

# Module 4

## Modernize Infrastructure and Applications with Google Cloud

### Lessons

- |           |   |
|-----------|---|
| <b>01</b> | Important cloud migration terms         |
| <b>02</b> | Modernizing infrastructure in the cloud |
| <b>03</b> | Modernizing applications in the cloud   |

Google Cloud

It's now time for module 4, "Modernize Infrastructure and Applications with Google Cloud." With the cloud, organizations can move away from investing in their own resources to run and maintain existing IT infrastructure, and instead shift their focus to creating new, higher-value products and services.

In this section you'll learn about:

- Important cloud migration terms.
- Options available to run compute workloads in the cloud, including virtual machines, containers, and serverless architecture.
- Options to modernize application development through rehosting and APIs.

## Module 4

### Modernize Infrastructure and Applications with Google Cloud

#### Lessons

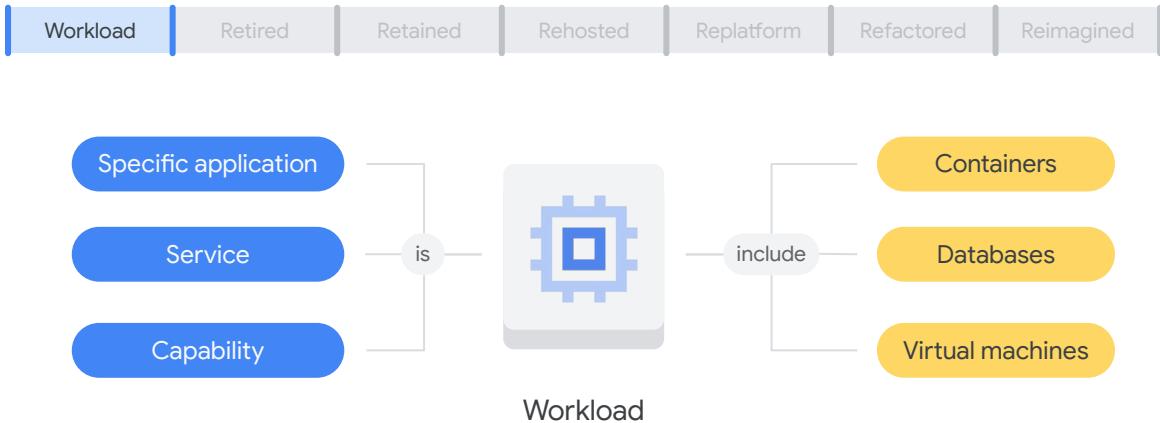
- 01 Important cloud migration terms
- 02 Modernizing infrastructure in the cloud
- 03 Modernizing applications in the cloud

Google Cloud

You'll hear some common terminology when learning about modernizing infrastructure and applications in the cloud.

Let's introduce, or remind you of, some of these terms.

# Important cloud migration terms



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The first is a **workload**. In cloud computing, a workload is a specific application, service, or capability that can be run in the cloud or on-premises. Workloads include containers, databases, and virtual machines.

## Important cloud migration terms

Workload

Retired

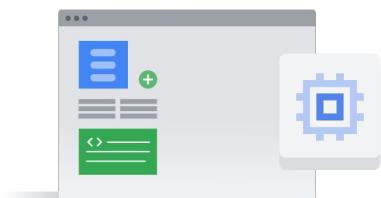
Retained

Rehosted

Replatform

Refactored

Reimagined



Retiring a workload means removing it from a platform.

— Unnecessary

— Not cost-effective

— Not secure

— Not compatible with a specific platform

Google Cloud

Sometimes workloads get **retired**. Retiring a workload means removing it from a platform. A workload might be retired because it's unnecessary, not cost-effective, secure, or compatible with a specific platform.

# Important cloud migration terms

Workload

Retired

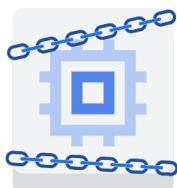
Retained

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Reimagined



Intentionally  
keeping a workload

Kept on-premises

Kept in a hybrid cloud environment

Managed by the business

Not subject to the same level of cloud provider control

Google Cloud

Alternatively, workloads are often **retained**. Retaining a workload means that it's intentionally kept. When a workload is retained, it's typically kept on-premises or in a hybrid cloud environment. This means that the workload will continue to be managed by the business and will not be subject to the same level of cloud provider control.

# Important cloud migration terms

Workload

Retired

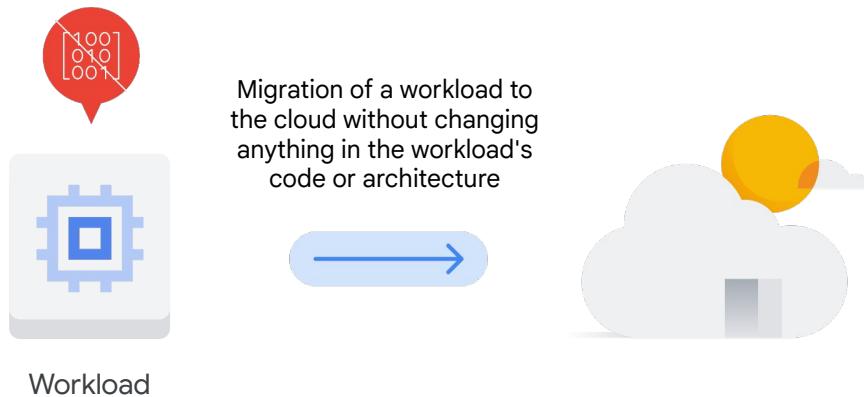
Retained

Rehosted

Replatform

Refactored

Reimagined



Google Cloud

Many workloads are **rehosted**. In cloud computing, "rehost" refers to the migration of a workload to the cloud without changing anything in the workload's code or architecture. This is often done as a first step in cloud migration, because it's the simplest and quickest way to run a workload in the cloud. This process is often referred to as **lift and shift**.

However, rehosting also has some drawbacks, including:

- It does not use all the benefits of cloud computing.
- Managing workloads that were rehosted without making any changes can be difficult.
- Scaling workloads that were rehosted without making any changes can also be difficult.

# Important cloud migration terms

Workload

Retired

Retained

Rehosted

Replatform

Refactored

Reimagined



Workload



Migrating a workload to the cloud while making some changes to the workload's code or architecture



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Then there is **replatform**. In cloud computing, "replatform" refers to the process of migrating a workload to the cloud while making some changes to the workload's code or architecture.

This process is often called **move and improve**.

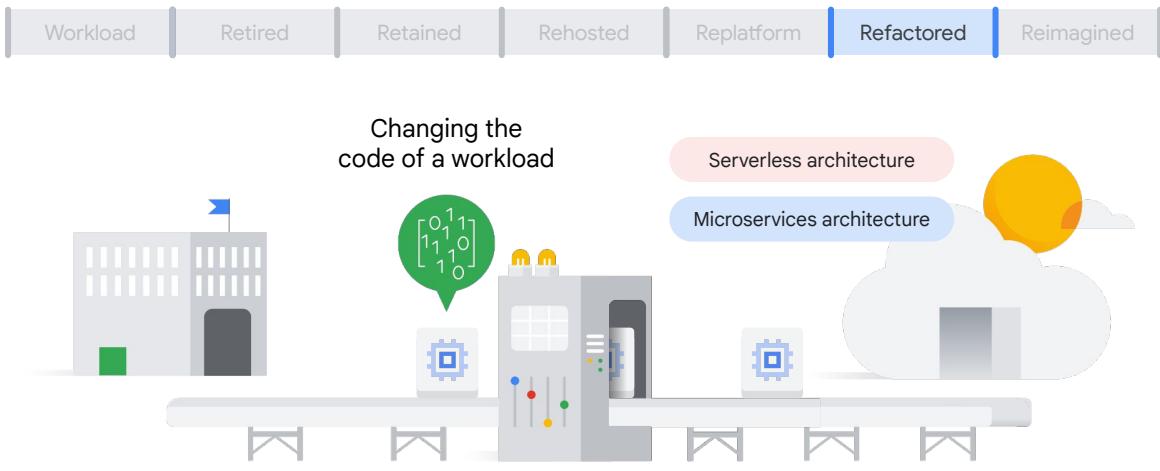
Replatforming lets organizations:

- Benefit from the cloud's scalability, reliability, and cost-effectiveness.
- Improve the performance of their workloads.
- And reduce the cost of their workloads.

However, replatforming also has some drawbacks, including:

- It can be a complex and time-consuming process.
- *Making the necessary changes* to the workload's code or architecture can be difficult.
- And *testing the changes* to the workload's code or architecture can also be difficult.

# Important cloud migration terms



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Sometimes workloads are **refactored**, which refers to the process of changing the code of a workload. For example, an organization might refactor a workload to use either a cloud-based microservices architecture or a cloud-based serverless architecture. We'll explore what those concepts mean later in this course.

Refactoring has some benefits. It means that workloads can become:

- More efficient, scalable, or secure
- A valuable investment for organizations that want to use all cloud capabilities

That being said, a possible drawback for organizations is that:

- Refactoring a workload can be a complex and time-consuming process.

# Important cloud migration terms

Workload

Retired

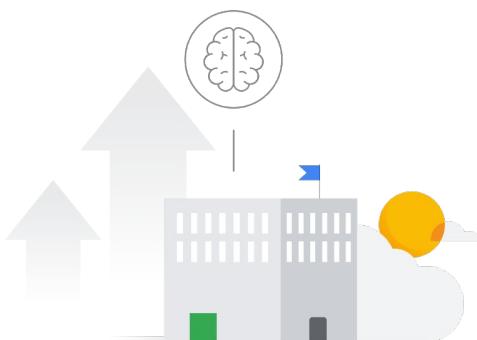
Retained

Rehosted

Replatform

Refactored

Reimagined



The process of rethinking how an organization uses technology to achieve its business goals

Cloud strategy

Artificial intelligence

Machine learning

Google Cloud

And finally, cloud modernization can inspire and incentivize organizations to **reimagine**. In cloud computing, "reimagine" refers to the process of rethinking how an organization uses technology to achieve its business goals. This can involve reconsidering the organization's current cloud strategy, and its use of other technologies, such as artificial intelligence and machine learning.

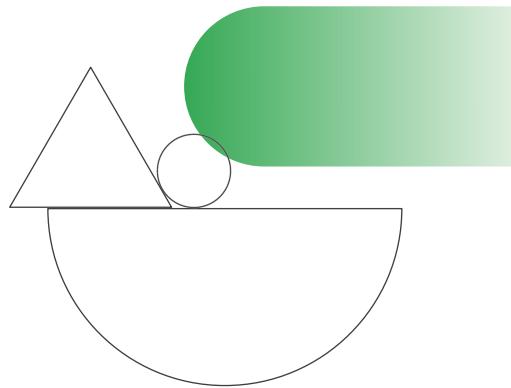
Reimagining cloud computing can help organizations to improve their efficiency, reduce costs, and increase agility. It can also help organizations better meet the needs of their customers and partners.

