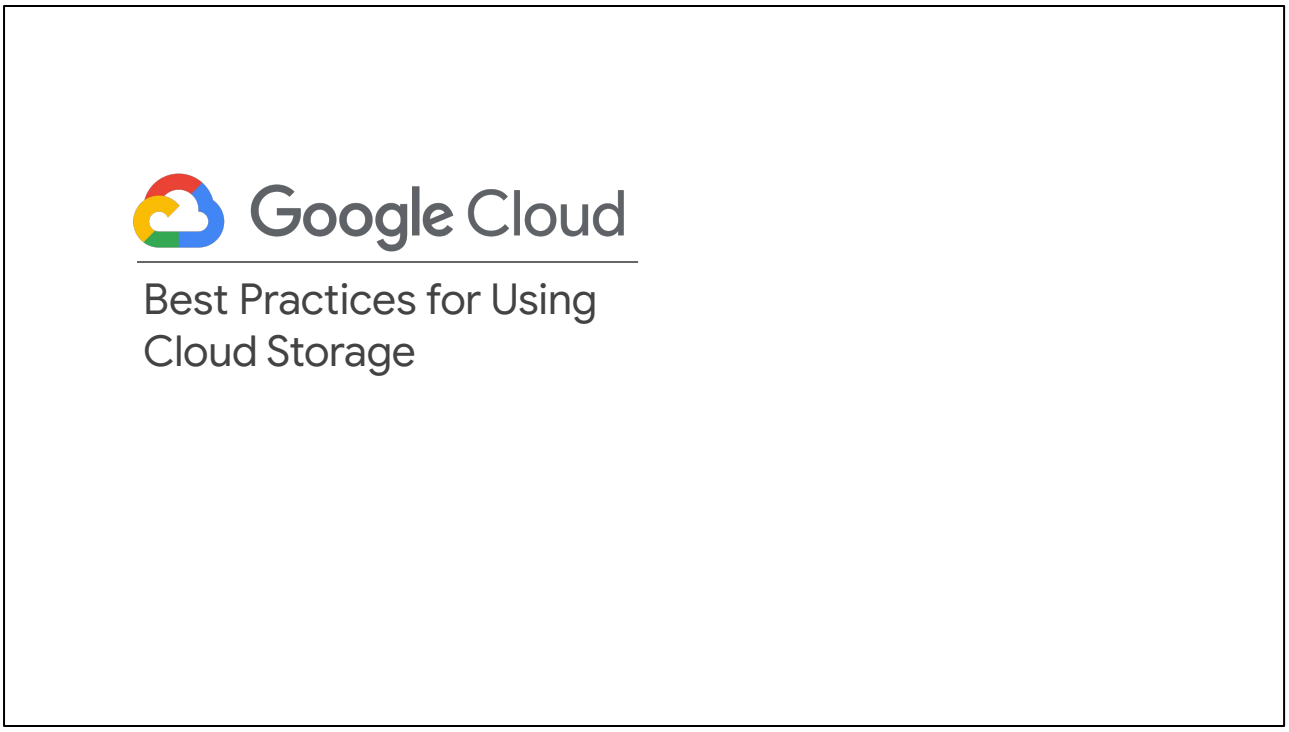


Course name: Developing Applications with Google Cloud
Module name: Best Practices for Using Cloud Storage

Featured products: Cloud Storage

Qwiklabs: Storing image and video files in Cloud Storage

10 minutes

For more information, see: https://cloud.google.com/storage/docs/best-practices

Follow these best practices for naming

Do	Don't
Use globally unique bucket names: `us-east1-appdev-bucket01` ✓	Use personally identifiable information (PII): `johndoebucket` ✗

Use GUIDs or the equivalent if your application needs a lot of buckets:
`037763b8-2b55-4887-bbb9-600e2c6c6014`
`f41b0c0c-9cfc-405d-970e-d4ee46e41279`
`7f62c421-ce22-4c3f-ad9c-17f342500f62` ✓
	Use user IDs, emails, project names/IDs, etc:
	`johndoe`
	`project-gcp-sales` ✗

Conform to standard DNS naming conventions: `mycompany-unique-bucket01` `yourllc-011-eu-central1` ✓	Use IP address notation: `192.168.5.4` ✗
	Use the goog prefix or include any spelling or close misspelling of google: `goog_bucket01284` `bucket-for-google-course01` ✗

Google Cloud

Google Cloud Storage bucket names are global and publicly visible and must be unique across the entire Google Cloud Storage. If your applications require many buckets, use GUIDs or the equivalent for bucket names. Your application should have retry logic in place to handle name collisions. Consider keeping a list to cross-reference your buckets.

