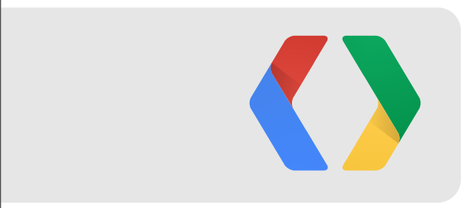

Google
Developers



Building developers.google.com on Google App Engine

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Developer Programs Engineer

Google Developers

Google Developers: developers.google.com

- Content management system
- Events calendar
- Developer showcase
- Google Developer Groups
- Google Developers Live
- Google I/O

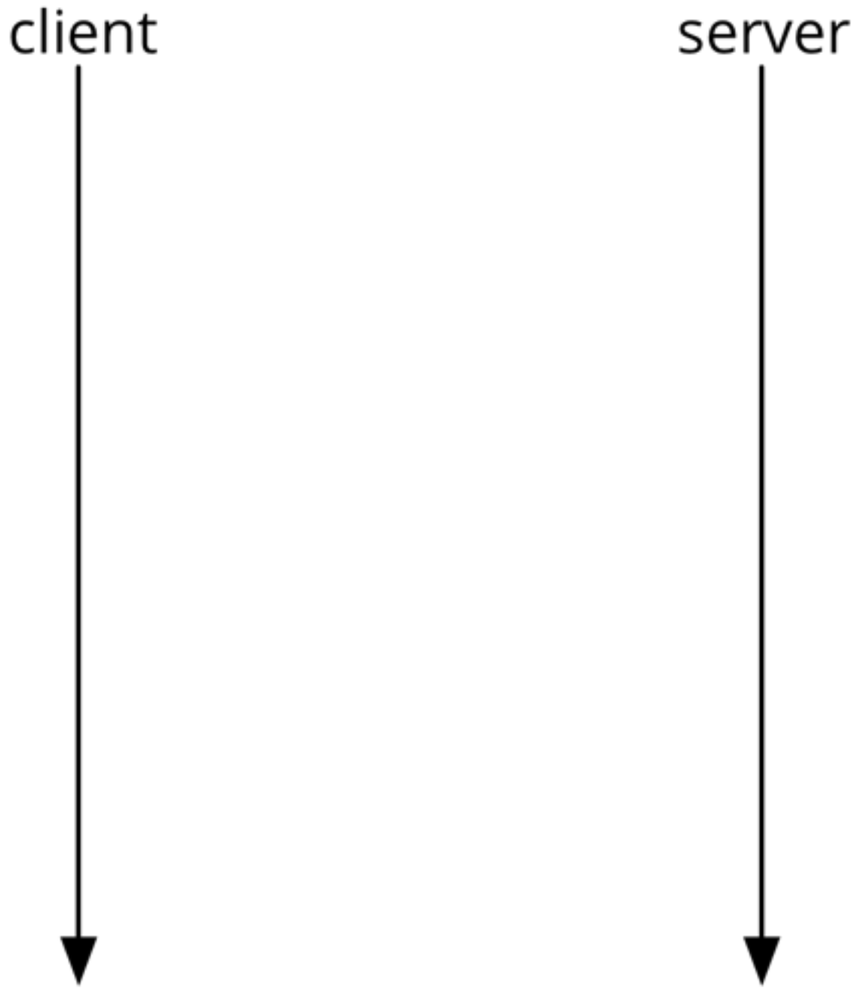
This Talk

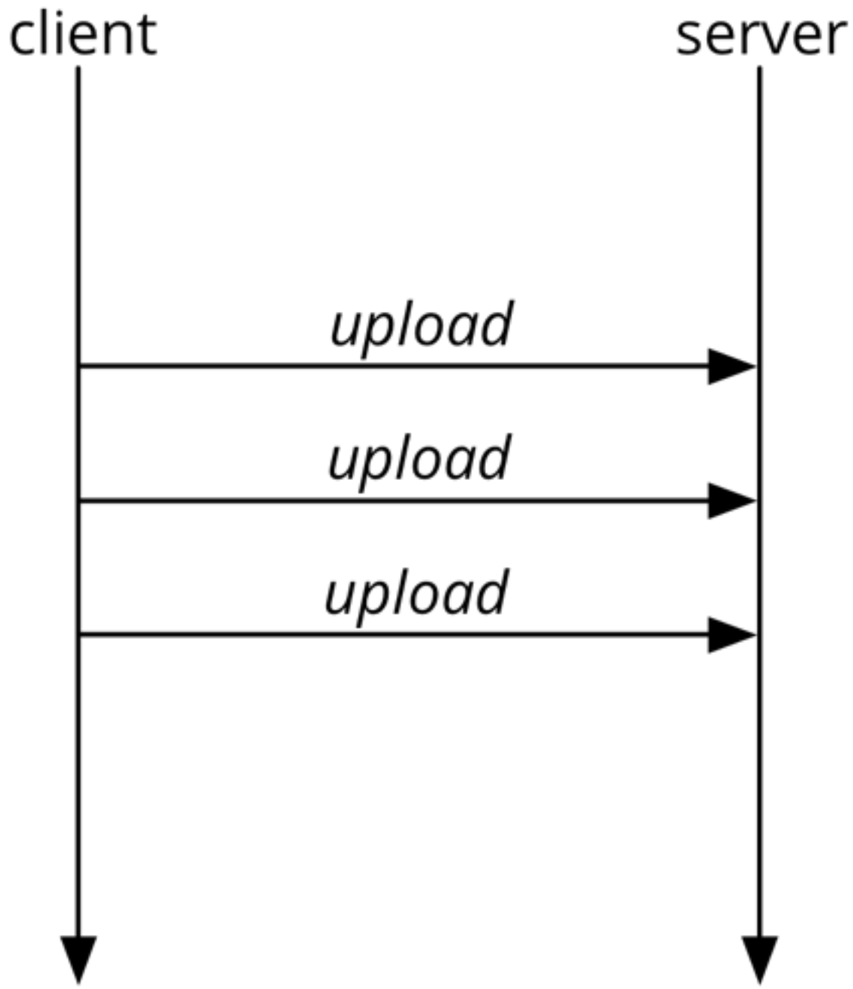
- Design of a piece of the content management system
    - What we actually use
    - Focus on the App Engine-y bits
- Tools and implementation
    - A modern implementation, in Python 2.7
    - Using modern features of App Engine
    - Discrepancies and alternatives

