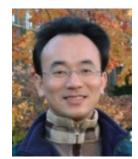
# 軟體工程



## (Software Engineering)

# 雲端運算與雲軟體架構 (Cloud Computing and Cloud Software Architecture)

1101SE07 MBA, IM, NTPU (M6131) (Fall 2021) Thu 11, 12, 13 (19:25-22:10) (209)



Accredited

**Min-Yuh Day** 

戴敏育

**Associate Professor** 

副教授

Institute of Information Management, National Taipei University

國立臺北大學 資訊管理研究所



### 課程大綱 (Syllabus)



- 週次 (Week) 日期 (Date) 內容 (Subject/Topics)
- 1 2021/09/23 軟體工程概論 (Introduction to Software Engineering)
- 2 2021/09/30 軟體產品與專案管理:軟體產品管理,原型設計 (Software Products and Project Management: Software product management and prototyping)
- 3 2021/10/07 敏捷軟體工程:敏捷方法、Scrum、極限程式設計
  (Agile Software Engineering:
  Agile methods, Scrum, and Extreme Programming)
- 4 2021/10/14 功能、場景和故事 (Features, Scenarios, and Stories)
- 5 2021/10/21 軟體工程個案研究 | (Case Study on Software Engineering I)
- 6 2021/10/28 軟體架構:架構設計、系統分解、分散式架構 (Software Architecture: Architectural design, System decomposition, and Distribution architecture)

### 課程大綱 (Syllabus)



- 週次 (Week) 日期 (Date) 內容 (Subject/Topics)
- 7 2021/11/04 基於雲的軟體:虛擬化和容器、軟體即服務 (Cloud-Based Software: Virtualization and containers, Everything as a service, Software as a service)
- 8 2021/11/11 期中報告 (Midterm Project Report)
- 9 2021/11/18 雲端運算與雲軟體架構 (Cloud Computing and Cloud Software Architecture)
- 10 2021/11/25 微服務架構:RESTful服務、服務部署 (Microservices Architecture, RESTful services, Service deployment)
- 11 2021/12/02 軟體工程產業實務 (Industry Practices of Software Engineering)
- 12 2021/12/09 軟體工程個案研究Ⅱ (Case Study on Software Engineering Ⅱ)

### 課程大綱 (Syllabus)



週次 (Week) 日期 (Date) 內容 (Subject/Topics)

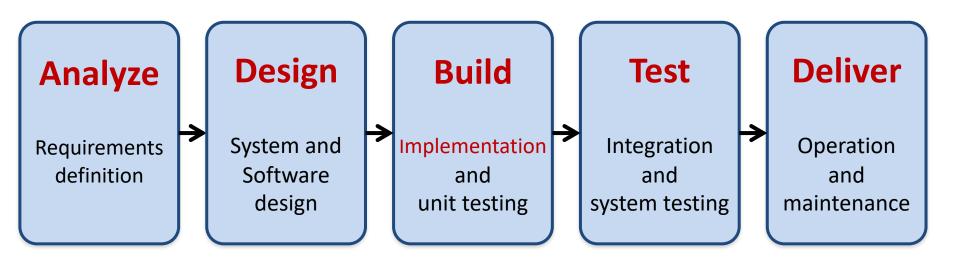
13 2021/12/16 安全和隱私 (Security and Privacy); 可靠的程式設計 (Reliable Programming)

14 2021/12/23 測試:功能測試、測試自動化、 測試驅動的開發、程式碼審查 (Testing: Functional testing, Test automation, Test-driven development, and Code reviews); DevOps和程式碼管理:程式碼管理和DevOps自動化 (DevOps and Code Management:

Code management and DevOps automation)

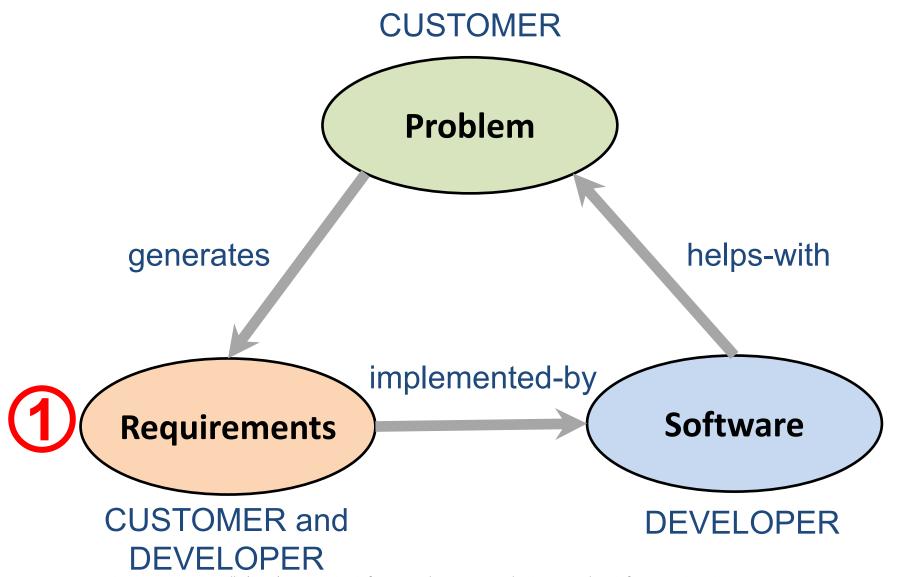
- 15 2021/12/30 期末報告 I (Final Project Report I)
- 16 2022/01/06 期末報告 II (Final Project Report II)
- 17 2022/01/13 學生自主學習 (Self-learning)
- 18 2022/01/20 學生自主學習 (Self-learning)

# Software Engineering and Project Management

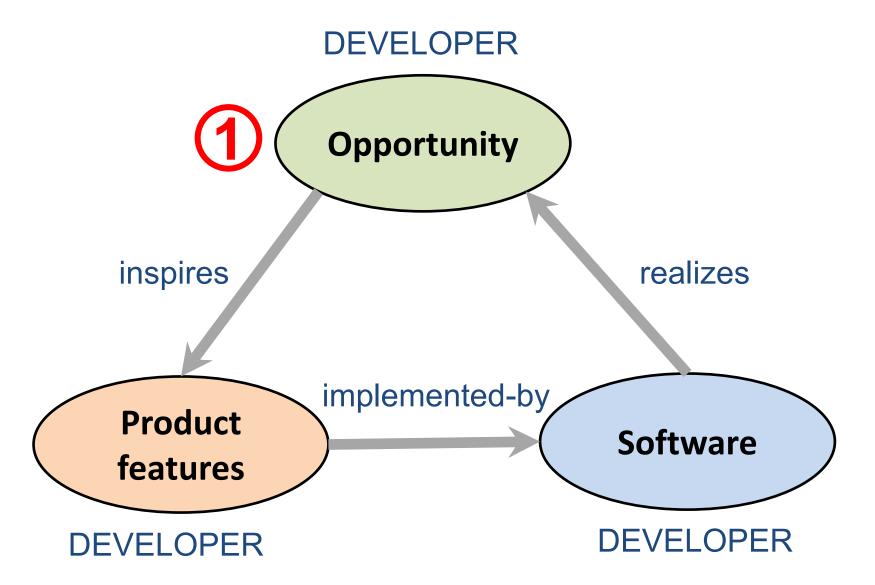


**Project Management** 

## **Project-based software engineering**



#### **Product software engineering**



#### Software execution models

Stand-alone execution

User's computer

User interface
Product functionality
User data

**Product updates** 

Vendor's servers

Hybrid execution

User's computer

User interface
Partial functionality
User data

Additional functionality
User data backups
Product updates

Vendor's servers

Software as a service

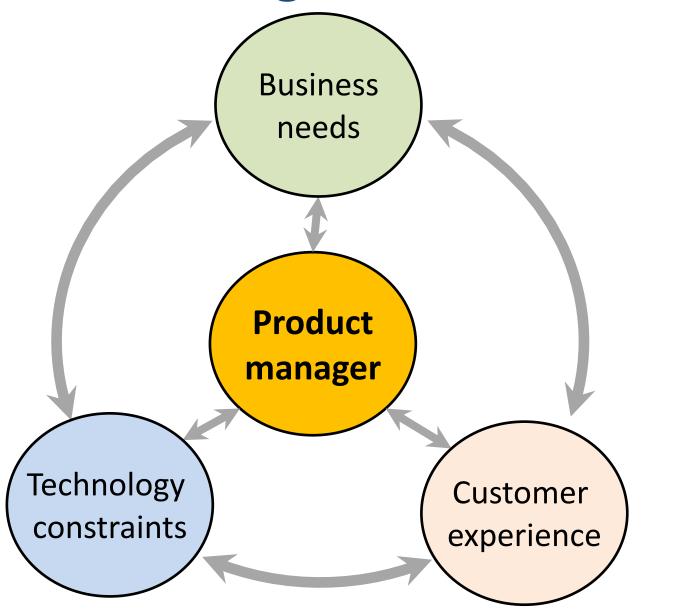
User's computer

User interface (browser or app)

