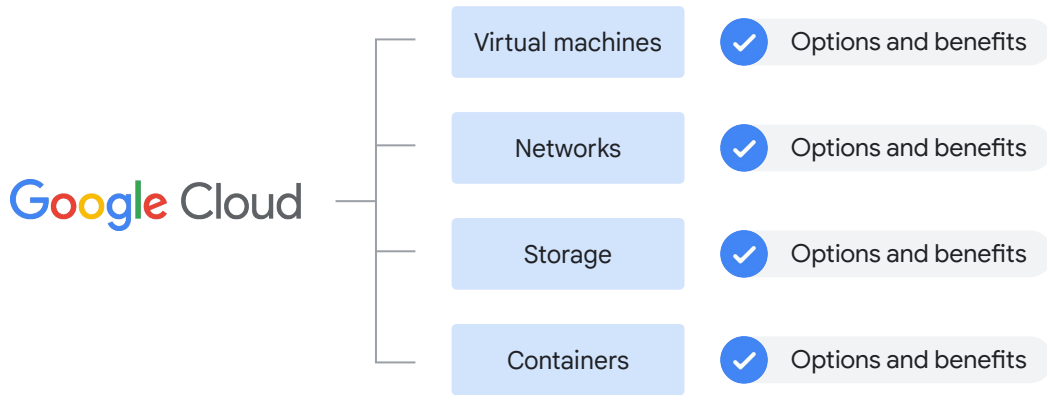




# Applications in the Cloud

# Recap



So far in this course, we've provided an introduction to Google Cloud and explored the options and benefits related to using virtual machines, networks, storage, and containers in the Cloud.

# Applications in the Cloud

- |    |                                   |
|----|-----------------------------------|
| 01 | App Engine                        |
| 02 | Google Cloud API management tools |
| 03 | Cloud Run                         |



In this section of the course, we'll turn our attention to developing applications in the cloud. We'll explore App Engine, three API management tools—Cloud Endpoints, API Gateway, and Apigee API Management—and Cloud Run.

# Applications in the Cloud

01 | [App Engine](#)

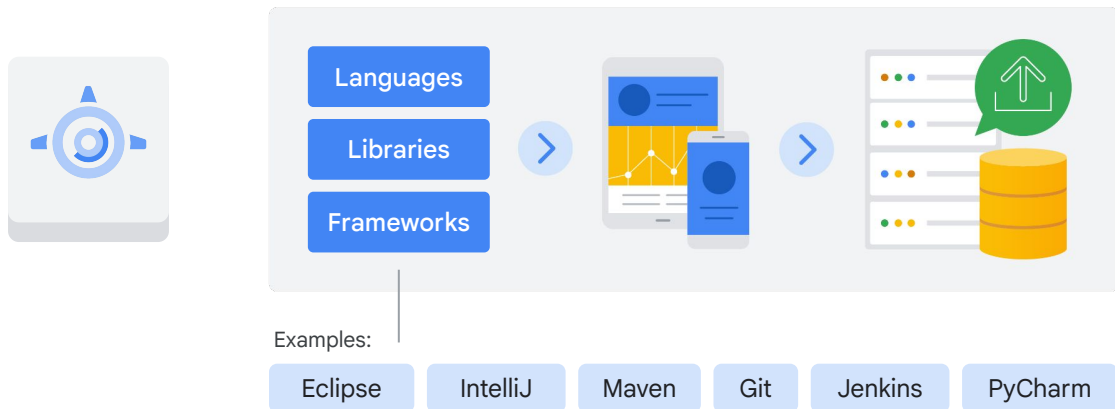
02 | Google Cloud API management tools

03 | Cloud Run



Let's begin with App Engine, which is a fully managed, serverless platform for developing and hosting web applications at scale.

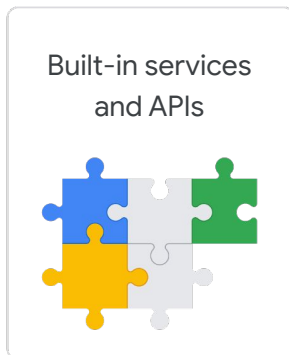
## App Engine interfaces with many development tools



So, how does it work?

With App Engine, you can choose from popular coding languages, libraries, and frameworks to develop apps with tools you're familiar with and then automatically provision servers and scale app instances based on demand. Options include Eclipse, IntelliJ, Maven, Git, Jenkins, and PyCharm. That means that you can upload your code, and Google will manage your app's availability.

