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Welcome to: **GCP Accelerated Certification Programme Professional Cloud Architect Workshop**

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google.roitraining.com



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Introduction

Course Objectives

In this course, you will learn how to:

- Prepare for the GCP Professional Cloud Architect certification exam
- Investigate business cases, cost optimization, and product strategies for major GCP services
- Deploy application using Compute Engine, Kubernetes, App Engine, and Cloud Functions
- Choose appropriate GCP storage services
- Examine security and compliance concerns in the cloud
- Explore Site Reliability Engineering and Stackdriver Monitoring
- Analyze GCP best practices and cloud case studies
- Review cloud architectures and implementations to solve common computing use cases

Start a Breakdown Document

Start a document and make notes about each GCP product

- Use a text editor, word, google-doc, etc

On this document, keep track of

- Key concepts
- Buzzwords
- Use cases
- Reasons to use/not use
- Common partner products/patterns

Use it as a way to breakdown/organize YOUR thoughts

Example/Starter Breakdown Document

Pull our Example/Starter Breakdown Document here

- <https://files.roitraining.com/GCP/Breakdown.txt>
- Add your OWN notes to help organize your thoughts



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 1: Cloud Architect Certification Overview

Chapter Objectives

In this chapter, we will:

- Review the certification exam format and guidelines

Chapter Concepts

Exam Overview

Prerequisites for the Exam

- The exam tests one's understanding of architecting, provisioning, and managing secure and reliable business solutions that leverage Google Cloud Platform technologies
- Experience with Google Cloud Platform at the level of course
 - Architecting with Google Compute Engine
 - Getting Started with Google Kubernetes Engine
 - Additional knowledge obtained by using GCP Hands-on
- Recommended experience:
 - 3+ years of industry experience
 - 1+ year experience on GCP

What You Are Tested On

- You are **not** tested on trivia (*what is the maximum number of this or that*)
- You are **not** required to code or configure a service
- You are tested on your:
 - Knowledge of what Google's cloud services are and their use cases
 - Understanding of how individual services work
 - Understanding of how Google's services are intended to fit together
- Can you choose which services to use for various cases optimizing:
 - Availability
 - Scalability
 - Security
 - Price

Exam Format

- Multiple-choice questions
 - Some are single select (pick correct answer from list)
 - Some are select 2 or 3 (select 2 of the 6 from list)
- Some questions are based on a case study
 - There are 3 case studies
- You have 2 hours to take the exam
 - You should get 50 multiple choice questions
- Grading is Pass/Fail

Taking the Exam

- Must register and schedule to take the exam
- Exam is delivered by Kryterion/Web Assessor
 - Take the online-proctored exam
 - Online with a remote proctor
 - Requires a good internet connection and a webcam
 - Take the onsite-proctored exam
 - Taken at a testing center
- Must prove your identity with 2 forms of ID
- Exam fee is \$200 - HSBC will give you a voucher code to cover 1st attempt



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 2: Realizing a Cloud Strategy

Chapter Objectives

In this chapter, you will:

- Make the business case for moving to the cloud
- Measure the success of cloud projects
- Architect cloud applications to optimize high availability, scalability, security, disaster recovery, and cost

Chapter Concepts

Moving to the Cloud

Success Measurements

Architectural Goals

Exam Prep

Business Case

- A business case defines a project's goals, opportunities, and costs
 - What are we trying to achieve?
 - How long will it take?
 - What will it cost?
 - What are the risks?
 - What are the rewards?
 - Why is this a good idea?

Product Strategy

- A company can't just run a wizard and be in the cloud
- What are some strategies that can be applied to make the move to the cloud easier, cost-effective, and less risky?
- Sometimes Google Cloud services seem interchangeable
 - Bigtable or Firestore
 - BigQuery or Cloud SQL
 - App Engine or Kubernetes Engine
- The exam asks you to make the best choice based on Google Practices
 - The right choice is not always obvious
 - Look for **keywords/buzzwords** that give you a hint

Cost Optimization

- Understanding costs for services is key to choosing services
 - Some services charge for what is allocated (Persistent disks)
 - Some services charge for what you use (BigQuery)
 - Some services require a server or cluster to be started (Bigtable)
 - Some services are serverless or NoOps (Pub/Sub)
- Some costs are pretty easy to calculate or predict
 - Storage in GBs
 - Compute in hours (billed in second increments)
- Some costs are hard to predict
 - Network egress
 - Requests per month

Trade-offs

- Nearly every architectural decision has some kind of trade-off
 - Should I choose Cloud SQL or BigQuery or Spanner?
 - Should we move our existing application as is to Compute Engine or rewrite to use App Engine?
 - Should we use a microservice or monolithic architecture?
- A competent Google Cloud Architect must first know what questions to ask
 - And know the pros and cons of each answer

Build, Buy, or Modify

- Unless you are a startup, you have legacy code, existing infrastructure, and existing processes
 - Do we move our existing applications into the cloud (lift and shift)?
 - Do we rewrite everything?
 - Do we scrap everything and start over?
 - Do we use some combination of the above?
 - Do we just decide it's too hard and leave everything as is?

Understand the Different Cloud Models

Define the following:

- IaaS
 - A service where the underlying resources are provided, but you still control aspects of the system including the operating system and application
- PaaS
 - All that is required from the user is the application—the rest is provided by the platform
- SaaS
 - Software is included
 - You are the end user

Chapter Concepts

Moving to the Cloud

Success Measurements

Architectural Goals

Exam Prep

Key Performance Indicators (KPIs)

- It is important to have objective ways of measuring success
 - Quantitative indicators can be represented numerically
- Key performance indicators should follow the SMART criteria
 - **S**pecific
 - **M**easurable
 - **A**chievable
 - **R**elevant
 - **T**ime bound
- What are some KPIs commonly used in IT?

Define the Following

- **Availability**
 - The proportion of time a system is functioning properly
- **Durability**
 - The ability of a system to remain functional with no loss of data
- **Latency**
 - The time between the start of an operation and its completion
- **Response Time**
 - Time a system takes to react to a given input

Chapter Concepts

Moving to the Cloud

Success Measurements

Architectural Goals

Exam Prep

Architectural Goals

- Different applications have different priorities
- What things are important?
 - Fault tolerance
 - High availability
 - Scalability
 - Elasticity
 - Disaster recovery
 - Low latency
 - Cost
 - Etc.

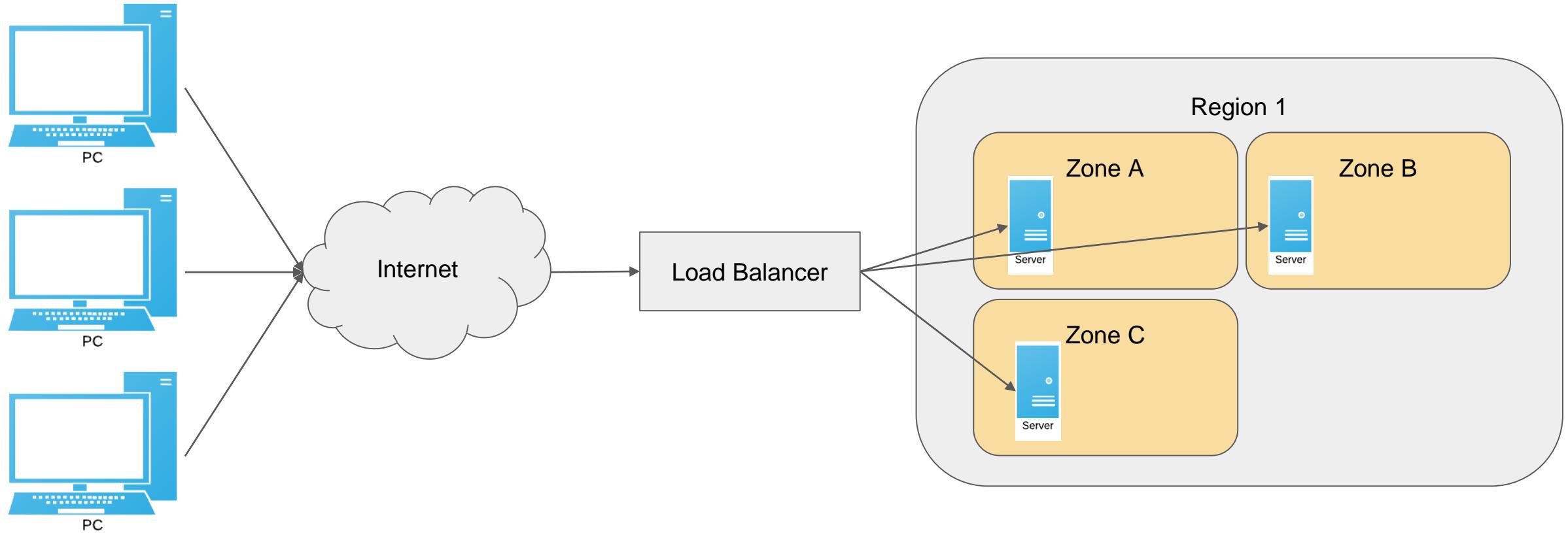
Fault Tolerance

- If there is a hardware failure, the application still works
 - Everything has a backup
- How can you deploy your applications so they are fault tolerant?

High Availability

- In GCP, you achieve high availability by deploying to multiple zones
 - Resources in different zones don't share a common point of failure
- Can you have 100% availability?
- Do you need 99.999% availability?
- Why might it be acceptable to deploy applications with less than 99.999% availability?

Fault Tolerant, High-Availability Architecture



Elastic Scalability

- Machines are easily added and removed to meet demand
 - No need to invest in hardware
 - Only pay for machines when they are being used
- Elasticity is a key to cost optimization

Elasticity (physics)

From Wikipedia, the free encyclopedia

In [physics](#), **elasticity** (from [Greek](#) ἔλαστος "ductile") is the ability of a body to resist a distorting influence or deforming force and to return to its original size and shape when that influence or force is removed. Solid objects will [deform](#) when adequate [forces](#) are applied on them. If the material is elastic, the object will return

Elastic Scalability in GCP

- List what needs to be setup for auto scaling in GCP:

Autoscaling

Instance Template

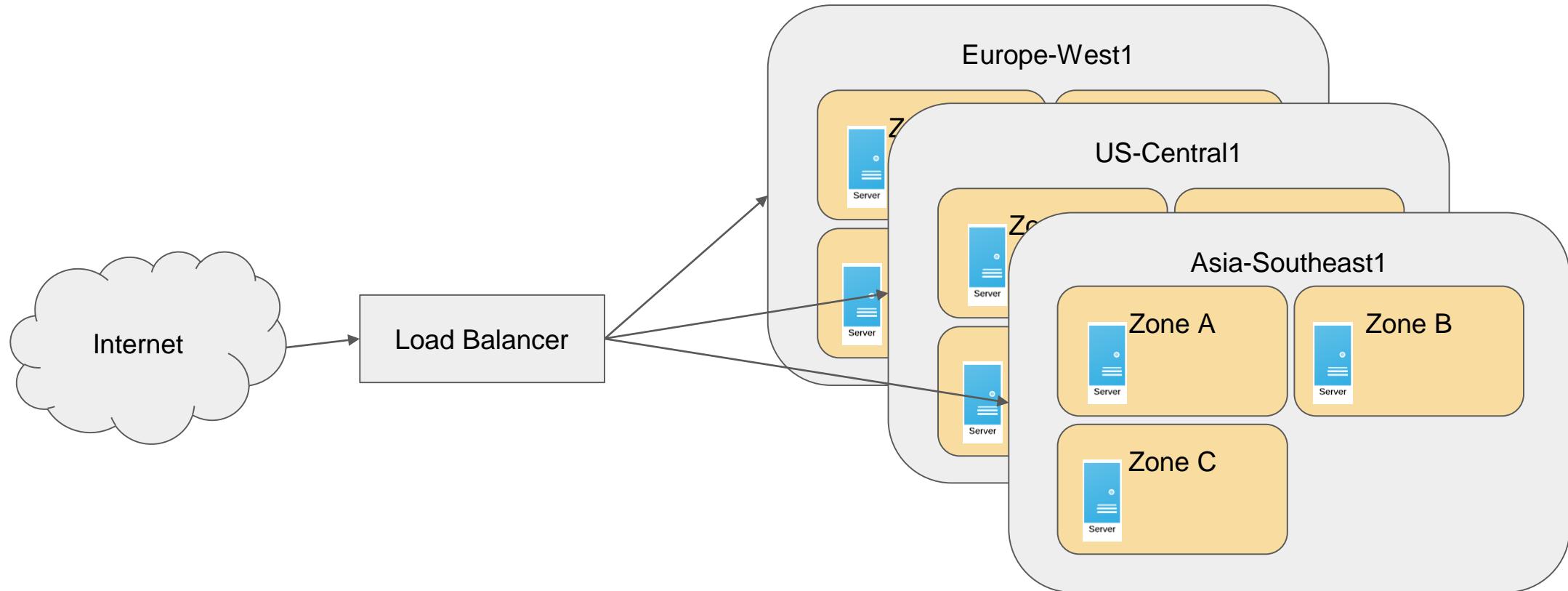
Managed Instance Group (MIG) based on the template

Rules for when to scale up and down

Disaster Recovery

- For most applications, deploying to multiple zones within a region achieves acceptable fault tolerance and high availability
- What if an entire region is down though?
- What might cause an entire region to be down?

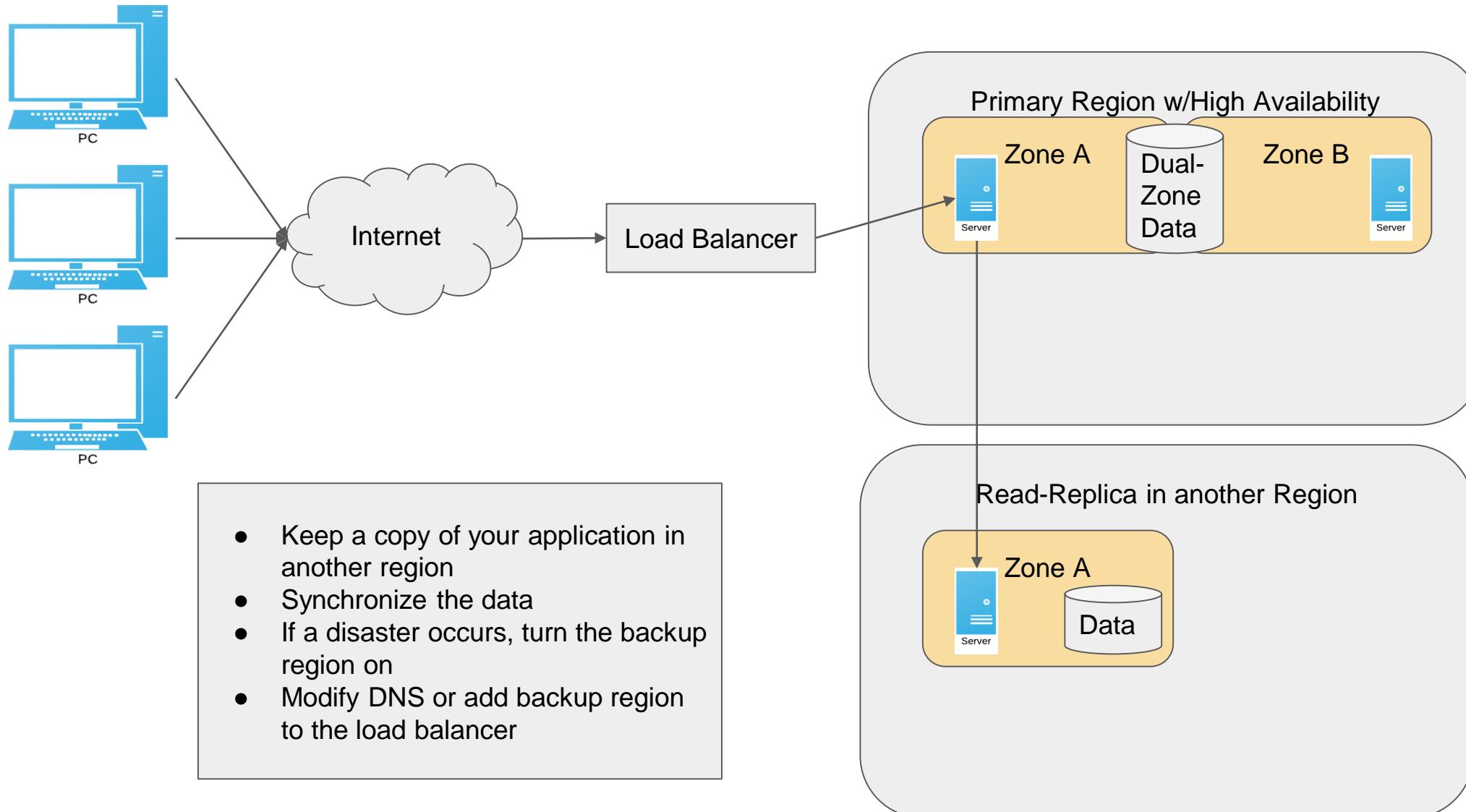
Disaster Recovery Architecture: Hot Standby/Active-Active



Disaster Recovery (continued)

- In the event of a natural or man-made disaster, a region could be down
- Application infrastructure can be stored in another part of the world and started in minutes if required

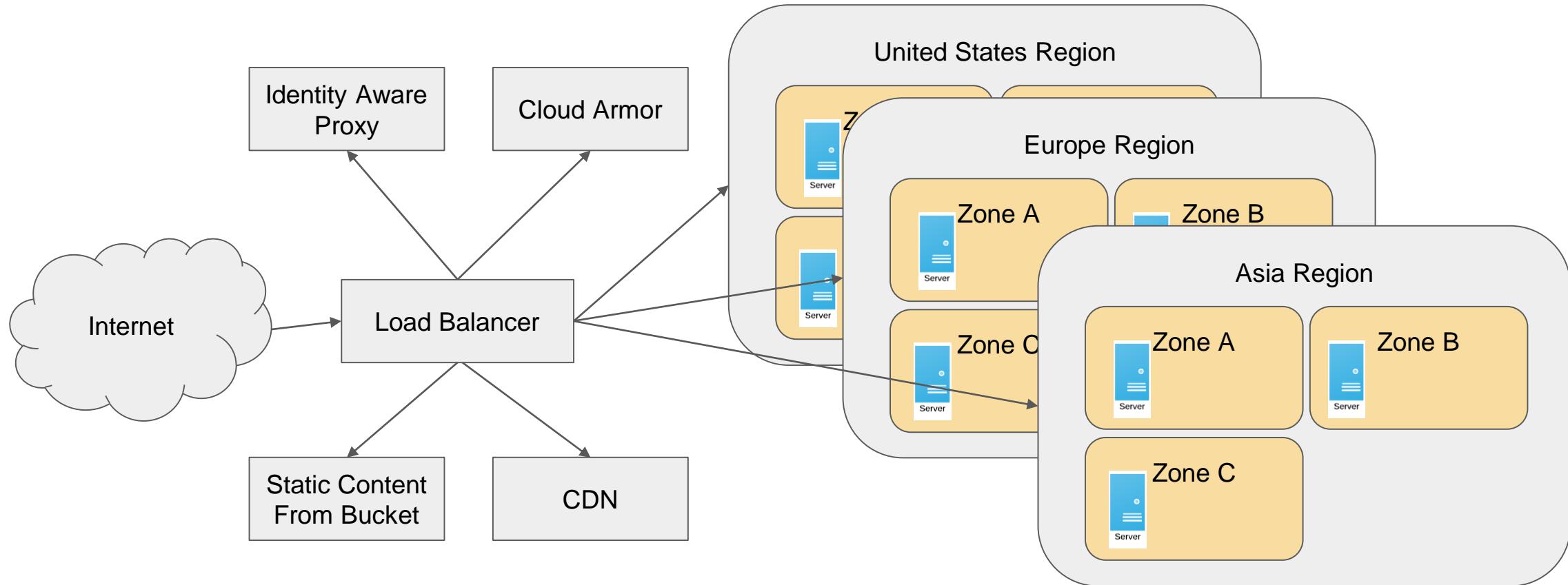
Disaster Recovery Architecture: Cold Standby



Delivering Content Worldwide

- If users are all over the world, deploy to multiple regions for minimum latency and maximum performance
- Send requests to the location nearest the user
 - GCP's load balancer works across regions
 - GCP's Content Delivery Network (Cloud CDN) caches data all over the world for low latency

