Multi-Tenancy
- Flexibility
- Service Excellence
- Comfortable Payment Structure



CapX vs Opex (Cloud Compute Context)

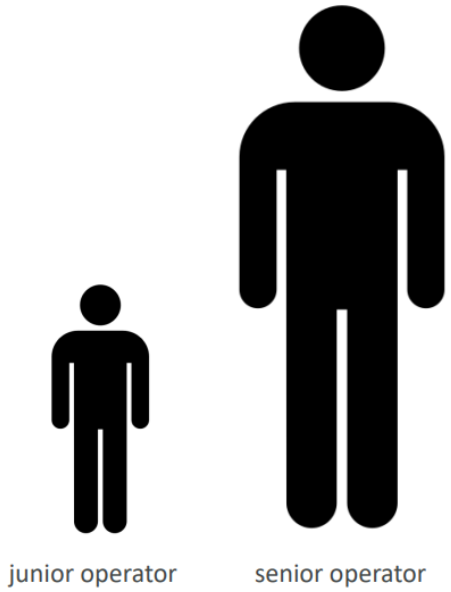


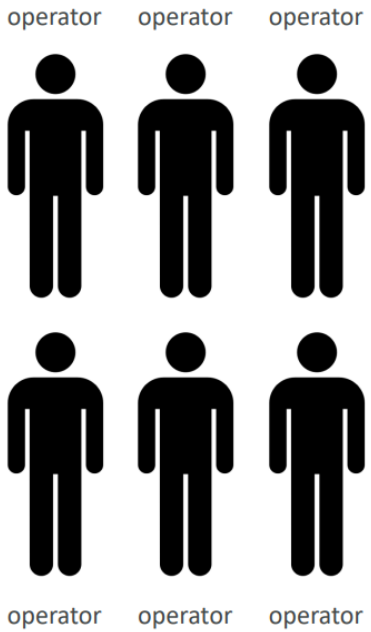
CapX vs Opex (Cloud Compute Context) Cont.

	CapX	OpeX
Up front Cost	Significant	None
Ongoing Cost	Low	Based on Usage
Value Over Time	Lowers	No Change
Early Termination	No	Anytime
Maintenance	Significant	Low

Vertical & Horizontal Scalability

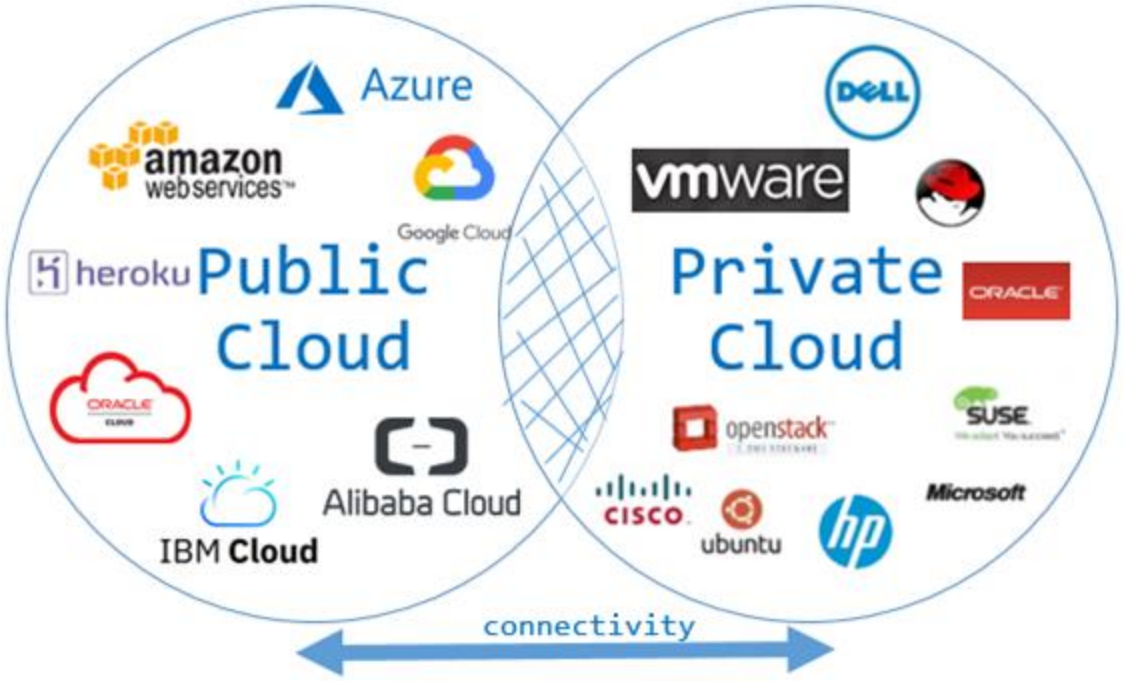
- Scalability means that an application / system can handle greater loads by adapting.
  - Vertical Scalability - Vertically scalability means increasing the size of the instance
  - Horizontal Scalability -Horizontal Scalability means increasing the number of instances / systems for your application