## App Engine provides a full range of built-in services



NoSQL datastores

Health checks

Memcache

Application logging

Load balancing

User authentication API

With App Engine, there are no servers to provision or maintain. App Engine provides built-in services and APIs, like NoSQL datastores, Memcache, load balancing, health checks, application logging, and a user authentication API that is common to most applications.

## App Engine offers software development kits (SDKs)



Each SDK includes:

- ✓ APIs and libraries
- ✓ Sandbox environment
- ✓ Deployment tools

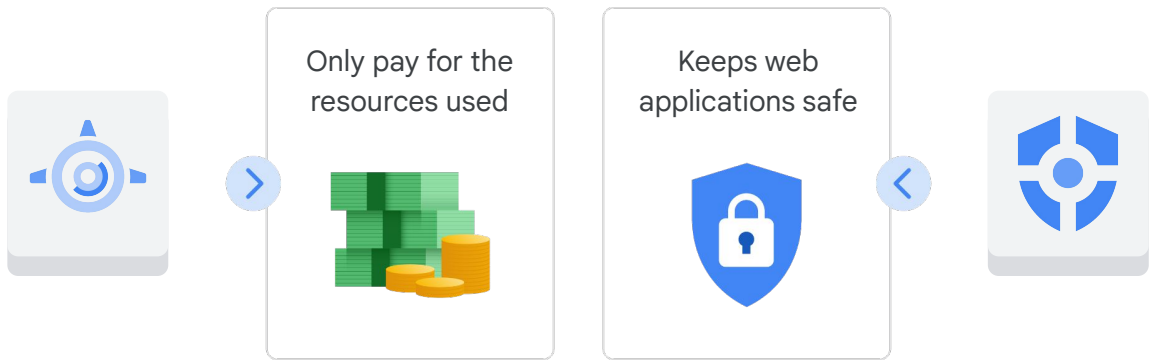
App Engine offers software development kits, or SDKs, to help develop, deploy, and manage your apps on your local machine.

Each SDK includes:

- All of the APIs and libraries available to App Engine,
- A simulated, secure sandbox environment that emulates all of the App Engine services on your local computer,
- And deployment tools to upload your application to the cloud and manage different versions.

The SDK manages your application locally, and the Google Cloud console manages your application in production. Use the console's web-based interface to create new applications, configure domain names, change which version of your application is live, examine access and error logs, and more.

## App Engine pricing and security

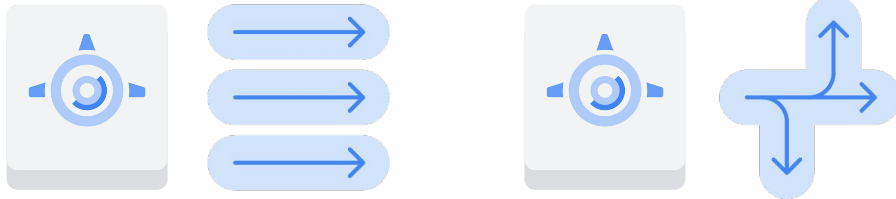


From a pricing perspective, you only pay for the resources you use with App Engine.

And [Security Command Center](#)—which is the security and risk management platform for Google Cloud—keeps web applications safe. Through the Google Cloud console, you can use the Security Command Center to automatically scan and detect common web application vulnerabilities.



## Two types of App Engine environments

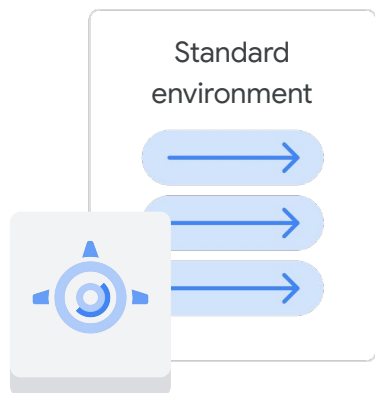


Standard

Flexible

There are two types of App Engine environments: **standard** and **flexible**.

## App Engine standard runs preconfigured containers



Persistent storage with queries, sorting, and transactions

Automatic scaling and load balancing

Asynchronous task queues for performing work outside the scope of a request

Scheduled tasks for triggering events at specified times or regular intervals

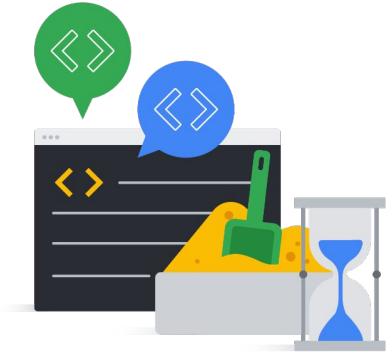
Integration with other Google Cloud services and APIs

The first is the App Engine **standard environment**, which is based on container instances running on Google's infrastructure. Containers are preconfigured with a runtime from a standardized list of supported languages and versions, which includes libraries that support App Engine standard APIs. For many applications, the standard environment runtimes and libraries may be all you need.