Avoid using any information in bucket names that can be used to probe for the existence of other resources. Use caution if putting personally identifiable information in object or bucket names, because they appear in URLs. Bucket names should conform to standard DNS naming conventions, because the bucket name can appear in a DNS record as part of a CNAME redirect.

If you use part of your company domain name in a bucket name (forward or reverse), Google will try to verify that you own the domain. Avoid using your company domain name in a bucket unless your DNS admin can verify ownership.

For more information, see:
https://cloud.google.com/storage/docs/bucket-naming#requirements

Follow these best practices for Cloud Storage traffic

- Consider:
  - Operations per second
  - Bandwidth
  - Cache control
- Design your application to minimize spikes in traffic.
- Use exponential backoff if you get an error.
- For request rates > **1000 write requests/second** or **5000 read requests/second**:
  - Start with a request rate below or near the threshold.
  - Double the request rate no faster than every 20 minutes.

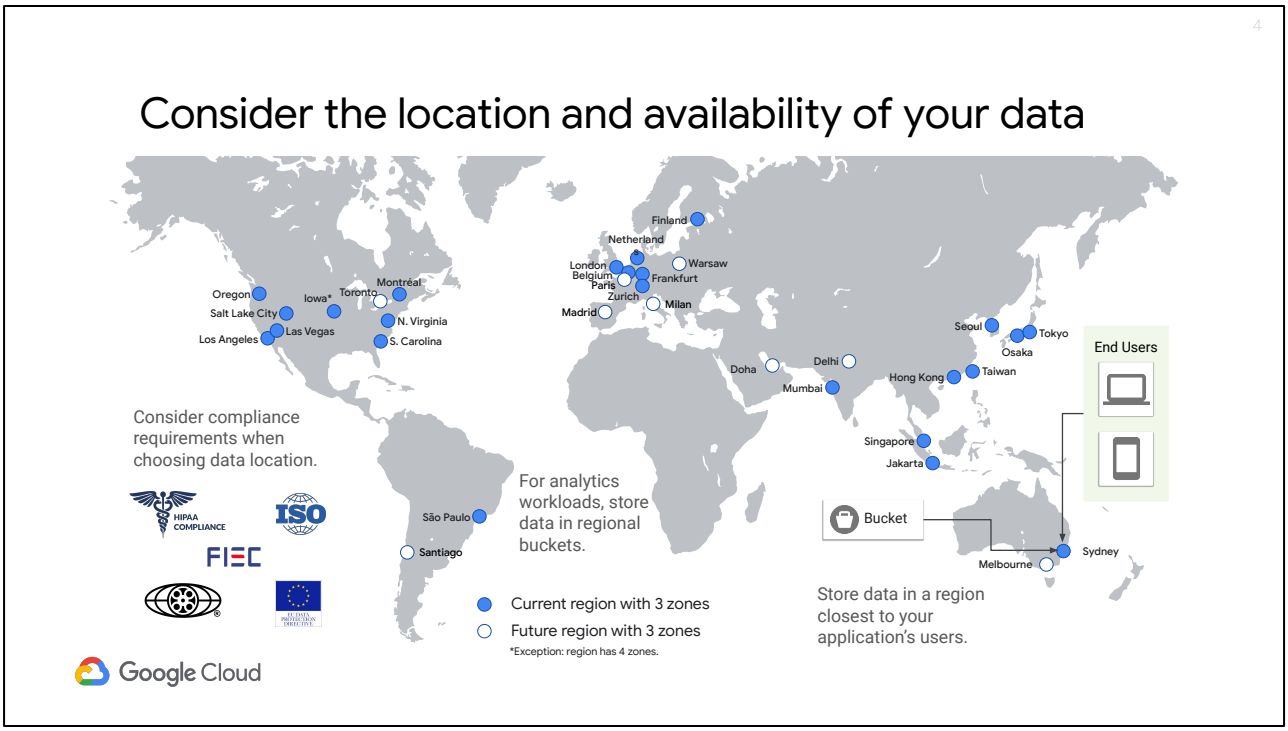
Google Cloud

Consider operations per second, bandwidth (how much data will be sent over what time frame), and cache control when designing your application with Cloud Storage. If you specify the Cache-Control metadata on objects, read latency will be lowered on hot or frequently accessed objects. Use exponential backoff if you get an error.