Types of Cloud Deployment Models

- Private Cloud
- Hybrid Cloud
- Public Cloud

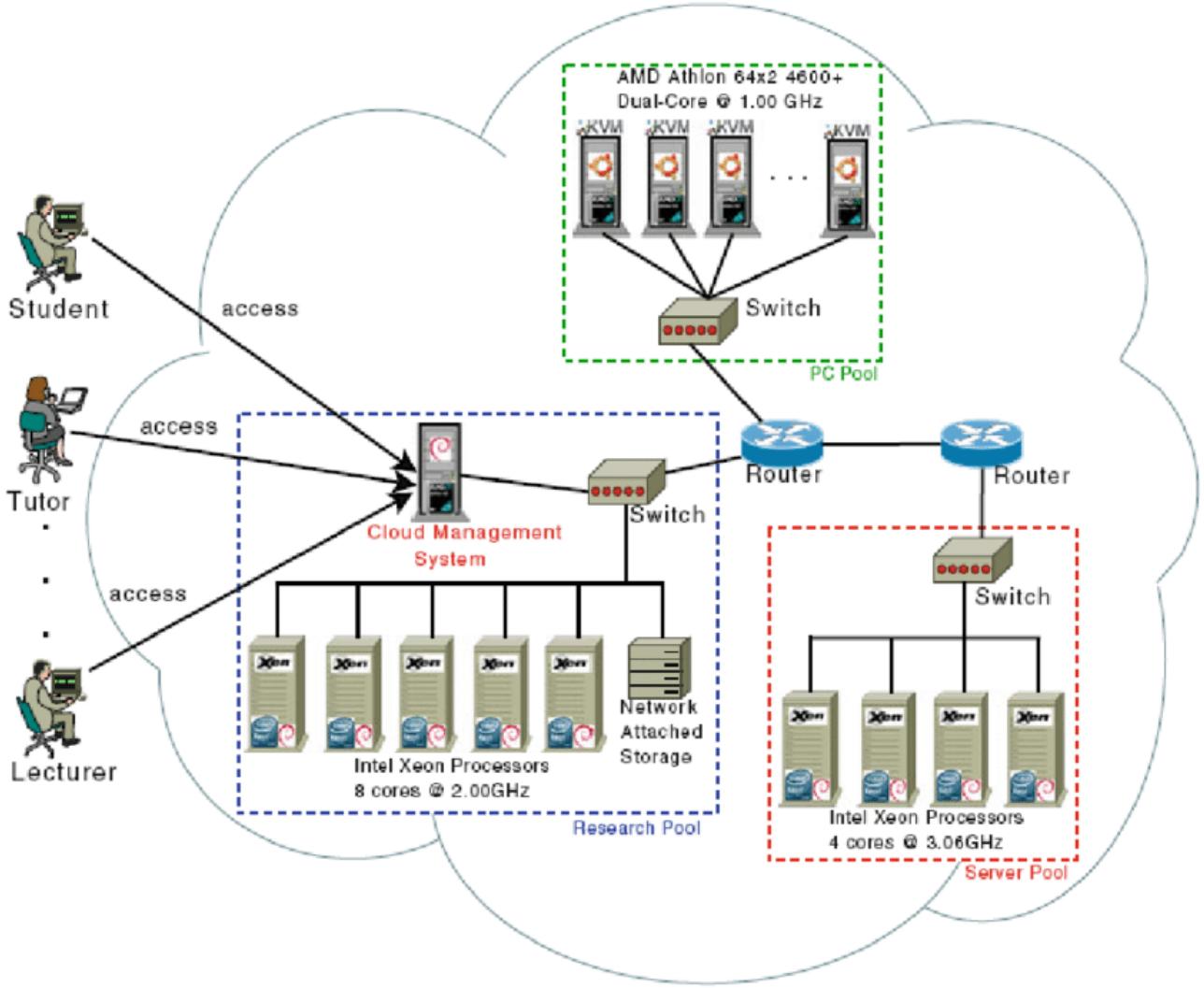


Private Cloud

- Private cloud is a type of cloud computing that delivers similar advantages to public cloud, including scalability and self-service, but through a proprietary architecture.

- A private cloud, also known as internal or corporate cloud, is dedicated to the needs and goals of a single organization whereas public clouds deliver services to multiple organizations.