Standard environment features include:

- Persistent storage with queries, sorting, and transactions.
- Automatic scaling and load balancing.
- Asynchronous task queues for performing work outside the scope of a request.
- Scheduled tasks for triggering events at specified times or regular intervals.
- And integration with other Google Cloud services and APIs.

## Standard environment has two requirements



01 Use specified versions of Java, Python, PHP, Go, Node.js, and Ruby

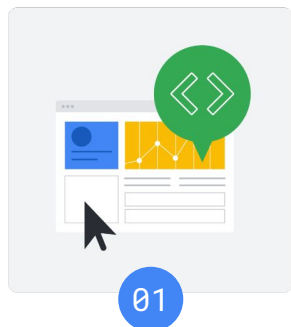
02 Application must conform to sandbox constraints that are dependent on runtime

There are a couple of requirements for using the standard environment:

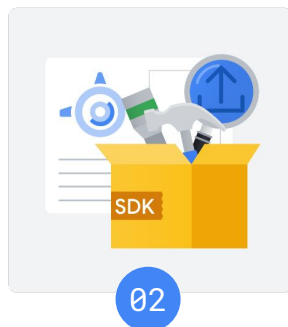
1. You must use specified versions of Java, Python, PHP, Go, Node.js, and Ruby.
2. Your application must conform to sandbox constraints that are dependent on runtime.

Applications run in a secure, sandboxed environment. This allows the App Engine standard environment to distribute requests across multiple servers, and scale servers to meet traffic demands. This means that your application runs within its own secure, reliable environment that is independent of the hardware, operating system, or physical location of the server.

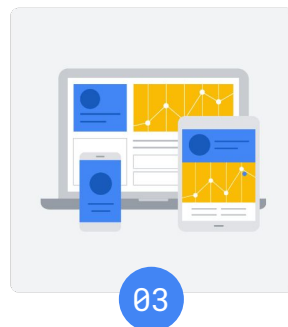
## Standard environment workflow



**Develop** web app  
and test locally



**Deploy** to App  
Engine with SDK

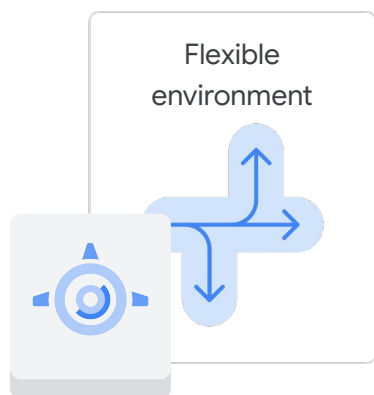


App Engine **scales**  
and services the app

A standard environment workflow typically follows these three steps:

1. **First**, a web application is developed and tested locally.
2. **Second**, the SDK is used to deploy the application to App Engine.
3. And **third**, App Engine scales and services the application.

## App Engine flexible environment uses custom containers



Instances are health-checked, healed, and co-located

Critical, backward-compatible updates are automatically applied to the underlying operating system

VM instances are automatically located by geographical region according to the settings in your project

VM instances are restarted on a weekly basis

App Engine also offers a **flexible environment**. If the standard environment's sandbox model is too restrictive for you, the flexible environment can let you specify the type of container your web application will run in.

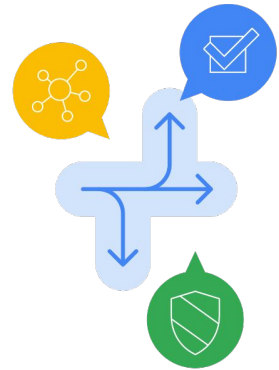
This option lets an application run inside Docker containers on Google Cloud's Compute Engine virtual machines. In this case, App Engine manages Compute Engine machines for you.

This means that:

- Instances are health-checked, healed as necessary, and co-located with other module instances within the project.
- Critical, backward-compatible updates are automatically applied to the underlying operating system.
- VM instances are automatically located by geographical region according to the settings in your project. Google's management services ensure that all of a project's VM instances are co-located for optimal performance.
- And VM instances are restarted on a weekly basis. During restarts, Google's management services will apply any necessary operating system and security updates.