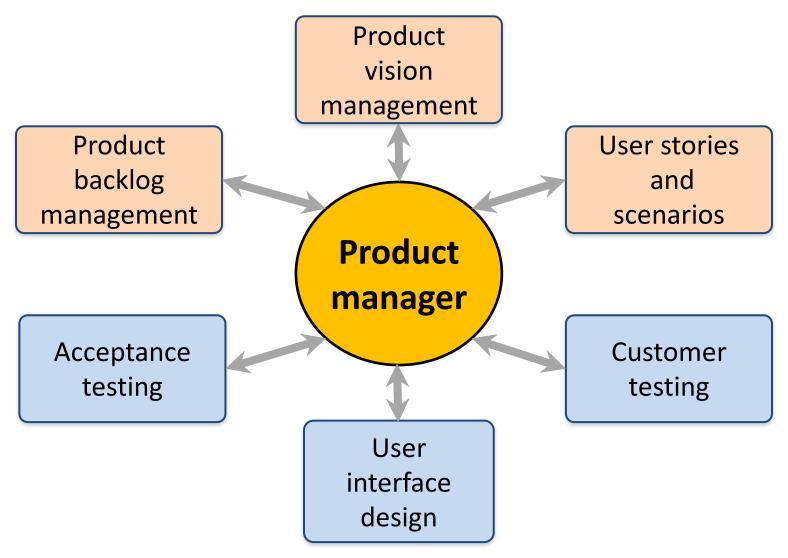
Product functionality
User data

Vendor's servers

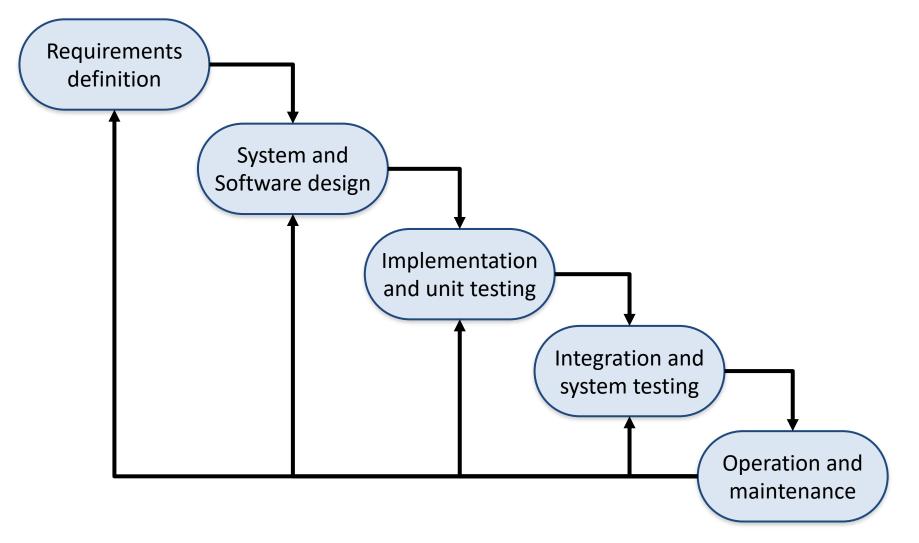
#### **Product management concerns**



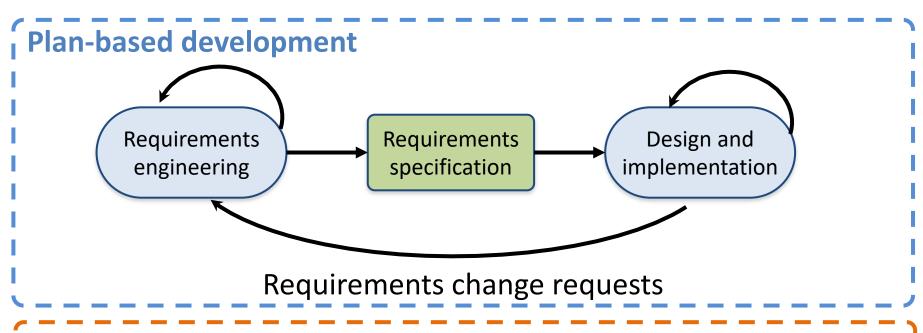
# Technical interactions of product managers