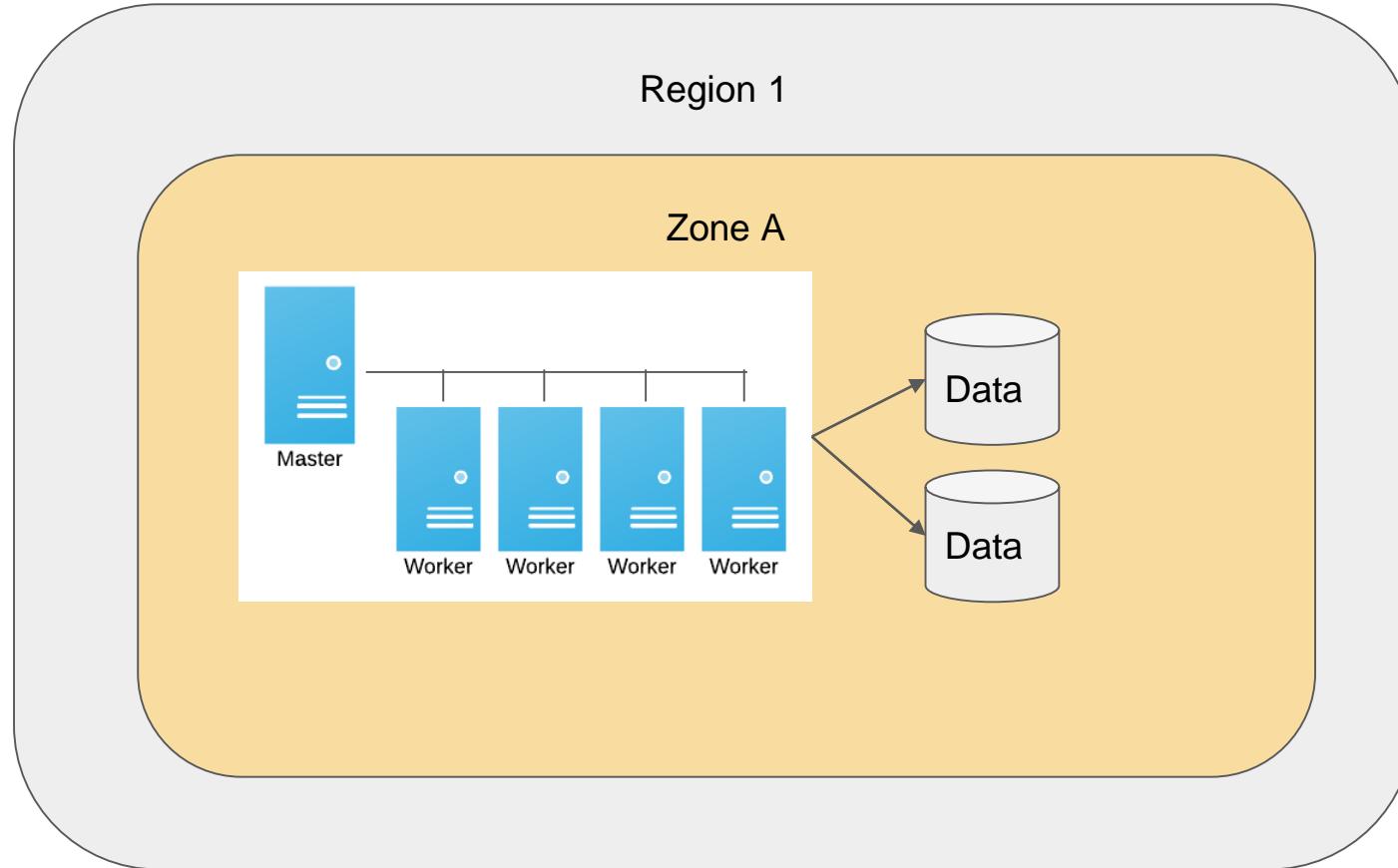
Delivering Content Worldwide Architecture



Big Data Processing

- Processing big data requires splitting the work among many machines
 - Dataproc Clusters (Hadoop/Spark) clusters run in a single-zone
 - Dataflow runs in a single-zone
 - BigQuery uses many machines to process data quickly
- To maximize performance, you need to minimize latency
- Keep data close to the clusters
 - Appropriate use of REGIONAL buckets
 - Twitter uses Dual-Region buckets for this purpose (availability+low latency)
- Keep all the machines in a cluster in the same zone

Big Data Processing Architecture



Chapter Concepts

Moving to the Cloud

Success Measurements

Architectural Goals

Exam Prep

Do Now: Practice Quiz



- Take this [practice quiz](#)
 - <https://quiz.roitraining.com/quiz1.html>

NOTE: these are NOT example exam questions. Question focus around topics just discussed and test-taking techniques



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 3: Cloud Solution Infrastructure

Chapter Objectives

In this chapter, you will:

- Migrate to the public cloud
- Deploy applications using Google Cloud infrastructure
- Set up networks to control access to our machines and services
- Automate deployments using Google App Engine
- Deploy hybrid cloud applications using Kubernetes Engine
- Build microservices using Google Cloud Functions

Chapter Concepts

Migrating to the Cloud

Interacting with Google Cloud Platform

Compute Services

Networking

Platform Services

Exam Prep

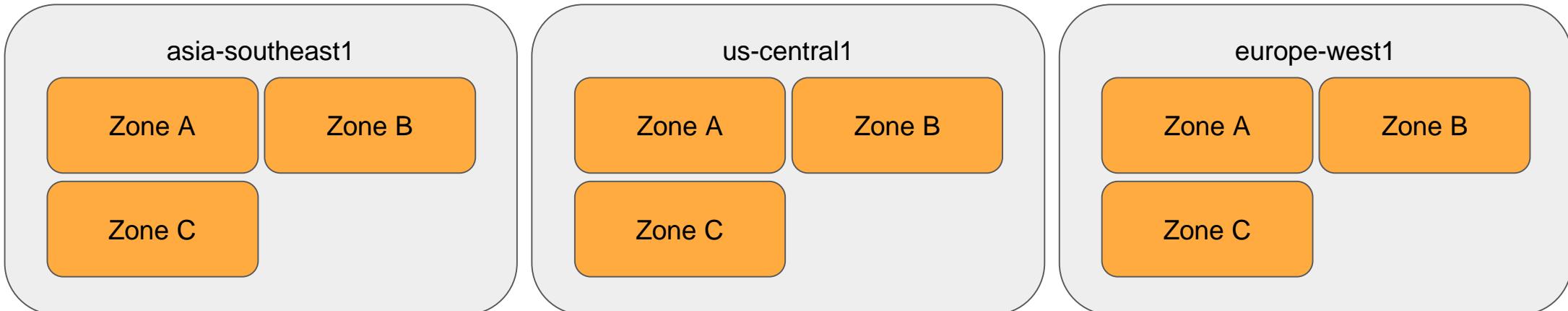
Regions

- Regions are massive data centers located in different parts of the world



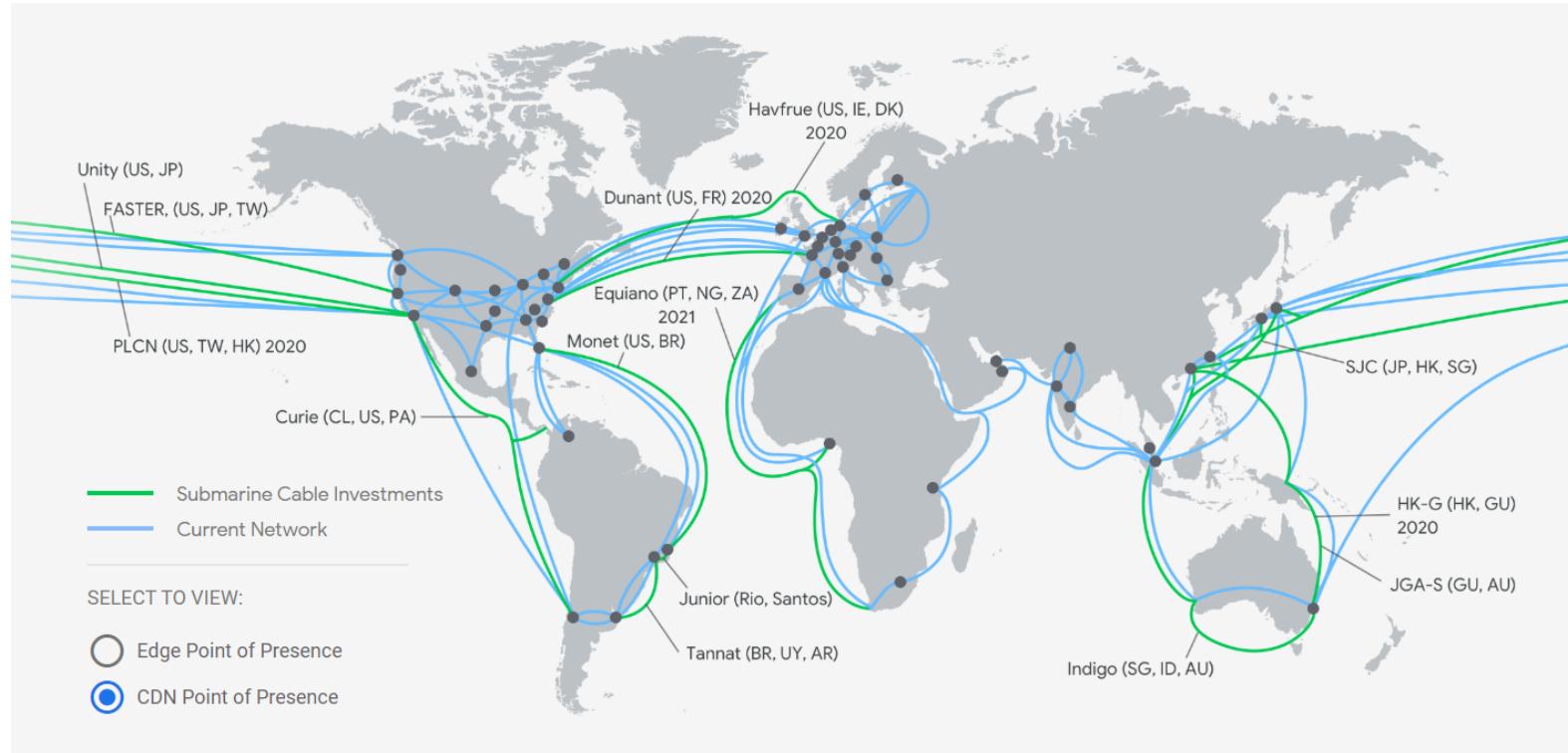
Zones

- Each region is divided into multiple zones
 - Region=Campus
 - Zone=Building/Virtual Building
- Zones are isolated from one another
 - Failures in one zone do not affect the other zones in a region
 - Resources in different zones share no common points of failure



Google's Network

- Google's data centers are connected with Google's own high-speed network
 - Edge Points of Presence provide access points to Google's Network
 - CDN (Content Delivery Network) provide caches all over the world



Do Now: Regions and Zones



Answer the following:

- Why would you deploy your applications or data into multiple regions?
- Why would you deploy to multiple zones?
- When might you deploy your servers and data into one zone?

Chapter Concepts

Migrating to the Cloud

Interacting with Google Cloud Platform

Compute Services

Networking

Platform Services

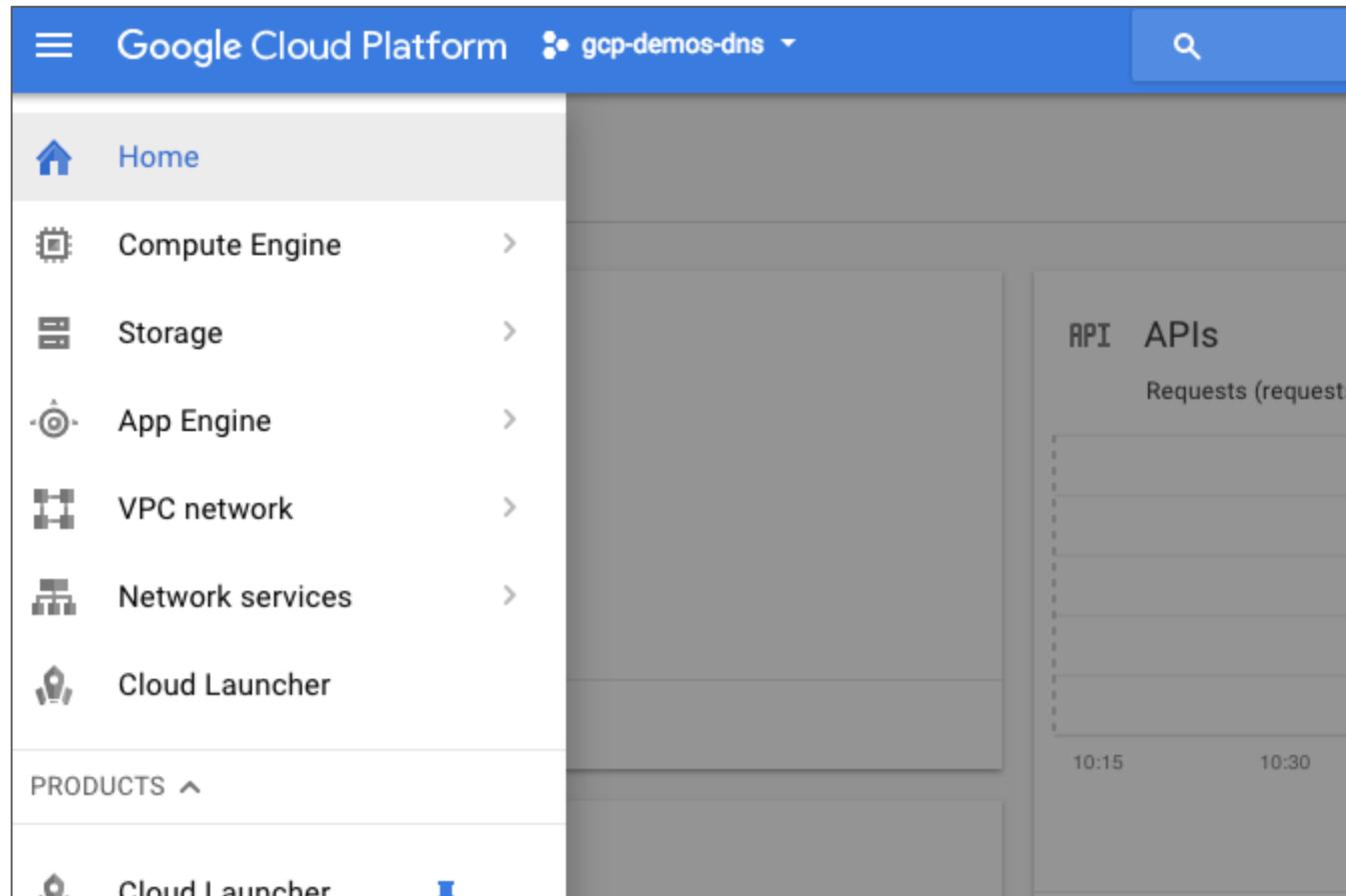
Exam Prep

There Are Several Ways to Interact with GCP

- Cloud Console
- Command Line Interface (CLI)
- REST-based API
- Client Libraries are available for many programming languages
- Important to have a basic understanding of them all, but be sure to be familiar with the console and CLI for the exam
- The exercises/tutorials provided in this course will provide some hands-on experience using the console and CLI

Cloud Console

- The cloud console (or web console) provides a web-based user interface

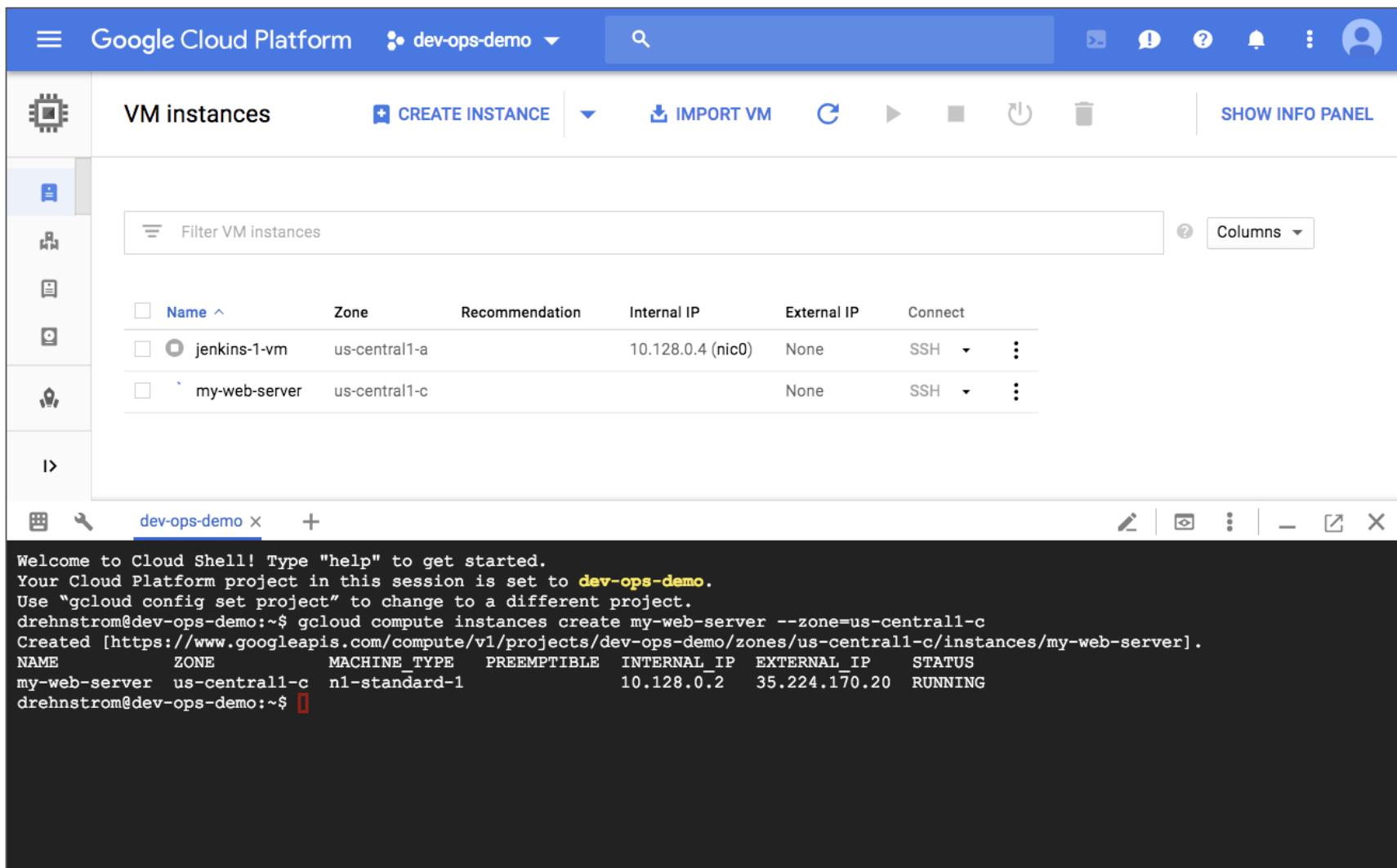


CLI

- Available for most operating systems
 - Must be configured with credentials
- Command line tools for Cloud Platform products and services
 - gcloud, gsutil (Cloud Storage), bq (BigQuery), kubectl (Kubernetes), cbt (Cloud BigTable)

```
gcloud compute instances create my-web-server --zone=us-central1-c
```