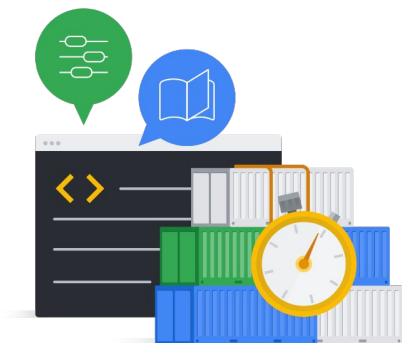
## Flexible environment use cases

- ✓ Microservices
- ✓ Authorization
- ✓ SQL & NoSQL databases
- ✓ Traffic splitting
- ✓ Logging
- ✓ Search
- ✓ Versioning
- ✓ Security scanning
- ✓ Memcache
- ✓ Content delivery networks



The flexible environment supports microservices, authorization, SQL and NoSQL databases, traffic splitting, logging, search, versioning, security scanning, Memcache, and content delivery networks.

## Flexible environment advantages



01 Take advantage of custom configurations and libraries, while focusing on writing code



02 Customize the runtime and the operating system of your virtual machine. Standard runtimes include Python, Java, Go, Node.js, PHP, .NET, and Ruby

03 Customize or provide runtimes by supplying a custom Docker image or Dockerfile

App Engine Flexible allows users to also benefit from custom configurations and libraries while still keeping their main focus on what they do best – writing code.

In addition, the App Engine flexible environment allows you to customize the runtime and the operating system of your virtual machine by using Dockerfiles. As in App Engine Standard, supported runtimes include Python, Java, Go, Node.js, PHP, and Ruby . However, in App Engine Flexible, developers can also use different versions of these runtimes or provide their own custom runtime by supplying a custom Docker image or using a Dockerfile from the open source community.

## Comparing the App Engine environments

	Standard environment 	Flexible environment 
Instance startup	Seconds	Minutes
SSH access	No	Yes (although not by default)
Write to local disk	No (some runtimes have read and write access to the /tmp directory)	Yes, ephemeral (disk initialized on each VM startup)
Support for 3rd-party binaries	For certain languages	Yes
Network access	Via App Engine services	Yes
Pricing model	After free tier usage, pay per instance class, with automatic shutdown	Pay for resource allocation per hour; no automatic shutdown

So, how do these two environments compare to each other?

Let's start with the standard environment, which is fast. It starts up instances of your application in seconds, but you have less access to the infrastructure in which your application runs. With the standard environment, you can't use ssh to connect to the virtual machines on which your application runs, and you can't write to a local disk. The standard environment does support third-party binaries for certain languages, and you can use App Engine to make calls to the network. Finally, in terms of pricing, after a free tier usage, you pay per instance class with automatic shutdown.

The flexible environment takes minutes to start up, instead of seconds. But it lets you use ssh to connect to the virtual machines on which your application runs, it lets you use local disk for scratch space, it lets you install third-party software, and it lets your application make calls to the network without going through App Engine. In terms of pricing, with the flexible environment, you pay for resource allocation per hour with no automatic shutdown.

Because App Engine uses Docker containers, you may be wondering how App Engine compares to Google Kubernetes Engine. App Engine's standard environment is for people who want the service to take maximum control of their web and mobile application's deployment and scaling. Google Kubernetes Engine, however, gives the application *owner* the full flexibility of Kubernetes. App Engine's flexible environment is somewhere between the two.



# Applications in the Cloud

01 App Engine

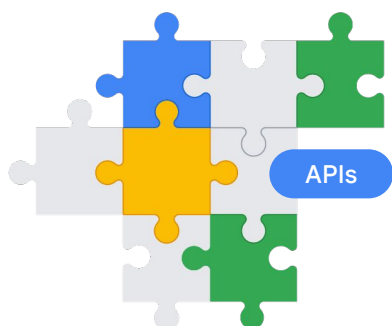
02 [Google Cloud API management tools](#)

03 Cloud Run



Now that you've had a thorough overview of App Engine, let's transition to Cloud Endpoints and Apigee API Management. These are Google Cloud's application programming interfaces, or API management tools.