## Activity

 10 min  Class  Page 21

Using the case studies that follow, practice identifying the most important modernization strategies:

- Rehost
- Replatform
- Refactor
- Reimagine



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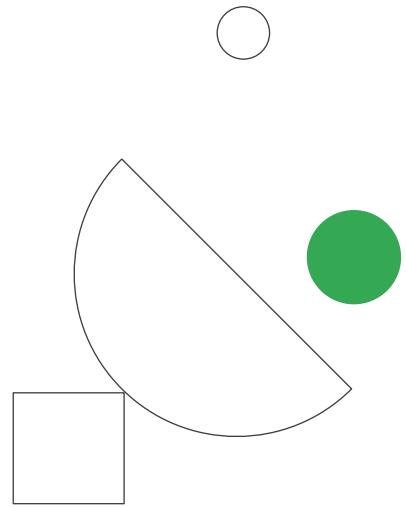
Now, let's practice determining which of the five key patterns for application modernization are most applicable to some sample case studies.

Which of the five core modernization areas best applies to this business case?

## Scenario 1

A multinational coffeehouse chain currently accepts orders in-person, by phone, or on their website. They want to provide customers with another way to order by building a new smartphone app. The app needs to be scalable and to function globally at low latency.

**Which modernization strategy should they adopt?**



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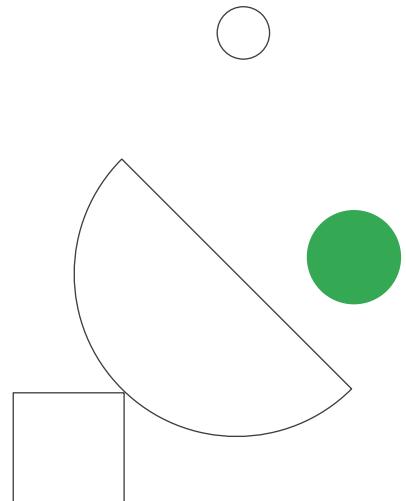
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- **Answer:** Reimagine
- **Explanation:** The organization wants to develop a new mobile application, instead of updating an existing product. To ensure the app functions as needed it should be developed in the cloud.
- **Bonus question:** Would GKE or App Engine be more appropriate to support this?
  - **App Engine:** App engine enables the creation of applications in the cloud, whilst managing application infrastructure to support simpler updates and rapid scalability.

## Scenario 1

### Answer: Reimagine

**Why?** The organization wants to develop a new mobile application, rather than updating an existing product. To ensure the app functions as needed it should be developed in the cloud.



Google Cloud

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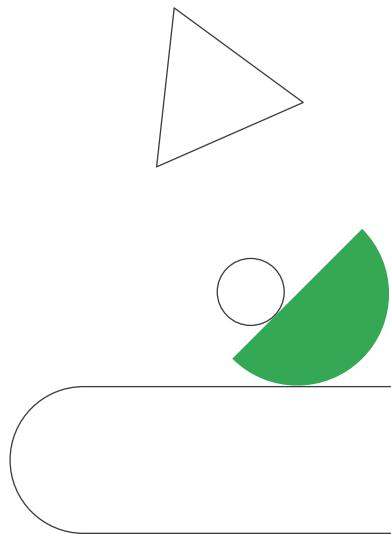
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## Scenario 2

A video game manufacturer distributes its products through applications on consoles and mobile devices, supported by legacy infrastructure.

Consumers are complaining that the app lacks features like cloud gaming and customizable profiles. The manufacturer wants to provide these, but is struggling to integrate them into the current application and can't risk extended downtime.

**Which modernization strategy should they adopt?**



Google Cloud

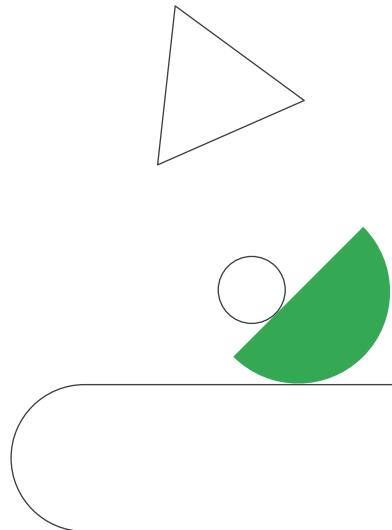
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- **Answer:** Refactor
- **Explanation:** Upgrading the existing application with these new features would be difficult due to legacy hardware limitations and the costs of downtime. Refactoring will allow them to integrate the new features into the existing application without having to risk extended downtime.

## Scenario 2

### Answer: Refactor

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Google Cloud

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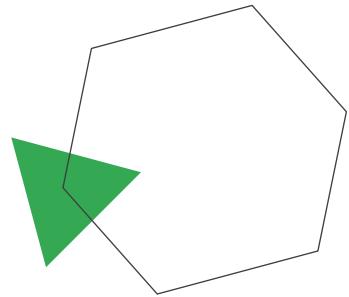
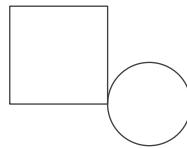
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## Scenario 3

A financial services company has a legacy application that is used to process customer transactions. The application is running on an outdated operating system and is not compatible with the company's newer hardware.

The financial services company wants to modernize the application without having to rewrite the entire application from the beginning.

**Which modernization strategy should they adopt?**



Google Cloud

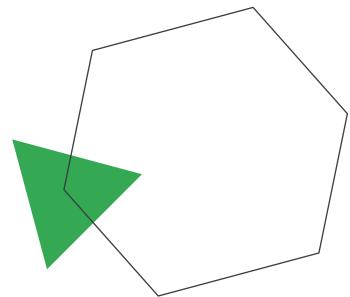
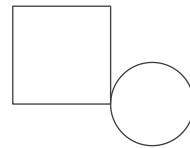
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- **Answer:** Replatform
- **Explanation:** The replatform strategy involves making minor changes to the application code to take advantage of the new operating system's features. This will allow the financial services company to modernize the application without having to rewrite the entire application from scratch.

## Scenario 3

### Answer: Replatform

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Google Cloud

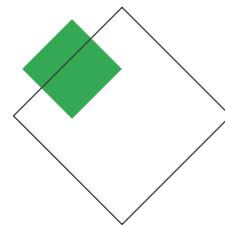
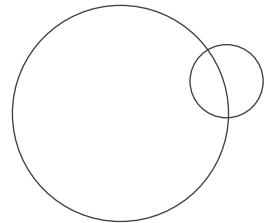
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## Scenario 4

A high-profile law firm has a large on-premises database of legal resources which can be accessed on-site, or on a web portal which is slow and unreliable. The firm now wants its databases to be accessible quickly and easily from anywhere.

Which modernization strategy should they adopt?



Google Cloud

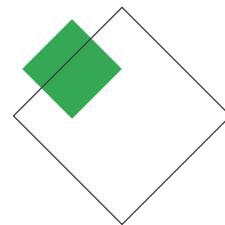
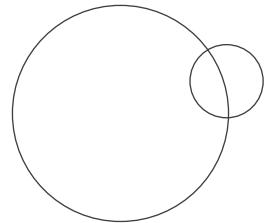
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## Scenario 4

### Answer: Rehost

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Google Cloud

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# Module 4

## Modernize Infrastructure and Applications with Google Cloud

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| 01 | Important cloud migration terms         |
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Google Cloud

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In this section you'll learn about:

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- Options available to run compute workloads in the cloud, including virtual machines, containers, and serverless architecture.
- Options to modernize application development through rehosting and APIs.

01



The benefits of  
running compute  
workloads in the cloud

## Compute refers to a machine's ability to process information



Compute

- Storing information
- Retrieving information
- Comparing information
- Analyzing information

Google Cloud

In the context of the cloud, compute refers to a machine's ability to process information. Associated tasks include storing, retrieving, comparing, and analyzing the information.

# Cloud computing uses a network of remote servers to provide on-demand access to resources



Google Cloud

Instead of relying on local servers and storage devices, cloud computing uses a network of remote servers to provide on-demand access to various computing resources, including applications, storage, and processing power.

## Recall the benefits of running compute workloads in the cloud



Google Cloud

So, why should an organization consider running compute workloads in the cloud? You'll recall from earlier in this course some benefits that running compute workloads in the cloud can bring to an organization.

- **Total Cost of Ownership (TCO):** Cloud providers offer a pay-as-you-go model, which means that organizations only pay for the resources used. They also offer discounts for long-term commitments, which can further reduce TCO for businesses that are planning to use cloud services for a long period.
- **Scalability:** If a business experiences a sudden spike in demand, it can easily scale up its cloud resources to meet the demand. Conversely, if they experience reduced demand, infrastructure can quickly scale down its cloud resources to save money.
- **Reliability:** Cloud providers offer a high degree of reliability and uptime, which gives businesses confidence that their data and applications will be available when they need them. Google Cloud, for example, has multiple data centers located in different parts of the world. This helps to ensure that if one data center goes down, the others can continue to operate.
- **Security:** In addition to physical data center security, cloud security features include data encryption, identity and access management, network security, virtual private clouds, and monitoring services that can detect and respond to security threats in real time.
- **Flexibility:** Organizations can choose the cloud services that best meet their needs at any point in time, and then change or adapt those services when necessary.

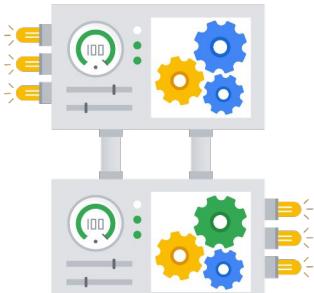
- **Abstraction:** Cloud providers remove the need for customers to understand the finer details of the infrastructure implementation by providing management of the hardware, software, and certain aspects of security and networking.



## Virtual machines

Google Cloud

## Virtualization is a form of resource optimization that lets multiple systems run on the same hardware



This means that they share the same:

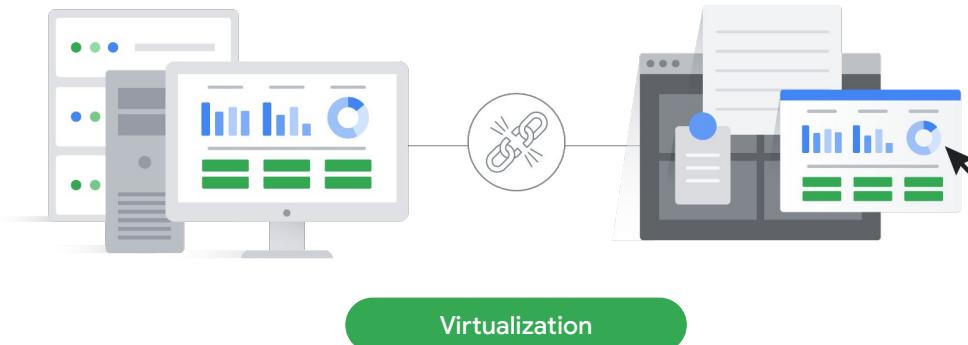
- Pool of processing
- Storage
- Networking resources

Google Cloud

Virtualization is a form of resource optimization that lets multiple systems run on the same hardware.

These systems are called **virtual machines**, or VMs. This means that they share the same pool of processing, storage, and networking resources. VMs enable organizations to run multiple applications at the same time on a server in a way that is efficient and manageable.

## Virtualization relieves the pressure to bind specific computing hardware resources to specific applications



Google Cloud

Traditionally, various technological pressures compelled many organizations to tightly bind specific computing hardware resources to specific applications. Virtualization technology relieved these pressures.