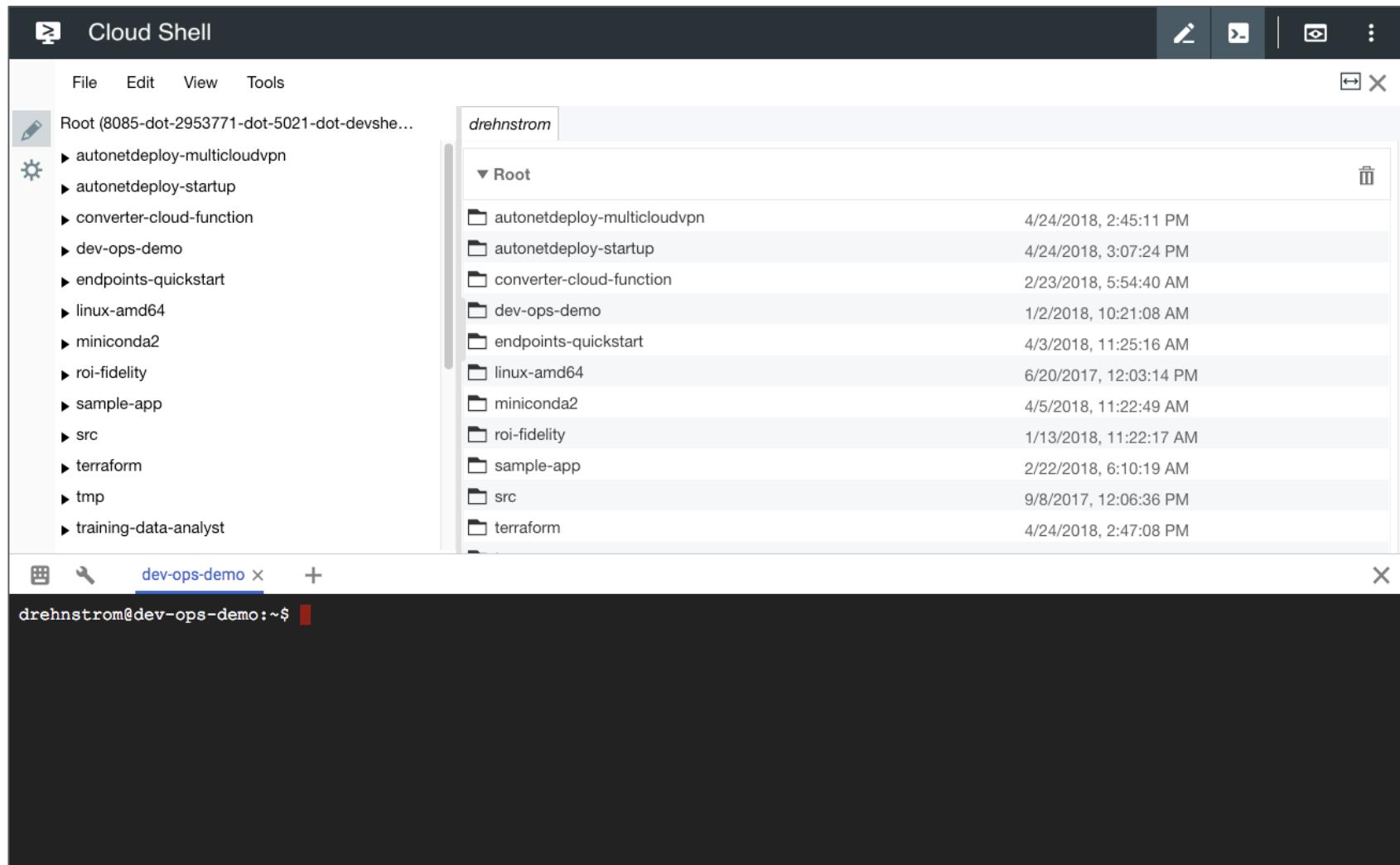
Google Cloud Shell



Cloud Shell Features

- 5 GB of persistent disk storage per user
- Google Cloud CLI and other tools pre-installed
- Language support, including SDKs, libraries, runtime environments, and compilers for Java, Go, Python, Node.js, PHP, and Ruby
- Web preview functionality, which allows you to preview web applications running on the Cloud Shell instance through a secure proxy
- Built-in authorization for access to projects and resources

Cloud Shell Code Editor



Chapter Concepts

Migrating to the Cloud

Interacting with Google Cloud Platform

Compute Services

Networking

Platform Services

Exam Prep

Google's Compute Service Choices



Compute Engine

Google's Compute Service Choices (continued)



Compute Engine



Kubernetes Engine

Google's Compute Service Choices (continued)



Compute Engine



Kubernetes Engine



App Engine

Google's Compute Service Choices (continued)



Compute Engine



Kubernetes Engine



App Engine



Cloud Functions

Google's Compute Service Choices (continued)



Compute Engine



Kubernetes Engine



App Engine



Cloud Functions



Cloud Run

Google Compute Engine (GCE)

- Infrastructure as a Service (IaaS)
 - High-performance virtual machines
 - Flexible pricing options
 - Pay for CPUs, memory, and disk space allocated
 - Persistent disks and snapshots
- Use many small machines and autoscaling to minimize cost
- When to use Compute Engine

Virtual Machines

Things to know:

- Linux and Windows are supported
- Specify the amount of memory and CPUs when creating the machine
 - Custom machine types are supported
- Machines are added to a network and a zone
- Machines can be assigned a public IP

Virtual Machine Pricing

Things to know:

- Charged by number of CPUs and memory allocated
- Additional cost may be added for licensing for certain VMs
 - Windows, SuSE, RedHat, and SQL Server are premium instances
- On-demand pricing billed by the second with a 1-minute minimum
 - Sustained use discounts applied starting at 25% of a month
- Committed use discounts (1 or 3 year commitments)
- Preemptible VMs offer the biggest discount
 - But can be turned off by Google at any time
- Visit the pricing page: <https://cloud.google.com/compute/all-pricing>

Disks and Snapshots

Things to know:

- Virtual disks can be created and attached to virtual machines
 - Two types of persistent disks: Standard and SSD
 - One type of temporary/swap/non-persistent: Local SSD
- Disks are more expensive than Google Cloud Storage
 - Pay for what you allocate, not what you use
- Snapshots are copies of disks at some moment in time
- Use snapshots to move disks to a different zone or region
- Disks can be resized at any time
 - Even if the disk is attached to a running instance

Chapter Concepts

Migrating to the Cloud

Interacting with Google Cloud Platform

Compute Services

Networking

Platform Services

Exam Prep

GCP Networking

- Google has the most powerful network in the world
 - Own all the fiber connecting their data centers
- Google uses a software-defined networking system
 - Abstracts many of the details for defining networks
 - Location of networking hardware doesn't determine configuration

GCP Networking Services

- VPC networks
- Firewall rules
- Load balancers
- Cloud CDN
- Cloud DNS
- Health monitoring
- VPN

VPC Networks

Things to know:

- Networks consist of a collection of subnets
 - Subnets are bound to regions and can span zones
 - Each subnet defines a private IP address range
- Networks can span multiple regions around the world
 - Machines in the same network can communicate via their private IPs regardless of their region
- Use multiple networks to isolate machines
 - By default, VMs in different networks can only communicate with public IPs
- Machines without a public IP can only be accessed within a network
- Shared VPC allows a network to be shared across multiple projects

Demo: Networks



- Your instructor will demo creating a network and firewall rules

Firewall Rules

Things to know:

- By default, all ports are closed coming into a network
- Firewall rules are added to allow access to ports from external machines
- Firewall rules can be allow or deny
- Can use tags to control which rules apply to which machines in a network

VPC Network Peering

- Two VPC networks can be privately connected with VPC Network Peering
 - Allows machines in different networks to communicate with private IPs
 - The subnet IP ranges in peered VPC networks cannot overlap
 - The two networks can even be in different projects and organizations
- VPC Network Peering can:
 - Reduce latency
 - Connecting via private IPs will have lower latency than public IPs
 - Reduce cost
 - GCP charges egress bandwidth when using public IPs to communicate
 - Increase security
 - VMs may no longer require public access

Shared VPC

- Shared VPCs allows you to connect resources from multiple projects to a common VPC network
- You set up one project as a host project, and connect other projects to it called service projects
- Shared VPC allows you to:
 - Provide a single point of control for a multi-VPC environment
 - Enforce consistent access control policies at the organization level
 - Share resources from one VPC to other VPCs



Demo: Shared VPC

- Your instructor will demonstrate Shared VPC using several projects

Load Balancing and Autoscaling

- Need multiple machines in multiple zones to achieve high availability
 - Load balancer is required to route requests to a healthy instance
- An instance group is used to manage the machines in a region
- Autoscaling is configured in an instance group
 - Specify minimum and maximum number of machines
 - Specify a metric that determines when to add or remove machines
- Health check is used by instance group to ensure machines are reachable
- Instance groups create machines based on Instance Templates

Health Checks

- Used to ensure machines are ready to take requests
 - Instance groups will create new machines if existing ones aren't healthy
 - Load balancers use health checks to determine if they can send requests to machines

The screenshot shows a form for creating a new health check. The fields are as follows:

- Name**: web-server-health-check
- Description (Optional)**: (empty)
- Protocol**: HTTP
- Port**: 80
- Request path**: /
- Health criteria**:
 - Check interval**: 5 seconds
 - Timeout**: 5 seconds
 - Healthy threshold**: 2 consecutive successes
 - Unhealthy threshold**: 2 consecutive failures
- Create** and **Cancel** buttons at the bottom.

Cloud DNS

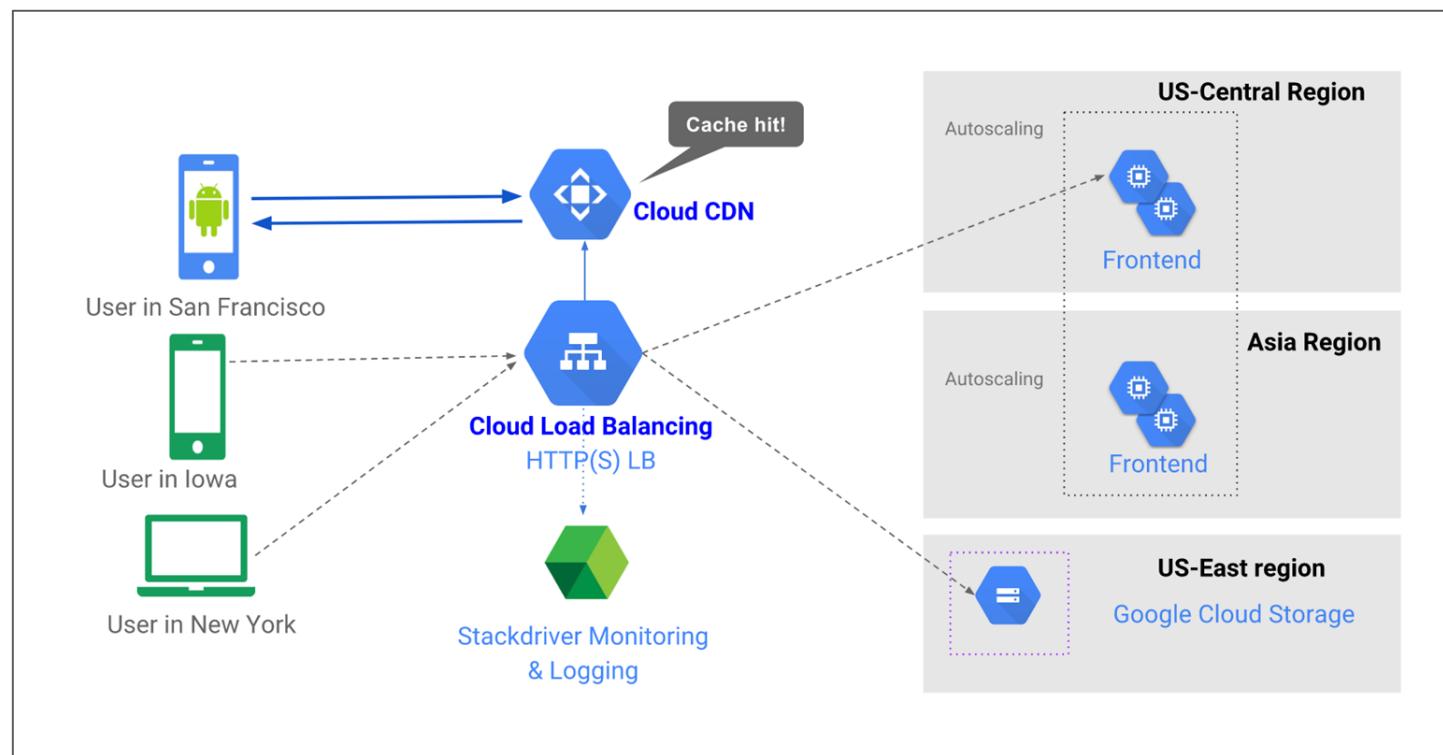
Things to know:

- Allows you to manage your domains right from GCP
- Map domains and subdomains to load balancers, cloud storage buckets, or App Engine applications
- See the [Cloud DNS](#) details

Cloud CDN

Things to know:

- Configured when setting up an HTTP(S) load balancer
 - Just check the box to enable CDN
 - Caches responses from machines in a back-end service or content in a bucket



Demo: Autoscaling and Load Balancing



- Your instructor will demonstrate Autoscaling and Load Balancing, along with
 - Domain Name System (DNS)
 - Static content delivered from a bucket
 - Content Delivery Network (CDN)
 - Cloud Armor
 - Identity Aware Proxy (IAP)

Hybrid Connectivity



Cloud Interconnect

Enterprise-grade connections to your Google VPC backed by industry-leading SLAs. Choose a 10 Gbps or 100 Gbps pipe and connect directly to a Google location with Dedicated Interconnect, or flexible bandwidth options (50 Mbps to 10 Gbps) with Partner Interconnect.



Cloud VPN

Connect your on-premises or other public cloud networks to your Google VPC securely over the internet through IPsec VPN at a low cost for your data bandwidth needs up to 3.0 Gbps. High availability VPN offers the best SLA in the industry, with a guaranteed uptime of 99.99%.



Peering

Access Google and Google Cloud features over VPN or the internet, while cutting egress fees. If you can meet Google's requirements, connect directly with Direct Peering, or choose a partner with Carrier Peering.

Cloud VPN

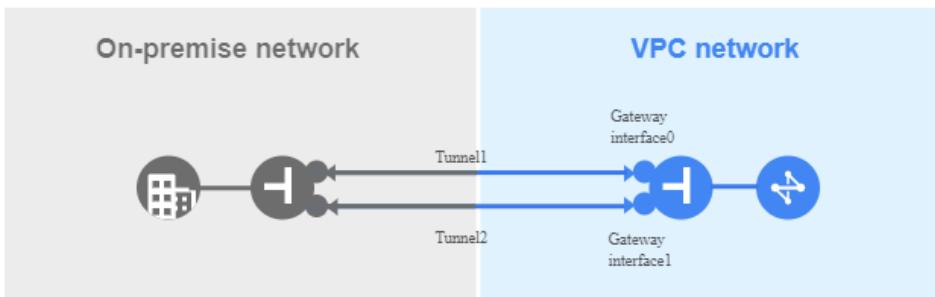
- Create a VPN Tunnel between
 - Google VPC Network and Corporate Network
 - Between two Google VPC Networks
 - Up to 3Gbp/s per tunnel
- Requires Public IP(s) on Corporate Network and Corporate VPN equipment
 - Classic VPN uses 1x IP address on each end - 99.9% availability
 - High Availability uses 2x IPs on each end - 99.99% availability
- NOT a client VPN (not for users connecting to GCP - Network to Network)

Cloud VPN (continued)

High-availability (HA) VPN

Supports dynamic routing (BGP) only
Supports high availability (99.99 SLA, within region)

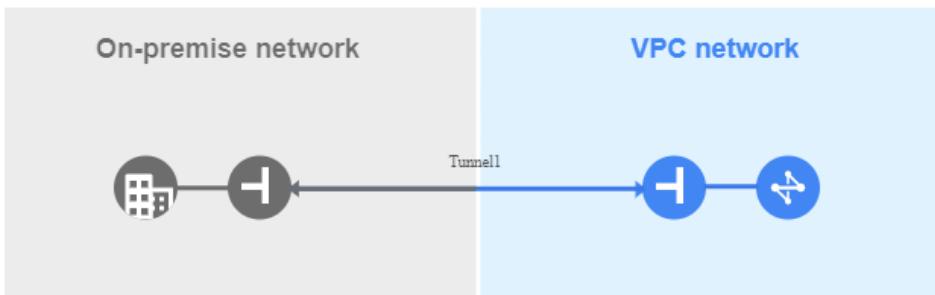
[Learn more](#)



Classic VPN

Supports dynamic routing and static routing
No high availability

[Learn more](#)



Cloud Interconnect

Things to know:

- Interconnect GCP offers several options to connect on-prem infrastructure to Google
 - Private IP addresses (On Premise) to Private IP addresses (GCP VPC Network)
 - Offers a 99.9% (single) or a 99.99% (multiple) uptime SLA
- Dedicated Interconnect - meet Google at a Edge Point of Presence (POP)
 - Dedicated, direct connection to VPC networks
- Carrier Interconnect - your telecom meets Google at a Edge POP
 - Interconnect link provided by a service provider

Cloud Interconnect

- Interconnect connects Google VPCs to Corporate Private IP
 - Private IP space to Private IP space via VLANs across Interconnect
 - Offers a 99.9% (single) or a 99.99% (multiple) uptime SLA
- Dedicated Interconnect
 - Meet Google at a Network Edge Locations/Point of Presence (POP)
 - Google has 144 Network Edge Locations (June 2020)
 - Requires physical/logic connections
 - Represented as a layer 2 or layer 3 connection
- Carrier Interconnect
 - Service provider meets Google at a Edge Point of Presence (POP)

Cloud Peering

- Peering shares Google's Public IPs directly with Corporate Public IPs
 - Reduces Egress prices for data transiting the connection
 - Peering is ONLY Public IP addresses, not Private IPs
 - Used for routing Public IP traffic thru Edge Point of Presences
 - Does NOT have an SLA
- Direct Peering
 - Dedicated, direct connection to Google's public network
 - Must have a presence in same location as Google (POP)
- Carrier Peering
 - Peering through service provider to Google's public network

Chapter Concepts

Migrating to the Cloud

Interacting with Google Cloud Platform

Compute Services

Networking

Platform Services

Exam Prep

Platform as a Service (PaaS)

- Automate the deployment of applications
- Platform services hide the details of infrastructure for applications
 - Automates the creation of load balancers, autoscaling, health checks
- Automatically installs patches and updates

App Engine

- App Engine applications are a collection of one or more services
 - Each service is deployed independently
 - Services scale independently
 - Different languages can be used for different services
- Can deploy multiple version simultaneously



App Engine (continued)

- Use traffic splitting to control which version(s) requests are sent to
- Integrates with other platform services for common use cases
 - Cloud Firestore is a completely managed NoSQL database
 - Memcache service used for in-memory caching across instances
 - Task Queue is a message queueing system used to pass messages between services



App Engine Environments

- App Engine Standard
- App Engine Flex



App Engine Standard Environment

Things to know:

- Uses Google-specific containers for deploying services
- Supports only specific versions of Python, Java, PHP, Go, Ruby, and Node.js
- Scales very quickly; containers can start in a couple hundred milliseconds
 - Will scale to zero instances when there is no traffic
- Free tier
- See the [App Engine Standard](#) docs

App Engine Flexible Environment

Things to know:

- Uses Docker containers for deploying services
- Supports any language that will run in a Docker container
 - Google provides preconfigured Docker containers for Python, Java, PHP, Go, Ruby, .NET, and NodeJS
- Docker containers run in a Compute Engine virtual machine
- Cannot scale to zero instances, so there is no free tier
- See the [App Engine Flexible](#) docs

Google Kubernetes Engine (GKE)

Things to know:

- Used to deploy containerized applications
- Applications deployed into a cluster of Compute Engine virtual machines
- Application configuration is defined using the open-source [Kubernetes](#) orchestration framework
 - Kubernetes supports other clouds and on-premises deployments
- See the [Google Kubernetes Engine](#) docs

Google Kubernetes Engine (GKE) (continued)

- GKE is more flexible than App Engine, but also less automated
 - Especially useful for hybrid deployments



Kubernetes Objects Definitions

Object	Definition
Clusters	Collections of machines that will run containers
Nodes	The machines in the clusters (can be physical or virtual machines)
Pods	These are the smallest unit of deployment, have one or more containers
ReplicaSets	Used to create multiple instances of a pod and guarantee pods are healthy and the right number exist
Services	Provide access to a set of pods
HorizontalPodAutoscalers	Monitor demand and scale pods up or down
Deployments	Configurations that define service specifications

Understanding Kubernetes Services

- Services provide access to your Kubernetes deployments

ClusterIP	The default service type. Has only an internal IP address that is only accessible by other services running inside the cluster.
LoadBalancer	A service that provides an external IP address. In GCP, this is implemented as a TCP load balancer. In AWS, this is implemented as an Elastic Load balancer. Not all Kubernetes deployments would support this type of service. Can be expensive if you have lots of services, which means lots of load balancers.
NodePort	Assigns a port between 30000 and 32767 to nodes in your cluster. When a node is accessed at that port, it routes to your service.
Ingress	Not really a service. Allows you to specify one or more paths that route to your services. Like a smart router or a reverse proxy. In GCP, an Ingress is implemented as an HTTP Load Balancer.