## APIs hide unnecessary details and simplify coding

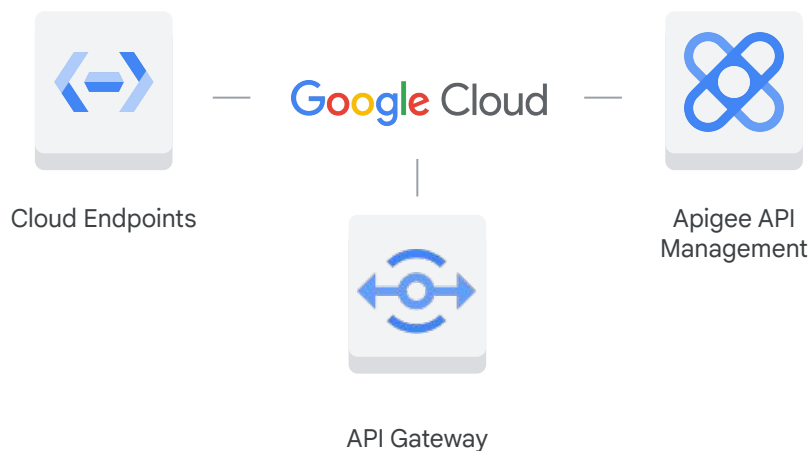


- ✓ A clean, well-defined interface
- ✓ Underlying implementation can change
- ✓ Changes to the API are made with versions

What is an API, exactly? A software service's implementation can be complex and changeable. If other software services had to be explicitly coded in detail in order to use that service, the result would be brittle and error-prone. So instead, application developers structure the software they write so that it presents a clean, well-defined interface that hides unnecessary detail, and then they document that interface. That's an application programming interface. The underlying implementation can change, as long as the interface doesn't, and other pieces of software that use the API don't have to know or care.

Sometimes you do have to change an API, perhaps to add or deprecate a feature. To cleanly make this kind of change to the API, developers create versions. For example, version 2 of an API might contain calls that version 1 does not. This means that programs that consume the API can specify the API version they want to use in their calls.

## Google offers powerful API management tools



Supporting an API is a very important task, and Google Cloud provides three API management tools: **Cloud Endpoints**, **API Gateway**, and **Apigee API Management**.

# Cloud Endpoints



Distributed API management system

Provides an API console, hosting, logging, monitoring, and other features

Use with any APIs that support the OpenAPI Specification

Supports applications running in App Engine, Google Kubernetes Engine, and Compute Engine

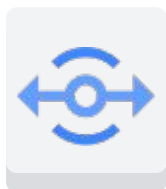
Clients include Android, iOS, and Javascript

Cloud Endpoints is a distributed API management system that uses a distributed Extensible Service Proxy, which is a service proxy that runs in its own Docker container. The goal is to help you create and maintain even the most demanding APIs with low latency and high performance.

Cloud Endpoints provides an API console, hosting, logging, monitoring, and other features to help you create, share, maintain, and secure your APIs. You can use Cloud Endpoints with any APIs that support the OpenAPI Specification.

Cloud Endpoints supports applications running in App Engine, Google Kubernetes Engine, and Compute Engine. Clients include Android, iOS, and Javascript.

# API Gateway



Backend implementations can vary for a single service provider

Provide secure access to your backend services through a well-defined REST API

Clients consume your REST APIS to implement standalone apps

Web-based services today provide a huge variety of functionality, meaning everything from map, weather, and image services, to games, auctions, and many other service types. Service providers have many options for how to implement, deploy, and manage their services. For example, one service might be developed in Java or .NET, while another uses Node.js.

Backend implementations can also vary for a single service provider. A service provider might have legacy services implemented using one architecture, and new services implemented using a completely different architecture.

API Gateway enables you to provide secure access to your backend services through a well-defined REST API that is consistent across all of your services, regardless of the service implementation.

Clients consume your REST APIS to implement standalone apps for a mobile device or tablet, through apps running in a browser, or through any other type of app that can make a request to an HTTP endpoint.

# Apigee Edge



Specific focus on business problems, like rate limiting, quotas, and analytics

Many Apigee API Management users provide a software service to other companies

Backend services for Apigee API Management don't need to be in Google Cloud

Another Google Cloud platform available for developing and managing API proxies is **Apigee API Management**. Unlike Cloud Endpoints, Apigee Edge has a specific focus on business problems, like rate limiting, quotas, and analytics. In fact, many Apigee API Management users provide a software service to *other* companies.

Backend services for Apigee API Management don't have to be in Google Cloud, and as a result, engineers also often use it to take apart legacy applications. So, instead of replacing a large, important application in one move, they can use Apigee API Management to peel off its services individually instead. This allows them to stand up microservices to implement each in turn, until the legacy application can finally be retired.