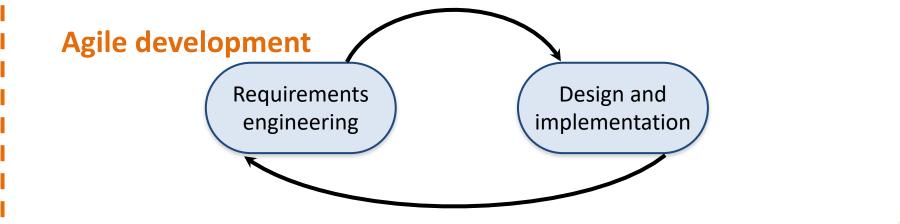


# Software Development Life Cycle (SDLC) The waterfall model

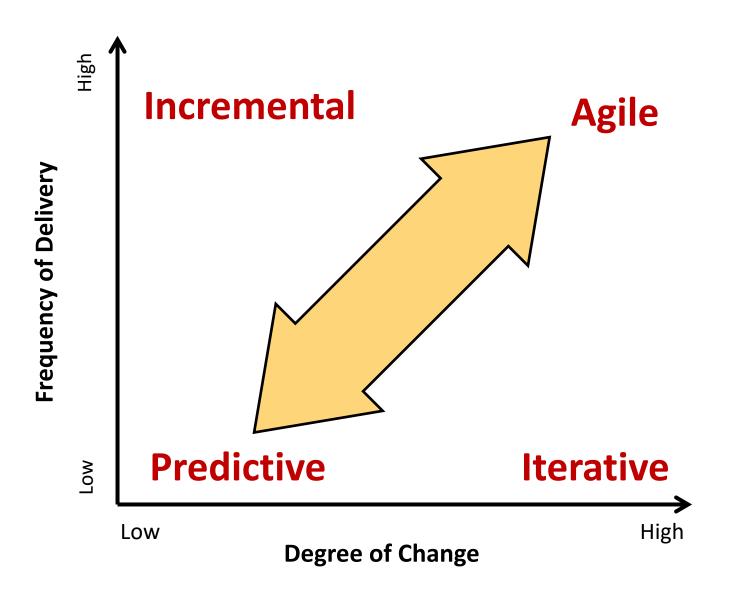


### Plan-based and Agile development

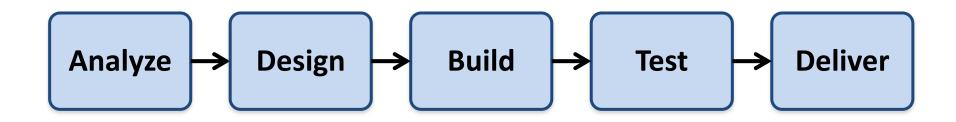




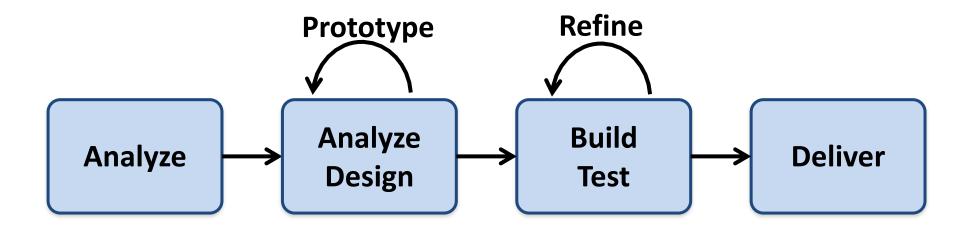
#### The Continuum of Life Cycles



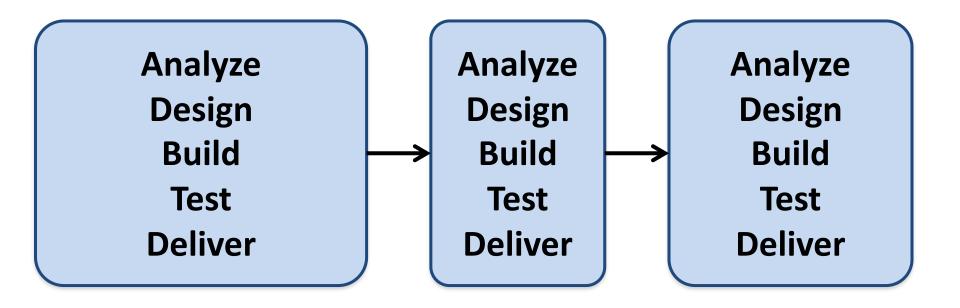
### **Predictive Life Cycle**



### **Iterative Life Cycle**



# A Life Cycle of Varying-Sized Increments



# Iteration-Based and Flow-Based Agile Life Cycles

#### **Iteration-Based Agile**

Requirements Analysis Design Build Test

Requirements
Analysis
Design
Build
Test

Requirements
Analysis
Design
Build
Test

Requirements
Analysis
Design
Build
Test

Repeat as needed

Requirements
Analysis
Design
Build
Test

Requirements
Analysis
Design
Build
Test

#### Flow-Based Agile

Requirements
Analysis
Design
Build
Test
the number of features in the
WIP limit

Requirements
Analysis
Design
Build
Test
the number of features in the WIP limit

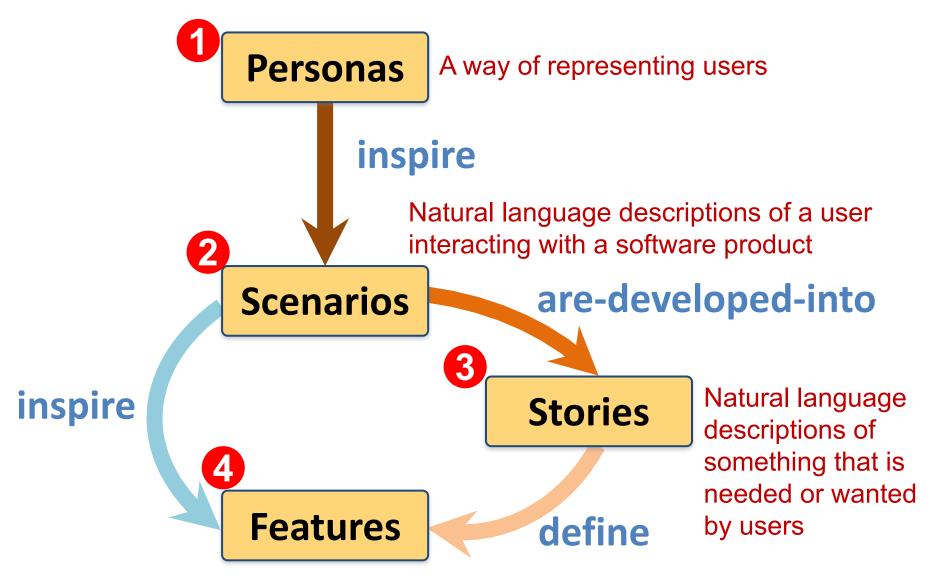
Requirements
Analysis
Design
Build
Test
the number of
features in the WIP

Repeat as needed ... Analysis
Design
Build
Test
the number of features in the
WIP limit

Requirements

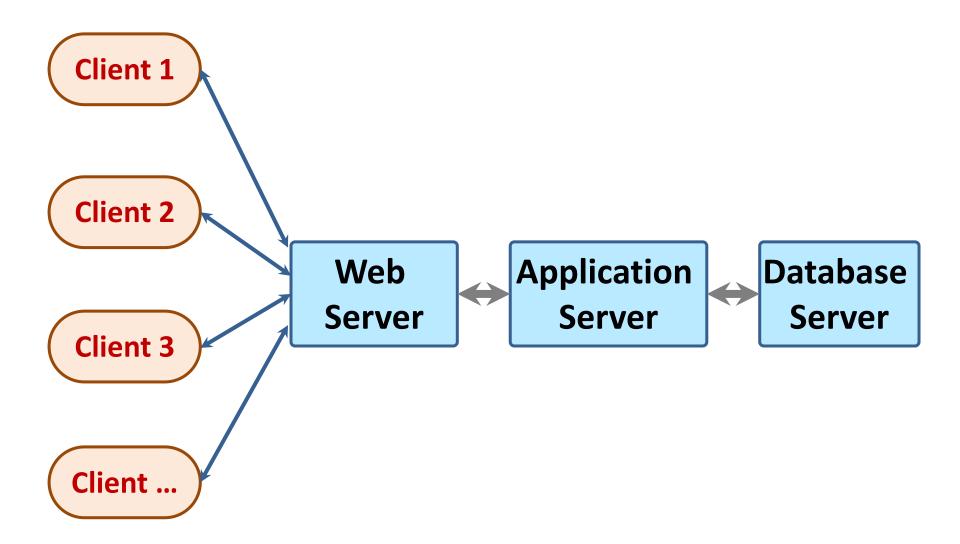
Requirements
Analysis
Design
Build
Test
the number of
features in the WIP
limit

#### From personas to features

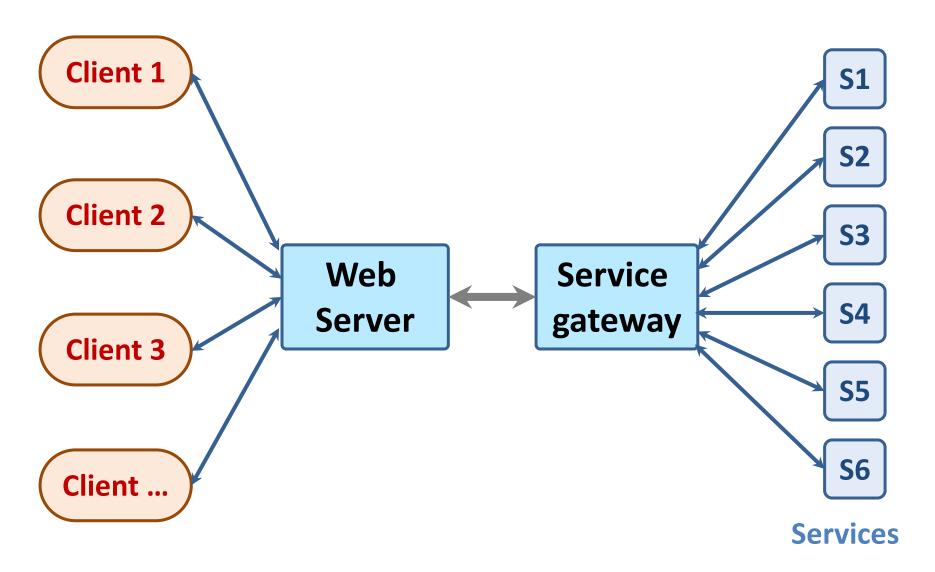


Fragments of product functionality

#### Multi-tier client-server architecture



#### **Service-oriented Architecture**



#### VM

#### **Container**

Virtual Virtual web server mail server Server Server software software Guest Guest OS OS **Hypervisor Host OS Server Hardware** 

User 1 User 2 **Container 1 Container 2 Application Application** software software Server Server software software **Container manager Host OS Server Hardware** 

#### **Everything as a service**

Photo editing

Software as a service (SaaS)

Logistics management

Cloud management Monitoring

Platform as a service (PaaS)

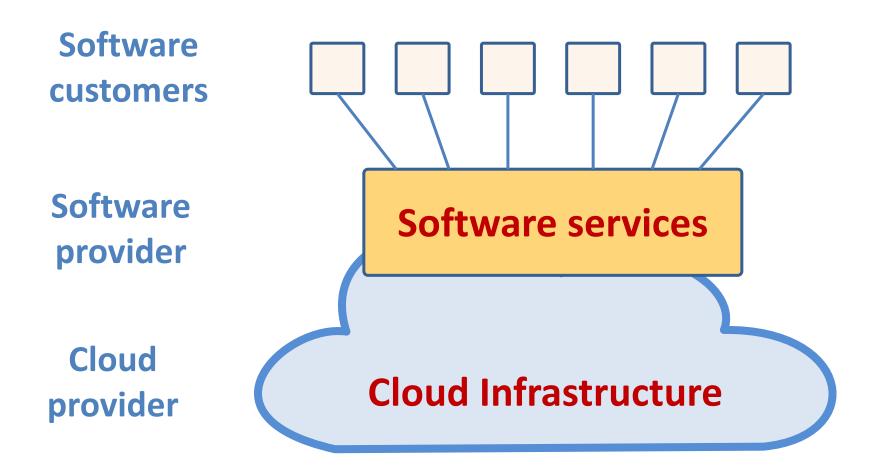
Database Software development

Storage Network Infrastructure as a service (laaS)

Computing Virtualization

Cloud data center

#### Software as a service



# Microservices architecture – key design questions

What are the microservices that make up the system?

How should data be distributed and shared?

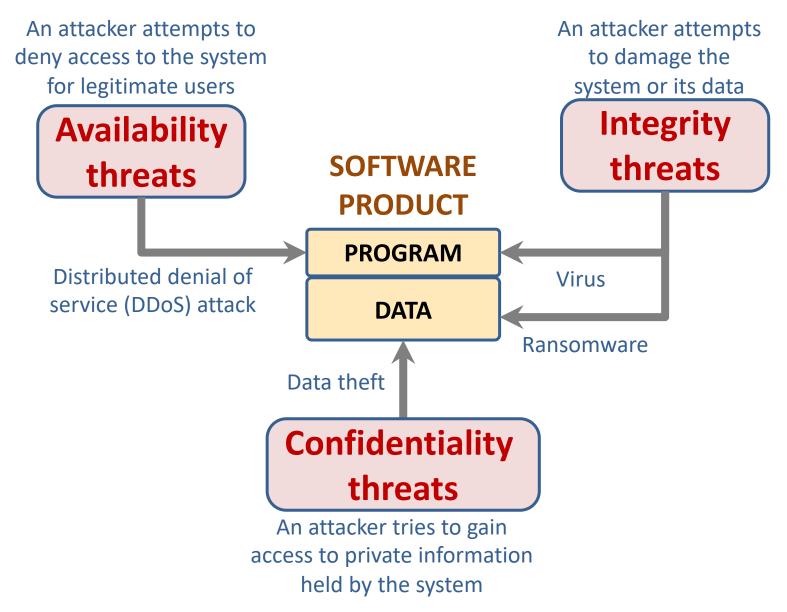
Microservices architecture design

How should microservices communicate with each other?

How should the microservices in the system be coordinated?

How should service failure be detected, reported and managed?