Source Repositories, Cloud Build and Container Registry

- Source Repositories are Git-compatible repositories
 - Hosted in GCP project
- Cloud Build is a fully managed Continuous Integration/Continuous Deployment (CI/CD) platform
 - Can build from source code located in Google Cloud Source Repositories, GitHub, or Bitbucket
 - Can build a variety of artifacts, including Docker containers
 - Processes Dockerfiles or Custom instructions in .yaml
- Container Registry stores built containers
 - Can be used as a source for container deployment (gcr.io)

Demo: Source to Containers



- Your instructor will demonstrate
 - Source Code Repositories
 - Cloud Build
 - Google Container Registry
 - Deploying the resulting container

Google Cloud Functions

Things to know:

- Serverless environments for running Node.js, Go, and Python functions
 - Just upload the code
- Microservice architecture where each function performs one job



Google Cloud Functions (continued)

Things to know:

- Responds to Cloud Storage changes, Pub/Sub messages, or web requests
- Incredibly fast and scalable
- Very inexpensive (first 2 million requests per month are free, as well as some computing time)
 - \$0.40 each additional requests, plus computing time
- See the [Cloud Functions](#) docs

Google Cloud Run

- Service that runs serverless containers in the cloud
 - Like a cloud function, but as a container
- Can run any language, library, and binary
 - Cloud Functions are limited to specific node.js, python, go runtimes
- Only pay when your container is running
 - First request starts container
 - Continues to run until no further requests
 - ON-DEMAND CONTAINERS



Do Now: Choosing Platform Services



- Fill in the table below:

Service	What is deployed (code or container)	Use Cases	Pricing Model
App Engine Standard			
App Engine Flex			
Kubernetes Engine			
Cloud Functions			
Cloud Run			

Chapter Concepts

Migrating to the Cloud

Interacting with Google Cloud Platform

Compute Services

Networking

Platform Services

Exam Prep

Do Now: Practice Quiz



- Take this [practice quiz](#)
 - <https://quiz.roitraining.com/quiz2.html>

NOTE: these are NOT example exam questions. Questions are focus around topics just discussed/teaching test-taking techniques



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 4: Storage and Big Data Solutions

Chapter Objectives

In this chapter, you will:

- Store binary data using Cloud Storage
- Store relational data with Cloud SQL and Spanner
- Store NoSQL data with Bigtable and Firestore
- Warehouse and analyze data using Google BigQuery
- Determine the right Google Cloud storage service for various use cases
- Introduce Big Data Tools on GCP

Chapter Concepts

GCP Storage Products

Big Data Products

Exam Prep

Types of Cloud Storage

- BLOB (Binary Large OBjects) storage is for storing any type of file
 - CLOB (Character Large OBject) is a subset of BLOB
- Relational storage is used for relational databases of file
 - ANSI SQL is the common language of relational databases
 - SELECT, INSERT, UPDATE, DELETE, CREATE, DROP
 - ACID
- NoSQL storage is for structured data
 - Similar to relational, but deviates from relational in one or more way
 - CAP Theorem: Consistency, Availability, Partitional Tolerance
 - Pick TWO of the THREE for a distributed system
- Data warehousing is for data analysis and reporting
 - BigQuery is Google Cloud's primary Data Warehouse tool

Google's Storage Service Choices



Cloud Storage



Cloud SQL



Spanner



Firestore



Bigtable



BigQuery

Cloud Storage

- BLOB storage
- Organized as objects in buckets
 - Bucket names must be unique in all of GCP
 - Maximum object size is 5TB per object / unlimited number of objects
 - Referenced as gs://bucketname/
- Can control access to buckets and objects inside buckets
 - Bucket level permissions
 - Individual object permissions
- All buckets have
 - High durability (99.99999999% annual durability)
 - Low latency (time to first byte typically tens of milliseconds)
- Bucket Location and Storage Class determines price and availability

Cloud Storage Classes

- Multiregional
 - Choose from U.S., Europe, or Asia
 - Data is replicated in multiple data centers in the chosen area
 - Use for delivering web content with the least latency to large area
- Dual Regional
 - Preconfigured to store data in two regions in a geographic location
- Regional
 - Choose a specific data center to store data in
 - Keep your data close to the applications that use it

Cloud Storage Classes (continued)

- Standard - example: Multi-regional is \$0.026 per GB per month
 - Cost per GB for storage, no GB data retrieval charge
 - No minimum time charge, pay for time stored, higher SLA than others
- Nearline - example: Multi-regional is \$0.01/GB/month + \$0.01/GB
 - Cost per GB for storage, plus data retrieval cost per GB
 - Minimum 30 day charge for storage
- Coldline - example: Multi-regional is 0.007/GB/month + \$0.02/GB retrieval
 - Minimum 90 day charge for storage
- Archive - example: Multi-regional is 0.004/GB/month + \$0.05/GB retrieval
 - Minimum 365 day charge
- ***Need to determine which storage class to use for particular use cases***

Do Now: Matching Storage Class to Use Case



- Draw an arrow to select the best storage location and class for each

Storing CSV files for analysis using a Hadoop cluster running in Google Cloud Dataproc

Multi-Regional

Archiving old emails to conform to a regulatory requirement

Regional

Storing static web files (.pdf, .jpg, .css, .js, etc.) for distribution all over the world

Standard

Storing data files that will be used for training in a machine learning project

Nearline

Storing a huge number of photos that will be made available via a website

Coldline

Storing snapshots of virtual machines in another region so they can be started if the main region is down

Archive

Bucket Features

- Object metadata
- Encryption by default
- Versioning
- Change notifications and lifecycle management
- Simple static website hosting
- Signed URLs
- Retention policies

Cloud Data Transfer Services

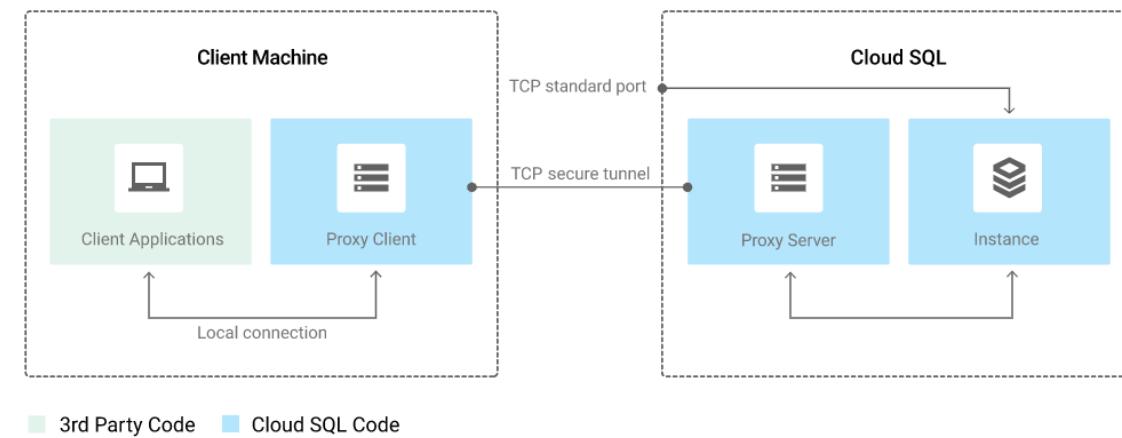
- Google provides a range of data transfer methods to get data into GCP
 - Choose based on type and volume of data
- Web console, gsutil, JSON API
 - Web console and gsutil -m option supports parallel transfers
- Storage Transfer Service
 - Bucket-to-bucket, AWS Bucket to GCS, Bucket, List of URLs to GCS
- Transfer Appliance
 - Google ships appliance to Customer
 - Customer sets encryption key, copy data onto appliance
 - Ship back to Google and Google stages encrypted data
 - Customer boots a Rehydrator Appliance from Marketplace
 - Customer REHYDRATES data into GCS and then uses data

Cloud SQL

- Relational database storage
 - ANSI SQL (SELECT, INSERT, UPDATE, DELETE, CREATE, DROP, etc)
- Supports specific versions of MySQL, PostgreSQL and SQL Server
 - MySQL: 5.6 & 5.7
 - PostgreSQL: 9.6, 10, 11, 12
 - SQL Server 2017
- Simple setup, automated administration
 - Normal: 1 region/1 zone - High Availability: 1 region/2 zones
 - Automated backups - Google performs daily backups
 - Requires maintenance window
 - 1 hour per week when Google can perform disruptive patching/OS reboot
 - Google is managing underlying OS and Database software

Cloud SQL Access

- Authorization (built-in firewall)
 - Supports Public or Private (VPC) access
 - Must authorize IP address/Range of IP Addresses that can access
- Cloud SQL Proxy can also be used instead of IP Authorization
 - Secure connections: encrypts traffic to/from database server
 - Proxy handles authentication with Cloud SQL
 - Run Proxy on Client Machine, VM or in Kubernetes Pod



Spanner

- Massively scalable relational database service
 - Understands ANSI SQL
 - Designed for extremely high availability
 - Accessed via RESTful / API
 - Add/Remove spanner nodes without restart (horizontal scaling)
 - Scales to hundreds or even thousands of nodes
- Available as a regional or specific multi-regional configuration
 - Regional SLA: 99.99% nodes operate compute in 3-zones
 - Multi-regional SLA: 99.999% nodes operate compute in multiple regions
- Strong consistency even with many servers/multiple regionals
 - Uses atomic clocks to synchronize transactions around the globe
- See the [Spanner](#) docs

Cloud SQL or Spanner?



NoSQL on GCP

NoSQL Databases (not only SQL)

- Key-value stores
 - Memcache (AppEngine Only)
 - MemoryStore
- Document Stores
 - Firestore/Datastore
- Wide-column Stores
 - BigTable
- Other types of NoSQL (Graph DB)
 - Compute Engine or Kubernetes Cluster
 - Load software

Memorystore

- Key-value Stores are simplest NoSQL DB
 - Think Windows Registry! It's the most widely used Key-Value
 - NOT queried using ANSI SQL
- Memorystore
 - Fully-managed in-memory data store service for Redis
 - Managed Service
 - Define amount of RAM used to store database
- NOTE: AppEngine includes a shared Memcache

Firestore/Datastore

- Firestore is the current NoSQL Document Store on Google Cloud
 - Store JSON blobs into records
 - MongoDB is a common NoSQL Document Store
- Completely managed, NoOps
 - Pay per read (\$0.60/million) and per write (\$1.80/million) operation
 - Support ACID transactions
 - Flexible indexing allows for very fast and flexible data retrieval
- Firestore is the next generation of Datastore
 - Firestore API - Mobile/Web applications with client-side synchronization
 - Datastore API - traditional database - everything on the backend
 - Firestore replaced Datastores backend with Firestores backend
- See the [Firestore](#) docs

Bigtable

- TB/PB Wide-column NoSQL database (like HBase/Cassandra)
 - Compatible with HBase API/can use HBase shell
- gcloud is used to create Bigtable clusters
 - Clusters are single-zone
 - Nodes can be added/removed without restart
 - Takes time for load to shift to new node
 - Additional clusters can be created in other zones/regions and replicated
- Bigtable tables are made up of columns
 - Use cbt (cloud-big-table) command line utility to create tables/columns
 - Each row in Bigtable table must have a unique key
 - Only index available is the key
 - Very fast data retrieval when key is used
- Bigtable is optimized for extremely reads and writes (<10ms with ssd)

Firestore or Bigtable?



BigQuery

- Data warehousing and data analysis service
 - Projects contain Datasets, Datasets are made up of Tables
 - Queries are charged base of columns data size used in Query (\$5/TB)
- Extremely inexpensive storage
 - BQ Storage is \$0.02/GB/month for 3 months (US or EU MultiRegional)
 - After 3 months \$0.01/GB/month if data in Table has not changed
 - Supports partitioning of data to reduce cost or improve performance
- Analyze data with plain ANSI SQL 2011 queries
- Extremely fast: jobs split across many BigQuery slots
- Easy to use: no indexes required, simple schemas
- NoOps: no need to provision anything
- See the [BigQuery](#) docs

Demo: BigQuery



- Grant has recorded a hour and a half session demonstrating BigQuery

<https://recordings.roitraining.com/hsbc/BigQueryDemo.mp4>

Do Now: Choosing Storage Services



Service	Use Cases:
Cloud Storage	
Cloud SQL	
Spanner	
Bigtable	
Firestore (Datastore)	
BigQuery	

Other Storage to be Familiar with



- Compute Engine Disks / Disks attached to VMs
 - Persistent, Persistent SSD
 - Pay for what you allocate
 - Larger disks give more IOPS
 - SSDs are faster than normal Persistent Disks
 - Local SSD (swap-space, do NOT survive power off)
 - Most disks are zonal. Dual-zone disks do exist
- Filestore - Managed Network File System (NFS)
 - Mounts in the filesystem of a linux VM
 - So appears as part of the file system
 - Used with Compute and Containers

Chapter Concepts

GCP Storage Products

Big Data Products

Exam Prep

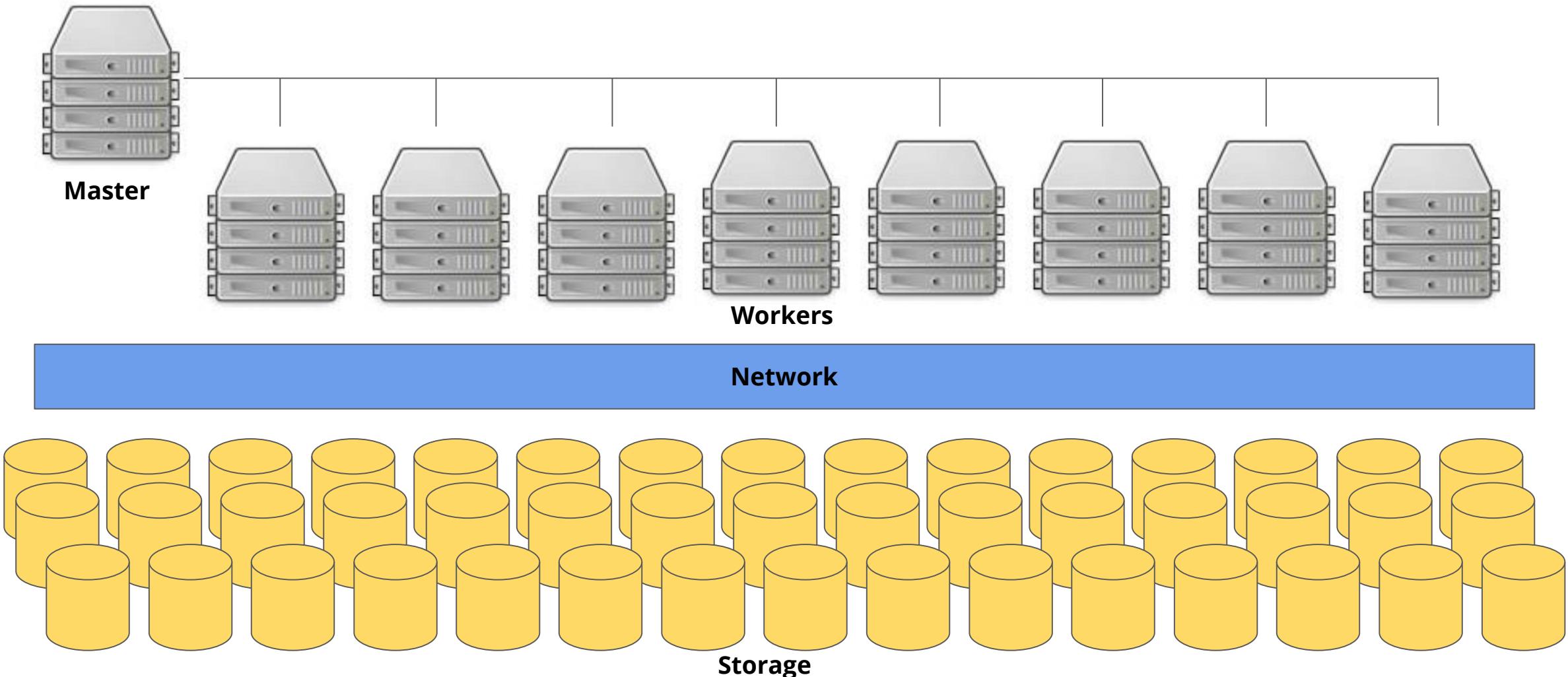
Google Version 1: GFS and MapReduce

- Google created a distributed file system named GFS (Google File System)
 - Allowed data to be read and written quickly
 - 1000's of servers, with 1000's of HD - make it look like ONE BIG FILESYSTEM
 - Files are split into shards, and stored across many disks
- Google created the MapReduce algorithm for splitting a job across many machines to get it done quicker
- GFS and MapReduce were later implemented at Yahoo based on a paper released by Google
 - This became HDFS and Hadoop
 - Hadoop project was later given to the Apache Group to manage

Google Version 2: Colossus and Dremel

- Colossus replaced GFS as the distributed file system
 - We know Colossus as Google Cloud Storage/Disk Infrastructure
- Dremel replaced MapReduce for distributed processing
 - Similar to Hive, Spark SQL, or Presto
 - We know Dremel as BigQuery

Big Data Processing Illustrated



Dataproc

- Service for easily creating Hadoop/Spark clusters
 - Simple configuration
 - Clusters created in just a couple minutes
 - Easy to submit jobs
- Dataproc clusters supports all common Hadoop and Spark frameworks
 - Easy to migrate on-premises workloads into the cloud

Separate Compute and Storage

- Dataproc creates an HDFS cluster, but don't use it for long-lived storage
- Store the data to analyze in Google Cloud Storage
 - Cloud Storage is cheaper (HDFS cluster created on Persistent Disks)
 - Only pay for what you use, not for what you allocate
- Separating storage and compute allows the cluster to be disposable
 - Can size the cluster for specific jobs
 - Delete the cluster as soon as possible
 - Only pay for it while it is working
 - Can recreate the cluster in a couple minutes

Dataproc Supports Hadoop Ecosystem



Data Processing Pipelines

- Perform a set of actions in a chain
 - Data from one or more sources is read into the pipeline
 - Actions are performed on the data to manipulate or transform it
 - The manipulated results are sent as output from the pipeline
- Actions within a data pipeline can run at the same time (concurrently)
- At scale, multiple machines can participate to get the pipeline done faster
- MapReduce jobs are examples of pipelines at scale
 - Multiple nodes read data from disk and perform an initial map step
 - Data is then organized by key (the shuffle step)
 - Keyed data is processed separately in parallel (the reduce step)

Batch vs. Streaming Pipelines

- Batch data flows process big chunks of data at set intervals
 - Analyzing daily logs
 - Importing monthly sales
 - Periodic data conversions
- Streaming data flows process data as it is accumulated
 - Analyzing traffic to determine the quickest route
 - What tweets are trending right now
 - What products are selling today

Google Cloud Dataflow

- Google Cloud Dataflow consists of two major pieces
 - A managed service for running data flow pipelines
 - Apache Beam SDK for making programming of data flows easier



Dataflow

Dataflow Managed Service

- Dataflow pulls together a number of GCP services to run data flows
 - It is the job of the Dataflow service to optimize execution
- Cloud Storage is used as a staging area for data flow code
 - Can also be used for data input and output
- BigQuery tables can be used for input and output
 - BigQuery is frequently the preferred tool to analyze data flow output
- Cloud Compute instances are used to execute data flows
 - The Dataflow service determines how many instances are required
 - Google's high-speed network is used to move data around
- Pub/Sub is used to provide streaming data flows

Apache Beam

- Open-source SDK for writing data processing pipelines
 - Parallelization (takes advantage of multiple threads/cores)
 - Aggregation (Reduce in Map-Reduce)
 - Watermarking / Late-arriving data processing
 - Streaming and Batch processing
- Java and Python versions
- Runs on any platform, not just Google Cloud Dataflow
 - Spark clusters, for example
- See <https://beam.apache.org/>



Java Word Count Example

```
Pipeline p = Pipeline.create(options);
p.apply(TextIO.read().from("gs://apache-beam-samples/shakespeare/*"))
    .apply("ExtractWords", ParDo.of(new DoFn<String, String>() {
        @ProcessElement
        public void processElement(ProcessContext c) {
            for (String word : c.element().split("[^\\p{L}]+")) {
                if (!word.isEmpty()) {
                    c.output(word);
                }
            }
        }
    })
    .apply(Count.<String>perElement())
    .apply("FormatResults", MapElements.via(new SimpleFunction<KV<String, Long>, String>() {
        @Override
        public String apply(KV<String, Long> input) {
            return input.getKey() + ":" + input.getValue();
        }
    })
    .apply(TextIO.write().to("wordcounts"));
p.run().waitUntilFinish();
```

Python Word Count Example

```
p = beam.Pipeline(options=options)
p | beam.io.ReadFromText('gs://dataflow-samples/shakespeare/kinglear.txt')
| 'ExtractWords' >> beam.FlatMap(lambda x: re.findall(r'[A-Za-z]+', x))
| beam.combiners.Count.PerElement()
| beam.Map(lambda (word, count): '%s: %s' % (word, count))
| beam.io.WriteToText('gs://my-bucket/counts.txt')

result = p.run()
```

Dataflow Templates

- Premade templates for creating Dataflow jobs with no coding
- Support both streaming and batch operations
- Support many different sources and sinks
 - Pub/Sub
 - Storage
 - BigQuery
 - Firestore
 - Spanner JDBC
 - Etc.

