
Cloud Tasks
Best practices and lessons learned

Giacomo Debidda

Freelance full stack developer / web performance consultant

I like TypeScript / Clojure / Zig

I also like:

- 📚 - add me on goodreads 🔗
- 🛹 - surfskating 🔗 actually
- 🛼 - it's time for a rollerblading emoji

jackdbd

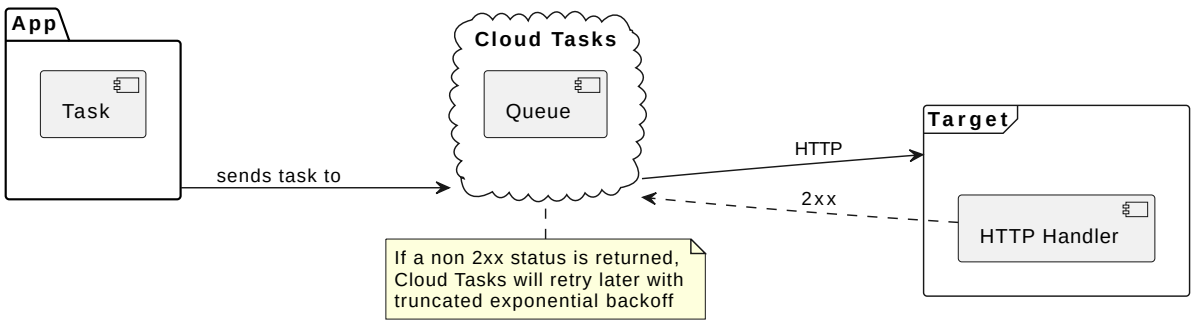
jackdbd

giacomodebidda.com

What is Cloud Tasks?

GCP's **fully managed** service to manage queues of **background tasks**.

Background task implies that the user or requester **does not wait** for the task to finish.



Use cases:

- Delegating potentially slow operations to a dedicated service
- Preserving requests in the context of a service outage
- Managing third-party API call rates (i.e. avoid HTTP 429 Too Many Requests) and handling retries
- Smoothing traffic spikes out by removing non-user-facing tasks from the main user flow

Queues in theory

1. Infinitely long.
2. Open at both ends (enqueue, dequeue).
3. FIFO (First In, First Out).
4. Exactly-once semantics.

Queues in Cloud Tasks

1. Limited rate of processing (set by us).
2. We can only add tasks to a queue (enqueue), not remove them (dequeue). We can delete tasks by their ID though! Cloud Tasks automatically deletes old tasks (see `taskTtl` in v2beta3).
3. No task execution order is guaranteed. We can schedule tasks for later, configure retries, force specific tasks to run!
4. No exactly-once semantics is guaranteed.

Cloud Tasks offers **at least once delivery**, but not **exactly-once semantics**.

> Cloud Tasks aims for a strict "execute exactly once" semantic. However, in situations where a design trade-off must be made between guaranteed execution and duplicate execution, the service errs on the side of guaranteed execution. As such, a non-zero number of duplicate executions do occur.

Queues

Configuration for a Cloud Task queue:

- GCP region
- Rate limits
- Retries
- Logging
- `taskTtl`: maximum amount of time that a task is retained in this queue (from v2beta3)
- `tombstoneTtl`: amount of time the task tombstone is retained after a task is deleted or executed. The tombstone is used in task de-duplication (from v2beta3)

Creating a queue

Using gcloud:

```
gcloud tasks queues create my-queue \
  --location europe-west3 \
  --max-dispatches-per-second 500 \
  --max-attempts 100
```

Or using an IaC tool like pulumi:

```
import * as gcp from '@pulumi/gcp'

const enable_cloudtasks = new gcp.projects.Service(
  'enable-cloudtasks-api',
  { service: 'cloudtasks.googleapis.com' }
)

const queue = new gcp.cloudtasks.Queue('my-queue',
  {
    location: 'europe-west3',
    name: 'my-queue',
    rateLimits: { maxDispatchesPerSecond: 500 },
    retryConfig: { maxAttempts: 100 },
    stackdriverLoggingConfig: { samplingRatio: 0.5 }
  },
  { dependsOn: [enable_cloudtasks] }
)
```

Tasks

Object (e.g. Plain Old Javascript Object) that represents a **piece of work** to be performed by **some service**.