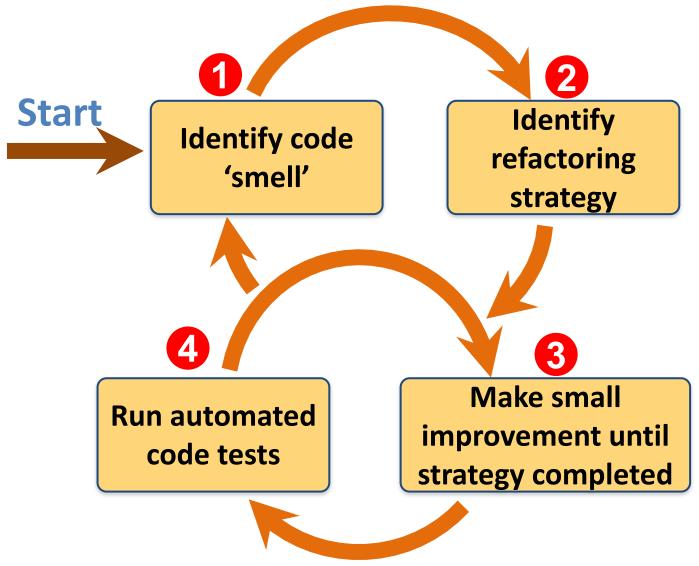
#### Types of security threat



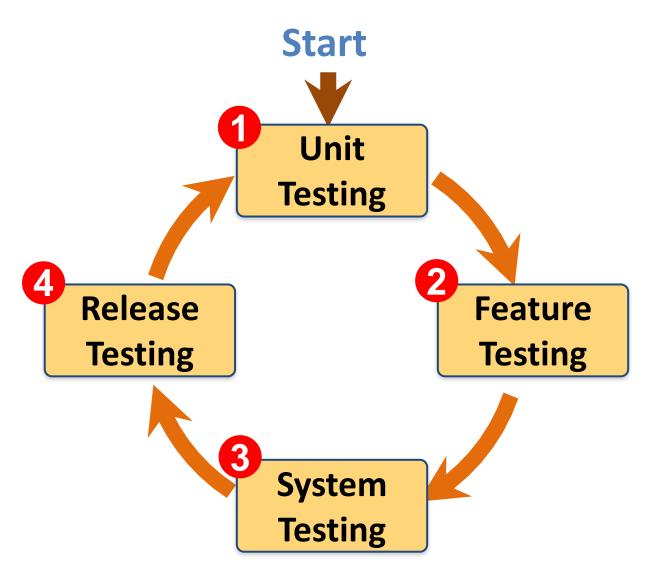
#### Software product quality attributes



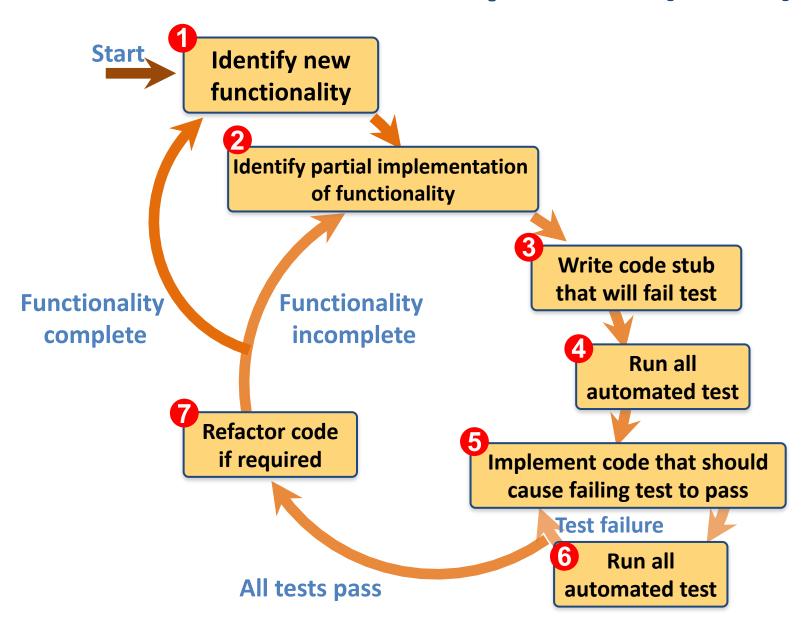
#### A refactoring process



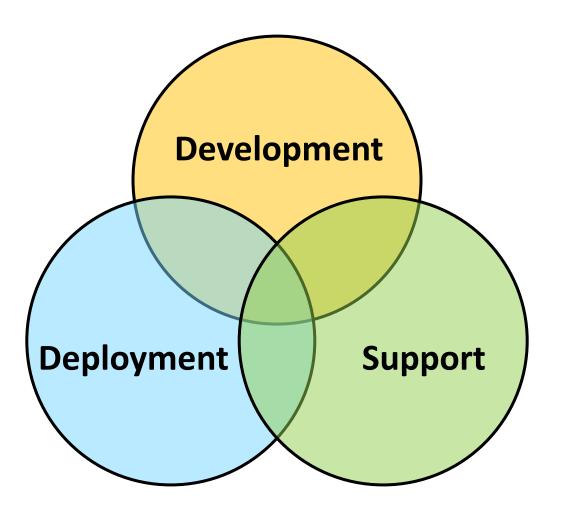
#### **Functional testing**



### Test-driven development (TDD)



# DevOps



#### Multi-skilled DevOps team

### Code management and DevOps

#### **DevOps automation**

Continuous integration

**Continuous deployment** 

Continuous delivery

Infrastructure as code



**Code management system** 



Recover

version information

Branching and merging

Code repository

Save and retrieve versions

Transfer code to/from developer's filestore



#### **DevOps measurement**



Data collection

Data analysis

Report generation

# Cloud Computing and Cloud Software Architecture

#### **Outline**

- Cloud Computing and Cloud Software Architecture
- AWS Certified Cloud Practitioner (CLF-C01)
- AWS Certified Solutions Architect Associate (SAA-C02)
- Web Application with AWS Core Services
- AWS Serverless Architecture
- Build a Serverless Web Application
  with Amazon S3, AWS Lambda, Amazon API Gateway,
  Amazon DynamoDB, and Amazon Cognito

#### **AWS Certifications**

#### Available AWS Certifications



#### Professional

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



#### Specialty aws certified Technical AWS Cloud experience in the DevOps Specialty domain as specified in the Engineer exam quide

#### Associate

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

SAA



aws certified SysOps Administrator Associate **Operations** 



Developer

#### Foundational

Six months of fundamental AWS Cloud and industry knowledge

**CLF** 

Cloud **Practitioner** 

aws certified Cloud Practitioner

#### aws aws certified certified Advanced **Big Data** Networking Specialty Specialty aws 🕏 certified Security Specialty aws 🕏 aws certified certified Machine Alexa Skill Learning Builder

Specialty

Specialty

Professional

#### **AWS Certifications**



#### **AWS Certified Cloud Practitioner**

- This certification provides individuals in a larger variety of cloud and technology roles with a way to validate their AWS Cloud knowledge and enhance their professional credibility.
- This exam covers four domains, including cloud concepts, security, technology, and billing and pricing.

# AWS Certified Solutions Architect - Associate

- This certification validates your ability to effectively demonstrate knowledge of how to architect and deploy secure and robust applications on AWS technologies.
- This exam is for anyone with at least one year of hands-on experience designing available, costefficient, fault-tolerant, and scalable and distributed systems on AWS.

# **AWS Academy and Certifications**

- AWS Academy Cloud Foundations (ACF)
  - AWS Certified <u>Cloud Practitioner</u> (CLF-C01)
  - https://aws.amazon.com/certification/certified-cloud-practitioner/

- AWS Academy Cloud Architecting (ACA)
  - AWS Certified Solutions Architect –Associate(SAA-C02)
  - https://aws.amazon.com/certification/certified-solutions-architect-associate/



Solutions Architect Associate

# AWS Certified Cloud Practitioner (CLF-C01)

Cloud Practitioner

Domain	% of Examination
Domain 1: Cloud Concepts	26%
Domain 2: Security and Compliance	25%
Domain 3: Technology	33%
Domain 4: Billing and Pricing	16%
TOTAL	100%

Solutions Architect Associate

Domain	% of Examination
Domain 1: Design Resilient Architectures	30%
Domain 2: Design High-Performing Architectures	28%
Domain 3: Specify Secure Applications and Architectures	24%
Domain 4: Design Cost-Optimized Architectures	18%
TOTAL	100%

# AWS Certified Cloud Practitioner (CLF-C01)



# AWS Certified Cloud Practitioner (CLF-C01)

### Domain 1: Cloud Concepts

- 1.1 Define the AWS Cloud and its value proposition
- 1.2 Identify aspects of AWS Cloud economics
- 1.3 List the different cloud architecture design principles

# AWS Certified Cloud Practitioner (CLF-C01)

### Domain 2: Security and Compliance

aws

- 2.1 Define the AWS shared responsibility model
- 2.2 Define AWS Cloud security and compliance concepts
- 2.3 Identify AWS access management capabilities
- 2.4 Identify resources for security support

# AWS Certified Cloud Practitioner (CLF-C01)

### Domain 3: Technology

- 3.1 Define methods of deploying and operating in the AWS Cloud
- 3.2 Define the AWS global infrastructure
- 3.3 Identify the core AWS services
- 3.4 Identify resources for technology support