For more information on setting object metadata, see: https://cloud.google.com/storage/docs/viewing-editing-metadata#edit

Design your application so that it minimizes spikes in traffic; spread updates out throughout the day. Google Storage has no upper bound on request rate, but for best performance when scaling to high request rates, follow the request rate and access distribution guidelines: If your request rate is less than 1000 write requests per second or 5000 read requests per second, then no ramp-up is needed. If your request rate is expected to go over these thresholds, you should start with a request rate below or near the thresholds and then double the request rate no faster than every 20 minutes.

For more information, see: https://cloud.google.com/storage/docs/request-rate



Consider the location and required availability of your data when choosing your storage options.

Store data in a region closest to your application's users, and consider region-specific compliance requirements when choosing data location. For analytics workloads, store your data in regional buckets to reduce network charges and for better performance (compared to multi-region or dual-region).

For more information, see: https://cloud.google.com/security/compliance

Consider the characteristics of your data

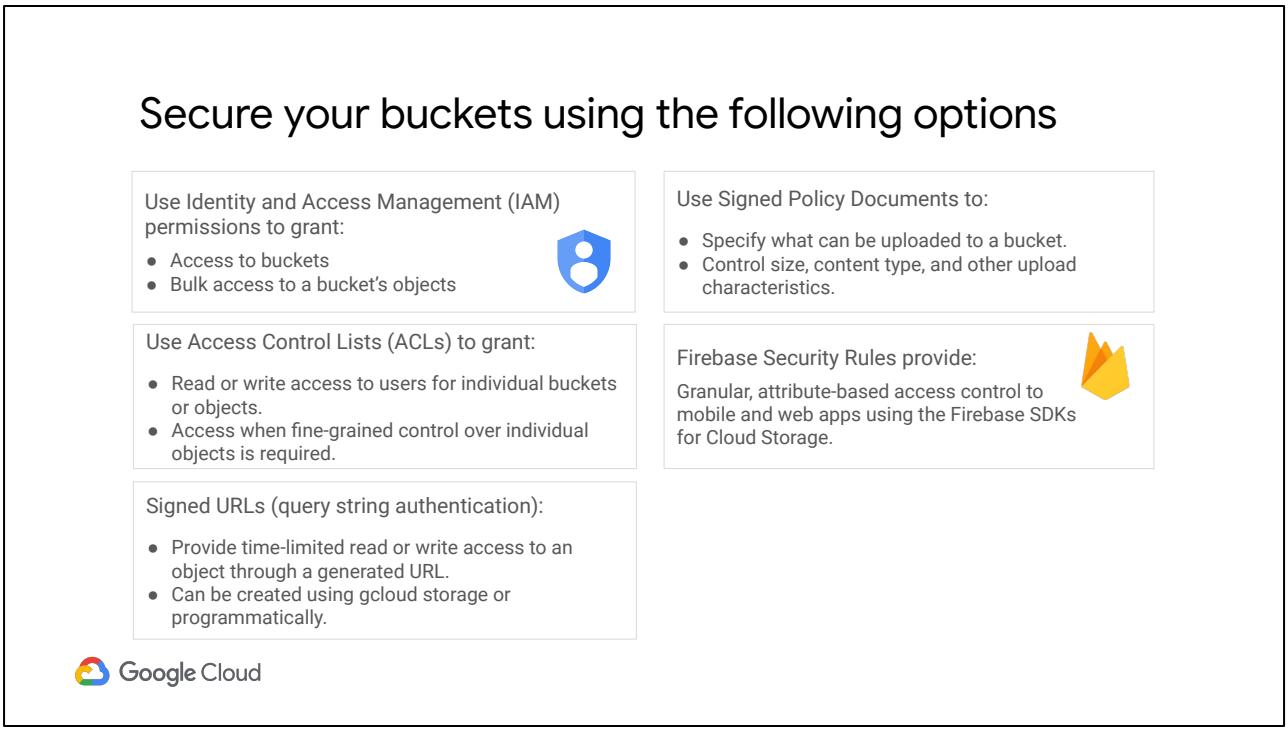
- Standard Storage:
  - Use for data served at high rate with high availability
  - No minimum storage duration and lowest operation charges
- Nearline Storage and Coldline Storage:
  - Use for infrequently accessed data that tolerates slightly lower availability
  - 30 and 90 day minimum storage durations respectively, with proportionate operation and storage charges
- Archive Storage:
  - Use for data accessed less than once a year with no availability SLA
  - 365 days minimum storage duration and lowest per-month storage charges