Dataflow Templates Illustrated

Get Started

Word Count

Process Data Continuously (stream)

Cloud Pub/Sub to BigQuery

Cloud Pub/Sub to Text Files on Cloud Storage

Cloud Pub/Sub to Avro Files on Cloud Storage

Cloud Pub/Sub to Cloud Pub/Sub

Stream Text Files from Cloud Storage to Cloud Pub/Sub

Stream Text Files on Cloud Storage to BigQuery

Data Masking/Tokenization using Cloud DLP from Cloud Storage

Process Data in Bulk (batch)

Text Files Cloud Storage to Cloud Pub/Sub

Text Files on Cloud Storage to BigQuery

Cloud Datastore to Text Files on Cloud Storage

Text Files on Cloud Storage to Cloud Datastore

Cloud Spanner to Text Files on Cloud Storage

Cloud Spanner to Avro Files on Cloud Storage

Avro Files on Cloud Storage to Cloud Spanner

Cloud BigTable to SequenceFile Files on Cloud Storage

SequenceFile Files on Cloud Storage to Cloud BigTable

Cloud Bigtable to Avro Files on Cloud Storage

Avro Files on Cloud Storage to Cloud Bigtable

Jdbc to BigQuery

Utilities

Bulk Compress Files on Cloud Storage

Bulk Decompress Files on Cloud Storage

Bulk Delete Entities in Cloud Datastore

Custom

Custom Template

Pub/Sub

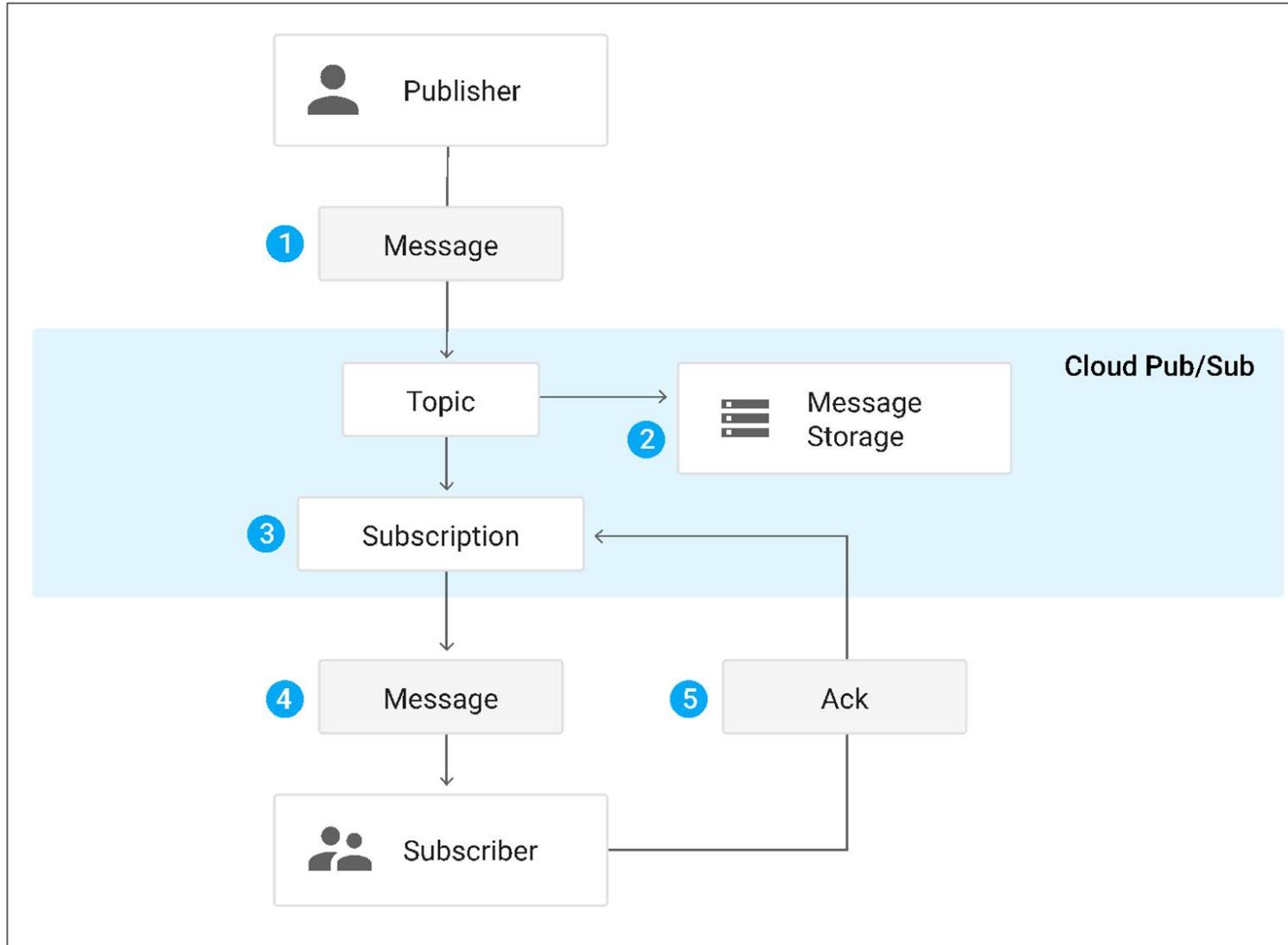
- Pub/Sub is a fully managed, massively scalable messaging service
 - It allows messages to be sent between independent applications
 - Can scale to millions of messages per second
- Pub/Sub messages can be sent and received via HTTP(S)
- Pub/Sub supports multiple senders and receivers simultaneously
- Pub/Sub is a global service
 - Messages are copied to multiple zones for greater fault tolerance
 - Uses dedicated resources in every region for fast delivery worldwide
- Pub/Sub is secure
 - All message are encrypted at rest and in transit



Topics and Subscriptions

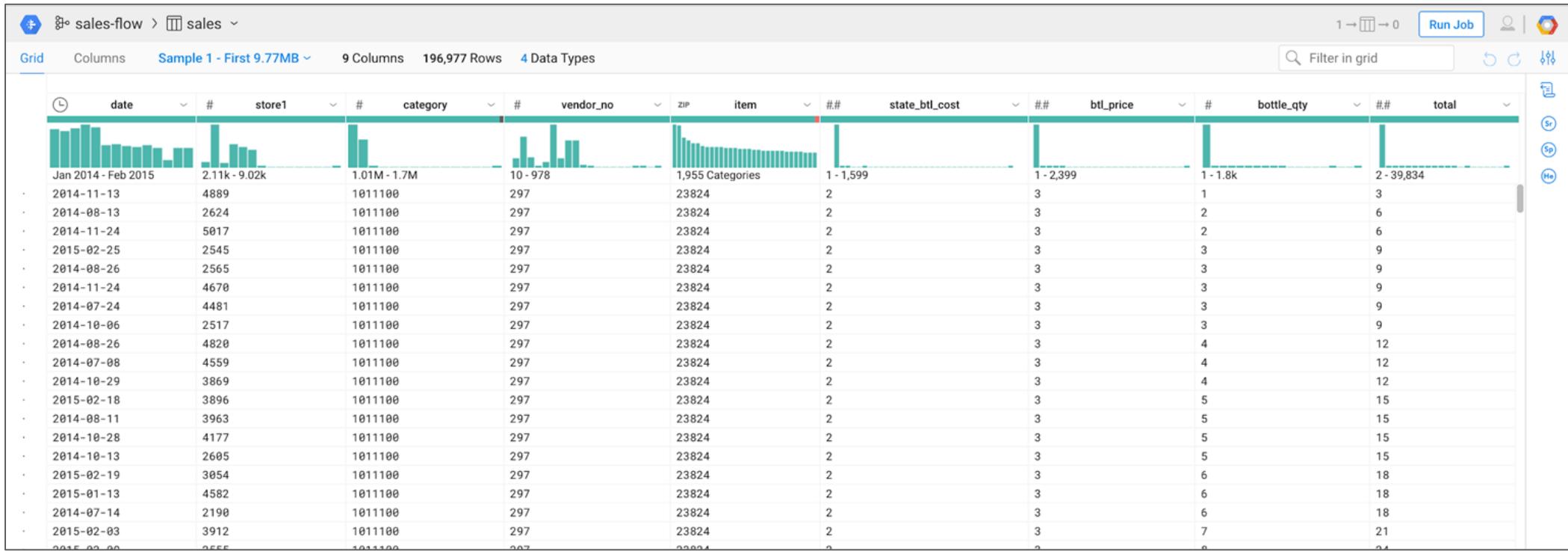
- Messages in Pub/Sub are sent to a Topic
 - Messages can contain data and attributes
- Topics are named endpoints where messages are sent
 - Topic names are in the form:
projects/<project-id>/topics/<topic-name>
- Subscriptions represent a stream of messages within a topic
 - Topics can contain multiple subscriptions
 - Each subscription belongs to one topic
 - Subscribers get messages from subscriptions

Pub/Sub Message Flow



Cloud Dataprep

- Visual tool for cleaning and manipulating data / Data Wrangling
 - Serverless, runs on top of Dataflow using tool from Trifacta
 - Can process very large datasets



Data Fusion

- Fully managed, code-free data integration
 - Used for building ETL/ELT data pipelines
 - Built on open-source CDAP (<https://cdap.io/>)
 - Cloud Dataproc is used to execute transformations
- Basic and Enterprise Editions
 - Basic can execute 2x Pipelines simultaneous
 - Enterprise has unlimited simultaneous execution
- Data Fusion Costs
 - Cloud Data Fusion instance hours to operate interface
 - Cloud Data Proc VMs for execution of transformations

Cloud Datalab

- Interactive tool for data analysis, machine learning, and many other tasks
- Based on Jupyter, an open-source project for creating iPython Notebooks
- Supports many languages: Python, JavaScript, Shell scripts, HTML, SQL, etc.
- Integrated with GCP, so access to other services like BigQuery are simple
- Integrates with Git to enable collaboration and sharing notebooks
- Runs in a Compute Engine Virtual Machine
 - No extra charge for Datalab beyond the machine cost

Google Cloud Data Studio

The screenshot shows the Google Data Studio beta interface. At the top, there's a navigation bar with the Google Data Studio logo, the text "Google Data Studio beta", and a "Home" link. To the right are icons for settings, three dots, and a user profile.

The main area features a "Start a new report" button with a large blue plus sign. Below it are four report thumbnails:

- Blank**: A white card with a large blue plus sign.
- Acme Marketing**: A Google Analytics report for ACME showing sessions, pages, and bounce rate.
- Search Console Report**: A Search Console report for Google Search Console showing search traffic and metrics.
- AdWords Overview**: An AdWords report showing click-through rate, conversion rate, and cost per click.

To the right of these thumbnails is a dropdown menu labeled "ALL TEMPLATES".

Below the thumbnails is a navigation bar with tabs: ALL (selected), OWNED BY ME, SHARED WITH ME, and TRASH. To the right of the tabs are a search bar and a sorting icon (AZ).

The main content area displays a list of reports under the heading "Earlier". Each report entry includes a thumbnail, the report name, the owner, the last opened date, and a more options icon (three dots). The reports listed are:

Owner	Last opened by me
Google Data Studio	Apr 21, 2017
Doug Rehnstrom	Mar 15, 2017
Google Data Studio	Jun 10, 2016
Google Data Studio	--
Google Data Studio	--
Google Data Studio	--

On the left side, there's a sidebar with sections for **REPORTS**, **DATA SOURCES**, **New Features!** (which includes "Video tutorials" and "Learn by watching!"), and **User settings**.

Cloud Composer

- Workflow orchestration service based on [Apache Airflow](#)
 - Can orchestrate workloads across GCP, on-prem, or other clouds
 - Uses Python as orchestration language
- Built-in connectors for many GCP services
 - Dataproc, Cloud MLE, GCS, Pub/Sub, BigQuery, Dataflow, etc.

Cloud IoT Core

- Fully managed service for connecting/managing/ingesting data from devices
 - Internet of Things (IoT) - devices
 - Protocol bridge for MQTT and HTTP
- Leverages Pub/Sub for communication
 - Cloud IAM for security
 - REST APIs for managing/retrieve/update devices
 - ML to the edge/on-premise
 - Real-time metrics thru Monitoring

Do Now: Practice Quiz



- Take this [practice quiz](#)

Chapter Concepts

GCP Storage Products

Big Data Products

Exam Prep

Do Now: Practice Quiz



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GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 5: Security and Compliance

Chapter Objectives

In this chapter, you will:

- Leverage what Google provides for securing our applications
- Use Identity Access Management to control who has access to our GCP projects
- Secure data stored in GCP
- Follow security best practices in the cloud

Chapter Concepts

Google Cloud Platform Security

IAM

Data Security

Security Best Practices

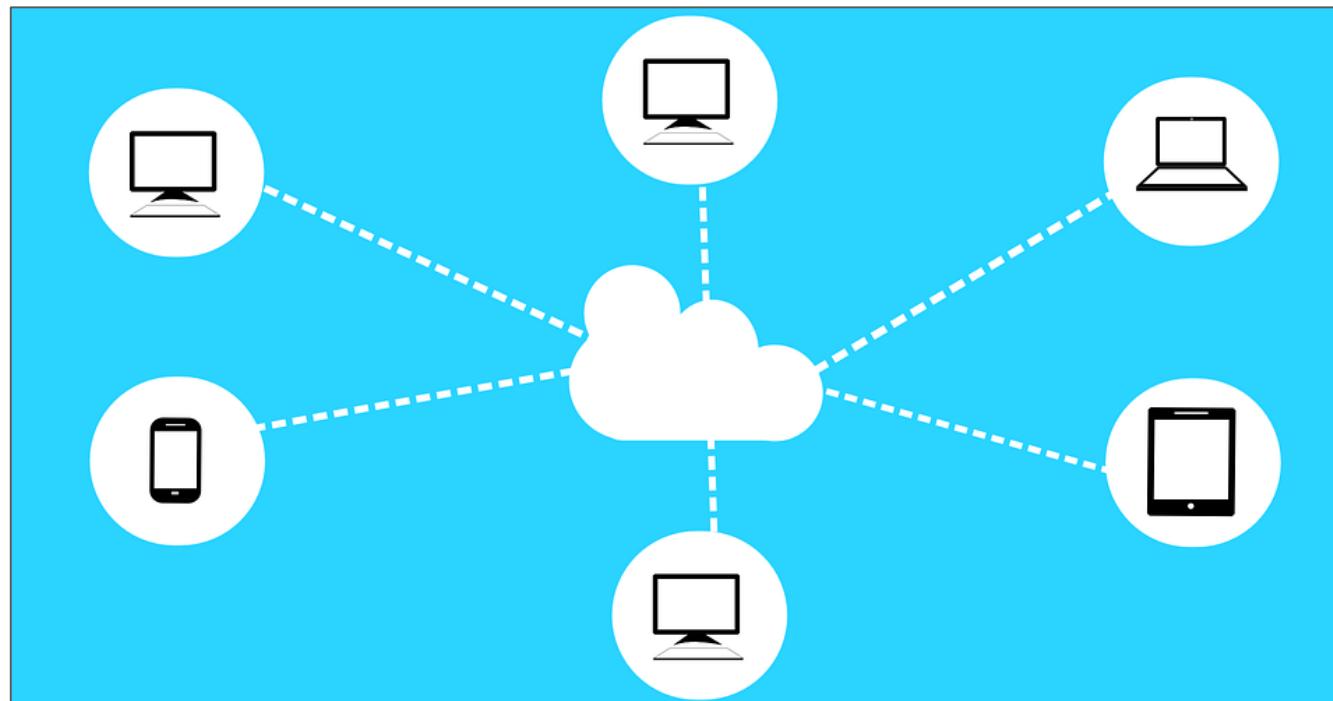
Exam Prep

The CIAs of Security

- Confidentiality
 - Private data is kept private
 - Encrypt private data when saving it or sending it across a network
- Integrity
 - Can we be sure data or messages have not been tampered with?
 - Use digital signatures, hashing, and checksums to ensure integrity
- Availability
 - Data and functionality is available only to users who are authorized

Security Responsibilities

- Cloud providers are responsible for providing a secure infrastructure
- You are responsible for securing your applications and data



Google's Secure Infrastructure

- Physical security
 - Data centers are protected and access to hardware limited
 - What happens to drives and other hardware when it is retired?
- Trusted insiders
 - Background checks done on data center employees
 - What individuals can do is limited to what they need to do their job
- Audits and logs
- Regulatory compliance
- Data encrypted at rest and in transit
- Read: <https://cloud.google.com/security/>

Homework: Google Security



- Read this: <https://cloud.google.com/security/>
- Watch this: <https://youtu.be/O-JXFQezWOc>

GCP Compliance Resource Center

- GCP conforms to global and industry-specific compliance standards
 - GDPR in the EU
 - FedRAMP and SOX in the US
 - HIPPA for the healthcare industry
 - PCI for banking
 - Many others...
- As a Professional Cloud Architect, you should be aware of compliance standards that are required for applications you are building
 - See: <https://cloud.google.com/security/compliance/>

Chapter Concepts

Google Cloud Platform Security

IAM

Data Security

Security Best Practices

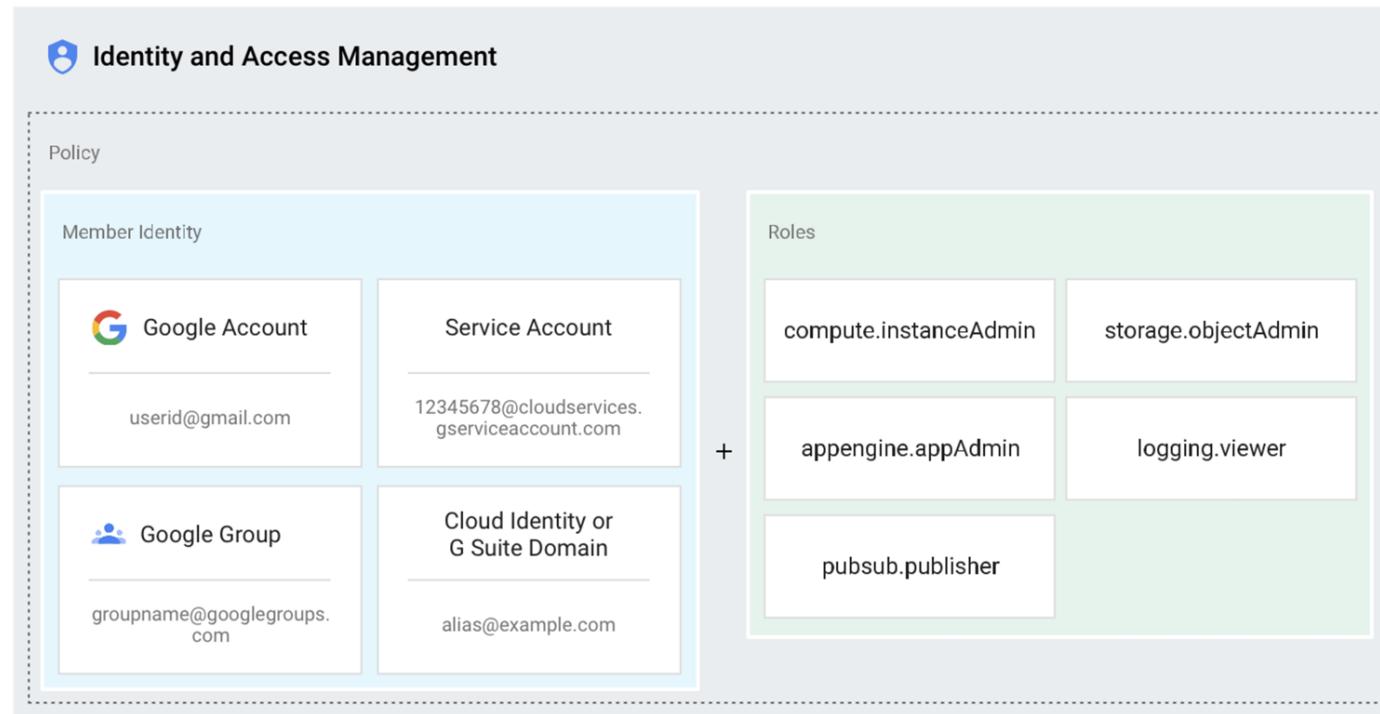
Exam Prep

Projects

- In GCP, every request and resource must be assigned to a project
- A project is like a container that encapsulates:
 - Billing
 - Resources
 - Users and their rights
- Each project is assigned a billing account
- APIs can be enabled and disabled within a project

IAM (Identity Access Management)

- Identify the human, machine, or application that is making a request
- Determine what roles that identity belongs to
- Based on the roles, is the requested operation allowed?