# Applications in the Cloud

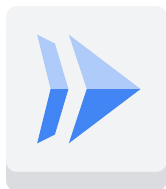
01 App Engine

02 Google Cloud API management tools

03 **Cloud Run**



## Cloud Run is managed serverless computing



A managed compute platform that can run stateless containers

Serverless, removing the need for infrastructure management

Built on Knative, an open API and runtime environment built on Kubernetes

Can automatically scale up and down from zero almost instantaneously, charging only for the resources used

The final application platform we'll explore in this section of the course is Cloud Run, a managed compute platform that lets you run stateless containers via web requests or Pub/Sub events.

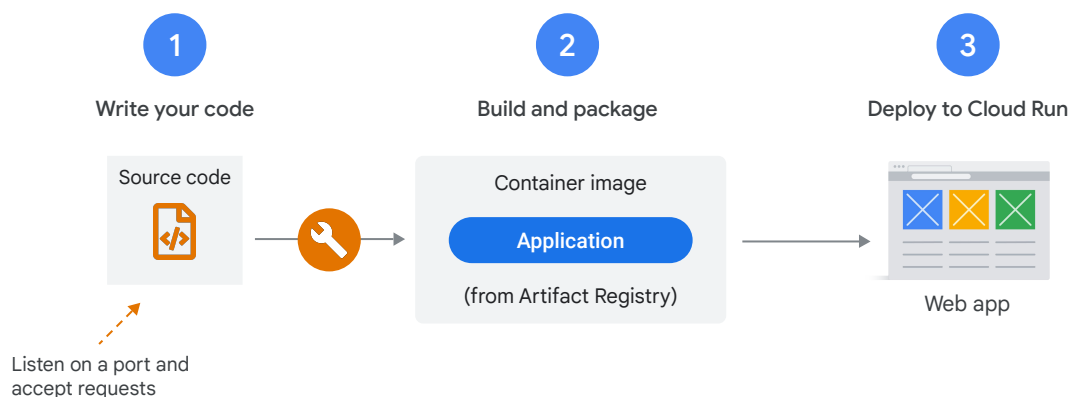
Cloud Run is serverless. That means it removes all infrastructure management tasks so you can focus on developing applications.

It is built on Knative, an open API and runtime environment built on Kubernetes that gives you freedom to move your workloads across different environments and platforms. It can be fully managed on Google Cloud, on Google Kubernetes Engine, or anywhere Knative runs.

Cloud Run is fast. It can automatically scale up and down from zero almost instantaneously, and it charges you only for the resources you use, calculated down to the nearest 100 milliseconds, so you'll never pay for your over-provisioned resources.



# Google Cloud Run workflow is a three-step process



The Cloud Run developer workflow is a straightforward three-step process.

- First, you write your application using your favorite programming language. This application should start a server that listens for web requests.
- Second, you build and package your application into a container image.
- Third, the container image is pushed to Artifact Registry, where Cloud Run will deploy it.

Note that Cloud Run can only deploy images that are stored in the Artifact Registry.

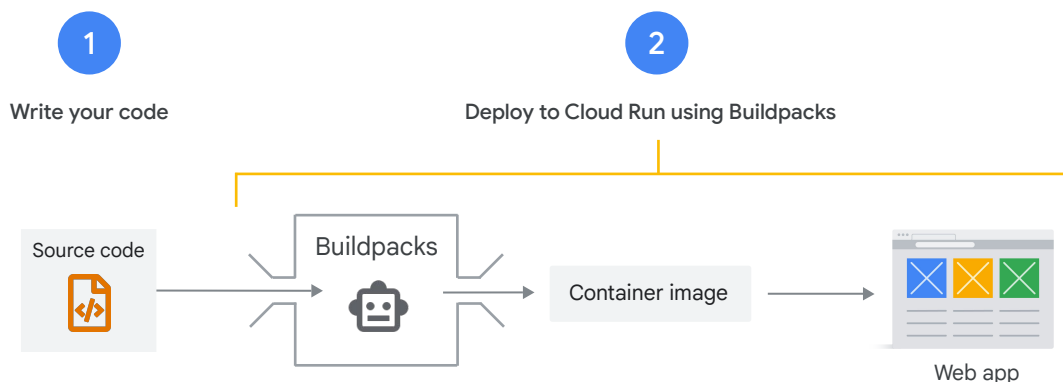
You can build, push and deploy your own code from your local source if you have the required permissions. (You can also deploy an image that already exists in Artifact Registry.)

Once you've deployed your container image, you'll get a unique HTTPS URL back.