# AWS Certified Cloud Practitioner (CLF-C01)

- Domain 4: Billing and Pricing
  - 4.1 Compare and contrast the various pricing models for AWS
  - 4.2 Recognize the various account structures in relation to AWS billing and pricing
  - 4.3 Identify resources available for billing support



### Domain 1: Design Resilient Architectures

Solutions Architect Associate

- 1.1 Design a multi-tier architecture solution
- 1.2 Design highly available and/or fault-tolerant architectures
- 1.3 Design decoupling mechanisms using AWS services
- 1.4 Choose appropriate resilient storage

### Domain 2: Design High-Performing Architectures

Solutions Architect Associate

- 2.1 Identify elastic and scalable compute solutions for a workload
- 2.2 Select high-performing and scalable storage solutions for a workload
- 2.3 Select high-performing networking solutions for a workload
- 2.4 Choose high-performing database solutions for a workload

- Domain 3: Design Secure Applications and Architectures
  - 3.1 Design secure access to AWS resources
  - 3.2 Design secure application tiers

Solutions Architect Associate

3.3 Select appropriate data security options

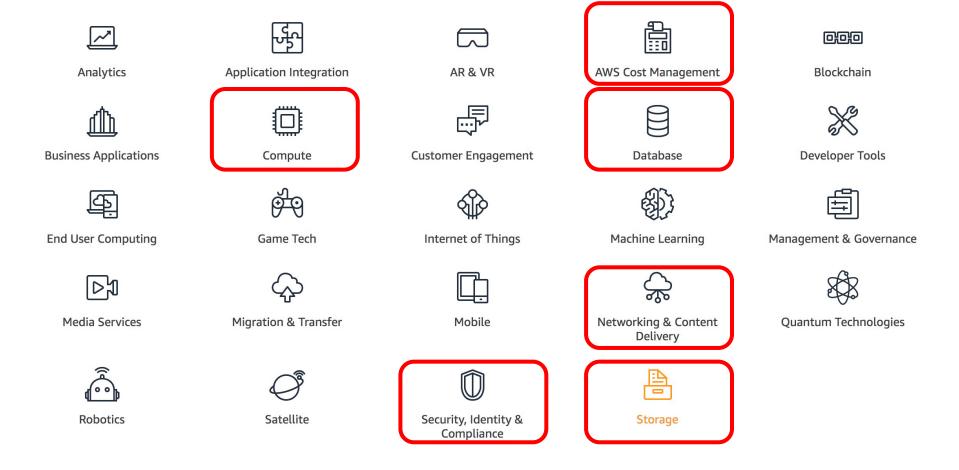
- Domain 4: Design Cost-Optimized Architectures
  - 4.1 Identify cost-effective storage solutions

Solutions Architect Associate

- 4.2 Identify cost-effective compute and database services
- 4.3 Design cost-optimized network architectures



# **AWS Products and Services**





# **AWS Compute**



#### Amazon EC2

Virtual servers in the cloud

#### Amazon Elastic Container Service

Run and manage docker containers

#### **AWS Batch**

Run batch jobs at any scale

#### AWS Lambda

Run code without thinking about servers

#### AWS Wavelength

Deliver ultra-low latency applications for 5G devices

#### Amazon EC2 Auto Scaling

Scale compute capacity to meet demand

#### Amazon Elastic Kubernetes Service

Run managed Kubernetes on AWS

#### AWS Elastic Beanstalk

Run and manage web apps

#### **AWS Outposts**

Run AWS infrastructure on-premises

#### VMware Cloud on AWS

Build a hybrid cloud without custom hardware

#### Amazon Elastic Container Registry

Store and retrieve docker images

#### Amazon Lightsail

Launch and manage virtual private servers

#### **AWS Fargate**

Run containers without managing servers or clusters

#### AWS Serverless Application Repository

Discover, deploy, and publish serverless applications



### **AWS Database**



#### Amazon Aurora

High Performance Managed Relational Database

#### Amazon ElastiCache

In-memory Caching System

#### Amazon Quantum Ledger Database (QLDB)

Fully managed ledger database

#### Amazon Redshift

Fast, Simple, Cost-effective Data Warehousing

#### Amazon DynamoDB

Managed NoSQL Database

#### Amazon Managed Apache Cassandra Service

Managed Cassandra-compatible database

#### Amazon RDS

Managed Relational Database Service for MySQL, PostgreSQL, Oracle, SQL Server, and MariaDB

#### Amazon Timestream

Fully managed time series database

### Amazon DocumentDB (with MongoDB compatibility)

Fully managed document database

#### Amazon Neptune

Fully Managed Graph Database Service

#### Amazon RDS on VMware

Automate on-premises database management

#### **AWS Database Migration Service**

Migrate Databases with Minimal Downtime



### **AWS Storage**



Amazon Simple Storage Service (S3)

Scalable Storage in the Cloud

Amazon FSx for Lustre

High-performance file system integrated with S3

**AWS Backup** 

Centralized backup across AWS services

CloudEndure Disaster Recovery

Highly automated disaster recovery

Amazon Elastic Block Store (EBS)

EC2 block storage volumes

Amazon FSx for Windows File Server

Fully managed Windows native file system

AWS Snow Family

Physical devices to migrate data into and out of AWS

Amazon Elastic File System (EFS)

Fully managed file system for EC2

Amazon S3 Glacier

Low-cost Archive Storage in the Cloud

**AWS Storage Gateway** 

Hybrid Storage Integration



# **AWS Networking & Content Delivery**



Amazon VPC

Isolated Cloud Resources

Amazon Route 53

Scalable Domain Name System

**AWS Cloud Map** 

Application resource registry for microservices

**AWS Transit Gateway** 

Easily scale VPC and account connections

Amazon API Gateway

Build, Deploy, and Manage APIs

**AWS PrivateLink** 

Securely Access Services Hosted on AWS

**AWS Direct Connect** 

Dedicated Network Connection to AWS

**Elastic Load Balancing** 

Distribute incoming traffic across multiple targets

Amazon CloudFront

Global Content Delivery Network

AWS App Mesh

Monitor and control microservices

AWS Global Accelerator

Improve application availability and performance



# AWS Security, Identity & Compliance



#### AWS Identity & Access Management

Manage User Access and Encryption Keys

#### Amazon GuardDuty

Managed Threat Detection Service

#### **AWS Artifact**

On-demand access to AWS compliance reports

#### **AWS Directory Service**

Host and Manage Active Directory

#### AWS Resource Access Manager

Simple, secure service to share AWS resources

#### AWS Shield

**DDoS Protection** 

#### Amazon Cognito

Identity Management for your Apps

#### Amazon Inspector

Analyze Application Security

#### **AWS Certificate Manager**

Provision, Manage, and Deploy SSL/TLS Certificates

#### AWS Firewall Manager

Central Management of Firewall Rules

#### **AWS Secrets Manager**

Rotate, Manage, and Retrieve Secrets

#### AWS Single Sign-On

Cloud Single Sign-On (SSO) Service

#### Amazon Detective

Investigate potential security issues

#### Amazon Macie

Discover, Classify, and Protect your Data

#### AWS CloudHSM

Hardware-based Key Storage for Regulatory Compliance

#### AWS Key Management Service

Managed Creation and Control of Encryption Keys

#### **AWS Security Hub**

Unified security and compliance center

#### **AWS WAF**

Filter Malicious Web Traffic



# **AWS Cost Management**



**AWS Cost Explorer** 

Analyze Your AWS Cost and Usage

Reserved Instance Reporting

Dive Deeper into Your Reserved Instances (RIs)

**AWS Budgets** 

Set Custom Cost and Usage Budgets

Savings Plans

Save up to 72% on compute usage with flexible pricing

AWS Cost and Usage Report

Access Comprehensive Cost and Usage Information



### **AWS Services**

- Amazon EC2
  - Virtual servers in the cloud
- Amazon Simple Storage Service (S3)
  - Scalable storage in the cloud
- Amazon Aurora
  - High performance managed relational database
- Amazon DynamoDB
  - Managed NoSQL database
- Amazon RDS
  - Managed relational database service for MySQL,
     PostgreSQL, Oracle, SQL Server, and MariaDB