Members

- Projects have members who can make requests, create resources, etc.
- Members can be identified by their:
 - Google account (@gmail.com, @roimoonbank.com) - humans/users
 - Service account - computer accounts/automation accounts
 - Google group (team@roimoonbank.com)
 - Entire G Suite/Cloud Identity domain (roimoonbank.com)
- There are also two special identifiers:
 - allAuthenticatedUsers
 - allUsers

Service Accounts

- Usually a member is a human
- Service accounts are special accounts that identify machines or applications
 - Service accounts are created in the form of an email
- Service accounts can be assigned one or more roles
- A computer or application can run using a service account identity
 - That machine will only be allowed to perform actions allowed by its roles
- Firewall rules can use service accounts

Roles

- Everything in Google Cloud Platform is done by requesting an action identified by a web service endpoint
 - Members are not assigned permissions to perform an action
 - Permissions are added to roles which members are assigned to
- Roles encapsulate a set of permissions
 - Google defines the roles and grants permissions that would be required for someone working in that role
- For example, if you want to create a storage bucket, you need to be a member assigned to a role that enables that action
- See: <https://cloud.google.com/iam/docs/understanding-roles>

Primitive Roles

- Are project-wide roles
 - Project viewer can see everything in a project
 - Project editor can change everything in a project
 - Project owner has all rights of editor and can add members
- The primitive roles do not provide fine-grained control over what members can do

Predefined Roles

- Roles that are specific to individual services
 - App Engine Admin, BigQuery User, or Storage Object Viewer are examples of predefined roles
 - Many predefined roles exist
- Google defines these roles and assigns what it thinks are sensible permissions for members working in that role
- Members can be assigned any number of roles
- One role can't remove permissions granted by another role
 - For example, if you make someone a project owner and a storage viewer, they have read-write access to storage

Custom Roles

- Custom roles are ones that you can define
- Custom roles provide very fine-grained control over what members can do

Demo: Roles and Service Accounts



- Your instructor will demonstrate
 - Roles and Custom Roles in an Organization
 - Service Accounts assigned to VMs

BigQuery IAM

- BigQuery Data can be secured at the Project Level or the Dataset Level
 - Project Level permissions (or inherited) allow to ALL Datasets
 - Dataset Level permissions applies to tables in a specific dataset
 - As of May 2020 - individual table permissions are not available (assume for exam)
 - June 2020 announced a beta for table/view permissions
- Pre-defined roles to remember
 - BigQuery User - can USE BigQuery in the projectrun queries in the
 - Can also read datasets
 - BigQuery Data Viewer - can INCLUDE project or dataset tables in query
 - MUST be a BigQuery User (usually in a different project) to run the query
 - BigQuery Data Owner / Data Editor - focuses on DataSets
 - BigQuery Admin - Full Control of BigQuery in project or dataset

Chapter Concepts

Google Cloud Platform Security

IAM

Data Security

Security Best Practices

Exam Prep

Data Encryption

- GCP provides a massively distributed file system
 - Individual files are broken into chunks and are stored separately
- Each chunk is encrypted with an individual data encryption key (DEK)
 - The encryption keys are encrypted with a key encryption key (KEK)
- Customers can choose from three key management options
 - Google Managed Encryption Keys
 - Customer Managed Encryption Keys (CMEK)
 - Customer Supplied Encryption Keys (CSEK)
 - Note: not all products support CSEK

Encryption by Default

- Let Google manage the entire encryption process for you
 - All data is encrypted at rest automatically
 - Google manages the keys and key rotation
- This is the right solution for most use cases

Customer Managed Encryption Keys (CMEK)

- Manage key creation, rotation, and destruction using Google's Cloud Key Management (KMS) service
 - Keys are kept in KMS
 - Service account is used to access the keys when required
- Customer has control over
 - Key Creation
 - Rotation/Rotation Interval
 - Active/Deleted Keys
 - Auditability

Customer Supplied Encryption Keys (CSEK)

- You generate the keys and keep them on-premises
 - Google uses the key in memory and does not write it to storage
 - Sends the keys as part of API service calls
- NOTE: Not all products support CSEK
 - Primary products are GCE and GCS

Chapter Concepts

Google Cloud Platform Security

IAM

Data Security

Security Best Practices

Exam Prep

Principle of Least Privilege

- A user, machine, or program should only be able to perform the actions required by their job
 - Assign a minimal set of roles to members
 - Use service accounts to identify machines and applications

Principle of least privilege

From Wikipedia, the free encyclopedia

Not to be confused with [Rule of least power](#).

In [information security](#), [computer science](#), and other fields, the **principle of least privilege** (also known as the **principle of minimal privilege** or the **principle of least authority**) requires that in a particular [abstraction layer](#) of a computing environment, every module (such as a [process](#), a [user](#), or a [program](#), depending on the subject) must be able to access only the information and [resources](#) that are necessary for its legitimate purpose.^{[1][2]}

Separation of Duties

- Divide a process into more than one job
 - No individual has the rights to perform the entire job
 - Intended to prevent fraud by imposing a system of checks and balances

Separation of duties

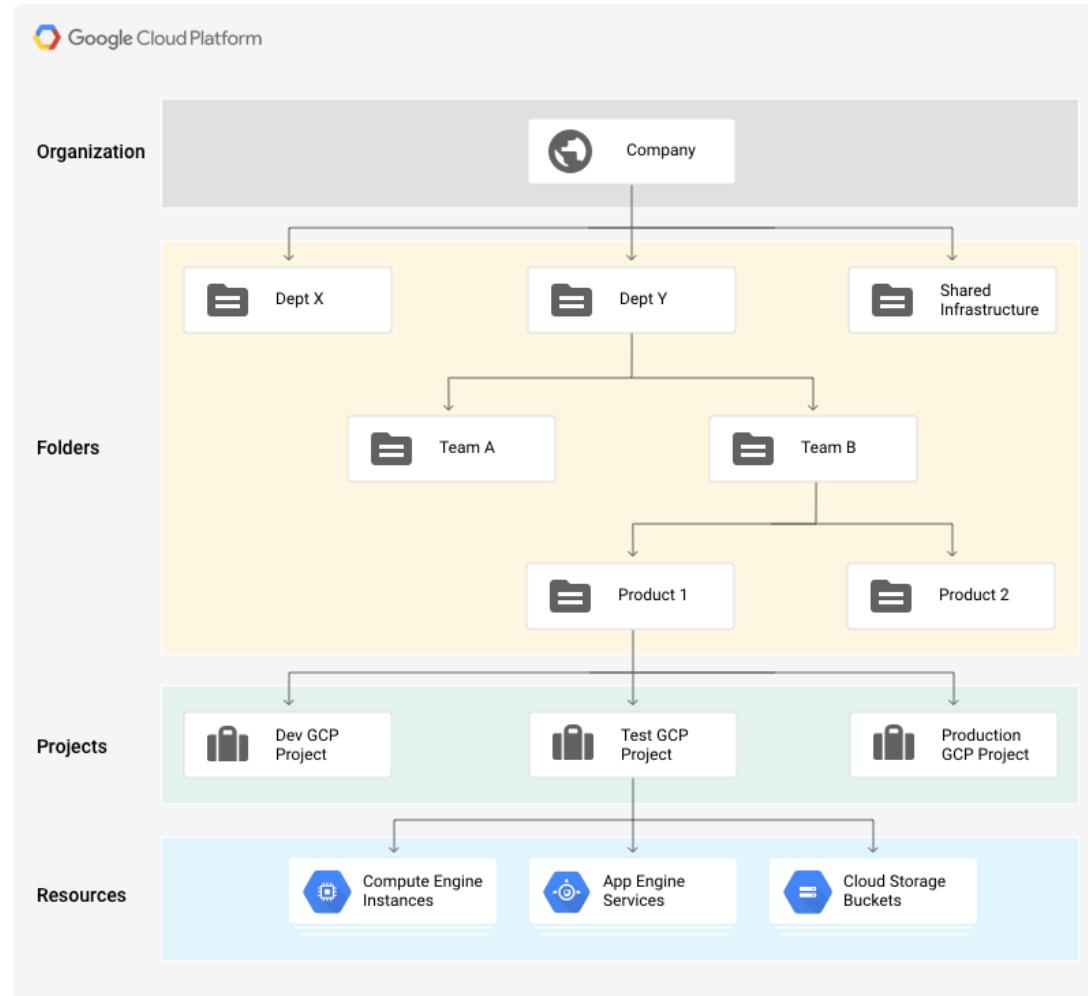
From Wikipedia, the free encyclopedia

Separation of duties (SoD) (also known as "Segregation of duties") is the concept of having more than one person required to complete a task.

Logging and Auditing

- Requests to Compute Engine, App Engine, BigQuery, Cloud SQL, Deployment Manager, Cloud VPN, and Cloud Storage are all logged
- Tools are provided to read and analyze the logs
- Have some process in place for regularly auditing the logs

Understanding IAM Hierarchy



Rights granted at the organization level apply to all resources in the company

Consider projects are trust boundaries within an organization (Separation of Duties)

Roles allow fine-grained control over what members can do within a project (Principle of Least Privilege)

Can assign rights to individual resources within a project (Buckets, for example)

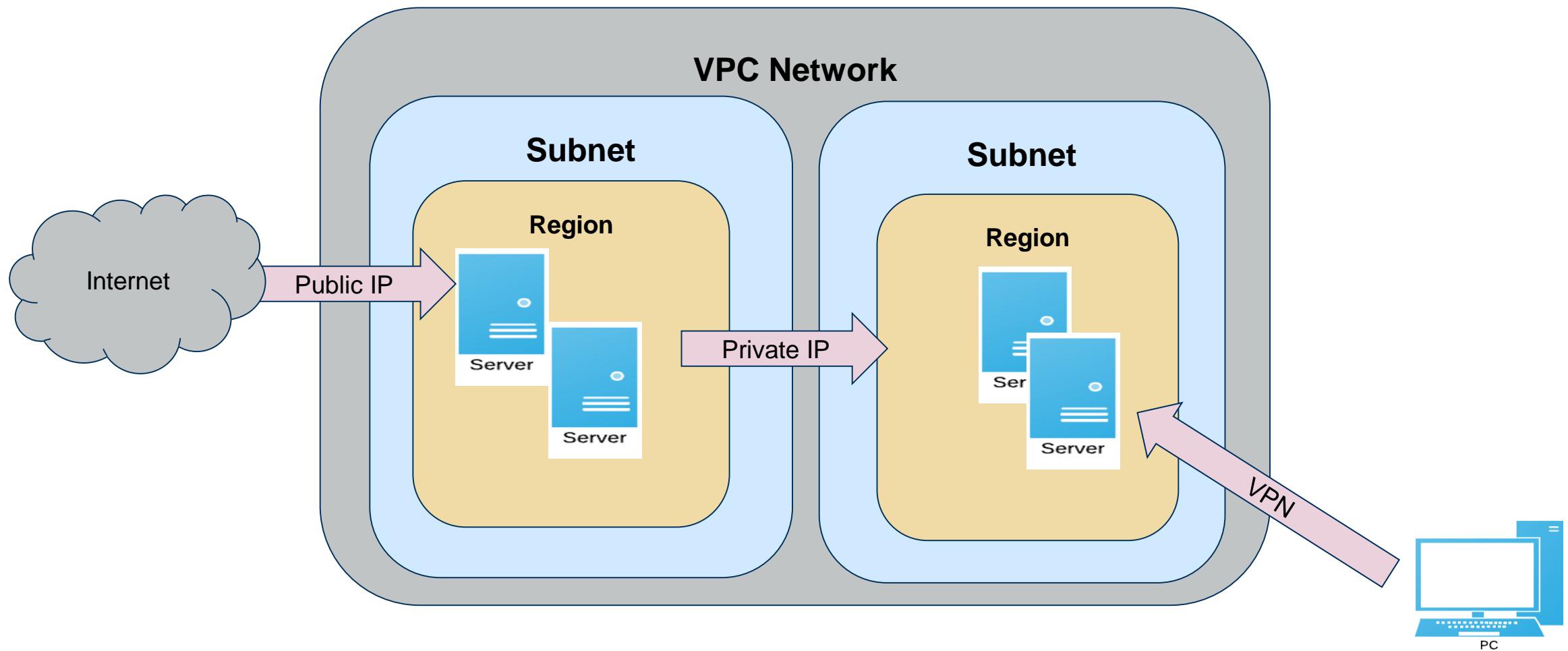
IAM Best Practices

- Use more restricted rights at the higher levels
 - Resources added at lower levels will inherit those restrictions
 - Privileges can be added at lower levels when necessary
- Use service accounts and roles to secure machines and applications
- Manage users in groups when possible
- Audit your logs
- Use roles to enforce the principle of least privilege
- Use projects for separate duties

Network Security

- Each Google project has one or more networks
 - Networks consist of one or more subnets
 - Computers within a network can communicate via their internal IPs
 - Computers in different networks communicate via external IPs
- Use different networks to isolate different machines
- Do not assign an external IP to a machine you do not want to be reachable over the Internet
- Use VPNs or network peering for secure access between different networks

Secure Network Architecture



Firewalls

- Firewall rules to control access to ports
- By default, all ports are closed
- Add firewall rules to networks to open ports
- Tags can be used to determine which rules apply to particular machines
 - Firewall rules can also be assigned based on service account

VPC Service Controls

- Firewall rules to control access to ports
 - But how do you restrict access to APIs?
- VPC Service control operate using the Organization
 - Configured at the Org Level
 - Assign what APIs can be called
 - Assign to projects the VPC Service Control applies to

Demo: VPC Service Controls



- Your instructor will demo VPC Service Controls

Security Command Center

- Centralized Organization Security
 - Not a project-level option

Chapter Concepts

Google Cloud Platform Security

IAM

Data Security

Security Best Practices

Exam Prep

Do Now: Practice Quiz



- Take Take this [practice quiz](#)
 - <https://quiz.roitraining.com/quiz4.html>

NOTE: these are NOT example exam questions. Questions are focus around topics just discussed/teaching test-taking techniques



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 6: Monitoring in the Cloud

Chapter Objectives

In this chapter, you will:

- Monitor cloud resources and applications
- Leverage Operations monitoring services

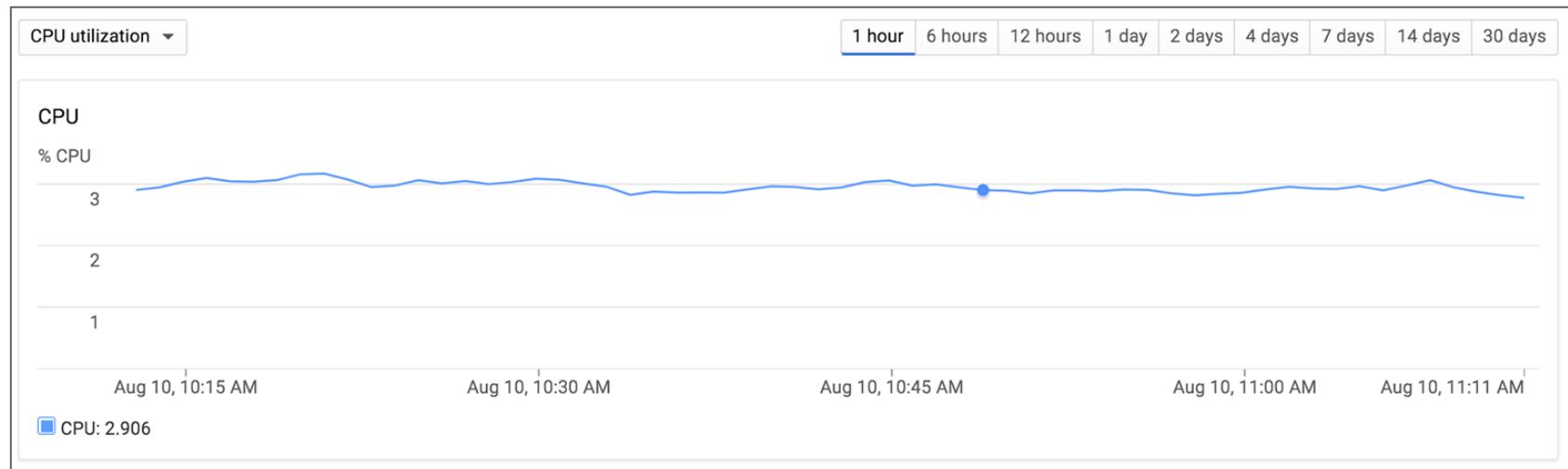
Chapter Concepts

Operations

Exam Prep

Resource Monitoring

- Operations Monitoring can be used to monitor many different resources
 - App Engine, disks, buckets, virtual machines, and many more
 - In addition to GCP resources, AWS resources can be monitored as well
- Different metrics can be monitored depending on the resource
 - CPU usage, network traffic, uptime, message count, etc.
 - Custom metrics can be created



Logging

Logging and Monitoring Agents

- Installed on VMs to provide additional logs & metrics
 - Google can only monitor hypervisor activities and metrics by default
 - Agents can provide OS and Application specific logging
- Cloud Logging Agent - puts logs into Stackdriver Logging
 - Based on fluentd
- Cloud Monitoring Agent - reports metrics to stackdriver monitoring

Log Exports

- Logs can be exported for further analysis
- Export destinations include:
 - BigQuery
 - Cloud Storage
 - Pub/Sub
- Can create advanced filters to specify which log entries to export
- Set a destination to Pub/Sub to immediately respond to a log export