Private Cloud Architecture

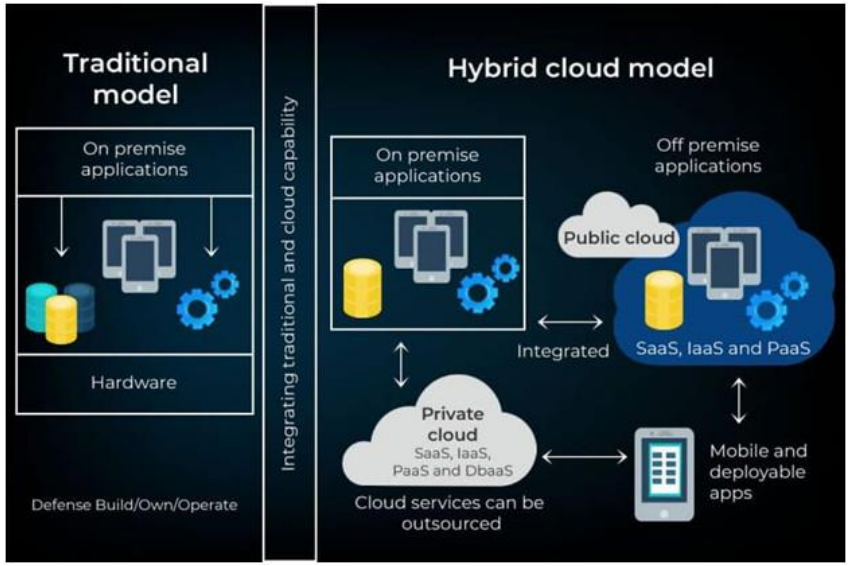


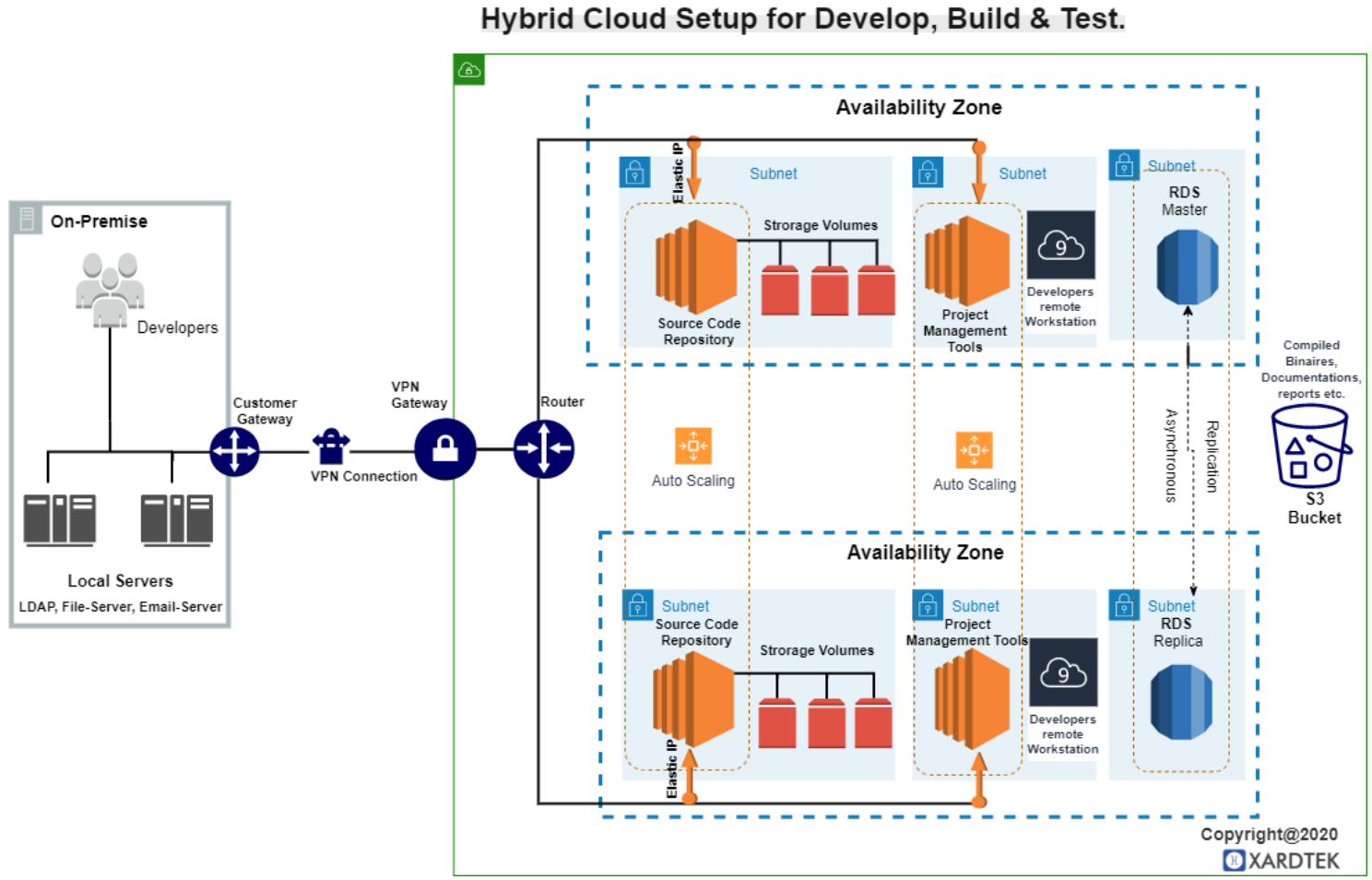
Hybrid Cloud

- Hybrid cloud refers to a mixed computing, storage, and services environment made up of on-premises infrastructure, private cloud services, and a public cloud—such as Amazon Web Services (AWS) or Microsoft Azure—with orchestration among the various platforms.

- Using a combination of public clouds, on-premises computing, and private clouds in your data center means that you have a hybrid cloud infrastructure.