Explicit invocation: who creates the task retains full **control of execution**.

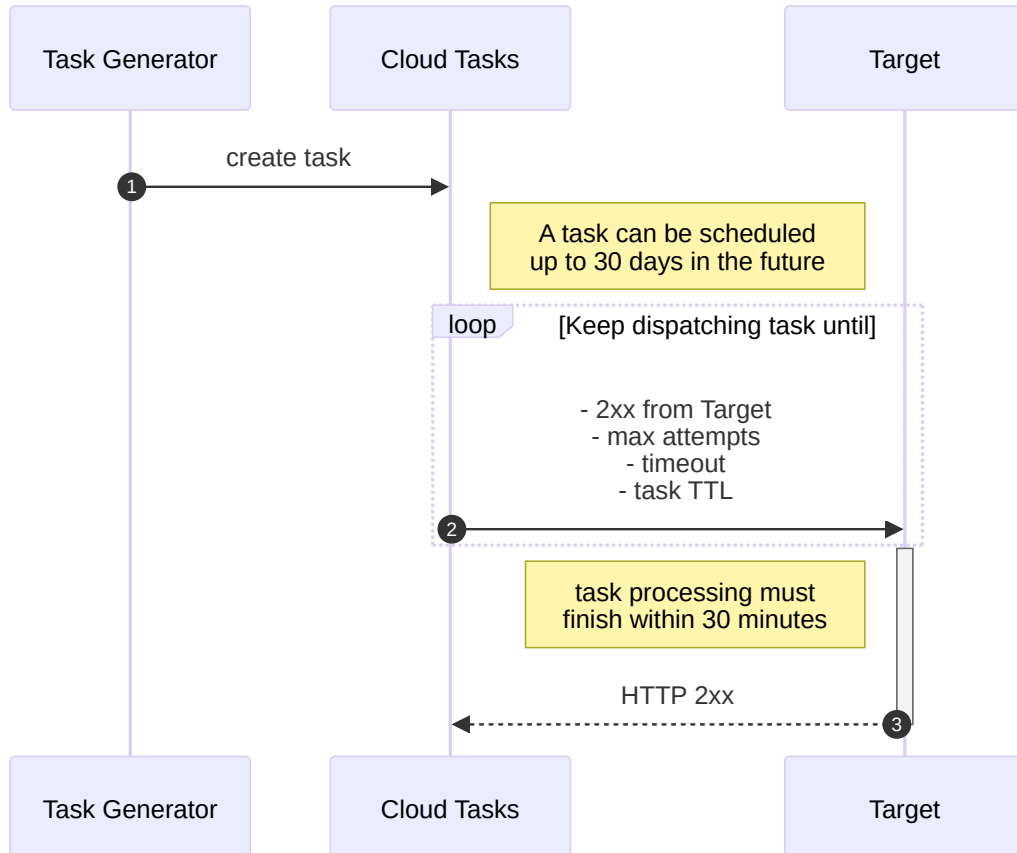
Task configuration for an HTTP task:

- URL of the endpoint (required)
- Unique name
- HTTP method
- HTTP request headers
- Request body
- Authentication (API Key, OIDC token, OAuth token)
- Schedule time
- Dispatch deadline (e.g. wait max 30 minutes for the worker to process the task)