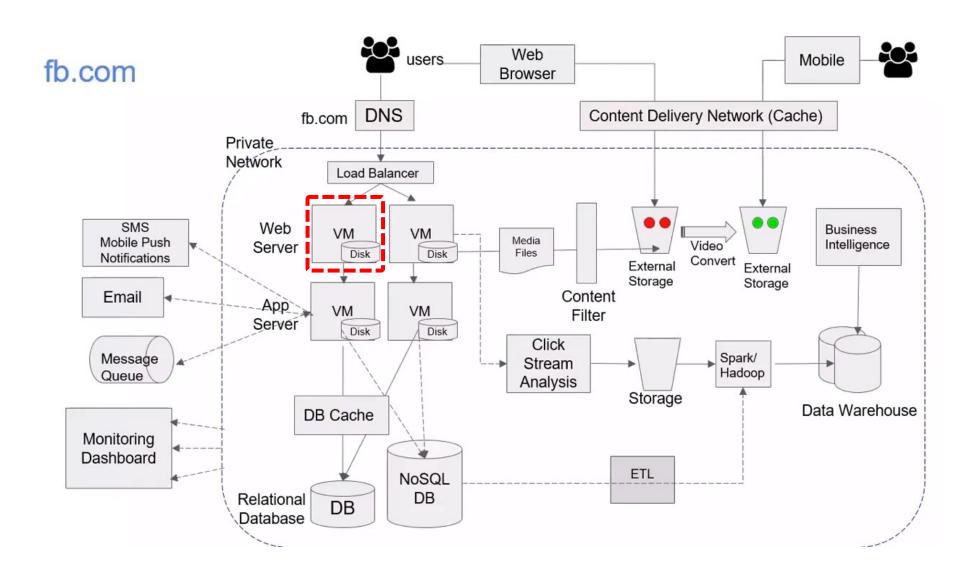
### **AWS Services**

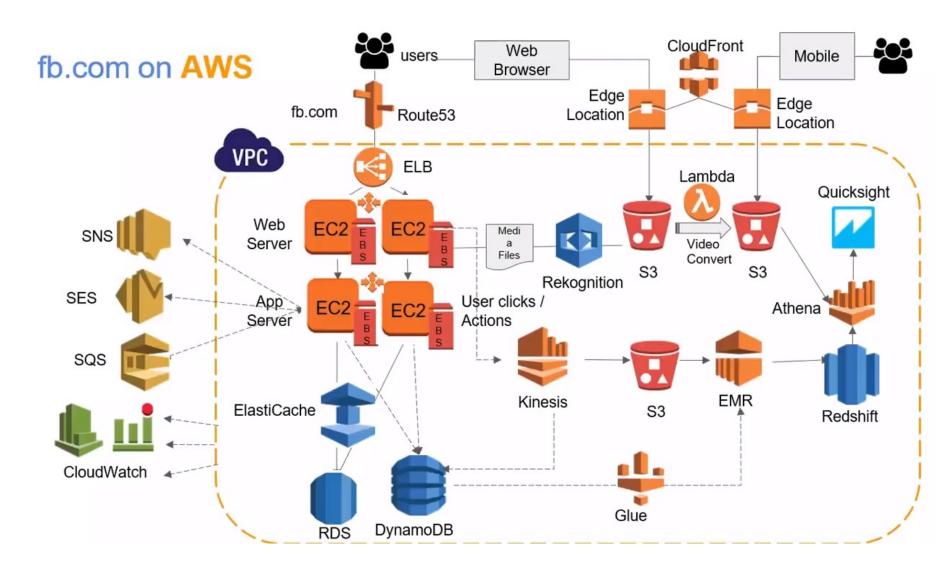
- AWS Lambda
  - Run code without thinking about servers
- AWS Elastic Beanstalk
  - Run and manage web apps
- Amazon VPC
  - Isolated cloud resources
- Amazon Lightsail
  - Launch and manage virtual private servers
- Amazon SageMaker
  - Build, train, and deploy machine learning models at scale

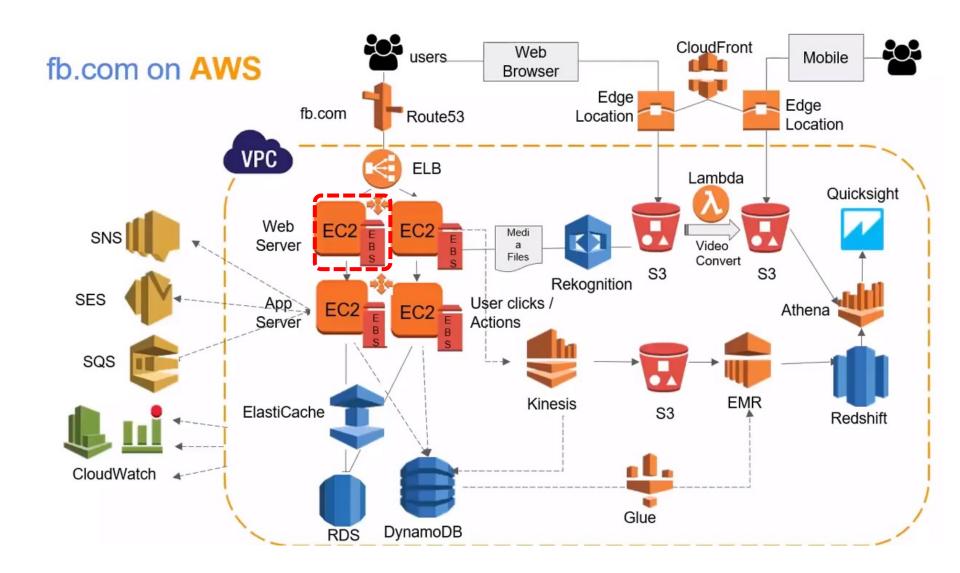


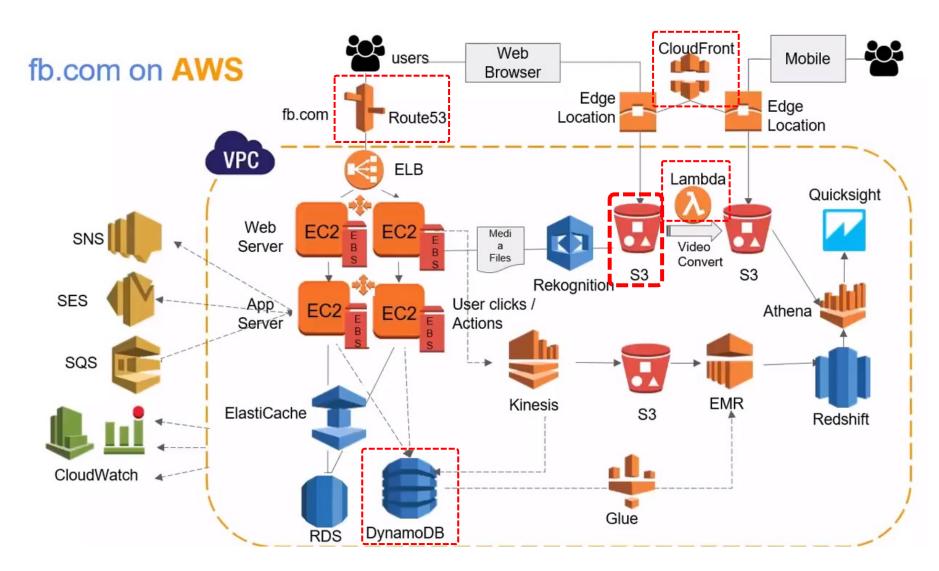
# Web Application with AWS Core Services