# Compute Engine



Compute Engine

IaaS solution

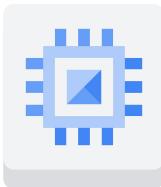
Lets users create and run virtual machines on Google infrastructure.



Google Cloud

**Compute Engine** is Google Cloud's infrastructure as a service (IaaS) product that lets users create and run virtual machines on Google infrastructure.

# Compute Engine



Compute Engine

- ✔ There are no upfront investments.
- ✔ Thousands of virtual CPUs can run on a system that's designed to be fast and to offer consistent performance.
- ✔ Each VM contains the power and functionality of a full-fledged operating system.
- ✔ A VM can be configured much like a physical server by specifying:
  - The amount of CPU power and memory needed
  - The amount and type of storage needed
  - The operating system

Google Cloud

There are no upfront investments, and thousands of virtual CPUs can run on a system that's designed to be fast and to offer consistent performance.

Each virtual machine contains the power and functionality of a full-fledged operating system. This means a virtual machine can be configured much like a physical server: by specifying the amount of CPU power and memory needed, the amount and type of storage needed, and the operating system.

# Virtual machine instances

Can be created through the:



- 01** Google Cloud console, which is a web-based tool to manage Google Cloud projects and resources
- 02** Google Cloud CLI (command-line interface) by using infrastructure automation tools such as Terraform or the Compute Engine API

Google Cloud

A virtual machine instance can be created through the Google Cloud console, which is a web-based tool to manage Google Cloud projects and resources and the Google Cloud CLI (command-line interface) by using infrastructure automation tools such as Terraform or the Compute Engine API.

An API, or Application Programming Interface, is a set of instructions that allows different software programs to communicate with each other. We'll learn about APIs in more detail later in this course.

## Sustained-use discounts

- Bills by the second
- 1 minute minimum
- Sustained-use discounts
  - They apply automatically to VMs the longer they run.
  - For each VM that runs for more than 25% of a month, Compute Engine applies a discount for every incremental hour of use.

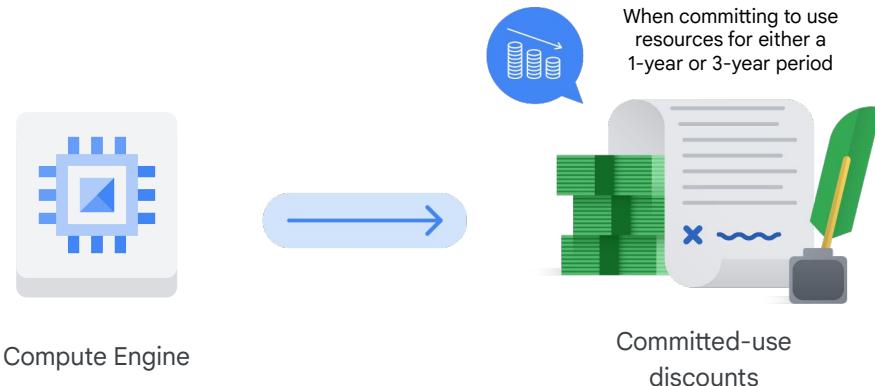


Virtual Machine

Google Cloud

When you use virtual machines, Compute Engine bills by the second with a one-minute minimum, and **sustained-use discounts** start to apply automatically to virtual machines the longer they run. So, for each VM that runs for more than 25% of a month, Compute Engine automatically applies a discount for every incremental hour of use.

## Committed-use discounts

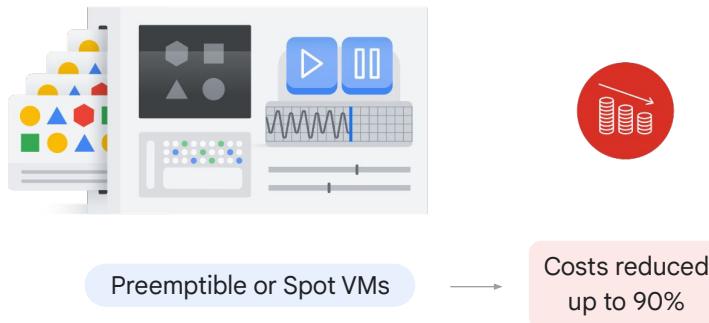


Google Cloud

Compute Engine also offers **committed-use discounts**. This means that when committing to use resources for either a 1-year or 3-year period, discounts are offered over the on-demand prices.

## Preemptible and Spot VMs

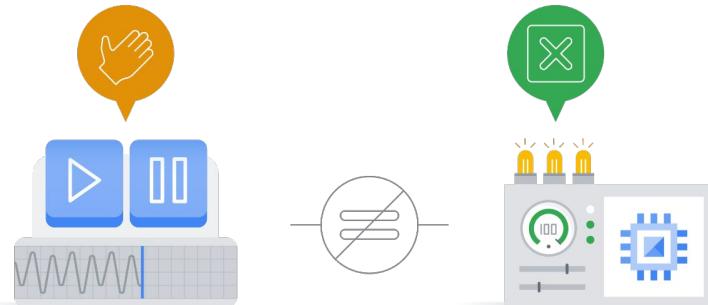
Example: batch job analyzing a large dataset



Google Cloud

And then there are **Preemptible and Spot VMs**. Let's say that a workload doesn't require a human to sit and wait for it to finish, such as a batch job analyzing a large dataset. Costs can be reduced, in some cases by up to 90%, by choosing Preemptible or Spot VMs to run the job.

## Preemptible and Spot VMs: Ensure that a job can be stopped and restarted without impact



Preemptible or Spot VM

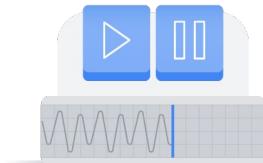
Compute Engine VM

Compute Engine has permission to terminate a VM if its resources are needed elsewhere.

Google Cloud

A Preemptible or Spot VM is different from an ordinary Compute Engine VM in only one respect: Compute Engine has permission to terminate a VM if its resources are needed elsewhere. Although savings are possible with preemptible or spot VMs, it needs to be ensured that a job can be stopped and restarted without impact.

## What's the difference?



Preemptible/Spot VM

### Spot VMs

- More features
- No maximum runtime
- Same pricing

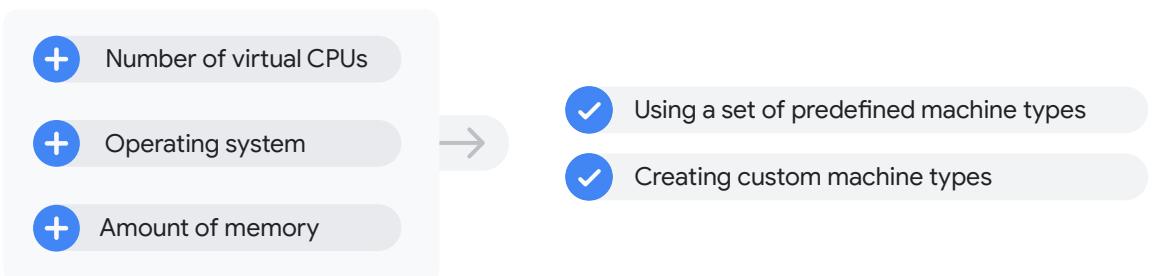
### Preemptible VMs

- Less features
- Runtime up to 24h
- Same pricing

Google Cloud

**Spot VMs** differ from Preemptible VMs by offering more features. For example, preemptible VMs can only run for up to 24 hours at a time, but Spot VMs don't have a maximum runtime. However, the pricing is currently the same for both.

## Compute Engine lets users choose the machine properties of their instances



Google Cloud

And finally, Compute Engine lets users choose the machine properties of their instances, like the number of virtual CPUs, the operating system, and the amount of memory, by using a set of predefined machine types or by creating custom machine types.

03



## Containers

## What is a container?



Containers

Containers provide **isolated environments** to run software services and optimize resources from **one piece of hardware**.

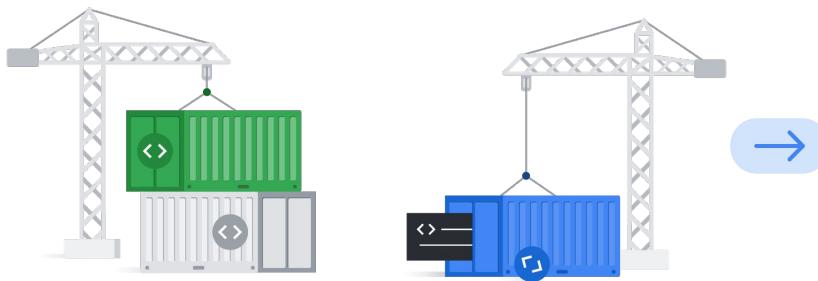
Google Cloud

Infrastructure as a service, or IaaS, lets users share compute resources with other developers by using virtual machines to virtualize the hardware.

This lets each developer deploy their own operating system, access the hardware, and build their applications in a self-contained environment with access to the necessary system resources.

**Containers** follow the same principle as virtual machines. They provide isolated environments to run software services and optimize resources from one piece of hardware. However, they're even more efficient.

## Containers let developers create predictable environments isolated from other system resources



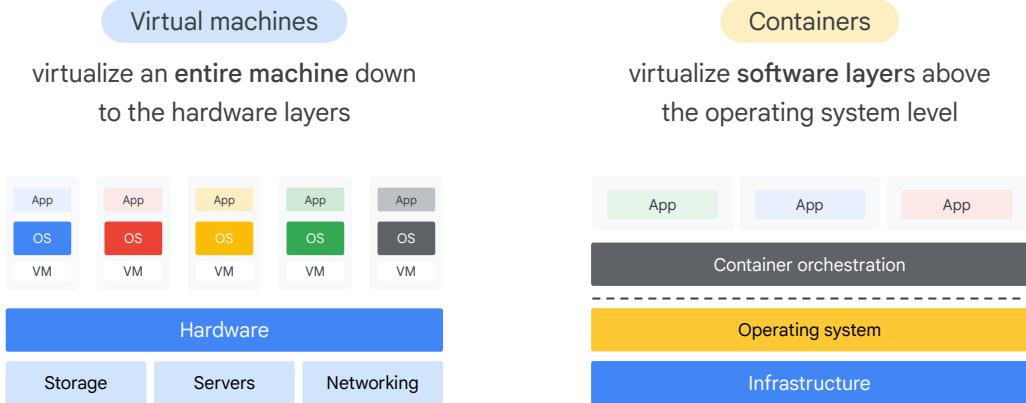
Developers can easily update a particular part of an application without affecting the rest of it.

Google Cloud

Containers let developers create predictable environments isolated from other system resources. So if a customer asks for a new feature, or a change in the application, developers can easily update that particular part of the application without affecting the rest.

Containers can run virtually anywhere, which makes development and deployment easy.