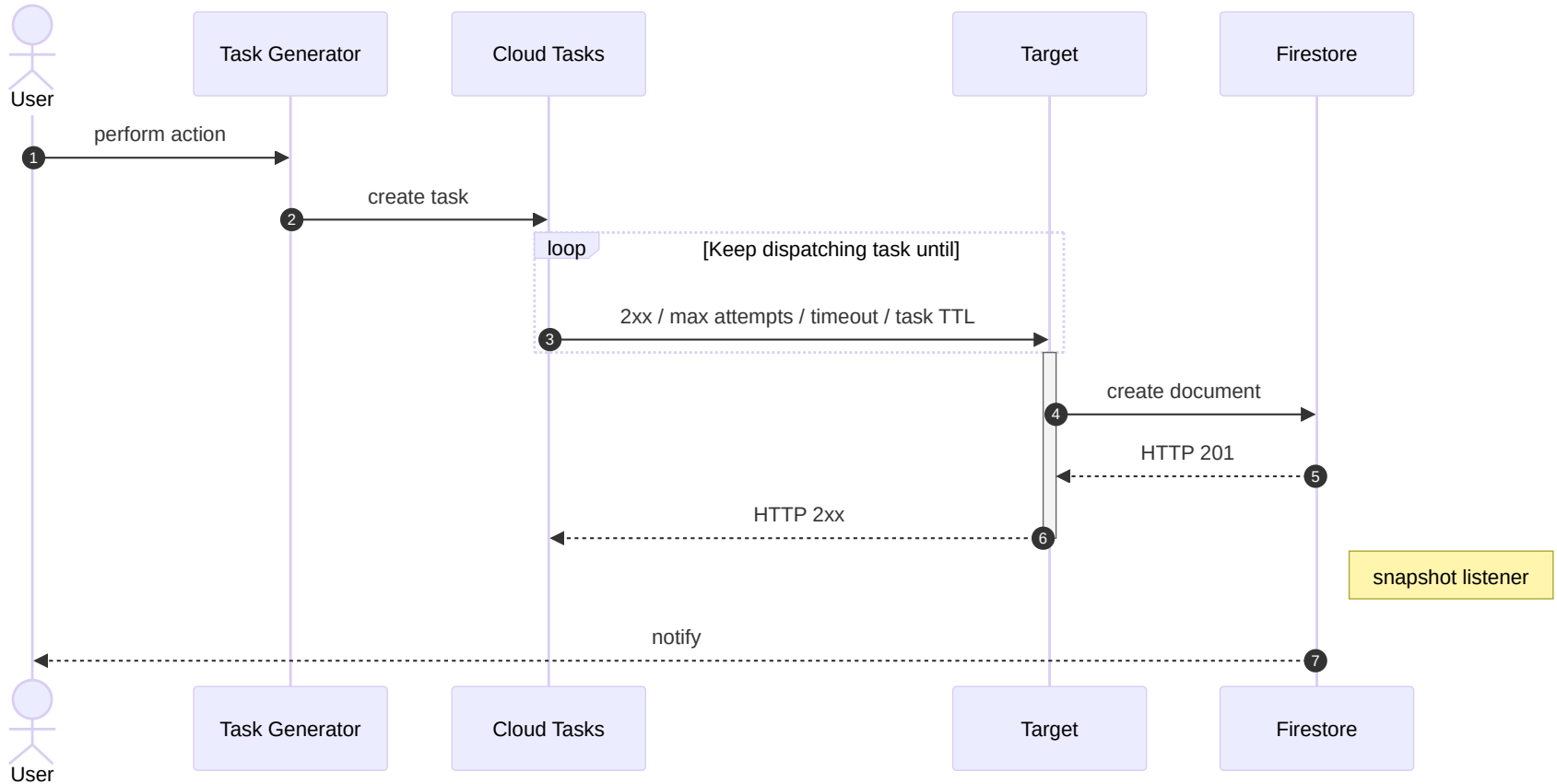
Creating an HTTP task

```
const {CloudTasksClient} = require('@google-cloud/tasks')

const client = new CloudTasksClient()

const project = 'devfest-milano-2023'
const location = 'europe-west3'
const queue = 'my-queue'
const parent = client.queuePath(project, location, queue)

const url = 'https://some-api-endpoint'
const payload = { foo: "bar" }
const str = JSON.stringify(payload)
const serviceAccountEmail =
  `task-enqueuer-user@${project}.iam.gserviceaccount.com`

const task = {
  httpRequest: {
    httpMethod: 'POST',
    url,
    oidcToken: { serviceAccountEmail, audience: url },
    headers: { 'Content-Type': 'application/json' },
    body: Buffer.from(str).toString('base64'),
  },
  name: 'my-task-id',
  // schedule the task 5 seconds from now
  scheduleTime: { seconds: Date.now() / 1000 + 5 },
}

const [response] = await client.createTask({parent, task})
```