Cloud Run then starts your container on demand to handle requests, and ensures that *all incoming requests* are handled by dynamically adding and removing containers.

Cloud Run is serverless. That means that you, as a developer, can focus on building your application, and not on building and maintaining the infrastructure that powers your application.

## Cloud Run also has a source-based workflow



For some use cases, a container-based workflow is great, because it gives you a great amount of transparency and flexibility.

If **you** build the container image, **you** have the power to decide **exactly** what file ends up in **your** container image, and **how** it gets there.

However, building an application is hard enough already, let alone having to think about **containerization** and the responsibilities that come with that.

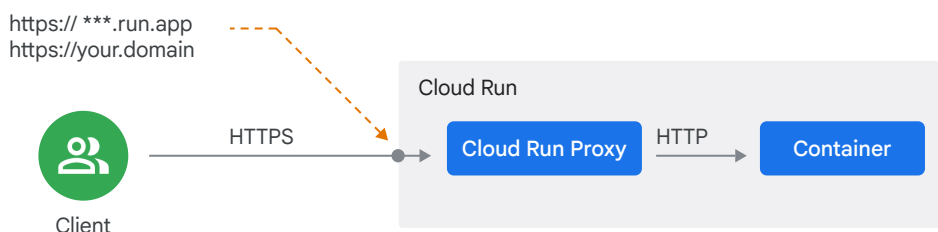
Sometimes, you're just looking for a way to turn source code into an HTTPS endpoint, and you want your vendor to make sure it your container image is secure, well-configured and built in a consistent way.

With Cloud Run, you can do both. You can use a container-based workflow, as well as a source-based workflow.

If you use the source-based approach, you'll deploy your source code, instead of a container image. Cloud Run then builds your source and packages the application into a container image for you.

Cloud Run does this using Buildpacks - an open source project.

## Cloud Run handles HTTPS serving for you



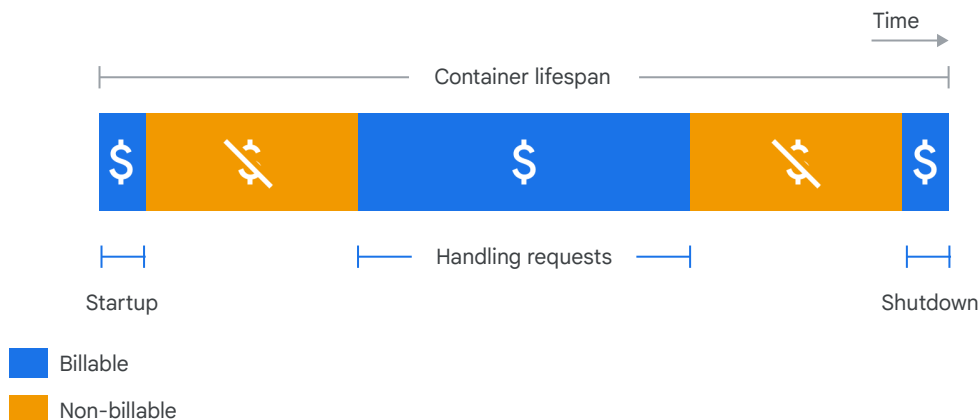
Cloud Run handles HTTPS serving for you. That means you only have to worry about handling web requests, and you can let Cloud Run take care of adding the encryption.

- By default, your application is exposed on a unique subdomain of the global \*.run.app domain
- You can also use your own, custom domain.

Cloud Run manages everything else:

- Generating a valid SSL certificate
- Configuring SSL termination correctly with secure settings
- Handling incoming requests, decrypting them and forwarding them to your application

## You are only charged when your container handles requests



The pricing model on Cloud Run is unique; as you only pay for the system resources you use while a container is handling web requests, with a granularity of 100ms, and when it is starting or shutting down.

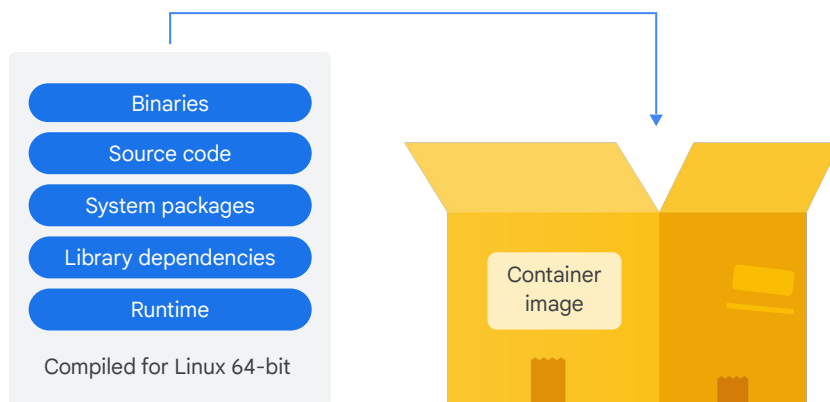
You do not pay for anything if your container does not handle requests.