### **Software Architecture**

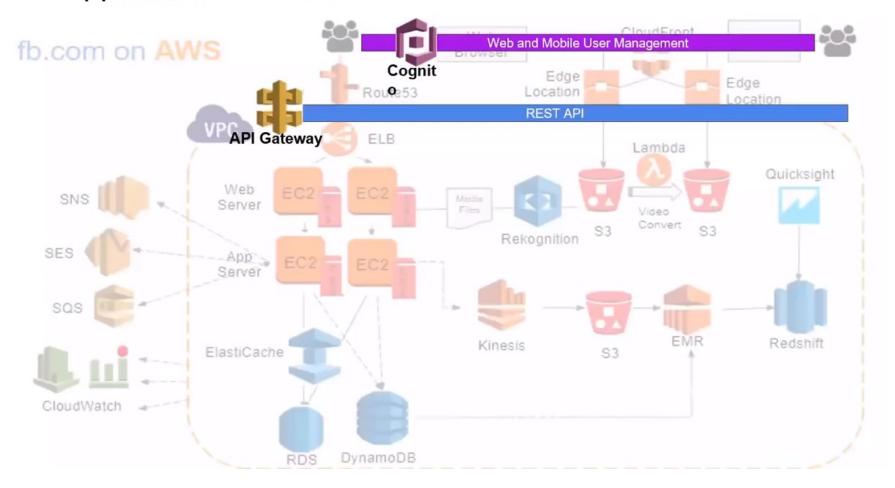


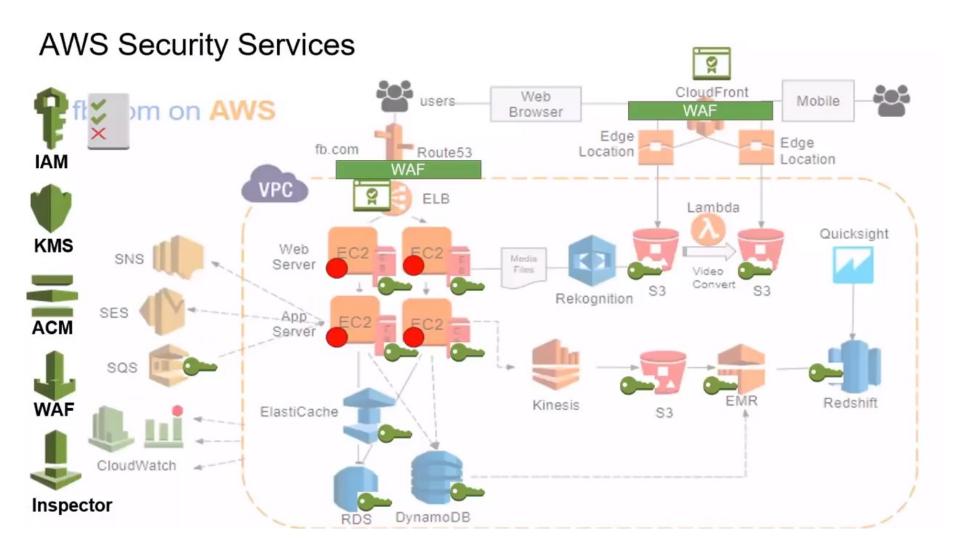


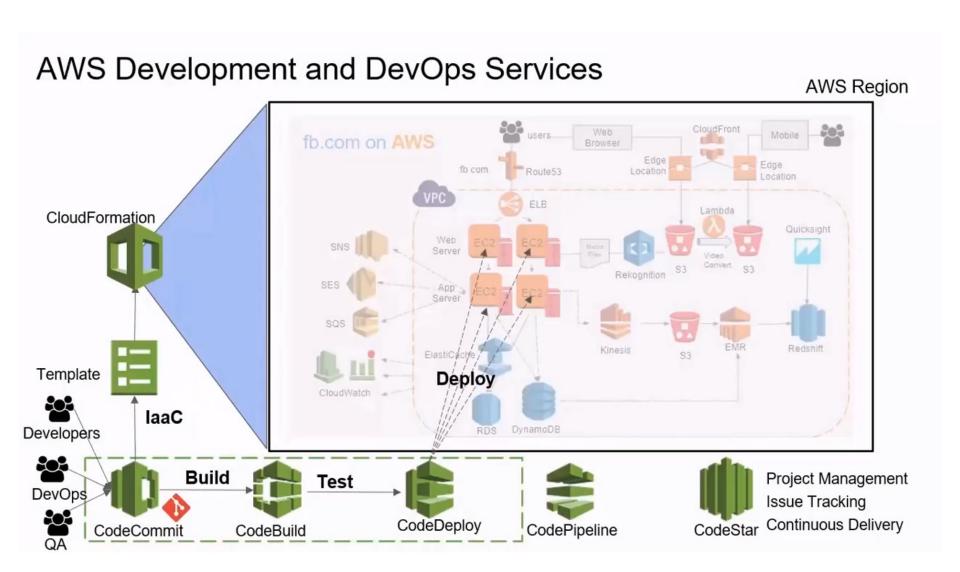




### **AWS Application Services**





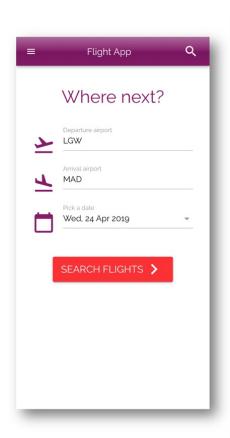




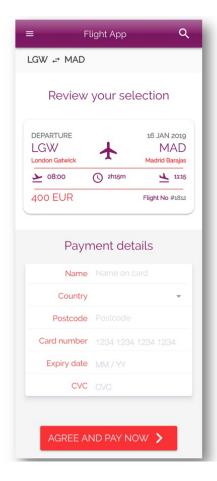
# **AWS** Serverless Architecture

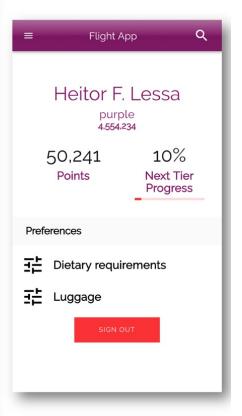


# **AWS Serverless Airline Booking**











# **AWS Serverless Airline Booking** Stack

UI/UX









Data/Lang









API/Auth







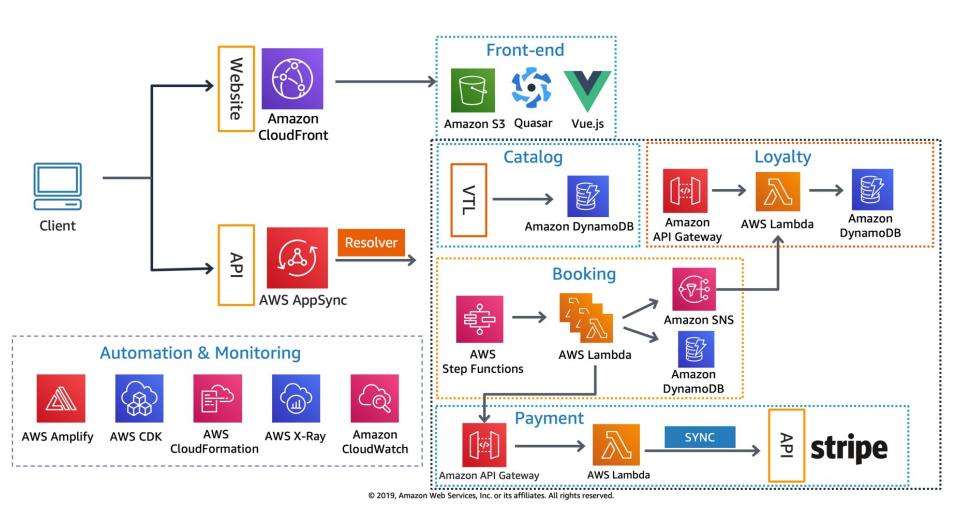
Messaging



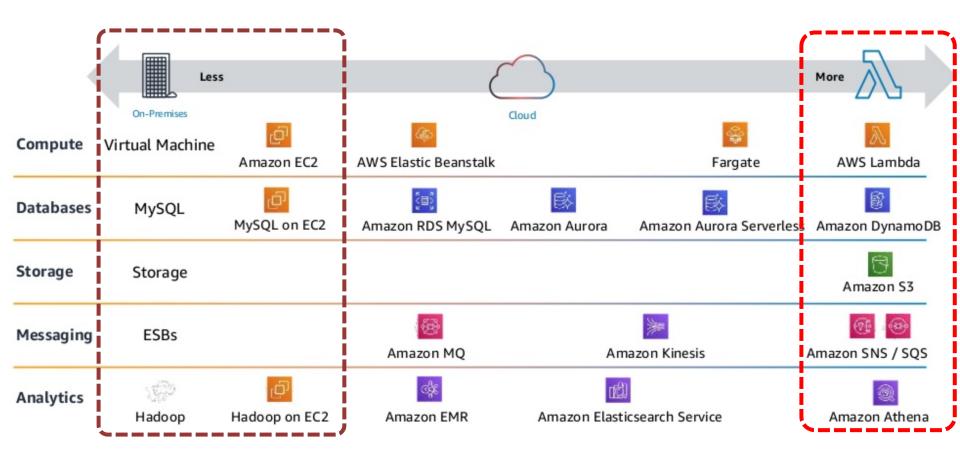




# AWS Serverless Airline Booking High level infrastructure architecture

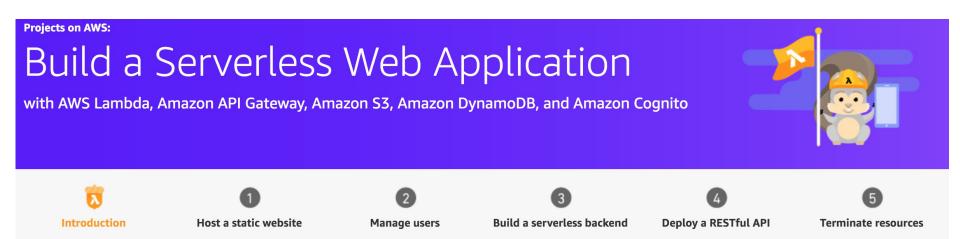


# AWS Serverless Architecture AWS Operational Responsibility Models









#### Overview

In this tutorial, you'll create a simple serverless web application that enables users to request unicorn rides from the Wild Rydes fleet. The application will present users with an HTML based user interface for indicating the location where they would like to be picked up and will interface on the backend with a RESTful web service to submit the request and dispatch a nearby unicorn. The application will also provide facilities for users to register with the service and log in before requesting rides.

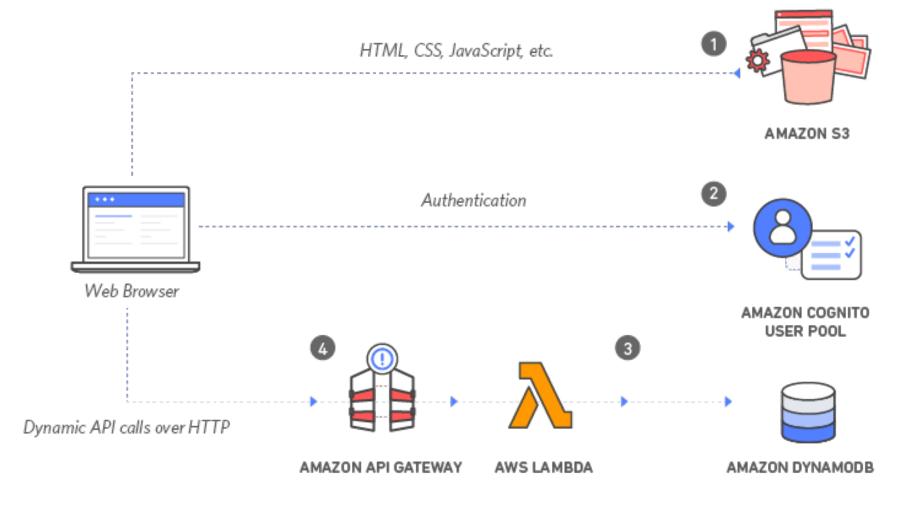
### **Application Architecture**

AWS Experience: Beginner

Time to complete: 2 hours

**Cost to complete:** Each service used in this architecture is eligible for the AWS Free Tier. If you are outside the usage limits of the Free Tier, completing this tutorial will cost you less than \$0.25\*.











with Amazon S3, AWS Lambda, Amazon API Gateway, Amazon DynamoDB, and Amazon Cognito

1

HTML, CSS, JavaScript, etc.