A basic example



A more advanced example



Notifications with SSE

We can implement a Cloud Run service that sends server-sent events (SSE) and receive those events on the frontend using an EventSource. Unfortunately, on serverless platforms SSE can be expensive and unreliable.

Pros:

- It's just HTTP, not a different protocol.
- Handles disconnect/reconnect and missed messages automatically.
- No need for special handshaking.

Cons:

- Unidirectional, **server-to-client** data stream.
- The Cloud Run service must be configured with CPU always allocated (i.e. never idle).
- Network proxies and other hardware/software can totally break SSE.
- When not used over HTTP/2, SSE suffers from a limitation to the maximum number of open connections, which can be especially painful when opening multiple tabs, as the limit is per browser and is set to a very low number (6).

SSE doesn't work well on Cloudflare Workers either.

Notifications with WebSockets

Cloud Run supports WebSockets, but it can be really expensive.

Pros:

- Bidirectional data stream.

Cons:

- It's not HTTP, it's a different protocol.
- The Cloud Run service must be configured with CPU always allocated.
- We need to handle request timeouts and client reconnects (or use a library that does it for us, like Socket.IO or Sente).

AWS has the IoT Device SDK , which allows MQTT over WSS (Websockets Secure). Google killed its IoT Core product.

A single Node.js server running Socket.IO could manage 55k connections.

Serverless-friendly notifications

Firestore

- Real-time updates available only in Firestore in Native mode
- Create a snapshot listener on the client
- Define security rules to restrict client-side access to the database

Firebase Cloud Messages (FCM)

- Push notifications via the browser Push API

Third-party services

- AWS SES, SendGrid, Mailgun, Postmark, etc (email)
- OneSignal, PushEngage, ntfy, etc (push notifications)
- Ably, PubNub, Pusher, etc (SSE, WebSockets)
- Twilio, AWS Pinpoint, etc (SMS)
- Telegram Bot API, Slack, WhatsApp API, etc

IAM

Task generator

The service account attached to the service that creates tasks and sends them to Cloud Storage must have the IAM roles **Task Enqueuer** and **Service Account User**:

- `roles/cloudtasks.enqueuer`
- `roles/iam.serviceAccountUser`

Cloud Tasks

The service account for Cloud Tasks is managed by Google. Double check that this service account exists and that it has the IAM role **Cloud Tasks Service Agent**:

`service-<project_number>@gcp-sa-cloudtasks.iam.gserviceaccount.com`

Task handler

The service account attached to the service that processes tasks must have the necessary IAM permissions to do its job. E.g. For a Cloud Run service that requires read/write access to Firestore we can assign the IAM roles `roles/run.invoker` and `roles/datastore.user`.