Google Cloud

Standard Storage provides the best availability, with the trade-off of a higher per-month storage price versus the lowest operation charges with no minimum duration. Standard Storage is a good option for data that is served at a high rate with high availability.

Nearline Storage and Coldline Storage are good options for infrequently accessed data and for data that tolerates slightly lower availability. With minimum storage durations of 30 days and 90 days respectively, operation charges are less than Archive Storage and storage charges are less than Standard Storage.

Archive Storage is suited for data that is accessed less than one a year, such as data stored for legal or regulatory reasons, or data required for data recovery. Archive Storage has no availability SLA, though the typical availability is comparable to Nearline Storage and Coldline Storage. Archive Storage has the lowest per-month storage charges with a 365 days minimum storage duration.



You can control access to your Cloud Storage buckets and objects using these options.

You can use Identity and access Management (IAM) permissions to grant access to buckets and to provide bulk access to a bucket's objects. IAM permissions do not give you fine-grained control over individual objects. For more information, see: https://cloud.google.com/storage/docs/access-control/using-iam-permissions

You can use Access Control Lists (ACLs) to grant read or write access to users for individual buckets or objects. It is recommended that you only use ACLs when you need fine-grained control over individual objects. For more information, see: https://cloud.google.com/storage/docs/access-control/create-manage-lists

Use signed URLs (query string authentication) to provide time-limited read or write access to an object through a URL you generate. The shared URL provides access to anyone it's shared with for the duration specified. You can create signed URLs using gsutil or programmatically with your application. For more information, see:

- Create a signed URL using gcloud storage: https://cloud.google.com/storage/docs/access-control/signing-urls-with-helpers#gcloud
- Create a signed URL programmatically: https://cloud.google.com/storage/docs/access-control/create-signed-urls-program

Signed policy documents allow you to specify what can be uploaded to a bucket. They allow greater control over size, content type, and other upload characteristics than using signed URLs. They are for website owners to allow visitors to upload files to Cloud Storage. Signed policy documents only work with form posts. For more information on signed policy documents, see: https://cloud.google.com/storage/docs/xml-api/post-object#policydocument

Firebase security rules provide granular, attribute-based access control to mobile and web applications using the Firebase SDKs for Cloud Storage. For more information, see: https://firebase.google.com/docs/storage/security

Consider these additional security best practices

- Use TLS (HTTPS) to transport data.
- Use an HTTPS library that validates server certificates.
- Revoke authentication credentials for applications that no longer need access to data.
- Securely store credentials.
- Use groups instead of large numbers of users.
- Bucket and object ACLs are independent of each other.
- Avoid making buckets publicly readable or publicly writable.

Google Cloud

Always use TLS to transport your data when you can. This ensures that both your credentials and your data are protected as you transport them over the network.

Make sure that you use an HTTPS library that validates server certificates. A lack of server certificate validation makes your application vulnerable to man-in-the-middle attacks or other attacks. Be aware that HTTPS libraries shipped with certain commonly used implementation languages do not, by default, verify server certificates.

When applications no longer need access to your data, you should remove permissions or revoke their authentication credentials.

Make sure that you securely store your credentials.

Prefer the use of groups, instead of explicitly listing large numbers of users. Not only do groups scale better, but they also provide a very efficient way to update the access control for a large number of objects at once.

Before adding objects to a bucket, check that the default object ACLs are set to your requirements. This may save you lots of time updating ACLs for individual objects.