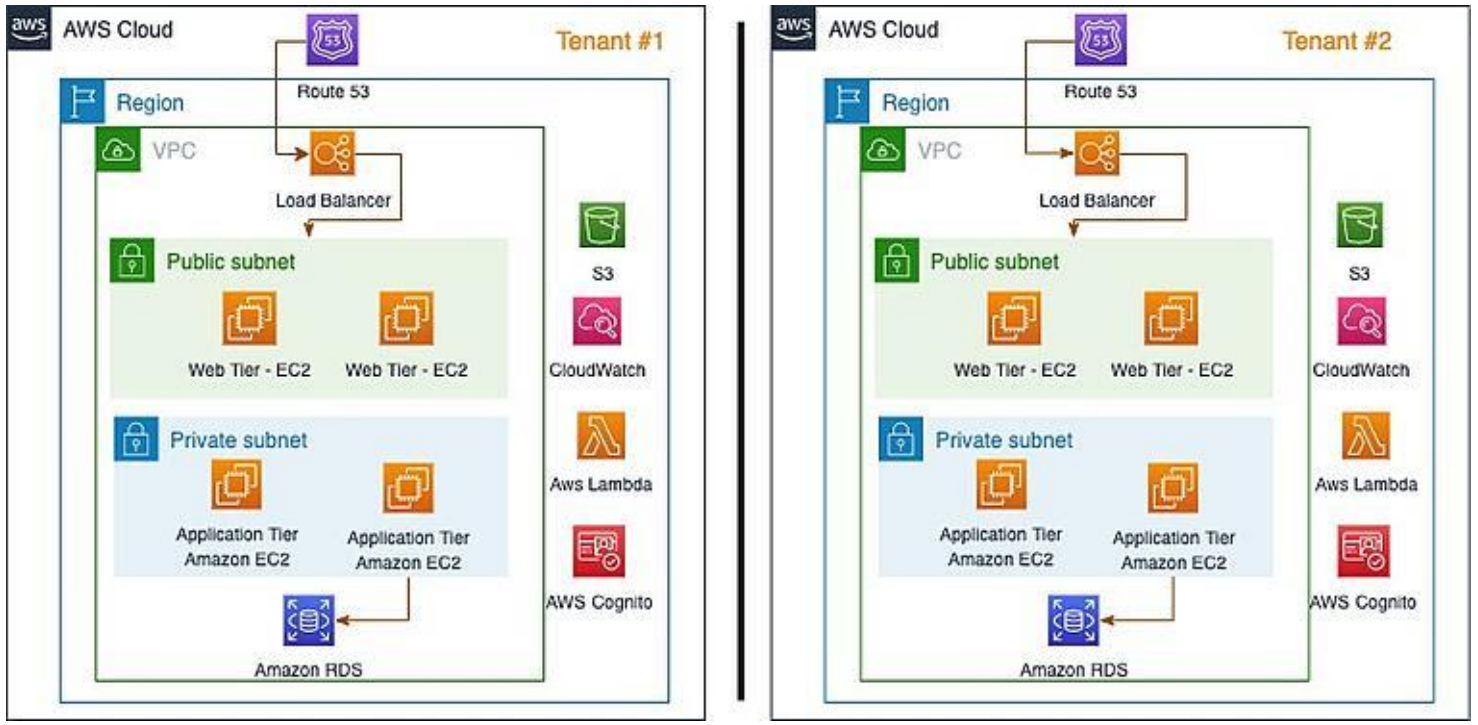
Hybrid Cloud Architecture



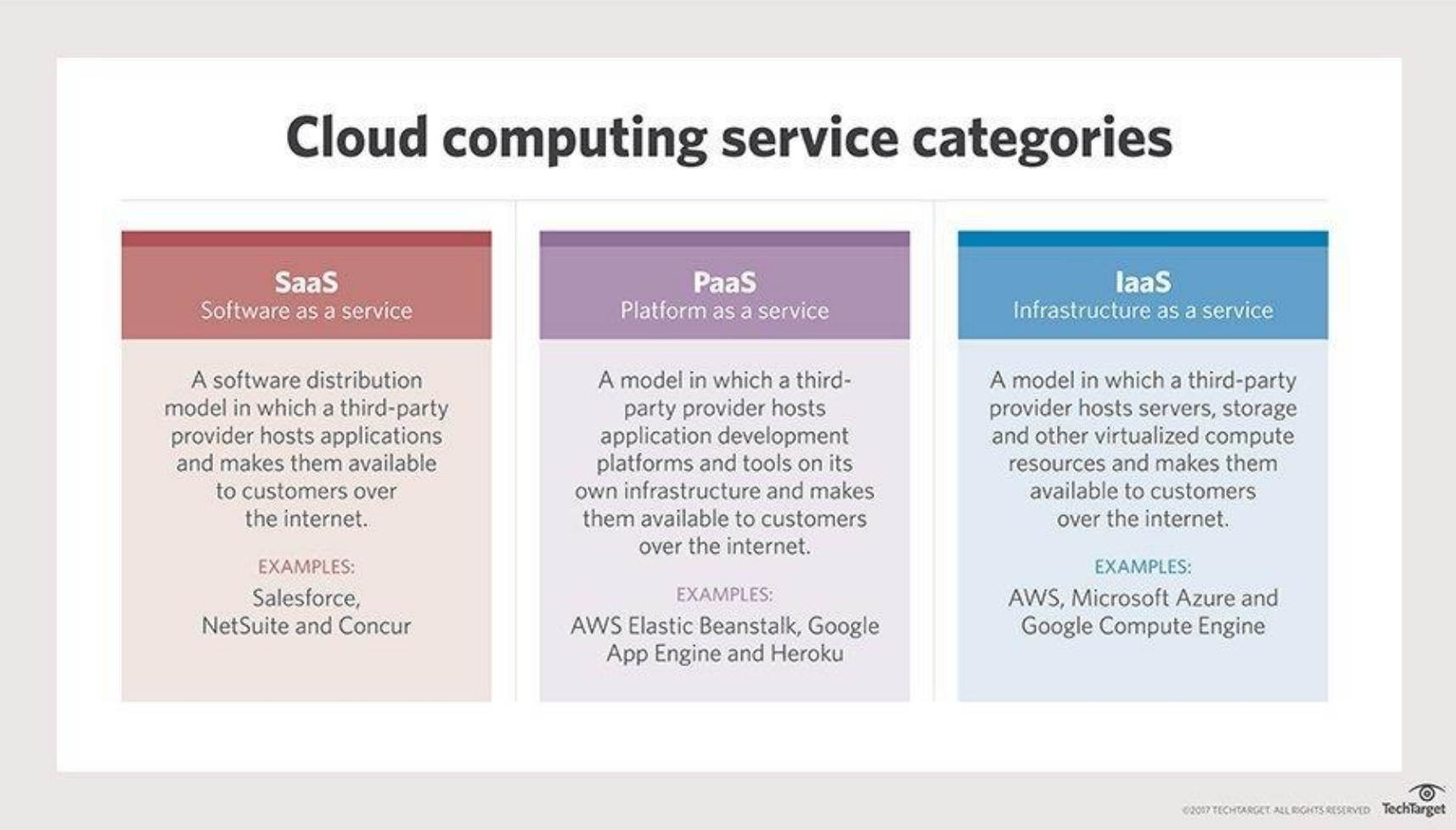


Public Cloud

- A public cloud is a platform that uses the standard cloud computing model to make resources -- such as virtual machines, applications or storage -- available to users remotely. Public cloud services may be free or offered through a variety of subscription or on-demand pricing schemes, including a pay-per-usage model.



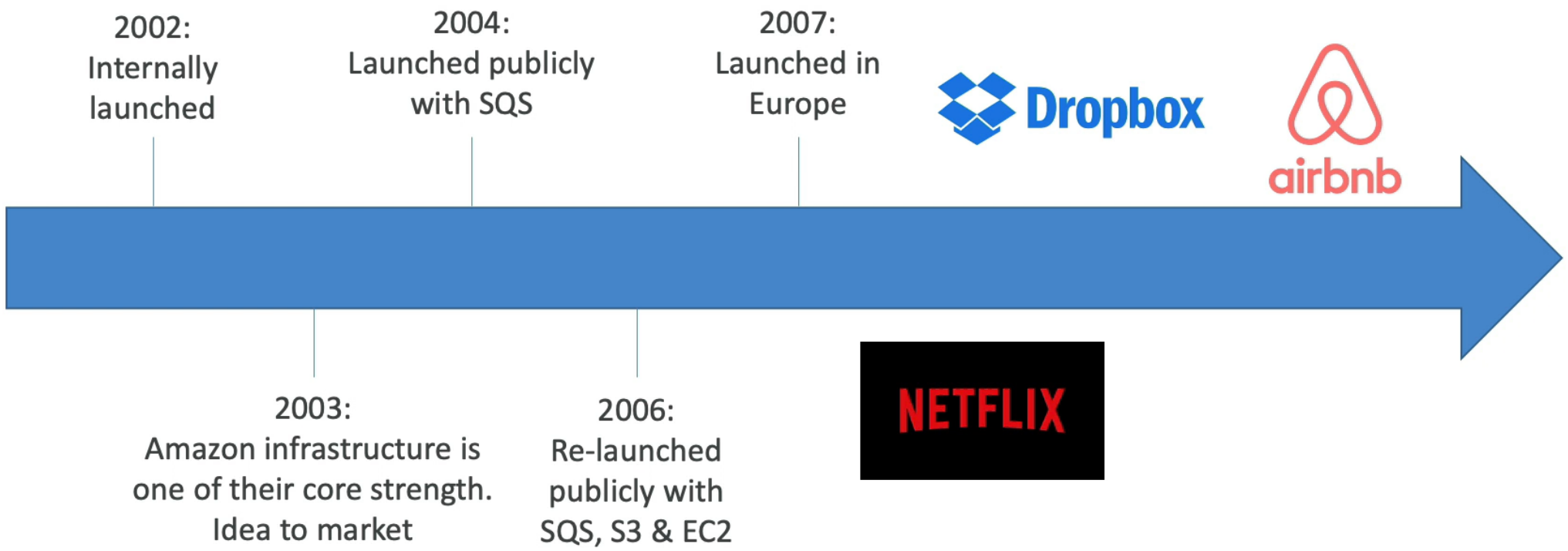
Types of Cloud Computing Services



Introduction

AMAZON WEB SERVICES

AWS Cloud History



AWS Global Reach

- In 2019, AWS had $35.02 billion in annual revenue.
- AWS accounts for 47% of the market in 2019 (Microsoft is 2nd with 22%)
- Pioneer and Leader of the AWS Cloud Market for the 9th consecutive year
- Over 1,000,000 active users