Error Reporting

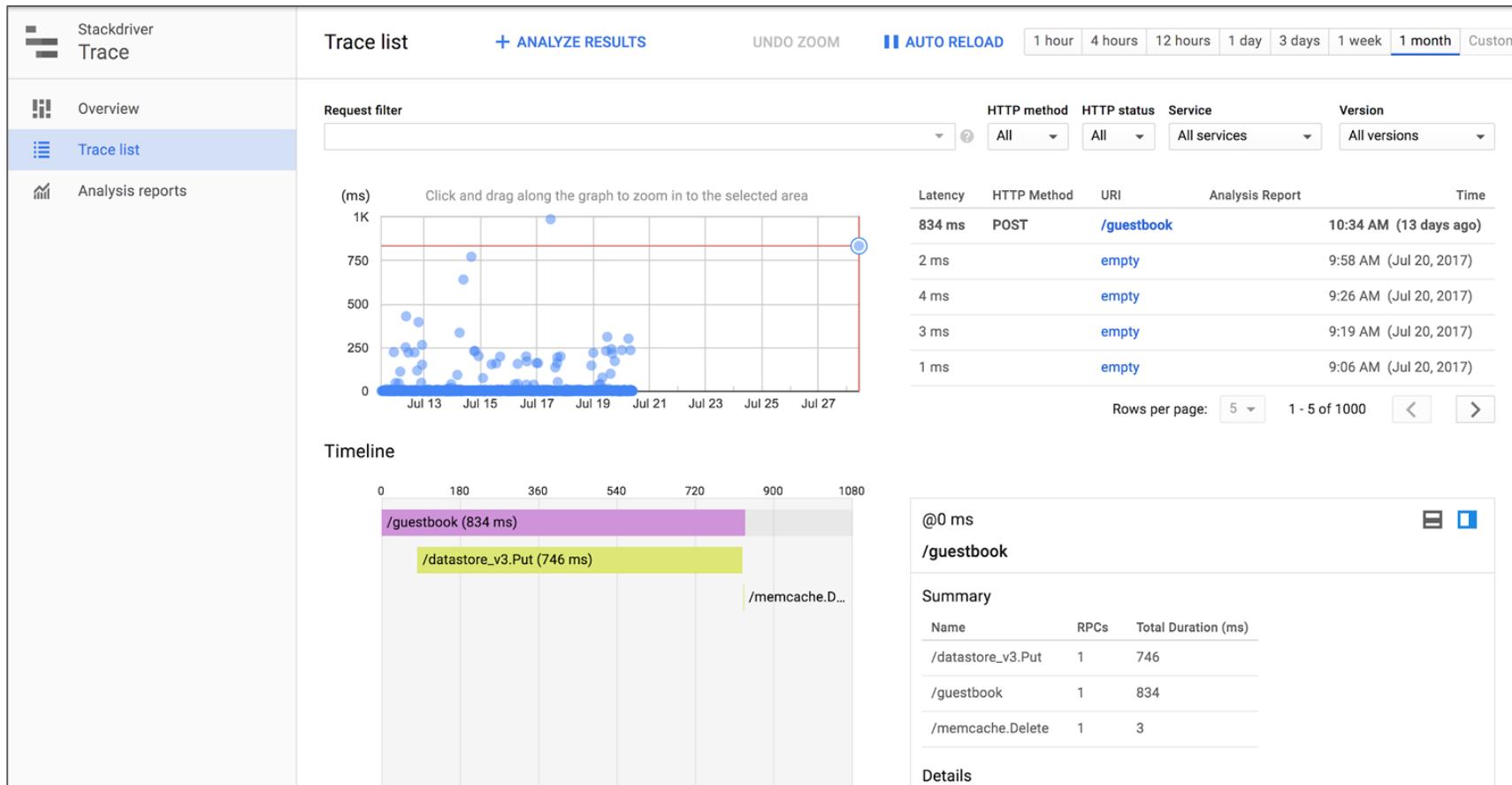
- Automatically set up with App Engine services
 - Can enable for services running in Compute Engine
 - Can integrate with Stackdriver logs
- Can enable automatic notification for errors

The screenshot shows the Stackdriver Error Reporting interface. At the top, there's a navigation bar with the Stackdriver logo, 'Stackdriver Error Reporting', 'All services' dropdown, 'All versions' dropdown, and a '► AUTO RELOAD' button. Below the navigation is a search/filter bar with 'Filter errors' and a time range selector showing '1 hour', '6 hours', '1 day' (which is selected), and '7 days'. The main area displays two sections: 'Errors in the last 7 days' and 'Errors in the last 30 days'. Under 'Errors in the last 7 days', it says 'No errors reported in the last 7 days.' Under 'Errors in the last 30 days', there's a table with the following data:

Occurrences	Error	Seen in	First seen	Last seen	Status
64	NEW TransformationError post (/base/data/home/apps/s~drehnstrom-1171/demo-5.39204722312107611	demo-5	13 days ago	13 days ago	500 N

Trace

- Displays requests along with their timings
 - Useful for debugging performance problems



Debugging

- Log points can be added to code of deployed applications
 - Creates a snapshot of the running app when a breakpoint is hit

The screenshot shows the Stackdriver Debug interface for a Google Cloud application named "demo-5".

Code Editor: The left pane displays the source code for `guestbook.py`. A red arrow points to line 43, which contains the line `self.response.write(template.render(template_values))`. This line is highlighted with a blue background.

Log Viewer: The bottom pane shows the logs for the application. It lists several log entries, including:

- 2017-08-02 (23:11:50.317) This request caused a new process to be started for your application, and thus caused yo...
- 2017-07-28 (11:04:53.747) URL being requested: GET https://pubsub.googleapis.com/v1/project... discovery.py:817
- 2017-07-28 (11:04:53.678) Attempting refresh to obtain initial access_token client.py:596
- 2017-07-28 (11:04:53.678) URL being requested: GET https://pubsub.googleapis.com/v1/project... discovery.py:817
- 2017-07-28 (10:39:15.281) Attempting refresh to obtain initial access_token client.py:596

Right Sidebar: The sidebar includes sections for Snapshot, Logpoint, Variables, and Call Stack. The Snapshot section shows a condition field with "(Optional)" and an expressions field with "(Optional)". The Variables section shows `self`, `guestbook_name` ('Default'), and `template`. The Call Stack section shows the call chain from `Guestbook.get` to `HandleRequest`.

Chapter Concepts

Stackdriver

Exam Prep

Self-Study: Stackdriver Tutorials

- Read the [Stackdriver Documentation](#)
- Run through the following tutorials:
 - <https://cloud.google.com/monitoring/quickstart-lamp>
 - <https://cloud.google.com/monitoring/alerts/uptime-checks>
 - <https://cloud.google.com/monitoring/alerts/>



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 7: Managing Cloud Applications (aka Site Reliability Engineering)

Chapter Objectives

In this chapter, you will:

- Deploy our applications using Site Reliability Engineering best practices
- Automate deployments and upgrades using DevOps features built into Google Cloud Platform
- Analyze common GCP application design patterns

Chapter Concepts

Site Reliability Engineering

DevOps

Exam Prep

What Is Site Reliability Engineering?



"Fundamentally, it's what happens when you ask a software engineer to design an operations function."

Ben Treynor Sloss, Vice President, Google Engineering, founder of Google SRE

- See: <https://landing.google.com/sre/>

Site Reliability Engineering

- Site Reliability Engineering is Google's version of DevOps
- Developers are given a budget of errors
 - When the error budget is reached, there are no more new features
 - Developers know this so they strive to deploy with no bugs
- Operations folks are themselves software developers
 - Automate all repetitive tasks
 - Deploying of software, running applications, maintenance, etc. are all seen as software problems to be solved with code

Site Reliability Engineers (SREs)

- SREs are software engineers
 - Work with development teams to ensure high availability, scalability, reliability, etc.
- Perform similar roles as traditional operations teams
- All operations problems are treated as software problems
 - Automate repetitive tasks
 - Fix problems with code

SLOs, SLIs, and SLAs

- ***Service Level Objectives*** are the aspirational attributes of an application
 - The application will be available 95% of the time
 - 80% of the time responses return in under 800 milliseconds
- ***Service Level Indicators*** determine if the app meets its objectives
 - How could we measure if the two SLOs above were met?
- ***Service Level Agreements*** are contracts made with your users
 - Google only applies SLAs to products that are generally available
 - Alpha and Beta versions of services have no SLA

Chapter Concepts

Site Reliability Engineering

DevOps

Exam Prep

Microservice Architecture

- Divide large programs into small, composable services
 - Services can communicate with one another over a network
 - Components typically communicate via HTTP(s)
- Services can be programmed independently of one another
- Services can be deployed and run independently of one another
- Services are versioned separately

Blue-Green Deployment

- Allow new revisions to be deployed with less risk and no downtime
- There are two copies of the production environment
 - Blue environment is taking requests
 - Green environment is idle
- When deploying a new version:
 - Update new version to green environment leaving the blue environment in place
 - Test the green environment
 - When testing is complete, move the workload to the green environment
 - Green is now blue; can turn the old environment off

Blue-Green Deployment in GCP

- App Engine completely automates blue-green deployments
 - Multiple versions of App Engine services can exist simultaneously
 - Can easily request any version by including the version in the URL
 - Testing can be done on new versions before migrating the load to them
- Kubernetes makes blue-green deployments easy as well
 - Pods use Docker containers
 - Create a configuration that uses the new version of a container and a new load balancer
 - Deploy the new version on the Kubernetes cluster leaving the old
 - Change the DNS to point to the new load balancer when ready

Rolling Updates

- Cloud services typically have multiple instances behind a load balancer
 - A number of VMs managed by an instance group
 - Multiple replicas of a pod in a Kubernetes cluster
- Rolling deployments update instances one at a time
 - Allows services to be updated with no downtime
- Supported by managed instance groups
- Supported by Kubernetes using the update command

A/B Testing

- A/B testing allows multiple versions of a program to run at the same time
 - Test the new version with a portion of the users
 - Compare usage and errors of the two versions
- Allows developers to get feedback and testing from real users prior to fully committing to a new version
- In App Engine, use traffic-splitting for A/B testing

Split traffic by

IP address ?

Cookie ?

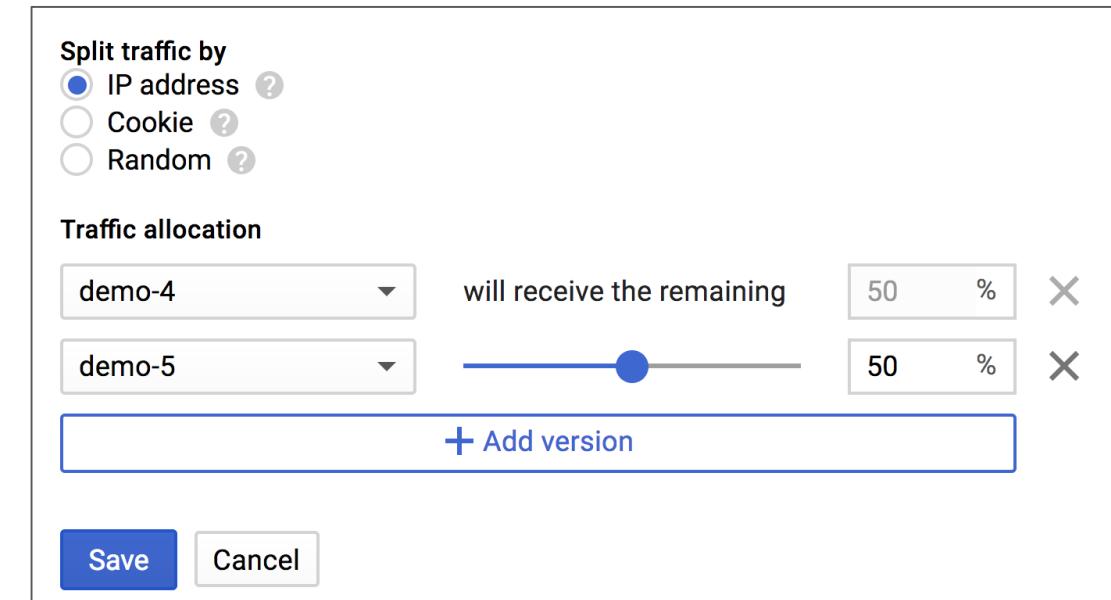
Random ?

Traffic allocation

Version	Allocation (%)	X
demo-4	50 %	X
demo-5	50 %	X

+ Add version

Save Cancel



Canary Releases

- A new version of a service is put into production alongside old versions
 - A small subset of select traffic is routed to the canary release
- Canary releases help developers know how a new version will perform when put into production
- Canary releases are easy to pull back if they fail their testing

Split traffic by

IP address ?

Cookie ?

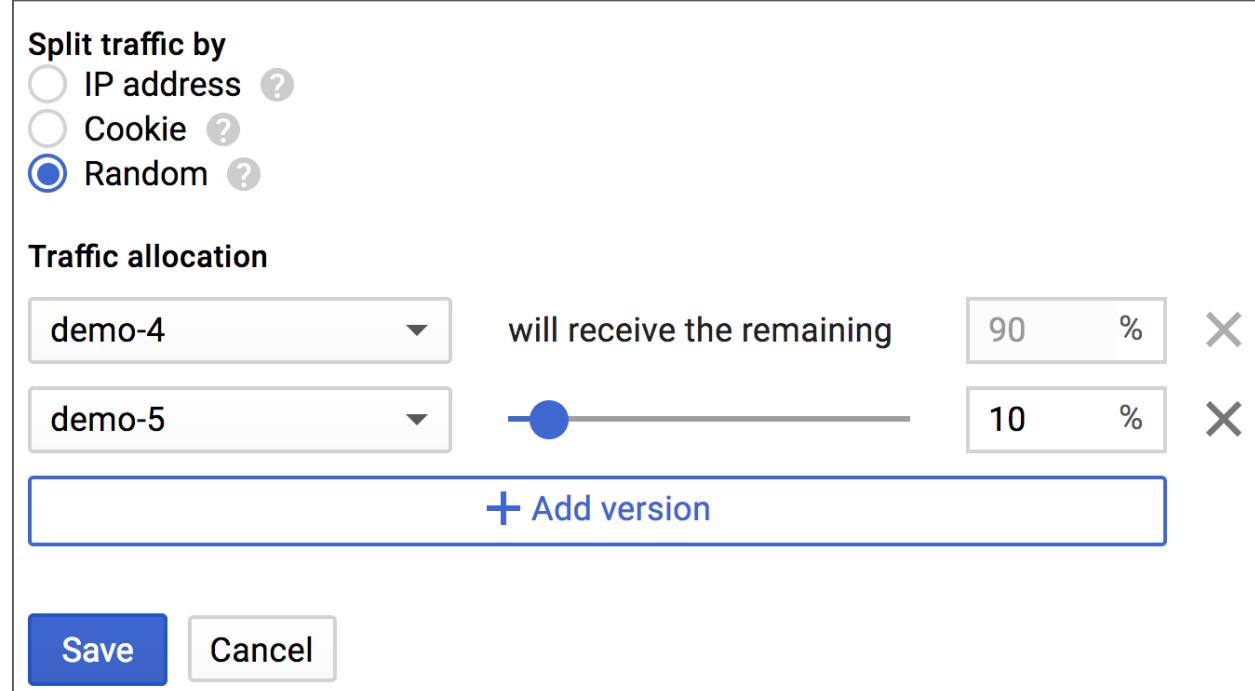
Random ?

Traffic allocation

demo-4	will receive the remaining	90 %	X
demo-5	10 %	X	

+ Add version

Save Cancel



CI/CD Pipelines on GCP

- Source Repositories - <https://cloud.google.com/source-repositories>
 - Private GIT repos
 - Referenced as
<https://source.developers.google.com/p/projectname/r/appname>
- Cloud Build - <https://cloud.google.com/cloud-build>
 - Continuous build, test and deploy
 - Trigger from code check-in or other events
- Container Registry - <https://cloud.google.com/container-registry>
 - Stores built containers
 - Referenced as gcr.io/projectname/containername/container
- Alternate: Jenkins and/or Spinnaker in VMs or Containers

Deployment Manager

- Infrastructure management service
 - Provides repeatable deployments
- Create a .yaml template describing your environment and use Deployment Manager to create resources
 - Can also use Python or Jinja2 templates to parameterize the configuration to easily reuse common configurations
- Alternate/Cloud Agnostic solution is Terraform by Hashicorp
 - Google Cloud Platform Providers are available
 - Most large organizations will use Terraform

Chapter Concepts

Site Reliability Engineering

DevOps

Common GCP Patterns

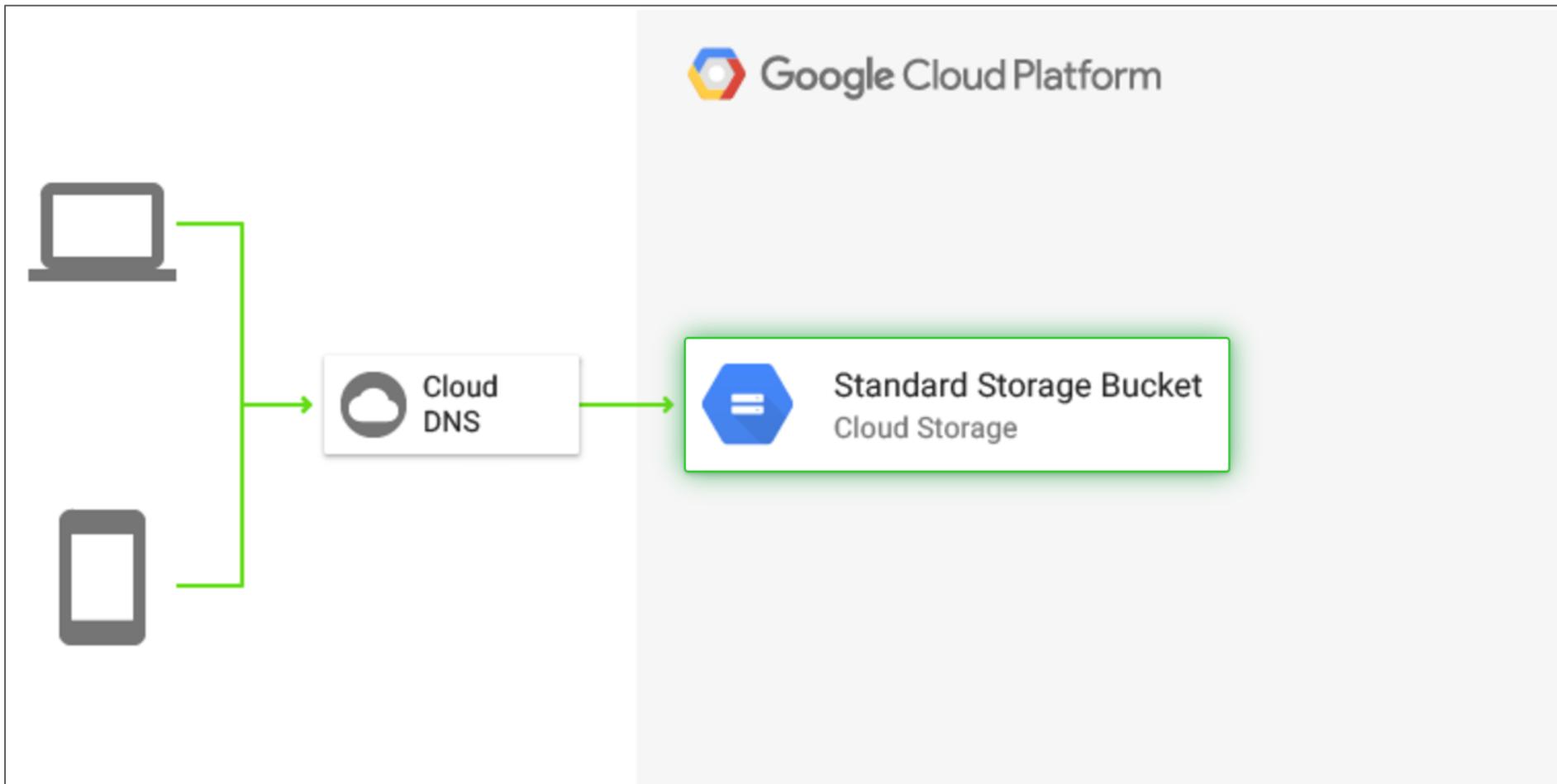
Exam Prep

Google's Cloud Solutions Architecture Reference

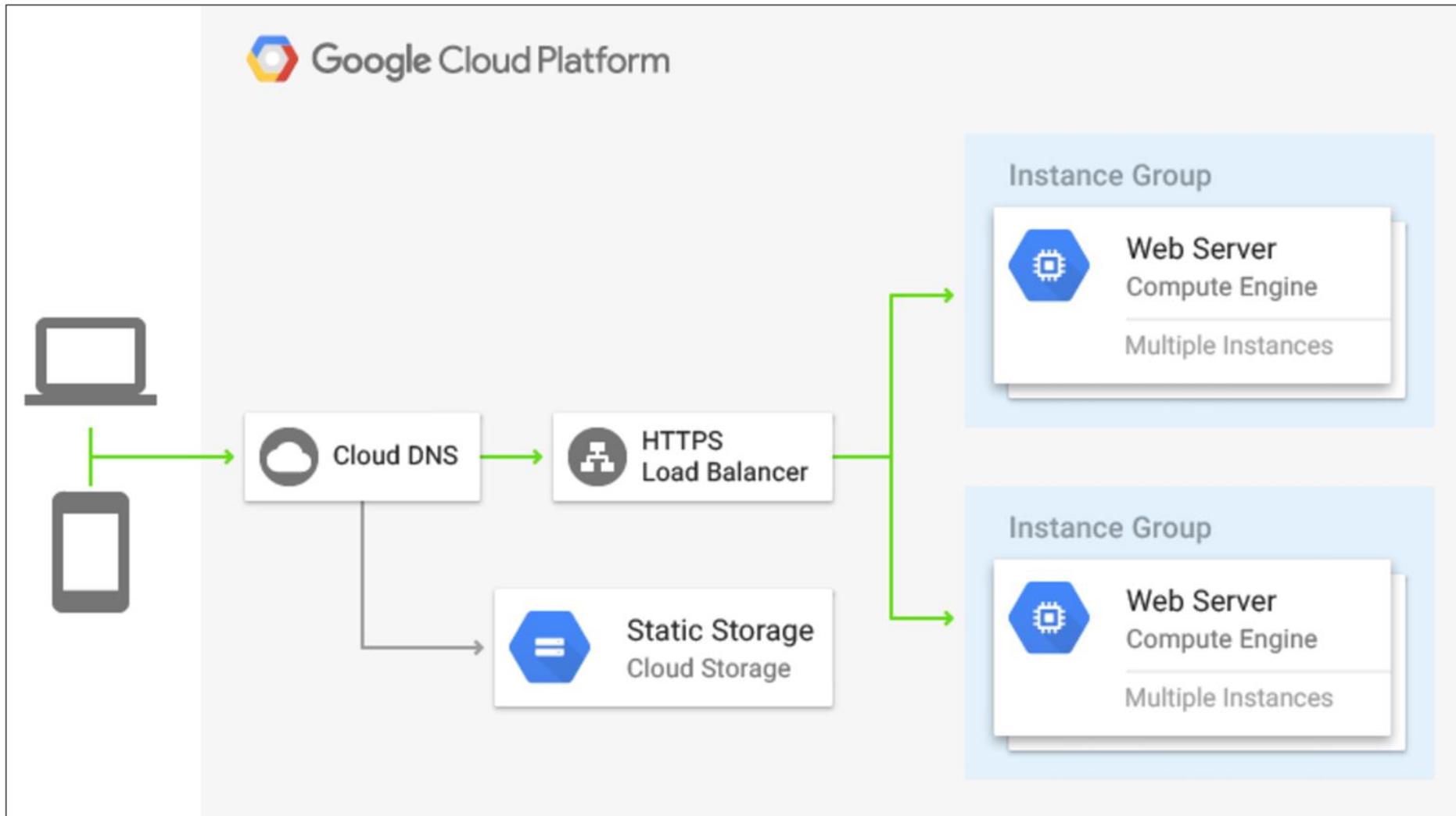
- Available at: <https://gcp.solutions/>
- Provides architectural solutions for common use cases deployed on GCP