Bucket and object ACLs are independent of each other, which means that the ACLs on a bucket do not affect the ACLs on objects inside that bucket. It is possible for a user without permissions for a bucket to have permissions for an object inside the

bucket.

Cloud Storage provides the ability to specify that objects in the bucket are publicly readable. After a bucket has been made publicly readable, data can be copied out of the bucket by anyone. It's effectively impossible to regain read control over an object written with this permission, so provide this access only when necessary. Cloud Storage buckets can also be made publicly writable. Although configuring a bucket this way can be convenient for various purposes, we recommend against using this permission: it can be abused for distributing illegal content, viruses, and other malware, and the bucket owner may be legally and financially responsible for the content stored in their buckets.

Consider retention policies and retention policy locks

- Add a retention policy to a bucket to specify a retention period.
  - If no policy exists, you can delete or replace objects.
  - If a policy exists, objects can only be deleted or replaced once their age is greater than the policy.
  - Applies retroactively to existing and new objects added to the bucket.
- Lock a retention policy to permanently set it on the bucket.
  - Once set, you cannot remove or reduce the retention period.
  - A bucket cannot be deleted unless every object in the bucket has met the retention period.
  - The retention period of a locked object can be increased.
  - Locking a retention policy can help with data compliance regulations.

The Bucket Lock feature allows you to configure a data retention policy for a Cloud Storage bucket that governs how long objects in the bucket must be retained. The feature also allows you to lock the data retention policy, permanently preventing the policy from being reduced or removed. There are some things you should consider when using retention policies and retention policy locks.

You can add a retention policy to a bucket to specify a retention period. If a bucket does not have a retention policy, you can delete or replace objects in the bucket at any time. If a bucket has a retention policy, objects in the bucket can only be deleted or replaced once their age is greater than the retention period. A retention policy retroactively applies to existing objects in the bucket as well as new objects added to the bucket.

You can lock a retention policy to permanently set it on the bucket. Once you lock a retention policy, you cannot remove it or reduce the retention period it has. You cannot delete a bucket with a locked retention policy unless every object in the bucket has met the retention period. You can increase the retention period of a locked retention policy. Locking a retention policy can help your data comply with record retention regulations. For more information see:
https://cloud.google.com/security/compliance/sec

Uniformly control access to Cloud Storage resources

- Uniform bucket-level access allows you to uniformly control access to Cloud Storage resources.
- The feature disables ACLs. Only IAM permissions grant access to the bucket and it's objects.
- Uniform bucket-level access is recommended, because it unifies and simplifies how you grant access to your Cloud Storage resources.

Cloud Storage offers two systems for granting you permission to access your buckets and objects, Identity and Access Management (IAM) and Access Control Lists (ACLs). These systems act in parallel in order for you to access a Cloud Storage resource, and only one of the systems needs to grant you permission. IAM is used throughout Google Cloud and allows you to grant a variety of permissions at the bucket and project levels. ACLs are used only by Cloud Storage and have limited permission options, but they allow you to grant permissions on a per-object basis.

In order to support a uniform permissioning system, Cloud Storage has uniform bucket-level access. Using this feature disables ACLs for all Cloud Storage resources. Access to Cloud Storage resources then is granted exclusively through IAM. After you enable uniform bucket-level access, you have 90 days to reverse your decision.

Generally, using uniform bucket-level access is recommended, because it unifies and simplifies how you grant access to your Cloud Storage resources. Using uniform bucket-level access also enables you to use other Google Cloud security features such as Domain Restricted Sharing and IAM Conditions. However, you might not want to use uniform bucket-level access and instead retain fine-grained ACLs. For example, if you want to control access to specific objects in a bucket via legacy ACLs or you want the uploader of an object to have full control over that object, but less access to other objects in your bucket.