Figure 1: Magic Quadrant for Cloud Infrastructure and Platform Services

Source: Gartner (July 2021)

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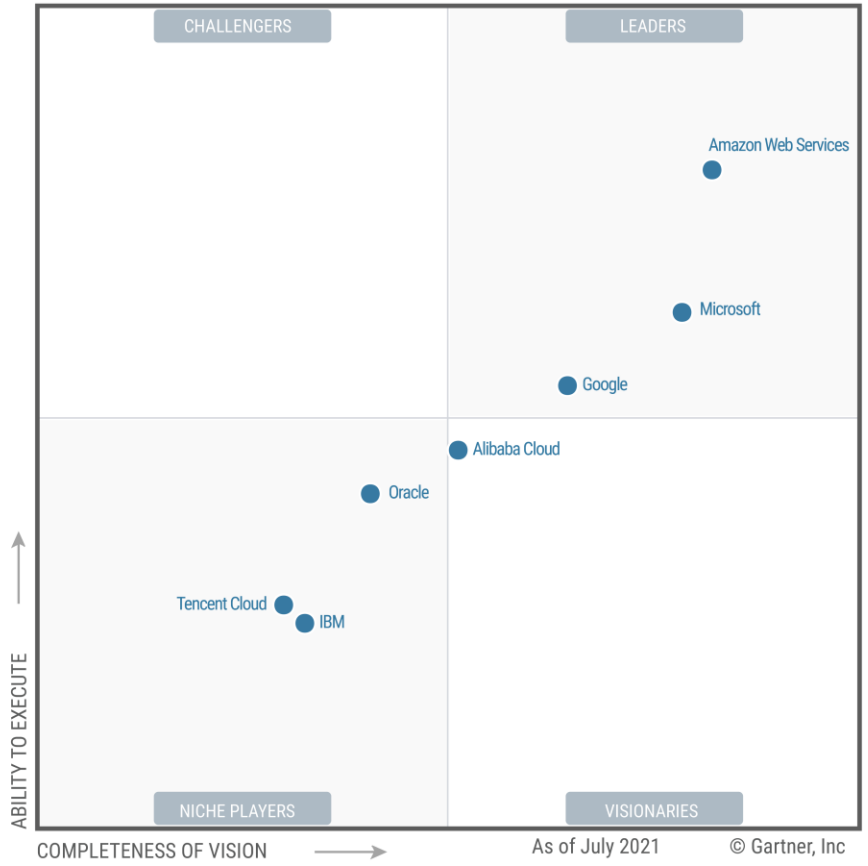
Figure 1: Magic Quadrant for Cloud Infrastructure and Platform Services



Source: Gartner (July 2021)

AWS Global Infrastructure

- AWS Regions
- AWS Availability Zones [AWS Data Centers]
- AWS Edge Locations

AWS Regions

- AWS has Regions all around the world
- Names can be ap-southeast-1, eu-west-3
- A region is a cluster of data centers

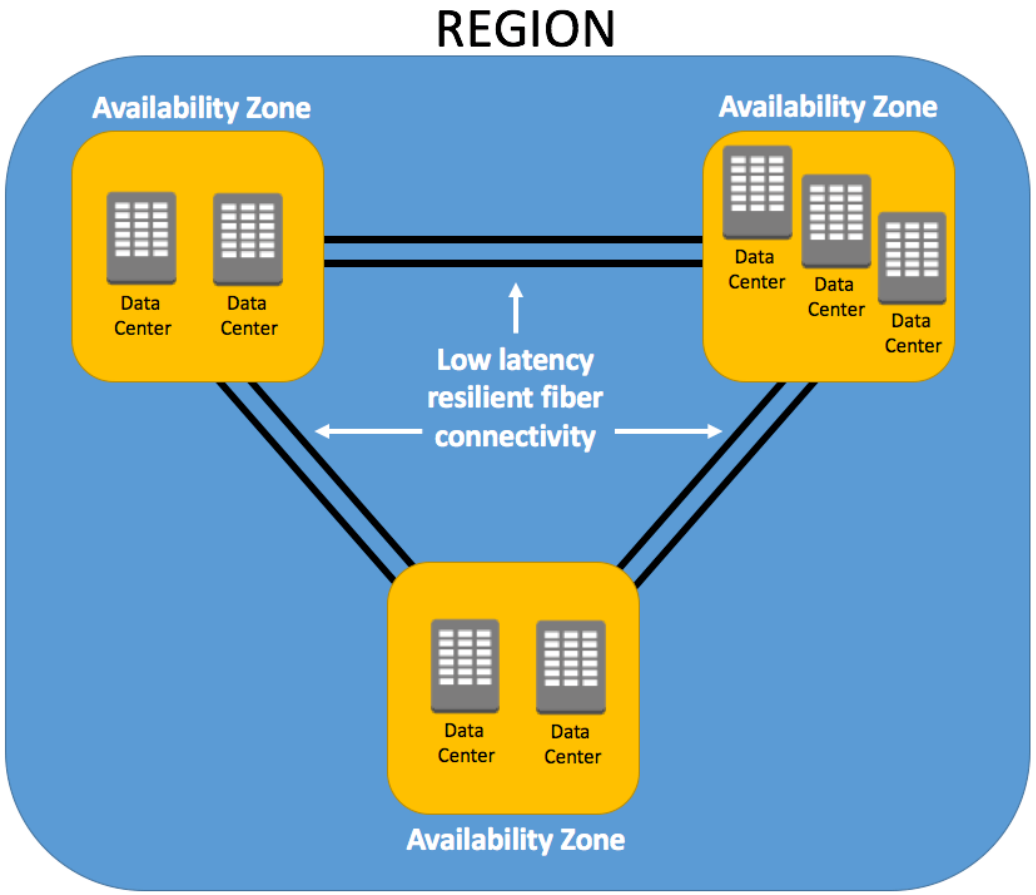
The AWS Cloud spans 84 Availability Zones within 26 geographic regions around the world, with announced plans for 24 more Availability Zones and 8 more AWS Regions in Australia, Canada, India, Israel, New Zealand, Spain, Switzerland, and United Arab Emirates (UAE).