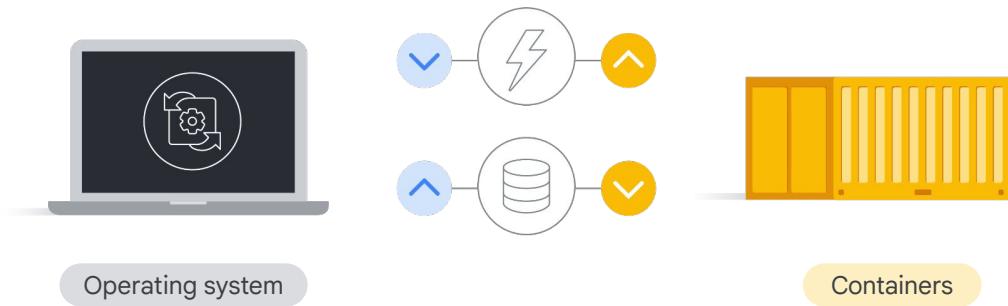
# The difference between a VM and a container



Google Cloud

The key difference between virtual machines and containers is that virtual machines virtualize an *entire* machine—down to the hardware layers—whereas containers only virtualize *software layers* above the operating system level.

**Containers start faster and use a fraction of the memory compared to booting an entire operating system**



Google Cloud

Containers start faster and use a fraction of the memory compared to booting an entire operating system.

## A container is packaged with the application and all of its dependencies



Containers can be:

- Independently developed
- Independently tested
- Independently deployed
- Well suited for a microservices-based architecture

Google Cloud

A container is packaged with your application and all of its dependencies so it has everything it needs to run. Containers can be independently developed, tested, and deployed and are well suited for a microservices-based architecture.

# Quiz

## Question

A travel company is in the early stages of developing a new application and wants to test it on a variety of configurations: different operating systems, processors, and storage options. What cloud computing option should they use?

- A. Containers
- B. A local development environment
- C. Colocation
- D. Virtual machine instances

Google Cloud

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# Quiz

## Answer

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- A. Containers
- B. A local development environment
- C. Colocation
- D. Virtual machine instances



Google Cloud

The correct answer is D.

- A. Containers
  - Why this is the **incorrect** answer: While containers are great for portability and scaling, they don't address the need to test against different operating systems and underlying hardware configurations, which is central to this use case.
- B. A local development environment
  - Why this is the **incorrect** answer: Relying only on a local environment severely limits the company's ability to test on different hardware and operating systems. It isn't practical or scalable for comprehensive testing of this kind.
- C. Colocation
  - Why this is the **incorrect** answer: Colocation involves renting space in a data center for your own physical servers. This offers control over hardware but it lacks the flexibility, speed, and cost-effectiveness of virtual machines for multi-configuration app testing.
- D. Virtual machine instances
  - Why this is the **correct** answer: Virtual machine instances are the ideal choice for this scenario because they allow the company to create isolated software environments, each with its own customizable operating system, processor configuration (within limits), and storage settings. This enables them to test their application thoroughly across a range of potential user systems without investing in lots of physical

- hardware.

# Quiz

## Question

What portion of a machine does a container virtualize?

- A. Software layers above the firmware level.
- B. Software layers above the operating system level.
- C. Hardware layers above the electrical level.
- D. The entire machine.

Google Cloud

What portion of a machine does a container virtualize?

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# Quiz

## Answer

What portion of a machine does a container virtualize?

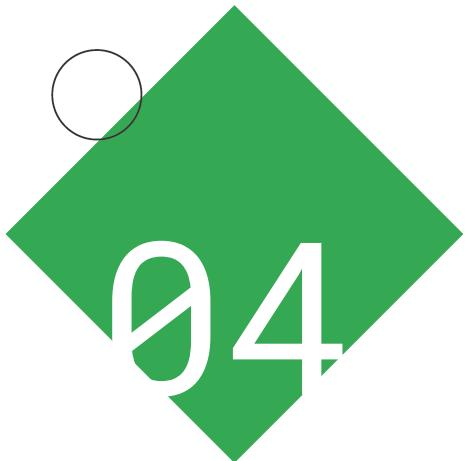
- A. Software layers above the firmware level.
- B. Software layers above the operating system level.
- C. Hardware layers above the electrical level.
- D. The entire machine.



Google Cloud

The correct answer is B.

- A. Software layers above the firmware level.
  - Why this is the **incorrect** answer: Firmware is low-level software embedded in hardware devices, which containers don't interact with directly.
- B. Software layers above the operating system level.
  - Why this is the **correct** answer: Containers virtualize the software layers above the operating system, allowing applications and their dependencies to run in isolated environments that share the same underlying host OS kernel.
- C. Hardware layers above the electrical level.
  - Why this is the **incorrect** answer: Containers specifically focus on software virtualization, not hardware.
- D. The entire machine.
  - Why this is the **incorrect** answer: This level of virtualization is achieved by virtual machines (VMs), which emulate an entire hardware system, including its own operating system.



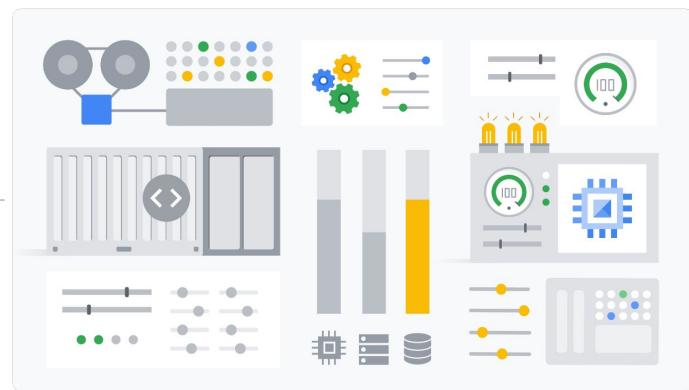
## Container management

Google Cloud

## Organizations need to manage their IT infrastructure as it becomes more complex

Keep containers secure.

Ensure that containers operate efficiently.



Google Cloud

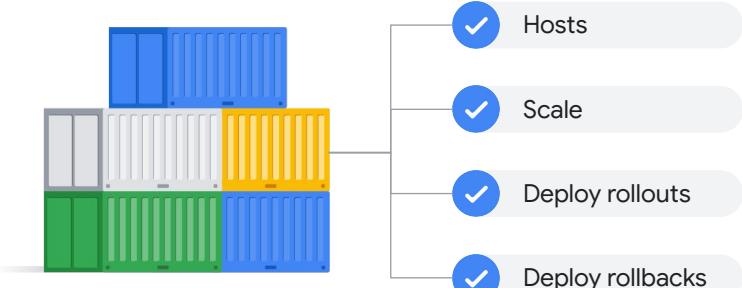
Containers improve agility, enhance security, optimize resources, and simplify managing applications in the cloud. And many organizations have a mix of virtual machines and containers; however, as their IT infrastructure setup becomes more complex, they often need a way to manage their services and machines.

For example, an organization can have millions and millions of containers. This requires keeping them secure, and ensuring that they operate efficiently can require significant oversight and management.

# Kubernetes



Is an open-source platform for managing containerized workloads and services.



Makes it easy to orchestrate many containers.

Google Cloud

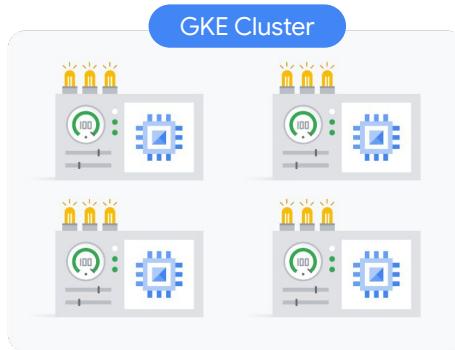
Kubernetes, originally developed by Google, is an open source platform for managing containerized workloads and services.

It makes it easy to orchestrate many containers on many hosts, scale them, and easily deploy rollouts and rollbacks. This improves application reliability, and reduces the time and resources needed to spend on management and operations.

# Google Kubernetes Engine (GKE)



A Google-hosted managed Kubernetes service in the cloud



Multiple machines

Compute Engine instances

Customizable

Type      No. of nodes

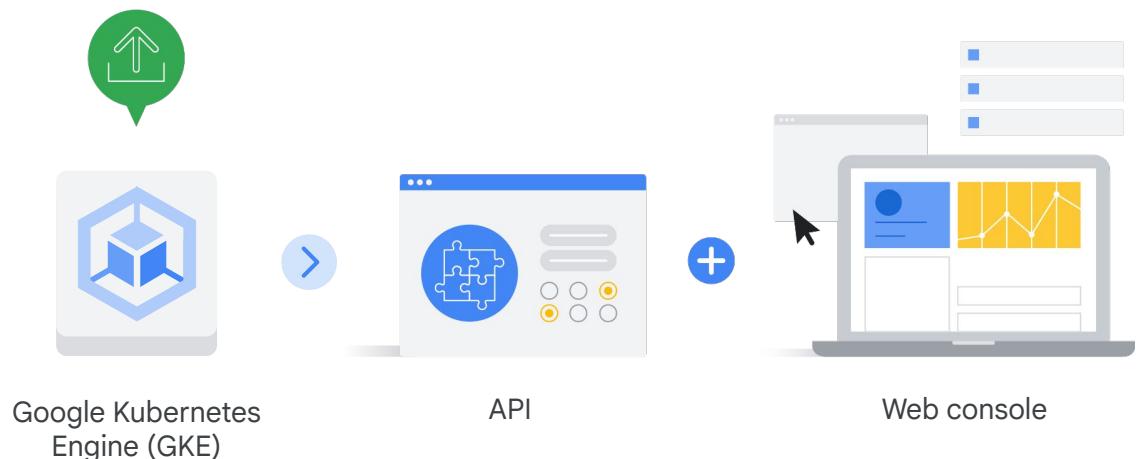
Network settings

Google Cloud

**Google Kubernetes Engine (GKE)** is a Google-hosted managed Kubernetes service in the cloud. The GKE environment consists of multiple machines, specifically Compute Engine instances, grouped to form a cluster. **Whereas Kubernetes has a control plane to manage all the clusters, GKE is an automated version where you don't even see a control plane, it's all automatically deployed and scaled.**

GKE clusters can be customized, and they support different machine types, numbers of nodes, and network settings.

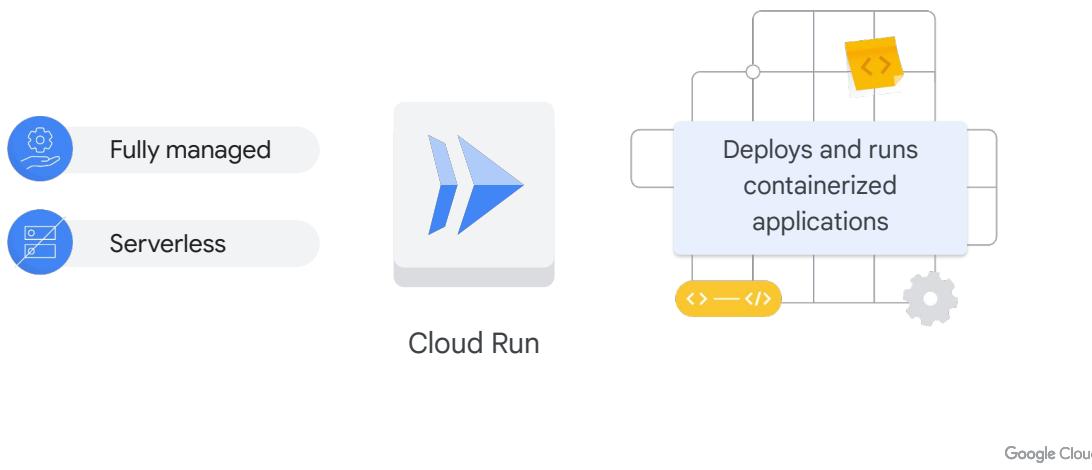
## Different ways to deploy applications with GKE



GKE makes it easy to deploy applications by providing an API and a web-based console. Applications can be deployed in minutes, and can be scaled up or down as needed.