Additionally, there is a small fee for every one million requests you serve.

The price of container time increases with CPU and memory. A container with more vCPU and memory is more expensive. Today, Cloud run can allocate up to 4 vCPUs and 8GB of memory.

Most of the other compute products (such as Compute Engine), charge for servers as long as they are running, even if you are not using them. That means you're often paying for idle server capacity.

## Cloud Run can run any binary



You can use Cloud Run to run any binary, as long as it is compiled for Linux sixty-four bit.

Now, this means you can use Cloud Run to run web applications written using popular languages, such as:

- Java
- Python
- Node.js
- PHP
- Go
- C++

And you can also run code written in less popular languages:

- Cobol
- Haskell
- Perl

As long as your app handles web requests, you're good to go.

# Module Quiz



## Quiz | Question 1

### Question

What other services are offered to the applications that App Engine runs?

- A. Just load balancing and user authentication
- B. NoSQL databases, in-memory caching, load balancing, health checks, logging, and user authentication
- C. Just NoSQL databases and user authentication
- D. NoSQL databases, in-memory caching, load balancing, health checks, and logging

## Quiz | Question 1

### Answer

What other services are offered to the applications that App Engine runs?

- A. Just load balancing and user authentication
- B. NoSQL databases, in-memory caching, load balancing, health checks, logging, and user authentication
- C. Just NoSQL databases and user authentication
- D. NoSQL databases, in-memory caching, load balancing, health checks, and logging



In addition to App Engine running applications; What services are offered to the applications it runs?

A: Just load balancing and user authentication.

Feedback: Sorry, that's not correct. App Engine offers NoSQL databases, in-memory caching, load balancing, health checks, logging, and user authentication to applications running in it.

**B: NoSQL databases, in-memory caching, load balancing, health checks, logging, and user authentication**

Feedback: That's correct! App Engine offers NoSQL databases, in-memory caching, load balancing, health checks, logging, and user authentication to applications running in it.

C: Just NoSQL databases and user authentication

Feedback: Sorry, that's not correct. App Engine offers NoSQL databases, in-memory caching, load balancing, health checks, logging, and user authentication to applications running in it.

D: NoSQL databases, in-memory caching, load balancing, health checks, and logging.

Feedback: Sorry, that's not correct. App Engine offers NoSQL databases, in-memory caching, load balancing, health checks, logging, and user authentication to applications running in it.



## Quiz | Question 2

### Question

You want to do business analytics and billing on a customer-facing API. Which Google Cloud service should you choose?

- A. Apigee API Management
- B. Cloud Endpoints
- C. Compute Engine API
- D. Cloud Run API

## Quiz | Question 2

### Answer

You want to do business analytics and billing on a customer-facing API. Which Google Cloud service should you choose?

- A. Apigee API Management
- B. Cloud Endpoints
- C. Compute Engine API
- D. Cloud Run API



You want to do business analytics and billing on a customer-facing API. Which Google Cloud service should you choose?

**A: Apigee API Management**

Feedback: Correct!

B: Cloud Endpoints

Feedback: Review the "Google Cloud API management tools" lecture.

C: Compute Engine API

Feedback: Review the "Google Cloud API management tools" lecture.

D: Cloud Run API

Feedback: Review the "Google Cloud API management tools" lecture.

## Quiz | Question 3

### Question

Cloud Run can only pull images from:

- A. Docker Hub
- B. Self-hosted registries
- C. Artifact Registry
- D. GitHub

## Quiz | Question 3

### Answer

Cloud Run can only pull images from:

- A. Docker Hub
- B. Self-hosted registries
- C. Artifact Registry
- D. GitHub



Cloud Run can only pull images from:

A: Docker Hub

Feedback: Review the "Cloud Run" lecture.

B: Self-hosted registries

Feedback: Review the "Cloud Run" lecture.

**C: Artifact Registry**

Feedback: Correct!

D: GitHub

Feedback: Review the "Cloud Run" lecture.

# Lab Intro

## Hello Cloud Run

The goal of this lab is for you to build a simple containerized application image and deploy it to Cloud Run.