AWS Availability Zones

- Each region has many availability zones (usually 3, min is 2, max is 6)
- The AZ are named based on their region
  - Example: • ap-southeast-2a • ap-southeast-2b

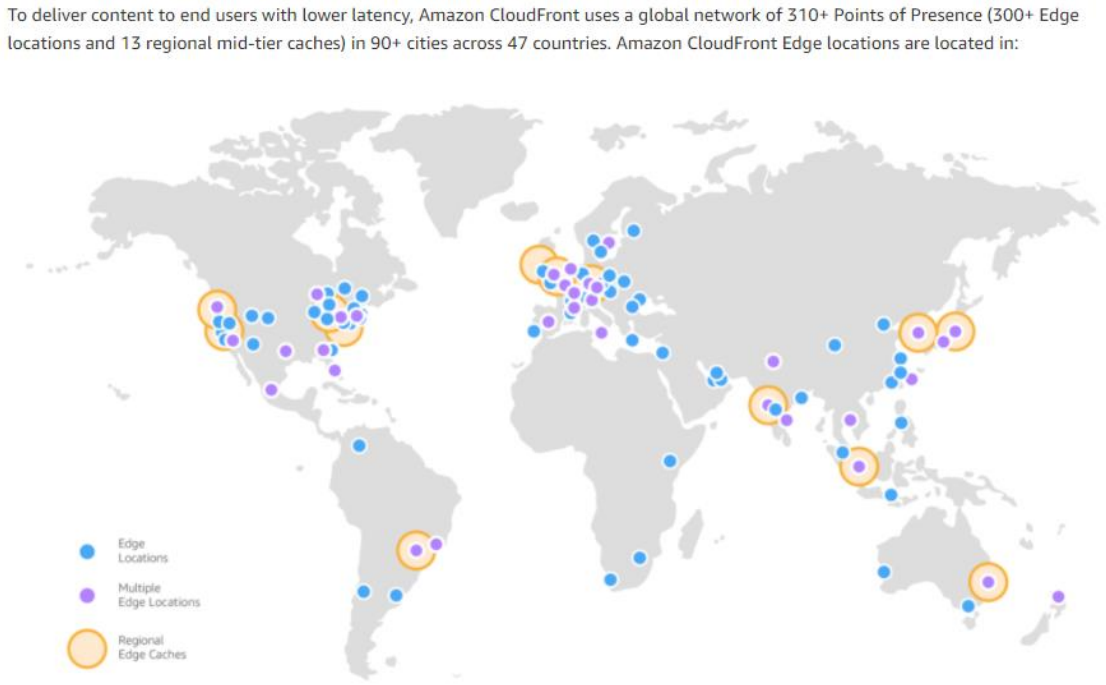
- Each availability zone (AZ) is one or more discrete data centers with redundant power, networking, and connectivity

- They’re separate from each other, so that they’re isolated from disasters • They’re connected with high bandwidth, ultra-low latency networking



Edge Locations

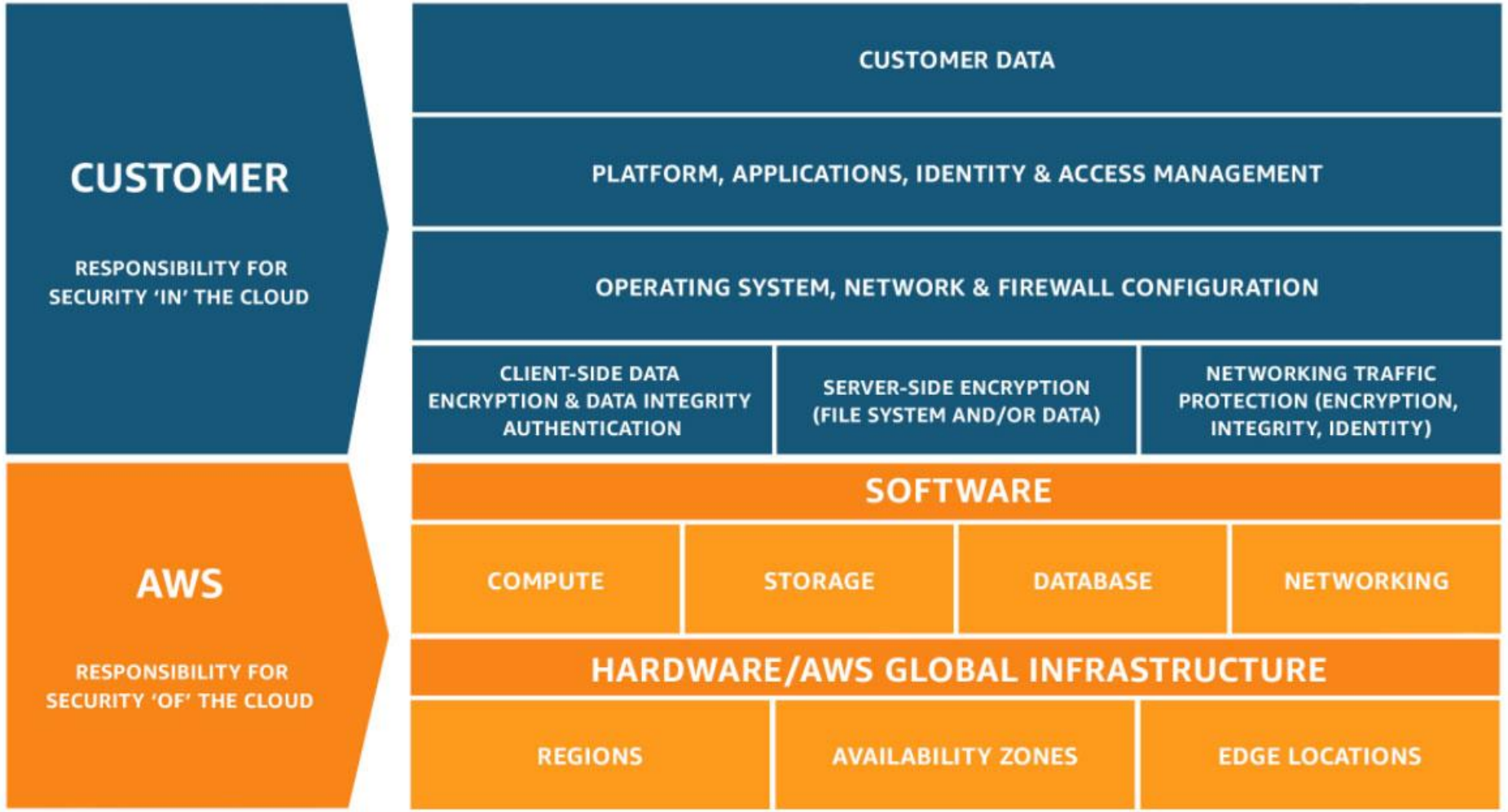
- Amazon has 216 Points of Presence (205 Edge Locations & 11 Regional Caches) in 84 cities across 42 countries.
- Content is delivered to end users with lower latency.