GKE also provides many features that can help monitor applications, manage resources, and troubleshoot problems.

## Cloud Run: Another option to run containerized apps on Google Cloud



Google Cloud

Another popular option for running containerized applications on Google Cloud is **Cloud Run**.

Cloud Run is a fully managed serverless platform to deploy and run containerized applications without needing to worry about the underlying infrastructure. After your application code is containerized and deployed to Cloud Run, Google Cloud takes care of scaling and managing the infrastructure automatically.

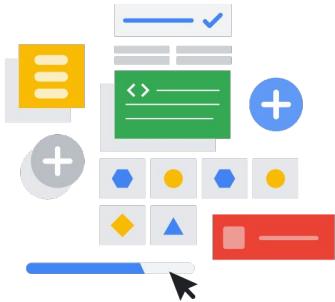
(Cloud Run) <https://cloud.google.com/run>

## Cloud Run is ideal for running stateless applications



Cloud Run

↑ Scale up  
↓ Scale down



Suitable for simple and lightweight applications, such as web applications

Google Cloud

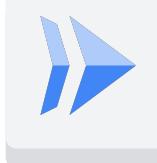
Cloud Run is ideal for running stateless applications that need to scale up and down quickly in response to traffic. This makes Cloud Run most suitable for simple and lightweight applications, such as web applications.

## Google Kubernetes vs. Cloud Run



GKE

Provides lots of control over a Kubernetes environment with complex applications to run.



Cloud Run

Is a simple, fully managed serverless platform that can scale up and down quickly.

Google Cloud

In summary, GKE is ideal when lots of control is required over a Kubernetes environment and there are complex applications to run.

Alternatively, Cloud Run is ideal for when a simple, fully managed serverless platform that can scale up and down quickly is required.

## Scenario

### Question

An ecommerce company is developing a new web application that will be used by customers to browse products, add items to their carts, and checkout. The company wants to deploy the application that is scalable and reliable, and that can handle a large number of concurrent users during peak periods.

Should the company use **GKE** or **Cloud Run** to deploy the application?

Google Cloud

Let's pause to examine a scenario and decide if a company should use **GKE** or **Cloud Run** to deploy the application?

So, should the company use GKE or Cloud Run to deploy the application?

# Scenario

## Answer

An ecommerce company is developing a new web application that will be used by customers to browse products, add items to their carts, and checkout. The company wants to deploy the application that is scalable and reliable, and that can handle a large number of concurrent users during peak periods.

Should the company use GKE or Cloud Run to deploy the application?

In this scenario, the e-commerce company should choose **Cloud Run**. Cloud Run is ideal for running applications that need to scale up and down quickly in response to traffic. This makes Cloud Run most suitable for simple and lightweight applications, such as web applications. It is also a good choice for companies that do not want to worry about managing infrastructure.

Google Cloud

In this scenario, the e-commerce company should choose **Cloud Run**.

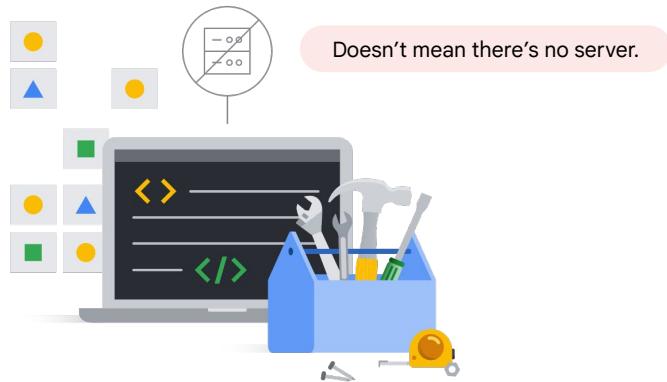
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05



Serverless  
computing

## Serverless computing



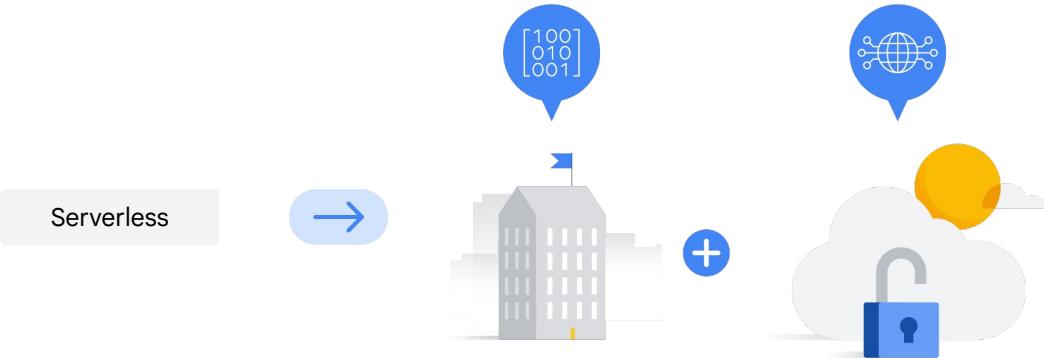
When resources, like compute power, are automatically provisioned in the background as needed.

Google Cloud

Another option for modernizing cloud applications is serverless computing. Serverless computing doesn't mean there's no server, it means that resources, like compute power, are automatically provisioned in the background as needed.

The advantage here is that organizations won't pay for compute power unless they're running a query or application.

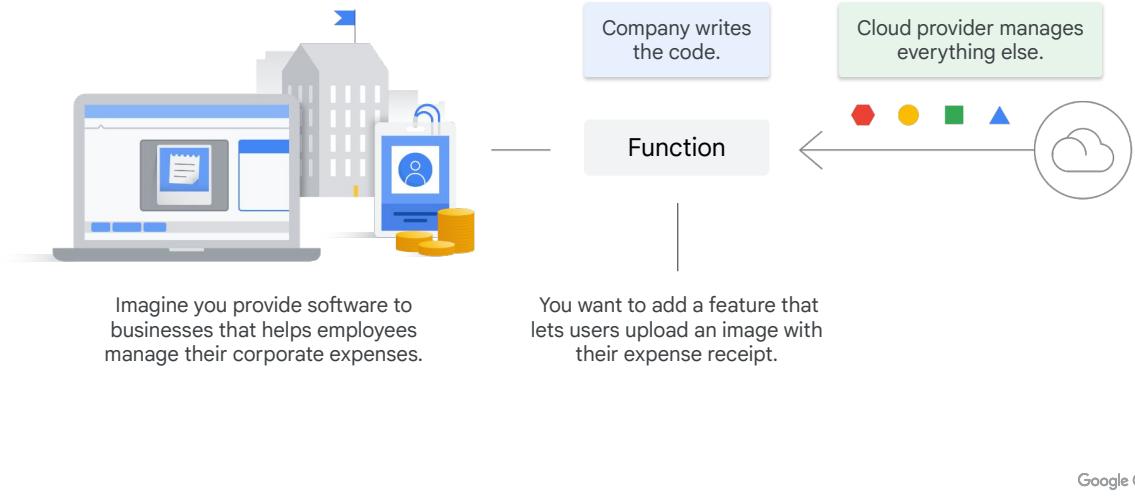
# Serverless computing



Google Cloud

At its simplest definition, serverless means that businesses provide the code for whatever function they want, and the public cloud provider does everything else.

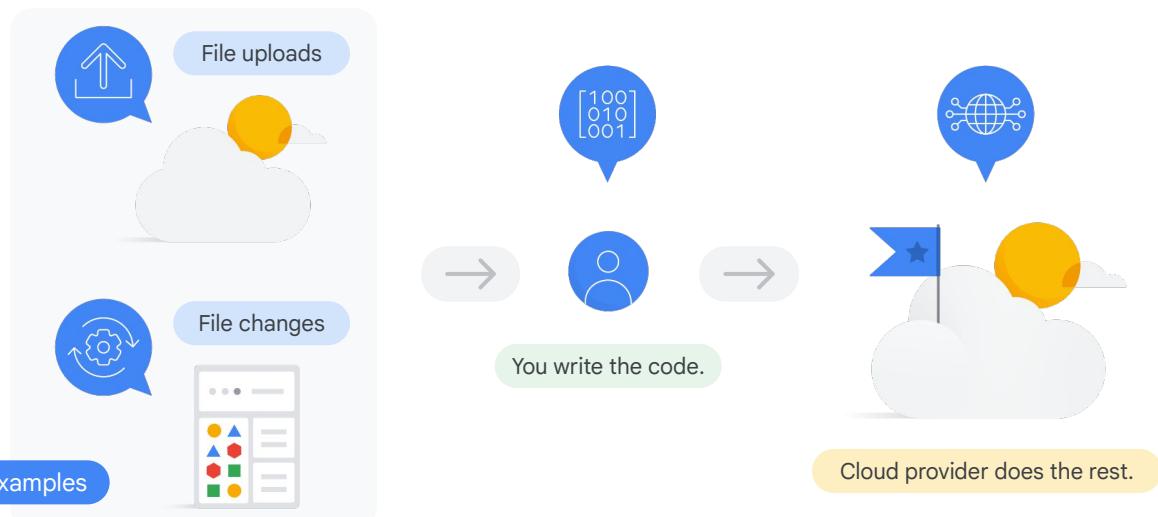
## An example



Imagine you provide software to businesses that helps employees manage their corporate expenses, and you want to add a feature that lets users upload an image with their expense receipt.

In this case, the ability to upload an image is called a **function**. You, as the software development company, write the code for that function directly into your public cloud platform. From there, the public cloud provider manages everything else.

## Serverless computing: Function as a service

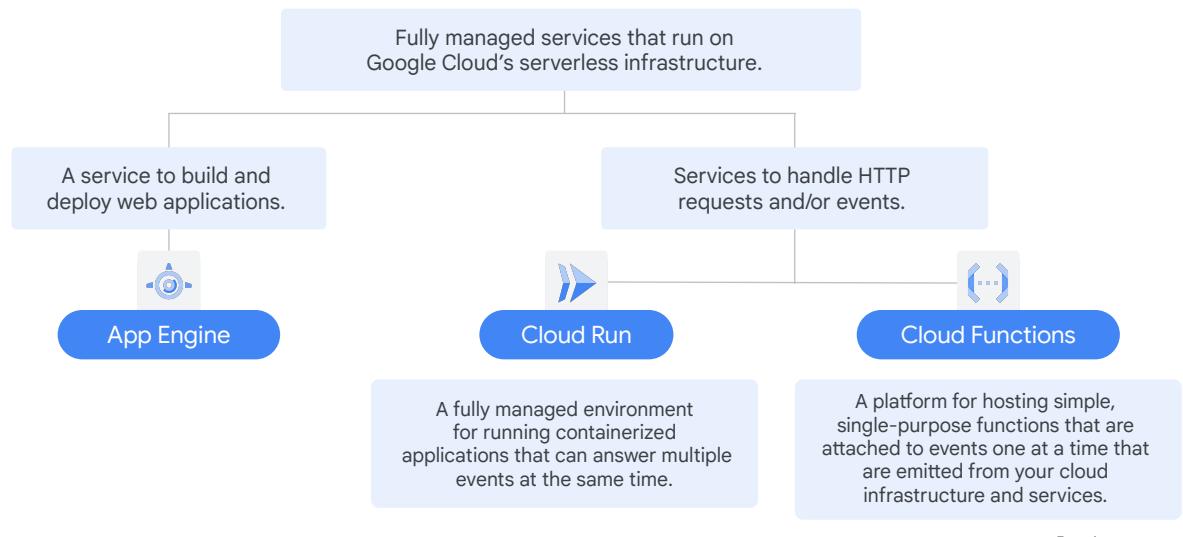


Google Cloud

One type of serverless computing solution is called *function as a service*.