Consider these best practices for uploading data

- If using XMLHttpRequests:
  - Don’t close and re-open the connection.
  - Set reasonably long timeouts for upload traffic.
- Make the request to create the resumable upload URL from the same region as the bucket and upload location.
- Avoid breaking transfers into smaller chunks.
- Avoid uploading content that has both:
  - `content-encoding gzip`
  - `content-type` that is `compressed`

Google Cloud

If you use XMLHttpRequest (XHR) callbacks to get progress updates and detect that progress has stalled, do not close and re-open the connection. Doing so creates a bad positive feedback loop during times of network congestion. When the network is congested, XHR callbacks can get backlogged behind the acknowledgement (ACK/NACK) activity from the upload stream, and closing and reopening the connection when this happens uses more network capacity at exactly the time when you can least afford it.

For upload traffic, set reasonably long timeouts. For a good end-user experience, you can set a client-side timer that updates the client status window with a message (e.g., "network congestion") when your application hasn't received an XHR callback for a long time. Don't just close the connection and try again when this happens.

If you use Google Compute Engine instances with processes that POST to Cloud Storage to initiate a resumable upload, you should use Compute Engine instances in the same locations as your Cloud Storage buckets. You can then use a geo IP service to pick the Compute Engine region to which you route customer requests, which will help keep traffic localized to a geo-region. For resumable uploads, the resumable session should stay in the region in which it was created. Doing so reduces cross-region traffic that arises when reading and writing the session state, which improves resumable upload performance.

Avoid breaking a transfer into smaller chunks if possible, and instead upload the entire content in a single chunk. Avoiding chunking removes fixed latency costs,

improves throughput, and reduces QPS against Cloud Storage.

If possible, avoid uploading content that has both content-encoding: gzip and a content-type that is compressed, because this may lead to unexpected behavior. You can also use decompressive transcoding (automatically decompressing a file for the requestor) by storing the file in gzip format in Cloud Storage and setting the associated metadata to Content-Encoding: gzip. For more information, see: https://cloud.google.com/storage/docs/transcoding#decompressive_transcoding

Consider the following if using gsutil for Cloud Storage

- `gsutil -D` will include 0Auth2 refresh and access tokens in the output.
- `gsutil --trace-token` will include 0Auth2 tokens and the contents of any files accessed during the trace.
- Customer-supplied encryption key information in .boto config is security-sensitive.
- In a production environment, use a service account for gsutil.

Google Cloud

`gsutil` is a Python application that lets you access Cloud Storage from the command line. You can use `gsutil` to do a wide range of bucket and object management tasks. Where applicable, you should use `gcloud storage` commands instead of `gsutil` commands.

If you run `gsutil -D` (to generate debugging output) it will include OAuth2 refresh and access tokens in the output. Make sure to redact this information before sending this debug output to anyone during troubleshooting/tech support interactions.

If you run `gsutil --trace-token` (to send a trace directly to Google), sensitive information like OAuth2 tokens and the contents of any files accessed during the trace may be included in the content of the trace.

Customer-supplied encryption key information in the .boto configuration is security sensitive. The proxy configuration information in the .boto configuration is security-sensitive, especially if your proxy setup requires user and password information. Even if your proxy setup doesn't require user and password information, the host and port number for your proxy is often considered security-sensitive. Protect access to your .boto configuration file.

If you are using `gsutil` from a production environment, use service account credentials instead of individual user account credentials. These credentials were designed for such use and protect you from losing access when an employee leaves your company.

For more information, see:
https://cloud.google.com/storage/docs/gsutil/addlhelp/SecurityandPrivacyConsiderations#recommended-user-precautions

Validate your data

Data can be corrupted during upload or download by:

- Noisy network links
- Memory errors on:
  - Client computer
  - Server computer
  - Routers along the path
- Software bugs

Validate data transferred to/from bucket using:

- CRC32c Hash
  - Is available for all cloud storage objects
  - Can be computed using these libraries:
    - Boost for C++
    - crcmod for Python
    - digest-crc for Ruby
  - `gcloud storage` automatically performs integrity checks on all uploads and downloads
- MD5 Hash
  - Is supported for non-composite objects
  - Cannot be used for partial downloads

Google Cloud

Data can be corrupted while it is uploaded to or downloaded from the cloud by noisy network links, memory errors on client or server computers or routers along the path, and software bugs. Validate the data you transfer to/from buckets using either CRC32c or MD5 checksums.