Choose an AWS Region

- Compliance with **Data Governance and Legal Requirements**: data never leaves a region without your explicit permission.
- Proximity to customers reduced latency.
- Available services within a Region: new services and new features aren't available in every Region.
- Pricing: pricing varies region to region and is transparent in the service pricing page.
- AWS Regional Services (amazon.com)

AWS Shared Responsibility Model



AWS Console

AWS has Global Services

- Identity and Access Management (IAM)
- Route 53 (DNS service)
- CloudFront (Content Delivery Network)
- WAF (Web Application Firewall)

Most AWS services are Region-scoped

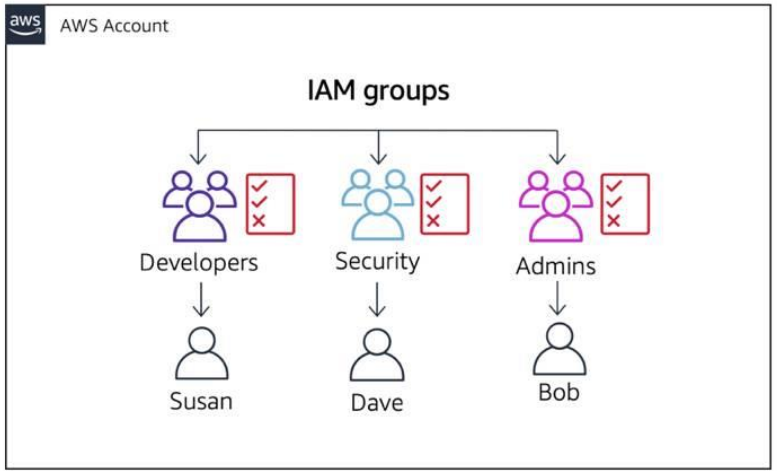
- Amazon EC2 (Infrastructure as a Service)
- Elastic Beanstalk (Platform as a Service)
- Lambda (Function as a Service)

IAM

AMAZON WEB SERVICES

IAM: Users & Groups

- IAM = Identity and Access Management, Global service.
- Root account created by default, shouldn’t be used or shared Users are people within your organization, and can be grouped.
- Groups only contain users, not other groups.
- Users don’t have to belong to a group, and user can belong to multiple groups.



IAM: Permissions

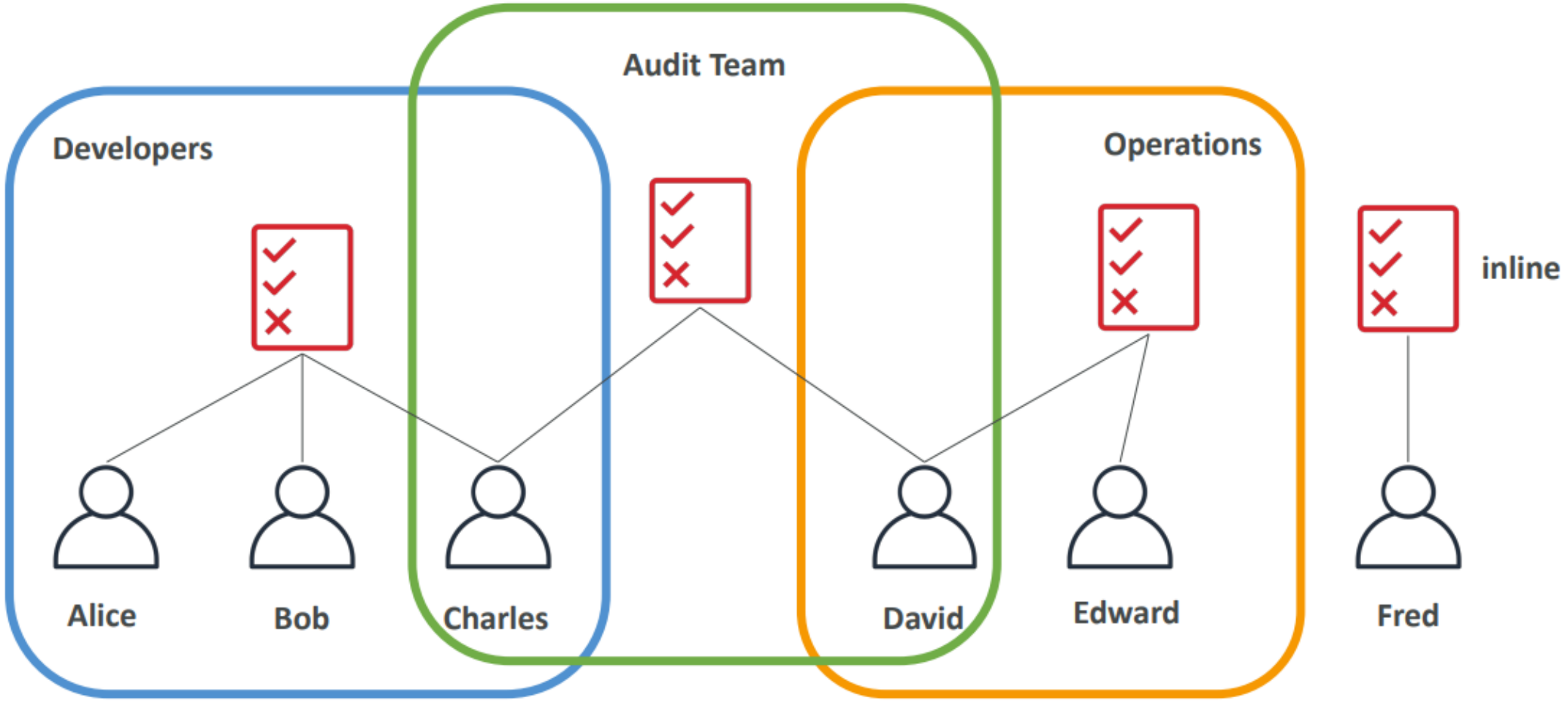
- Users or Groups can be assigned JSON documents called policies.
- These policies define the permissions of the users.
- In AWS you apply the least privilege principle: don’t give more permissions than a user needs.