Some functions are a response to specific events, like file uploads to cloud storage or changes to database records. You write the code that defines the response to those events, and the cloud provider does everything else.

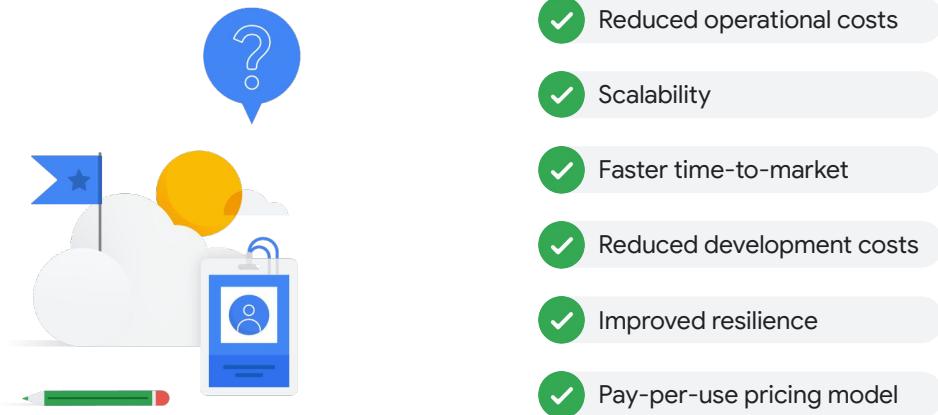
# Google Cloud's serverless computing products



Google Cloud offers several serverless computing products.

1. The first is **Cloud Run**, which is a fully managed environment for running containerized applications. Cloud Run dynamically scales the number of container instances up or down based on the volume of incoming requests. This means it can handle multiple concurrent events without you needing to manually provision resources.
2. Then there is **Cloud Functions**, which is a platform for hosting simple, single-purpose functions that are attached to events emitted from your cloud infrastructure and services. For example, sending a notification to a mobile device when a new order is placed on a website.
3. And there is also **App Engine**, which is a service to build and deploy web applications.

## Serverless computing benefits



- ✓ Reduced operational costs
- ✓ Scalability
- ✓ Faster time-to-market
- ✓ Reduced development costs
- ✓ Improved resilience
- ✓ Pay-per-use pricing model

Google Cloud

Serverless computing has many benefits:

- **Reduced operational costs:** the cloud provider is responsible for the infrastructure and its maintenance. Therefore, the application owner does not need to invest in the infrastructure or the human resources required to manage it.
- **Scalability:** serverless computing provides automatic scaling of computing resources based on the application's demand. The cloud provider manages the scaling process, and the application owner only pays for the resources they use.
- **Faster time-to-market:** the need for infrastructure setup and configuration is eliminated, which reduces the time required to deploy applications. This feature lets the application owner focus on writing code and quickly deploying new features.
- **Reduced development costs:** The development process is simplified because developers can focus on the application's logic and not on the underlying infrastructure.
- **Improved resilience:** Serverless computing offers improved resilience and availability as the cloud provider automatically manages the infrastructure's failover and disaster recovery capabilities.
- **Pay-per-use pricing model:** the application owner only pays for the computing resources they use. This reduces the cost of unused resources and helps optimize costs.

## Module 4

### Modernize Infrastructure and Applications with Google Cloud

#### Lessons

- |    |   |
|----|---|
| 01 | Important cloud migration terms         |
| 02 | Modernizing infrastructure in the cloud |
| 03 | Modernizing applications in the cloud   |

Google Cloud

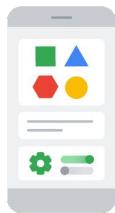
In the previous section of this course, you explored the benefits and options for modernizing IT infrastructure with the cloud.

Now let's focus on application modernization.

In this section of the course, you'll:

- Compare traditional and modern cloud application development methods.
- Explore considerations and tools for rehosting legacy applications in the cloud.
- Define application programming interfaces, or APIs.
- Examine the benefits of maintaining and managing APIs with Apigee API Management.
- And consider scenarios when a hybrid or multicloud strategy might be beneficial.

## What exactly is an application?



Application



A computer program or software that helps users do something.

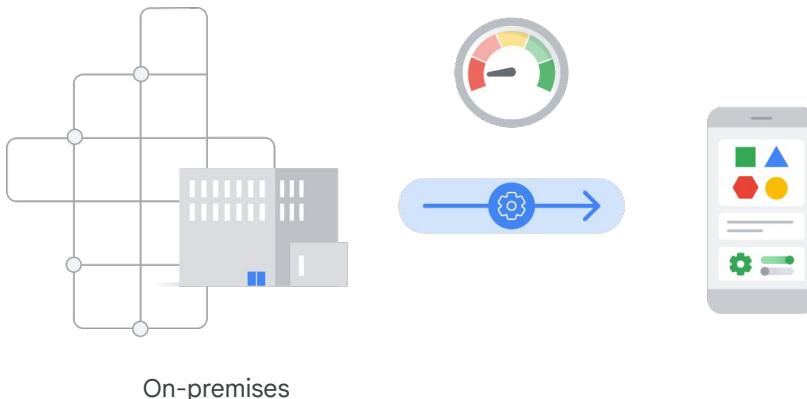
Google Cloud

But first, what exactly is an application?

In its basic form, an application is a computer program, or software, that helps users do something. And in this digital age, applications are everywhere.

Consider how many applications you interact with each day, from checking email to tracking your fitness with wearable technology that links to an app on your phone. Customers expect intuitive, well-functioning applications that can help them do things faster.

## On-premises application development often slows organizations down



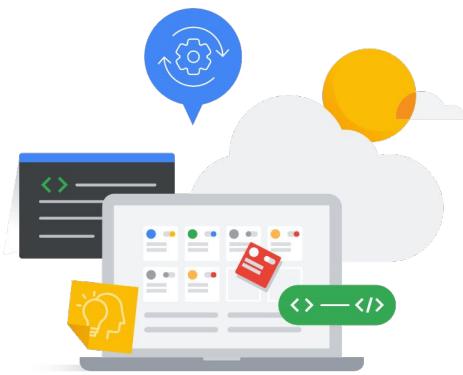
On-premises

Google Cloud

Applications have been developed on-premises for years, and often still are. However, on-premises application development often slows organizations down. Deploying an application on-premises can be time consuming and can also require specialized IT teams. Changes can often take six months or more to implement, which can create friction within different parts of an organization.

With cloud technology, businesses can modernize, develop, and manage applications in new ways, which makes them more agile and responsive to user needs.

# Modern cloud application development



-  Flexible
-  Scalable
-  Uses the latest technologies

Google Cloud

Thanks to advances in cloud technology, the way that software applications are developed has drastically changed. With modern cloud application development, software development is **flexible**, **scalable**, and **uses the latest cloud computing technologies** to build and deploy applications.

## Traditional software development



### Monolithic applications

Required application components to be developed and deployed as a single, tightly coupled unit, typically using a single programming language.

Google Cloud

In the past, the traditional software development approach—often referred to as monolithic applications—required all the components of an application to be developed and deployed as a single, tightly coupled unit, typically using a single programming language.

# Benefits of modern cloud application development



- ✓ Microservices architecture
- ✓ Deployment with managed services
- ✓ Pay-as-you-go pricing
- ✓ Scalability
- ✓ Highly available and resilient
- ✓ Monitoring and management tools

Google Cloud

There are many benefits to the modern cloud application development approach.

- We'll begin with **architecture**. Modern cloud applications are typically built as a collection of microservices. Microservices are independently deployable, scalable, and maintainable components that can be used to build a wide range of applications. This can help organizations bring business value to market faster, because features can be released as they're completed without waiting for the rest of the application to be complete.
- Regarding **deployment**, modern applications are typically deployed to the cloud and can use managed or partially managed services. Managed services take care of the day-to-day management of cloud-based infrastructure, such as patching, upgrades, and monitoring. This can free up staff to focus on other tasks, such as developing new applications. Partially managed services offer a hybrid approach, where businesses manage some aspects of their cloud-based applications themselves and the cloud provider manages others.
- In terms of **cost**, modern cloud applications use a pay-as-you-go pricing model, which can make them extremely cost-effective when configured efficiently. That means that organizations don't always need to pay for resources they aren't fully utilizing. Developers can also use prebuilt APIs, which we'll explore later in this section of the course, and other tools offered by the cloud provider to build and deploy their applications quicker.
- And then there is **scalability**. Modern cloud-based applications can easily be scaled up or down to meet user demands.
- Modern cloud applications are designed to be **highly available and resilient**,

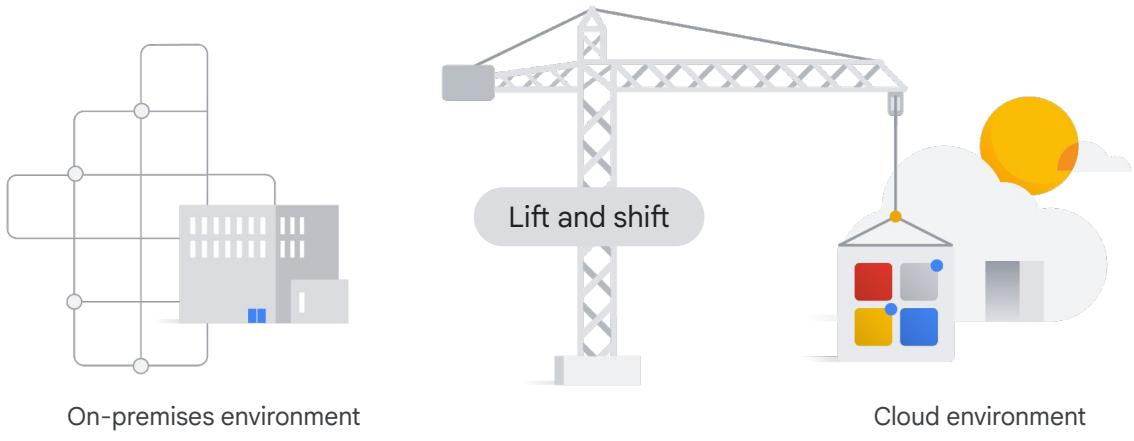
- with built-in features like *load balancing*, which is the process of distributing network traffic evenly across multiple servers that support an application, and *automatic failover*, which is a process that allows a cloud-based application to automatically switch to a backup server if a failure occurs.
- Additionally, cloud service providers typically offer robust **monitoring and management tools** that allow developers to quickly identify and respond to issues, which can further improve the reliability of cloud applications.