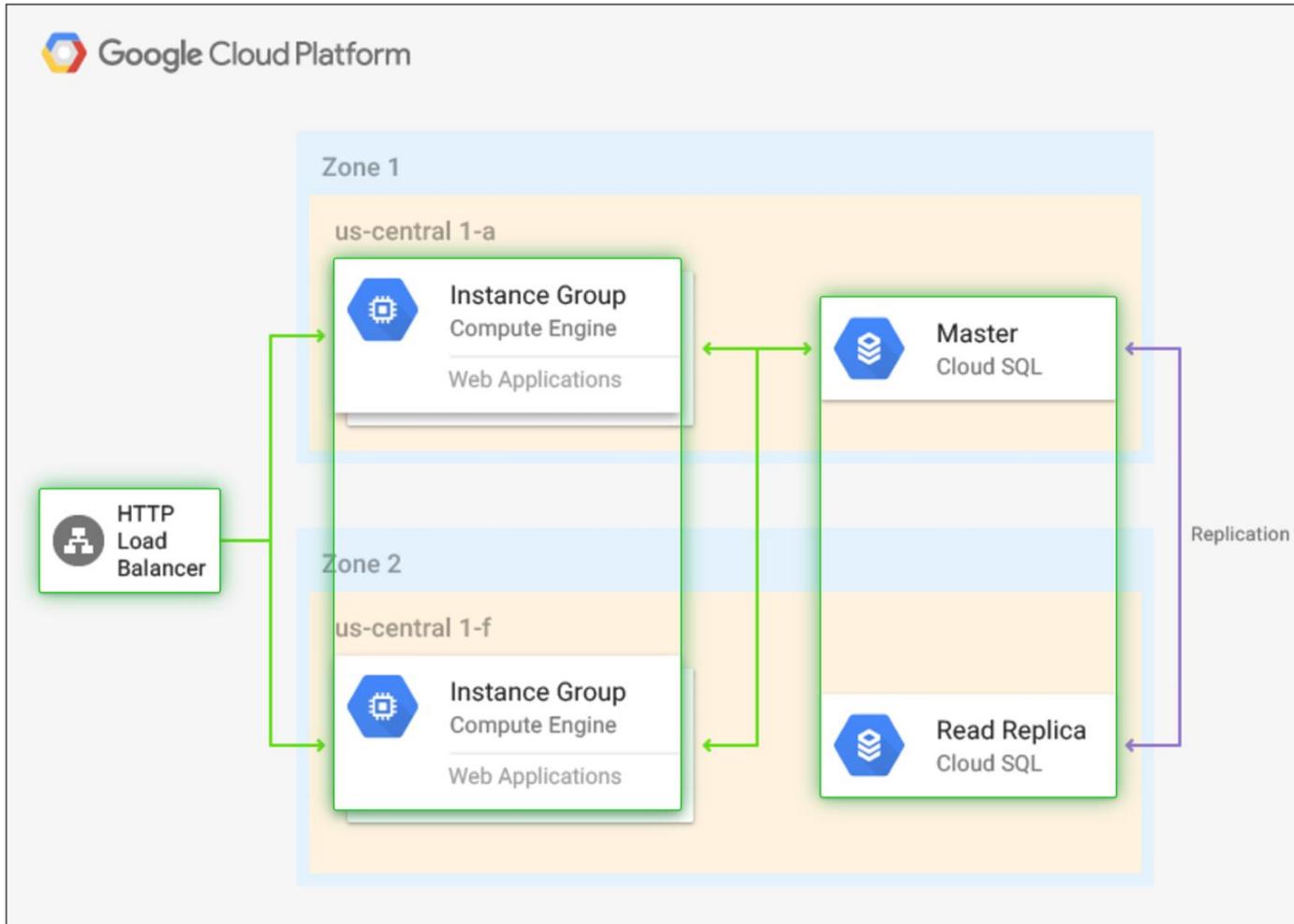
Static Website Hosting



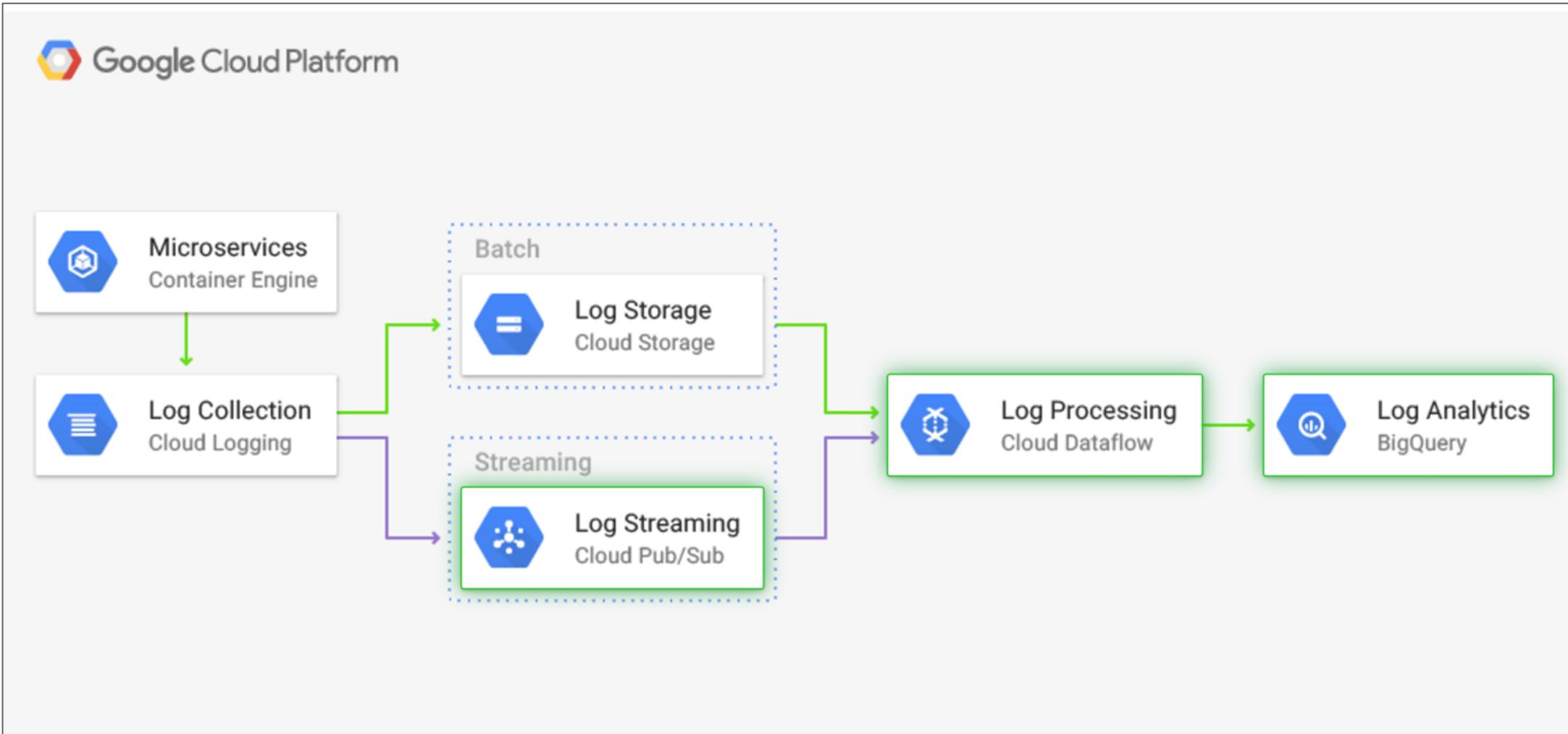
Disaster Recovery



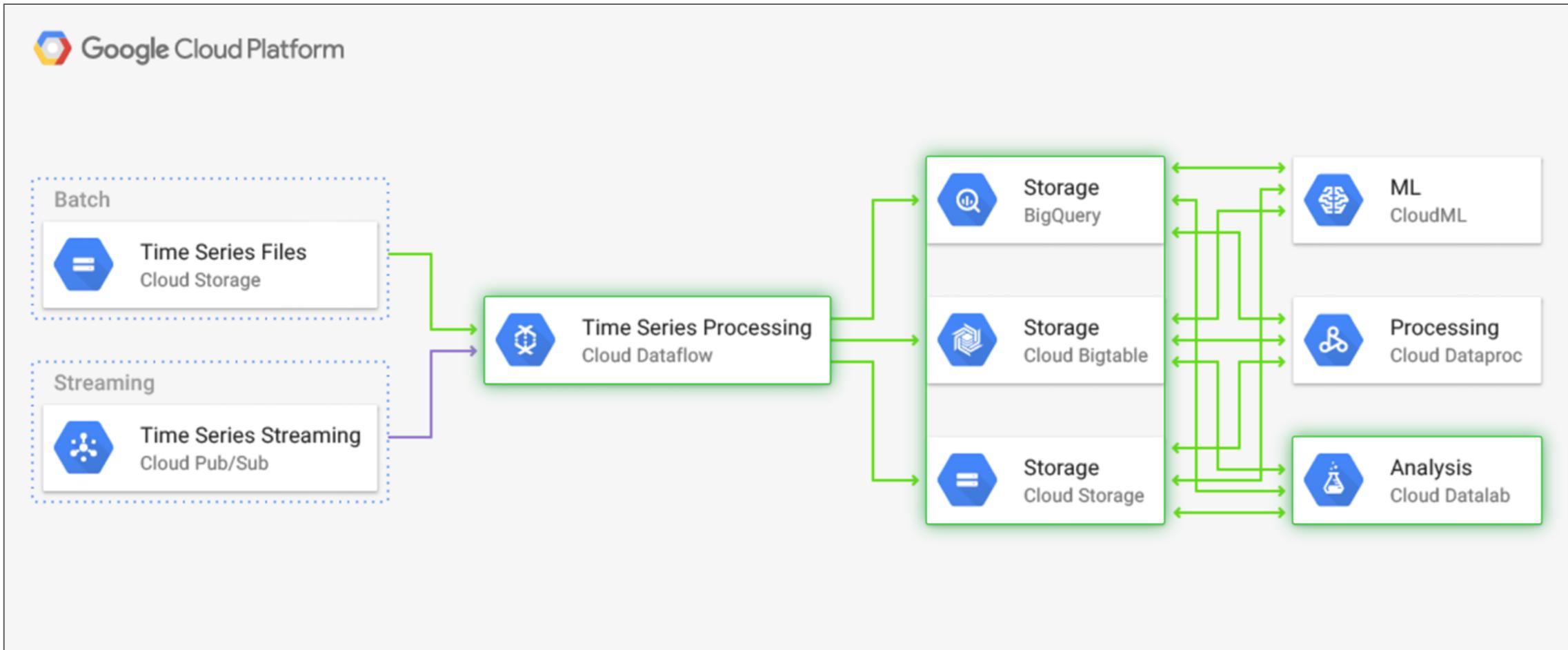
Dynamic Website Hosting



Log Processing



Time Series Data Processing



Chapter Concepts

Site Reliability Engineering

DevOps

Common GCP Patterns

Exam Prep

Do Now: Practice Quiz



- Take Take this [practice quiz](#)
 - <https://quiz.roitraining.com/quiz5.html>

NOTE: these are NOT example exam questions. Questions are focus around topics just discussed/teaching test-taking techniques



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 8: Big Data

Objectives

- Identify and experience the Big Data Tools that might be referenced on the Cloud Architect Exam
 - Dataproc (Managed Hadoop/Pig/Hive/Spark)
 - Dataflow (Apache Beam in Java/Python)
 - Pub/Sub (Messaging)
 - Dataprep (Program-less Data wrangling using Dataflow)
 - Data Fusion (Programm-less Data Transformation using Dataproc)
 - Datalab / AI Notebooks
 - Data Studio
 - IoT Core



GCP Accelerated Certification Programme
Professional Cloud Architect Workshop

Chapter 8: Case Studies

Chapter Objectives

In this chapter, you will:

- Design and architect solutions for the three case studies you need to know for the GCP Certified Professional Cloud Architect exam
- See: <https://cloud.google.com/certification/cloud-architect>

Chapter Concepts

Mountkirk Games

Dress4Win

TerramEarth

Exam Prep

Do Now: GCP Case Study



- Read the following case study: [Mountkirk Games](#)
- List below some Google Cloud Platform Services that would be used when implementing this case study

Chapter Concepts

Mountkirk Games

Dress4Win

TerramEarth

Exam Prep

Do Now: GCP Case Study



- Read the following case study: [Dress4Win](#)
- List below some Google Cloud Platform Services that would be used when implementing this case study

Chapter Concepts

Mountkirk Games

Dress4Win

TerramEarth

Exam Prep

Do Now: GCP Case Study



- Read the following case study: [TerramEarth](#)
- List below some Google Cloud Platform Services that would be used when implementing this case study

Chapter Concepts

Mountkirk Games

Dress4Win

TerramEarth

Exam Prep

ROI Practice Exams



- Link to [ROI Case Study Practice Exam](#)
 - <https://quiz.roitraining.com/arch-practice-exam.html>
 - 20 Questions designed by the ROI Training Team
 - Designed around the case studies
- Link to [ROI Security Practice Exam](#)
 - <https://quiz.roitraining.com/security-quiz.html>
 - 10 Questions designed by the ROI Training Team
 - Designed around security concepts

These quizzes ARE good representations of the Cloud Architect Exam

Google Cloud Advanced Skills & Certification Workshop:
Professional Cloud Architect

Additional Resources

Links

- Read the following documentation:

- [Compute Engine](#)
- [Networking](#)
- [App Engine](#)
- [Storage Options](#)
- [GCP Security](#)
- [IAM](#)
- [Stackdriver](#)
- [Site Reliability Engineering](#)
- [GCP Solutions](#)

Videos

- Watch these videos:
 - [Google Cloud Platform APIs Demo](#)
 - [Google Cloud Platform Deployment Manager Demo](#)
 - [Google Cloud Platform Cloud Functions Demo](#)
 - [Google Cloud Platform Container Engine Demo](#)
 - [Navigating Google Cloud Platform: a guide for new GCP users](#)
 - [Google Cloud Platform for day-to-day ITOps](#)
 - [Google Cloud Platform Storage Versioning Demo](#)
 - [Google Cloud Platform Enabling CORS](#)
 - [Google Cloud Platform Cloud SQL Demo](#)
 - [Google Cloud Platform Datastore Demo](#)

Videos (continued)

- [Google Cloud Platform Bulk Loading to Datastore Demo](#)
- [GCP Security Overview by Niels Provos](#)
- [Infrastructure & Operations: How Google Does Planet-Scale Engineering for Planet-Scale Infrastructure](#)

Tutorials

- Here is a list of all the Tutorials/Exercises from this course
 - Be sure to run through them all to gain hands-on experience with GCP
- [Set up a GCP Account](#)
- [Networks](#)
- [Virtual Machines](#)
- [Disks and Snapshots](#)
- [Images](#)
- [Load Balancing and Autoscaling](#)
- [App Engine](#)
- [Storage](#)
- [BigQuery](#)
- [Dataproc](#)

Google Professional Cloud Architect

Practice Exam

- Official Google Cloud Architect Practice Exam
<https://cloud.google.com/certification/practice-exam/cloud-architect>
- Additional Exams from other certifications:
 - Associate Cloud Engineer (ACE):
 - <https://cloud.google.com/certification/practice-exam/cloud-engineer>
 - Professional Data Engineer:
 - <https://cloud.google.com/certification/practice-exam/data-engineer>
 - Professional Cloud Security Engineer:
 - <https://cloud.google.com/certification/practice-exam/cloud-security-engineer>
 - Professional Cloud Network Engineer:
 - <https://cloud.google.com/certification/practice-exam/cloud-network-engineer>



Google Cloud Advanced Skills & Certification Workshop:
Professional Cloud Architect

Course Summary

Course Summary

In this course, you have learned how to:

- Prepare for the GCP Cloud Architect certification exam
- Investigate business cases, cost optimization, and product strategies for major GCP services
- Explore Site Reliability Engineering
- Examine security and compliance concerns in the cloud
- Analyze GCP best practices and cloud case studies
- Review cloud architectures and implementations to solve common problems

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Java

Leadership and Management Skills

Machine Learning and Neural Networks

Microsoft Exchange

.NET and Visual Studio

Networking and IPv6

Oracle and SQL Server Databases

OpenStack and Docker

Project Management

Python and Perl Programming

Security

SharePoint

Software Analysis and Design

Software Engineering

UNIX and Linux

Web and Mobile Apps

Windows and Windows Server



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Application Development	Google Cloud Fundamentals: Core Infrastructure	Developing Applications with GCP	Getting Started with Google Kubernetes Engine	Professional Cloud Developer- Google Cloud Advanced Skills & Certification Workshop				
Associate Cloud Engineer Track	Google Cloud Fundamentals: Core Infrastructure	Architecting with Google Compute Engine	Associate Cloud Engineer-Google Cloud Advanced Skills & Certification Workshop	Getting Started with Google Kubernetes Engine				
Professional Cloud Architect Track	Google Cloud Fundamentals: Core Infrastructure	Architecting with Google Compute Engine	Architecting with Google Cloud: Design & Process	Professional Cloud Architect-Google Cloud Advanced Skills & Certification Workshop	Architecting with Google Kubernetes Engine		Architecting Hybrid Cloud Infrastructure with Anthos	Security in Google Cloud Platform
Professional Cloud DevOps Engineer Track	Architecting with Google Kubernetes Engine	Architecting with Google Cloud: Design & Process	Logging, Monitoring, and Observability in GCP					
Data and Machine Learning	Google Cloud Fundamentals: Big Data & Machine Learning	Data Engineering on GCP	From Data to Insights with GCP	Professional Data Engineer-Google Cloud Advanced Skills & Certification Workshop		Machine Learning with TensorFlow on GCP		
Cloud Security	Google Cloud Fundamentals: Core Infrastructure	Networking in Google Cloud	Security in Google Cloud Platform	Professional Cloud Security Engineer-Google Cloud Advanced Skills & Cert Workshop				
Cloud Network Engineer	Google Cloud Fundamentals: Core Infrastructure	Networking in Google Cloud			 ROI TRAINING MAXIMIZE YOUR TRAINING INVESTMENT™			



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