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": "ec2:Describe*",
            "Resource": "*"
        },
        {
            "Effect": "Allow",
            "Action": "elasticloadbalancing:Describe*",
            "Resource": "*"
        },
        {
            "Effect": "Allow",
            "Action": [
                "cloudwatch:ListMetrics",
                "cloudwatch:GetMetricStatistics",
                "cloudwatch:Describe*"
            ],
            "Resource": "*"
        }
    ]
}
```

IAM Policies Structure

- Consists of • Version: policy language version, always include “2012 -10 - 17”
  - Id: an identifier for the policy (optional)
  - Statement: one or more individual statements (required)
- Statements consists of
  - Sid: an identifier for the statement (optional)
  - Effect: whether the statement allows or denies access (Allow, Deny)
  - Principal: account/user/role to which this policy applied to
  - Action: list of actions this policy allows or denies.
  - Resource: list of resources to which the actions applied to
  - Condition: conditions for when this policy is in effect (optional)

IAM Policies Inheritance



IAM – Password Policy

- Strong passwords = higher security for your account
- In AWS, you can setup a password policy:
  - Set a minimum password length
  - Require specific character types:
    - including uppercase letters
    - lowercase letters
    - Numbers
    - non-alphanumeric characters
- Allow all IAM users to change their own passwords
- Require users to change their password after some time (password expiration)
- Prevent password re-use

Multi Factor Authentication - MFA

- Users have access to your account and can possibly change configurations or delete resources I your AWS account
- You want to protect your Root Accounts and IAM users
- MFA = password you know + security device you own

MFA devices options in AWS

Virtual MFA device

Google Authenticator
(phone only)

Authy
(multi-device)

Support for multiple tokens on a single device.

Universal 2nd Factor (U2F) Security Key

YubiKey by Yubico (3rd party)

Support for multiple root and IAM users using a single security key

How can users access AWS ?

- To access AWS, you have three options:
  - AWS Management Console (protected by password + MFA)
  - AWS Command Line Interface (CLI): protected by access keys
  - AWS Software Developer Kit (SDK) - for code: protected by access keys
- Access Keys are generated through the AWS Console
- Users manage their own access keys
- Access Keys are secret, just like a password. Don’t share them
- Access Key ID ~= username
- Secret Access Key ~= password

What’s the AWS SDK?

- AWS Software Development Kit (AWS SDK)
- Language-specific APIs (set of libraries)
- Enables you to access and manage AWS services programmatically
- Embedded within your application
- Supports
  - SDKs (JavaScript, Python, PHP, .NET, Ruby, Java, Go, Node.js, C++) • Mobile SDKs (Android, iOS, …)
- IoT Device SDKs (Embedded C, Arduino, …) • Example: AWS CLI is built on AWS SDK for Python

IAM Guidelines & Best Practices

- Don’t use the root account except for AWS account setup
- One physical user = One AWS user
- Assign users to groups and assign permissions to groups
- Create a strong password policy
- Use and enforce the use of Multi Factor Authentication (MFA)
- Create and use Roles for giving permissions to AWS services
- Use Access Keys for Programmatic Access (CLI / SDK)
- Audit permissions of your account with the IAM Credentials Report
- Never share IAM users & Access Keys

2 ? AWS Certifications

Available AWS Certifications

Select a certification badge below to learn more.

Professional

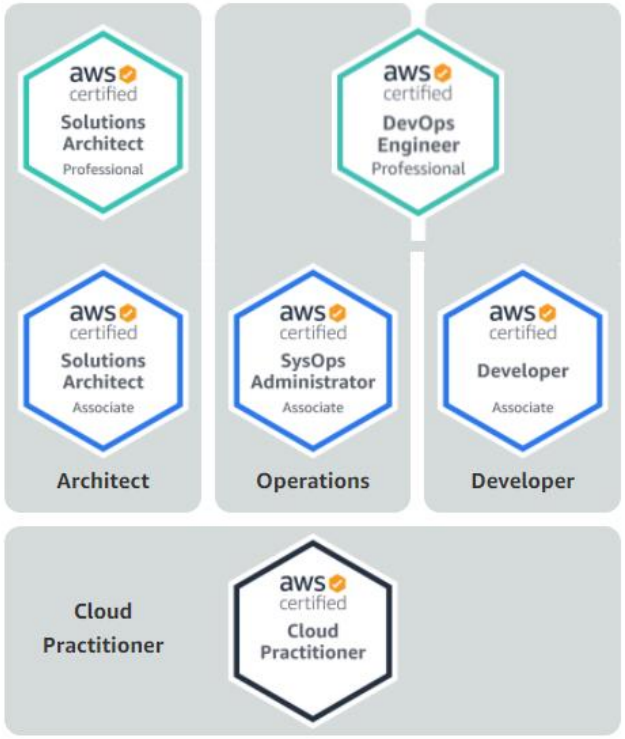
Two years of comprehensive experience designing, operating, and troubleshooting solutions using the AWS Cloud

Associate

One year of experience solving problems and implementing solutions using the AWS Cloud

Foundational

Six months of fundamental AWS Cloud and industry knowledge



Specialty

Technical AWS Cloud experience in the Specialty domain as specified in the **exam guide**