## Rehosting legacy applications in the cloud

Google Cloud

## Sometimes specialized legacy applications aren't compatible with cloud-native applications

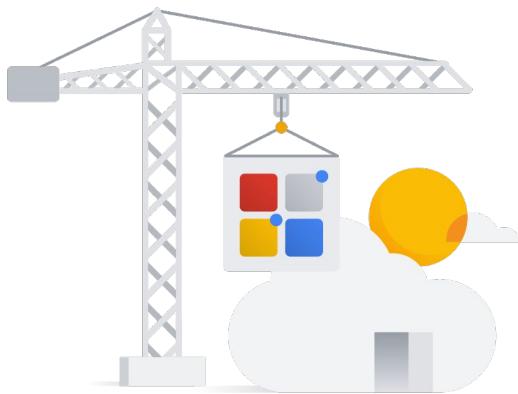


Google Cloud

When a business decides to modernize and move its operations to the cloud, it might be running several specialized legacy applications that aren't compatible with cloud-native applications.

In these situations, a business might take a **rehost migration path**, commonly referred to as *lift and shift*, where an application is moved from an on-premises environment to a cloud environment without making any changes to the application itself.

## The benefits of rehosting applications



✓ Cost savings

✓ Scalability

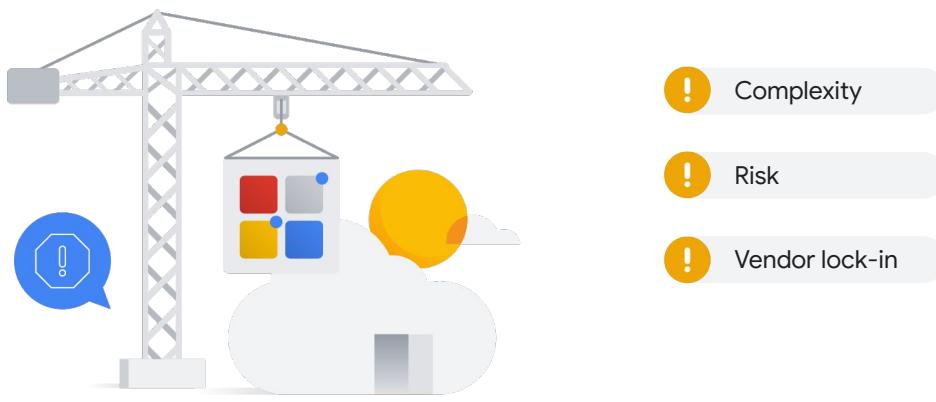
✓ Reliability

✓ Security

Google Cloud

Rehosting applications brings with it the many benefits of cloud computing that we explored earlier, such as cost savings, scalability, reliability, and security.

## Potential drawbacks to choosing a rehost migration path for legacy applications



! Complexity

! Risk

! Vendor lock-in

Google Cloud

However, there are also some potential drawbacks to choosing a rehost migration path for legacy applications, including:

- **Complexity:** rehosting can be a complex process. Businesses need to carefully plan the migration process and ensure that they have the right resources in place.
- **Risk:** migrating applications to the cloud always involves some risk. Businesses need to carefully assess and identify potential risks and ensure that they have a plan in place in case of any problems.
- **Vendor lock-in:** by moving applications to the cloud, businesses might become locked into a particular cloud provider. This can potentially make it difficult to switch providers later.

## Solutions for rehosting specialized legacy applications



Google Cloud  
VMware Engine



Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.



Bare Metal  
Solution



Is a fully managed cloud infrastructure solution that lets organizations run their Oracle workloads on dedicated, bare metal servers in the cloud.

Google Cloud

Google Cloud offers several solutions for rehosting specialized legacy applications.

The first is **Google Cloud VMware Engine**, which helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations. With Google Cloud VMware Engine, organizations can maintain their existing VMware environments and operational processes, while benefiting from the scalability, security, and reliability of Google Cloud. By doing this, organizations can also access a range of Google Cloud services such as BigQuery, AI/ML, and Google Kubernetes Engine, which lets them modernize their application environment and use new capabilities and technologies as needed.

And for organizations with legacy applications on Oracle, Google Cloud offers **Bare Metal Solution**. This is a fully managed cloud infrastructure solution that lets organizations run their Oracle workloads on dedicated, bare metal servers in the cloud.

:

- (VMware Engine) <https://cloud.google.com/vmware-engine>
- (Bare Metal Solution) <https://cloud.google.com/bare-metal>

# Quiz

## Question

What phrase refers to when a workload is rehosted without changing anything in the workload's code or architecture?

- A. Move and improve
- B. Refactor and reshape
- C. Reimagine and plan
- D. Lift and shift

Google Cloud

What phrase refers to when a workload is rehosted without changing anything in the workload's code or architecture?

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# Quiz

## Question

What phrase refers to when a workload is rehosted without changing anything in the workload's code or architecture.

- A. Move and improve
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- C. Reimagine and plan
- D. Lift and shift



Google Cloud

The correct answer is D.

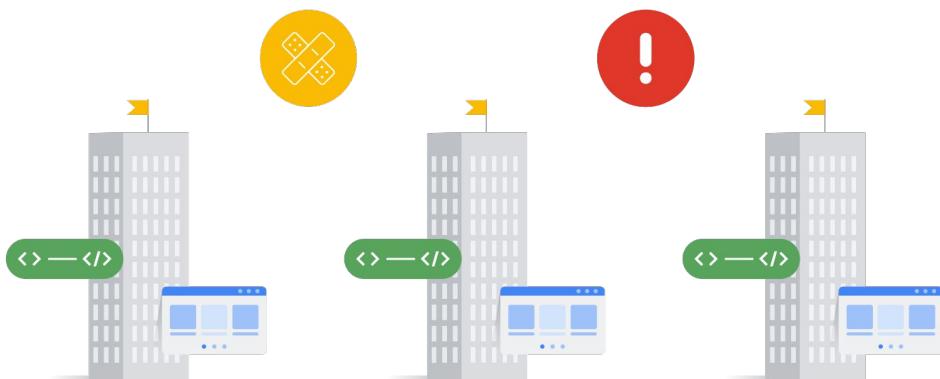
- A. Move and improve
  - Why this is the **incorrect** answer: This implies making modifications or upgrades during the migration process.
- B. Refactor and reshape
  - Why this is the **incorrect** answer: These terms indicate that the workload's code or architecture is being revised.
- C. Reimagine and plan
  - Why this is the **incorrect** answer: This focuses on a more strategic redesign of the workload, rather than simply relocating it.
- D. Lift and shift
  - Why this is the **correct** answer: This phrase describes the process of migrating a workload to a different environment (usually the cloud) without making any changes to its code or architecture.



## Application programming interfaces (APIs)

Google Cloud

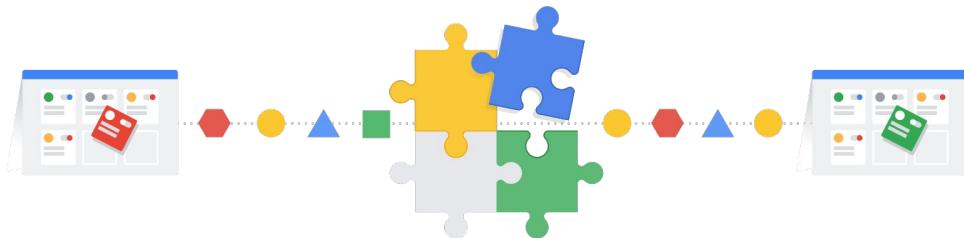
## Implementing a software service can be complex and changeable



Google Cloud

Implementing a software service can be complex and changeable. And if each software service that an organization uses has to be coded for each implementation, the result can be fragile and error-prone.

# Application programming interfaces (APIs)

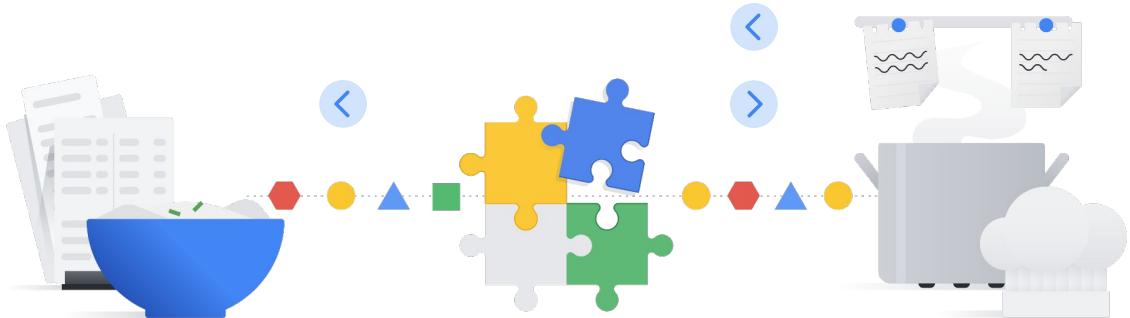


A set of instructions that lets different software programs communicate with each other

Google Cloud

One way to make things easier is to use APIs, **or application programming interfaces**. An API is a set of instructions that lets different software programs communicate with each other. Think of it as an intermediary between two different programs, which provides a standardized and predictable way for them to exchange data and interact.

## An API is like a waiter in a restaurant



An API takes requests from one software program (the customer).

Communicates with another program (the kitchen).

Returns a response (the food) back to the requesting program (the customer).

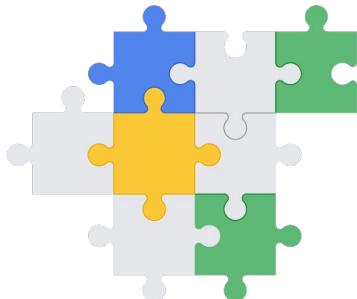
Google Cloud

An API is like a waiter in a restaurant. The waiter takes orders from customers, communicates with the kitchen and then brings the food back to the customers.

Similarly, an API takes requests from one software program (the customer), communicates with another program (the kitchen), and then returns a response (the food) back to the requesting program (the customer).

API's also protect your back-end data because you select what you want to expose, similar to how a restaurant selects the options they wish to serve on their menu. This means that a customer can't order something that's not on the menu, just like third parties can't call upon data that you haven't selected to expose via the API.

## APIs can be used in many different applications



Social media

Mobile apps

Web services

APIs let developers access functionality and data from other programs without having to write all the code. This saves **time** and **effort**.

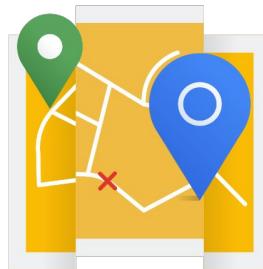
Google Cloud

APIs can be used in many different applications, from social media platforms to mobile apps and web services. They let developers access functionality and data from other programs without having to write all the code themselves, saving time and effort.

# Google APIs



APIs that use  
the power of  
Google to search



APIs that let  
developers access  
Google Maps data



APIs that let  
developers  
translate text

Google Cloud

Google itself provides many APIs that let developers access its products and services.

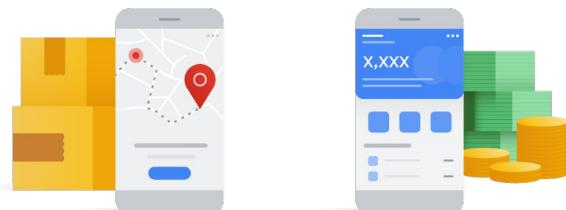
These include:

- APIs that use the power of Google to search across a website or collection of websites.
- APIs that let developers access **Google Maps** data, such as maps, directions, and traffic information.
- And APIs that let developers translate text from one language to another.