Cloud Tasks vs Cloud Pub/Sub (1/2)

Feature	Cloud Tasks	Cloud Pub/Sub
At least once delivery	Yes	Yes
Configurable retries	Yes	Yes
Task creation deduplication	Yes	No
Scheduled delivery	Yes	No
Ordered delivery	No	Yes with ordering keys
Explicit rate controls	Yes	Pull subscriber clients can implement flow control
Pull via API	No	Yes
Batch insert	No	Yes
Multiple handlers/subscribers per message	No	Yes

Cloud Tasks vs Cloud Pub/Sub (2/2)

Feature	Cloud Tasks	Cloud Pub/Sub
Task/message retention	30 days	Up to 31 days
Max size of task/message	1 MB	10 MB
Max delivery rate	500 qps per queue	No upper limit
Geographic availability	Regional	Global
Maximum push handler/subscriber processing duration	30 minutes (HTTP) 10 minutes (App Engine Standard automatic scaling) 24 hours (App Engine Standard manual or basic scaling) 60 minutes (App Engine Flexible)	10 minutes for push operations
Number of queues/subscriptions per project	1,000/project, more available via quota increase request	10,000/project

Cloud Tasks

Trigger

A Cloud Tasks **task** runs immediately or according to its configured `scheduleTime`.

Rates

A task can run up to the `maxDispatches` value of the queue it is dispatched from. The maximum value is 500 (see the queue's rate limits config).

Retries

Cloud Tasks adopts a truncated exponential backoff strategy to retry failed tasks (see the queue's retry config).

Cloud Scheduler

Trigger

A Cloud Scheduler **job** runs according to the cron expression you defined.

Rates

A job can run max **once per second**.

Retries

Cloud Scheduler adopts a truncated exponential backoff strategy to retry failed jobs.

Make your tasks easy to identify

- Give you tasks a `name`. Use something self-explanatory. For example, `VERB-WHAT-UTC_TIMESTAMP`.
- Add a custom HTTP header containing the identifier of the service that created that task. For example, `X-Task-Created-By` or `X-Task-Enqueued-By`.
- Keep in mind `tombstoneTtl` for task deduplication.

Implement idempotent task handlers

Idempotency:

- is **different** from safety.
- means that multiple identical requests will have the **same outcome**.
- does **not** mean that the server has to respond in the same way on each request. If the constraint is violated, the server should return HTTP 409 Conflict.

We can implement an idempotent task handler using:

- a constraint from our business logic.
- ETags (only for existing resources, so only for PATCH requests, not for POST requests).
- an idempotency key (e.g. Stripe API).

Reference:

- HTTP methods: Idempotency and Safety
- Making POST and PATCH requests idempotent
- Pattern: Idempotent Consumer
- Handling Duplicate Messages (Idempotent Consumers)

Test your system

Use an emulator?

No official emulator. There is aertje/cloud-tasks-emulator but I haven't tried it yet.

Integration tests

Test the integration between Cloud Tasks and your components (task generator and task handler).

Since Cloud Tasks is not a service under our control, these tests are **cross-system** integration tests and someone might argue they are not that useful.

System tests (e2e)

Test the system as a single piece, as an end user would use it.

Other tests: load testing, chaos testing

Stress test your system with an HTTP load generator like Locust, artillery or autocannon.

Simulate outages of 3rd paty services your system depends on (e.g. Stripe is down).

Metrics

Setup monitoring and alerting. E.g. queue depth over threashold.

https://cloud.google.com/tasks/docs/dual-overview#metrics

Queue overload and target overload.

The recommended defense is the same 500/50/5 pattern suggested for queue overload: if a queue dispatches more than 500 TPS, increase traffic triggered by a queue by no more than 50% every 5 minutes.

https://cloud.google.com/tasks/docs/manage-cloud-task-scaling

This article suggests 4 metrics about your tasks you should monitor.

https://www.keypup.io/blog/cloudtasker-monitor-your-cloud-tasks-jobs-on-gcp

2 of these metrics are specific for cloudtasker (a Ruby library that uses Cloud Tasks)

https://github.com/keypup-io/cloudtasker

cloudtasker can store your tasks in Memorystore.

1. Cloud Tasks queue size (aka queue depth)
2. Cloud Run billable runtime (ok, ma è una metrica di Cloud Run, non di Cloud Tasks)
3. Job duration (cloudtasker-specific)
4. Redis memory (cloudtasker-specific)

Demo

TODO: link to demo.

Thanks!