Cloud Storage supports server-side validation for uploads, but client-side validation is also a common approach. If your application has already computed the object's MD5 or CRC32c before starting the upload, you can supply it with the upload request, and Cloud Storage will create the object only if the hash you provided matches the value Google calculated. Alternatively, users can perform client-side validation by issuing a request for the new object's metadata, comparing the reported hash value, and deleting the object in case of a mismatch.

All Cloud Storage objects have a CRC32c hash. Libraries for computing CRC32c include Boost for C++, crcmod for Python, and digest-crc for Ruby. Java users can find an implementation of the algorithm in the GoogleCloudPlatform crc32 Java project. `gcloud storage` automatically performs integrity checks on all uploads and downloads. Additionally, you can use the "`gcloud storage hash`" command to calculate a CRC for any local file.

MD5 hashes are supported for non-composite objects. The MD5 hash only applies to a complete object so it cannot be used to integrity check partial downloads cause by performing a range GET.

For more information about hashes and e-tags:
https://cloud.google.com/storage/docs/hashes-etags
https://cloud.google.com/sdk/gcloud/reference/storage/hash

You can host static websites

You can allow scripts hosted on other websites to access static resources stored in a Cloud Storage bucket.

You can also allow scripts hosted in Cloud Storage to access static resources hosted on a website external to Cloud Storage.

The Cross-Origin Resource Sharing (CORS) topic describes how to allow scripts hosted on other websites to access static resources stored in a Cloud Storage bucket.

You can also allow scripts hosted in Cloud Storage to access static resources hosted on a website external to Cloud Storage. The website is serving CORS headers so that content on storage.googleapis.com is allowed access. It is recommended that you dedicate a specific bucket for this data access.

For more information, see: https://cloud.google.com/storage/docs/cross-origin

Quiz

Which of the following buckets follows naming best practices?

A. 192.168.0.1

B. 037763b8-2b55-us-east1

C. Google_bucket_112

D. janedoebucket

Google Cloud

Which of the following buckets follows naming best practices?

a. 192.168.0.1
b. 037763b8-2b55-us-east-1
c. google_bucket_112
d. janedoebucket

Quiz

Which of the following buckets follows naming best practices?

A. 192.168.0.1

B. 037763b8-2b55-us-east1

C. Google_bucket_112

D. janedoebucket

Google Cloud

The bucket 037763b8-2b55-us-east-1 follows naming best practices. (B)

Quiz

Your application requires fine-grained control for users to download individual objects in a bucket. What option should you use to secure your storage objects?

A. Cloud IAM permissions

B. Signed Policy Documents

C. Access Control Lists (ACLs)

D. None of these options

Google Cloud

Your application requires fine-grained control for users to download individual objects in a bucket. What option should you use to secure your storage objects?

a. Cloud IAM permissions
b. Signed Policy Documents
c. Access Control Lists (ACLs)
d. None of these options

Quiz

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A. Cloud IAM permissions

B. Signed Policy Documents

C. Access Control Lists (ACLs)

D. None of these options

Google Cloud

If your application requires fine-grained control for users to download individual objects in a bucket, you should use Access Control Lists to secure your storage objects. (C)

Storing Image and Video Files in Cloud Storage

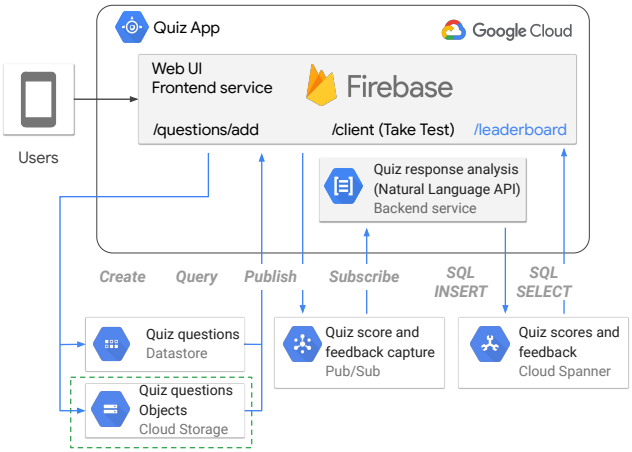
Duration: 45 minutes

Lab objectives

Create a Cloud Storage bucket

Review file upload UI and code changes

Write code to store upload file data in Cloud Storage



Google Cloud


Google Cloud