In fact, many Google Cloud products and services have documented APIs.

## APIs can create new business opportunities

Organizations can use APIs to improve online experiences for users.



Track shipments  
from within  
a third-party app

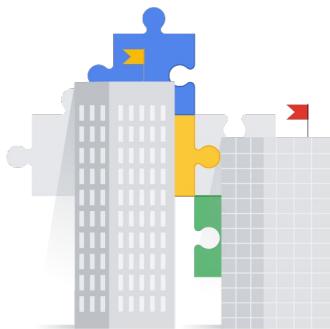
Check account  
balances from within a  
third-party app

Google Cloud

Using APIs can create new business opportunities for *organizations* and improve online experiences for *users*.

For example, an organization could expose an API that allows customers to track their shipments or check their account balances from within a third-party app.

## Companies can access an organization's data or services through an API



### APIs can:

- ✓ Be used to create new products and services
- ✓ Be used to generate new revenue streams
- ✓ Create partnerships

Google Cloud

There is also an opportunity for organizations to create new products that let *other* companies access their data or services through an API.

Let's explore why an organization might consider this business opportunity.

- **APIs can be used to create new products and services.** An organization could create an API that allows developers to access data from its database. This data could then be used to create new products and services.
- **APIs can be used to generate new revenue streams.** An organization could charge developers to access its APIs. This could generate new revenue streams for the organization and help to offset the costs of developing and maintaining the APIs.
- **APIs can create partnerships.** By exposing APIs, organizations can create partnerships with other companies or developers, which can lead to new business opportunities and collaborations.

By carefully considering the needs of their customers and partners, organizations can develop APIs that provide value and help to grow their businesses.

03

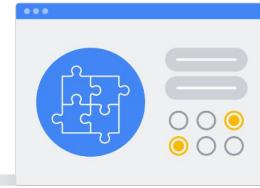
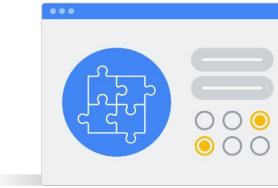
**Apigee API  
Management**

Google Cloud

# Apigee API Management



Apigee API  
Management



Google Cloud's API management service to operate APIs with enhanced scale, security, and automation

Google Cloud

When an organization has implemented APIs, it's important to maintain and manage them effectively. This can be done by using a platform such as **Apigee API Management**, Google Cloud's API management service to operate APIs with enhanced scale, security, and automation.

## Apigee API Management benefits



Apigee API Management



- It helps organizations secure their APIs.
- It tracks and analyzes API usage.
- It helps with developing and deploying APIs.
- It offers API versioning, API documentation, and even API throttling.

Google Cloud

Apigee is a popular choice for organizations that need to manage their APIs, because it offers many benefits.

- It helps organizations secure their APIs by providing features such as authentication, authorization, and data encryption.
- It tracks and analyzes API usage with real-time analytics and historical reporting.
- It helps with developing and deploying APIs through a visual API editor and a test sandbox.
- And it offers API versioning, API documentation, and even API throttling, which is the process of limiting the number of API requests a user can make in a certain period.

## Customer Story: AccuWeather



Let's take a look at a customer story that explains how **AccuWeather**, the leading source of weather forecasts and warnings, benefits from several features and aspects of the Apigee API platform, including: the **developer portal**, **API analytics**, **API monetization**, and **orchestration**.

**Video link:** <https://youtu.be/QEPJ00364ml>

**Video playtime:** 3:35

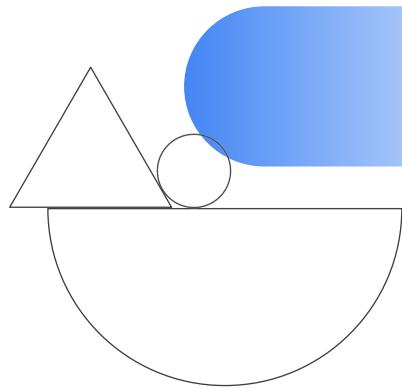
## Activity

⌚ 5 min

🌐 Class

🔒 Page 23

Identify the Google Cloud product that matches the listed criteria.



Google Cloud

Let's put what you've just learned into practice. On the slides that follow, you'll be shown a list of criteria. Identify the best Google Cloud storage product.

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

1

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

2

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

3

Google's API management platform that allows you to secure, manage, and publish APIs.

4

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

5

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

Let's start with the first column.

What is Google's serverless platform that allows you to run containers without having to manage any infrastructure?

Options include: Compute Engine, VMware Engine, App Engine, Cloud Run, GKE, Apigee API Management

## Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

2

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

3

Google's API management platform that allows you to secure, manage, and publish APIs.

4

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

5

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

The correct answer is **Cloud Run**. Now let's move on to the second column.

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

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Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

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Google's API management platform that allows you to secure, manage, and publish APIs.

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Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

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Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

What is Google's virtual machine service that allows you to create and manage virtual machines in the cloud?

Options include: Compute Engine, VMware Engine, App Engine, Cloud Run, GKE, Apigee API Management

## Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

3

Google's API management platform that allows you to secure, manage, and publish APIs.

4

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

5

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

The correct answer is **Compute Engine**. Now let's move on to the third column.

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

3

Google's API management platform that allows you to secure, manage, and publish APIs.

4

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

5

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

What product helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations?

Options include: Compute Engine, VMware Engine, App Engine, Cloud Run, GKE, Apigee API Management

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

**Google Cloud VMware Engine**

Google's API management platform that allows you to secure, manage, and publish APIs.

4

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

5

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

The correct answer is **Google Cloud VMware Engine**. Now let's move on to the fourth column.

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

Google Cloud VMware Engine

Google's API management platform that allows you to secure, manage, and publish APIs.

4

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

5

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

What is Google's API management platform that allows you to secure, manage, and publish APIs?

Options include: Compute Engine, VMware Engine, App Engine, Cloud Run, GKE, Apigee API Management

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

Google Cloud VMware Engine

Google's API management platform that allows you to secure, manage, and publish APIs.

**Apigee API Management**

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

5

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

The correct answer is **Apigee API Management**. Now let's move on to the fifth column.

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

Google Cloud VMware Engine

Google's API management platform that allows you to secure, manage, and publish APIs.

Apigee API Management

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

5

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

What is Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud?

Options include: Compute Engine, VMware Engine, App Engine, Cloud Run, GKE, Apigee API Management

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

Google Cloud VMware Engine

Google's API management platform that allows you to secure, manage, and publish APIs.

Apigee API Management

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

GKE

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

The correct answer is **Google Kubernetes Engine (GKE)**. Now let's finish up with sixth column.

# Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

Google Cloud VMware Engine

Google's API management platform that allows you to secure, manage, and publish APIs.

Apigee API Management

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

GKE

Google's fully managed platform for developing and hosting web applications.

6

Google Cloud

What is Google's fully managed platform for developing and hosting web applications?

Options include: Compute Engine, VMware Engine, App Engine, Cloud Run, GKE, Apigee API Management

## Activity

Identify the Google Cloud product that matches the listed criteria.

Google's serverless platform that allows you to run containers without having to manage any infrastructure.

Cloud Run

Google's virtual machine service that allows you to create and manage virtual machines in the cloud.

Compute Engine

Helps migrate existing VMware workloads to the cloud without having to rearchitect the applications or retool operations.

Google Cloud VMware Engine

Google's API management platform that allows you to secure, manage, and publish APIs.

Apigee API Management

Google's managed Kubernetes service that allows you to deploy and manage containerized applications in the cloud.

GKE

Google's fully managed platform for developing and hosting web applications.

App Engine

Google Cloud

The correct answer is **App Engine**.

# Quiz

## Question

What open source platform, originally developed by Google, manages containerized workloads and services?

- A. TensorFlow
- B. Go
- C. Kubernetes
- D. Angular

Google Cloud

What open source platform, originally developed by Google, manages containerized workloads and services?

- A. TensorFlow
- B. Go
- C. Kubernetes
- D. Angular

# Quiz

## Answer

What open source platform, originally developed by Google, manages containerized workloads and services?

- A. TensorFlow
- B. Go
- C. Kubernetes
- D. Angular



Google Cloud

The correct answer is C.

- A. TensorFlow
  - Why this is the **incorrect** answer: TensorFlow is an open-source machine learning library, not a container orchestration platform.
- B. Go
  - Why this is the **incorrect** answer: Go is a programming language; while it can be used to build containerized applications, it doesn't provide the management and orchestration features of Kubernetes.
- C. Kubernetes
  - Why this is the **correct** answer: Kubernetes is the open-source platform, originally developed by Google, designed specifically for managing containerized workloads and services. It provides features for deploying, scaling, networking, and automating the management of container-based applications.
- D. Angular
  - Why this is the **incorrect** answer: Angular is a front-end web development framework, unrelated to container management.

# Quiz

## Question

What name is given to an environment where an organization uses more than one public cloud provider as part of its architecture?

- A. Hybrid cloud
- B. Multicloud
- C. Edge cloud
- D. Duocloud

Google Cloud

What name is given to an environment where an organization uses more than one public cloud provider as part of its architecture?

- A. Hybrid cloud
- B. Multicloud
- C. Edge cloud
- D. Duocloud

# Quiz

## Answer

What name is given to an environment where an organization uses more than one public cloud provider as part of its architecture?

- A. Hybrid cloud
- B. Multicloud
- C. Edge cloud
- D. Duocloud



Google Cloud

The correct answer is B.

- A. Hybrid cloud
  - Why this is the **incorrect** answer: This describes a setup combining public cloud services with some form of private cloud or on-premises infrastructure.
- B. Multicloud
  - Why this is the **correct** answer: This term refers to the use of multiple public cloud providers (like AWS, Google Cloud, Azure) for different parts of an organization's IT infrastructure or application workload.
- C. Edge cloud
  - Why this is the **incorrect** answer: Edge cloud focuses on bringing computing resources closer to where data is generated or used, typically for low-latency applications.
- D. Duocloud
  - Why this is the **incorrect** answer: This isn't a standard term used in cloud computing.

# Quiz

## Question

What term describes a set of instructions that lets different software programs communicate with each other?

- A. Application programming interface
- B. Programming communication link
- C. Network programming interface
- D. Communication link interface

Google Cloud

What term describes a set of instructions that lets different software programs communicate with each other?

- A. Application programming interface
- B. Programming communication link
- C. Network programming interface
- D. Communication link interface

# Quiz

## Answer

What term describes a set of instructions that lets different software programs communicate with each other?

- A. Application programming interface
- B. Programming communication link
- C. Network programming interface
- D. Communication link interface



Google Cloud

The correct answer is A.

- A. Application programming interface
  - Why this is the **correct** answer: An API defines a set of rules and specifications that allow different software programs to interact with each other, regardless of their underlying implementation.
- B. Multicloud
  - Why this is the **incorrect** answer: This term is too broad and doesn't specifically refer to the standardized interface provided by an API.
- C. Network programming interface
  - Why this is the **incorrect** answer: While related, this term generally refers to low-level interfaces for network communication, not specifically the application-level interaction facilitated by APIs.
- D. Communication link interface
  - Why this is the **incorrect** answer: This term is not standard in the context of software development.