### **Static Web Hosting**

Amazon S3 hosts static web resources including HTML, CSS, JavaScript, and image files which are loaded in the user's browser.





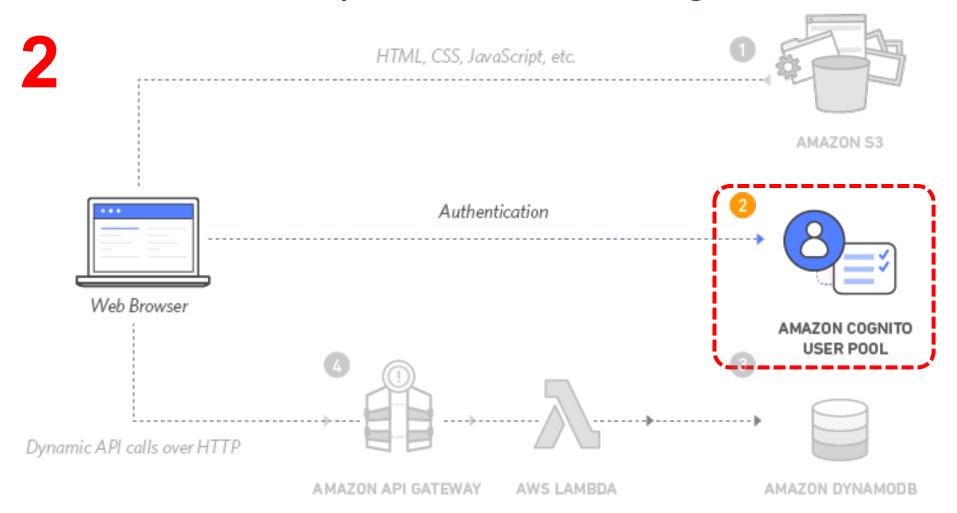


Dynamic API calls over HTTP



AMAZON DYNAMODB



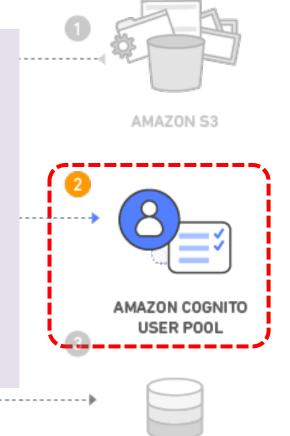




with Amazon S3, AWS Lambda, Amazon API Gateway, Amazon DynamoDB, and Amazon Cognito

2

# User Management Amazon Cognito provides user management and authentication functions to secure the backend API.



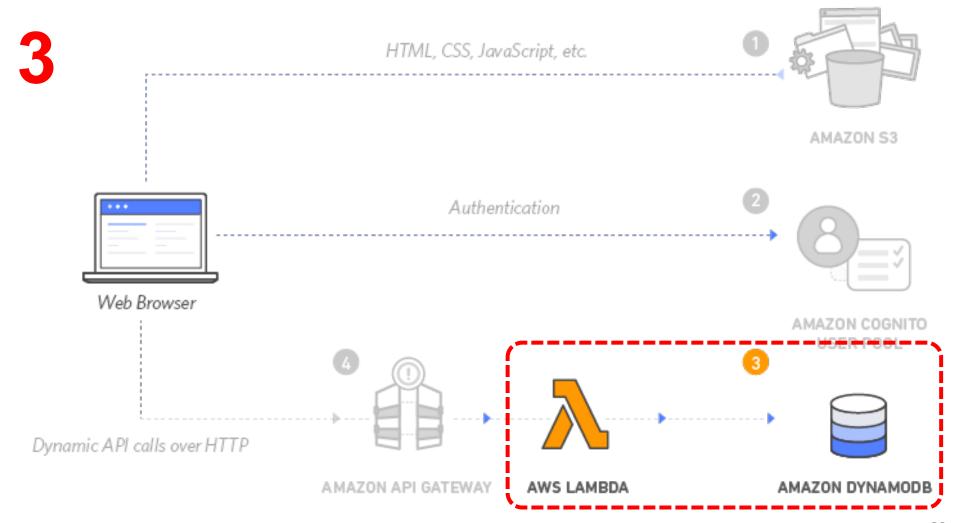
Dynamic API calls over HTTP

A MAZON API GATEWAY

AWS LAMBDA

AMAZON DYNAMODB



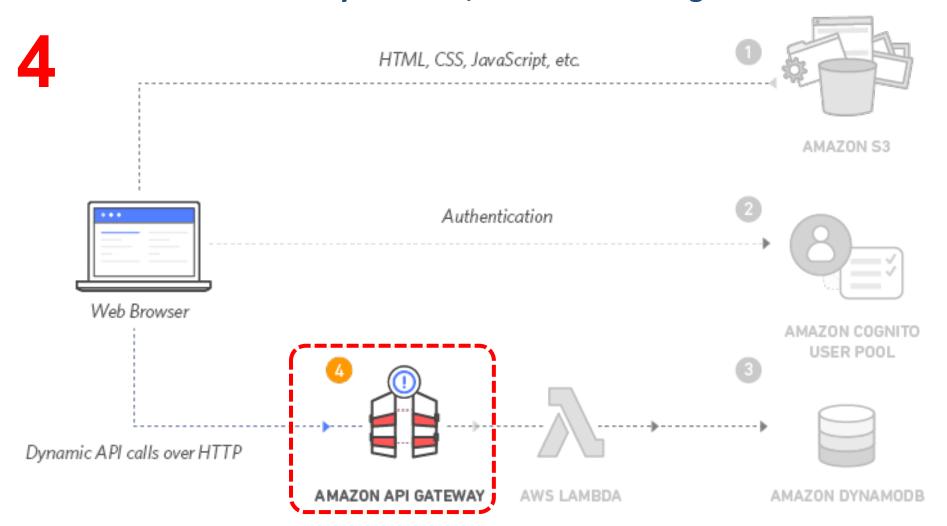




with Amazon S3, AWS Lambda, Amazon API Gateway, Amazon DynamoDB, and Amazon Cognito

Serverless Backend Amazon DynamoDB provides a persistence layer where data can be stored by the API's Lambda function. Web Browser Dynamic API calls over HTTP AMAZON API GATEWAY







with Amazon S3, AWS Lambda, Amazon API Gateway, Amazon DynamoDB, and Amazon Cognito

**RESTful API** JavaScript executed in the browser sends and receives data AMAZON S3 from a public backend API built using Lambda and API Gateway. USER POOL Dvnamic API calls over HTTP



with Amazon S3, AWS Lambda, Amazon API Gateway, **Amazon DynamoDB, and Amazon Cognito** 



## 5 Terminate resources

Resource Cleanup

You will terminate an Amazon S3 bucket, an Amazon Cognito User Pool, an AWS Lambda

function, an IAM role, a DynamoDB table, a

**REST API**, and a **CloudWatch** Log.

It is a best practice to delete resources you are no longer using to avoid unwanted charges.

Dynamic Ari calls over Hille



### Summary

- Cloud Computing and Cloud Software Architecture
- AWS Certified Cloud Practitioner (CLF-C01)
- AWS Certified Solutions Architect Associate (SAA-C02)
- Web Application with AWS Core Services
- AWS Serverless Architecture
- Build a Serverless Web Application
  with Amazon S3, AWS Lambda, Amazon API Gateway,
  Amazon DynamoDB, and Amazon Cognito

### References

- Ben Piper and David Clinton (2019),
   AWS Certified Solutions Architect Study Guide:
   Associate SAA-C01 Exam, 2 edition, Sybex, 2019
- AWS Cloud Practitioner Essentials (Second Edition)
  - https://aws.amazon.com/training/course-descriptions/cloud-practitioner-essentials/
- AWS Certified Cloud Practitioner
  - https://aws.amazon.com/certification/certified-cloud-practitioner/
- AWS Certified Solutions Architect Associate
  - https://aws.amazon.com/certification/certified-solutions-architect-associate/
- AWS Academy Cloud Foundations (AWS ACF), AWS Academy
- AWS Academy Cloud Architecting (AWS ACA), AWS Academy

### References

- Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.
- Ian Sommerville (2015), Software Engineering, 10th Edition, Pearson.
- Titus Winters, Tom Manshreck, and Hyrum Wright (2020), Software Engineering at Google: Lessons Learned from Programming Over Time, O'Reilly Media.
- Project Management Institute (2021), A Guide to the Project
   Management Body of Knowledge (PMBOK Guide) Seventh Edition
   and The Standard for Project Management, PMI
- Project Management Institute (2017), A Guide to the Project Management Body of Knowledge (PMBOK Guide), Sixth Edition, Project Management Institute
- Project Management Institute (2017), Agile Practice Guide, Project
   Management Institute