Requirements

- Content managed separately from other parts of the site
- File-based CMS
  - content developed “offline,” published with a client tool
  - developer publishes a set of changes at a time, over many files
- Access controls for publishing
- Fast file serving
- Many content developers working concurrently

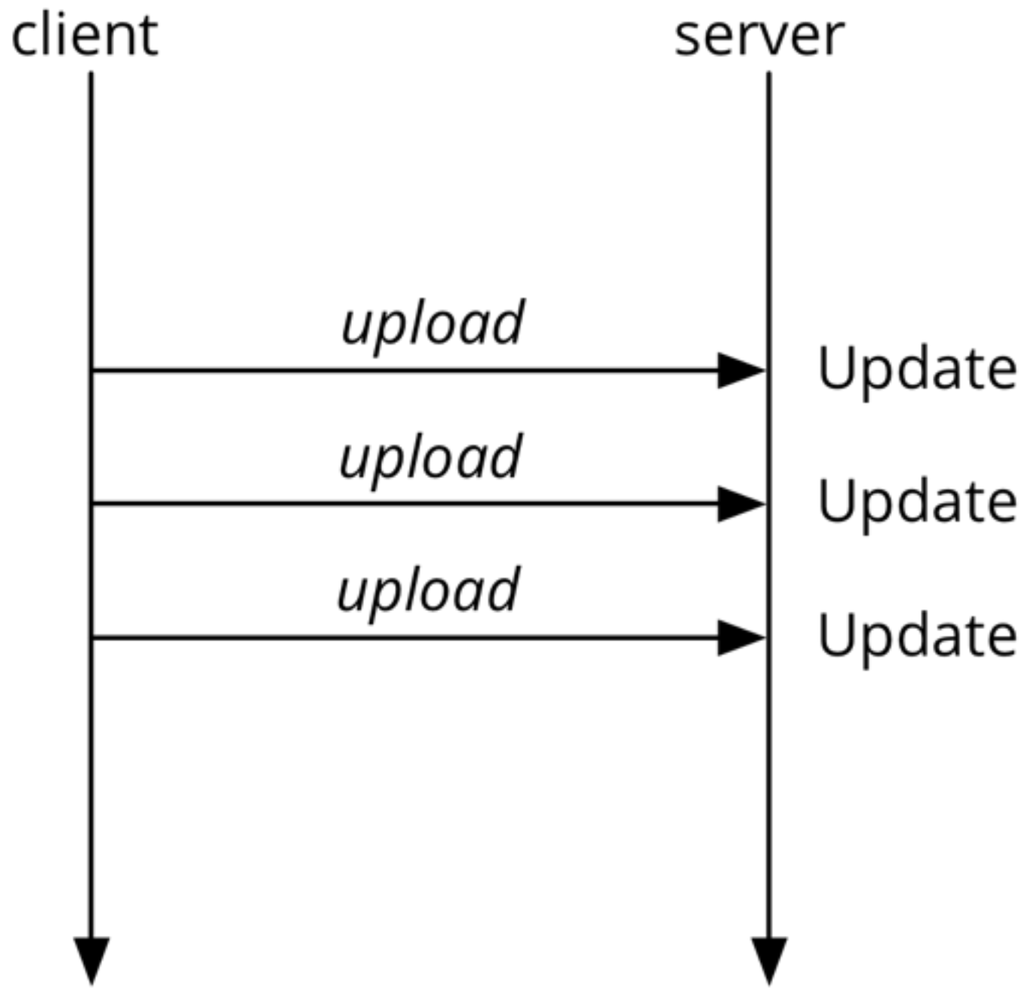
```
publish <dir-or-file> [<dir-or-file>...]
```

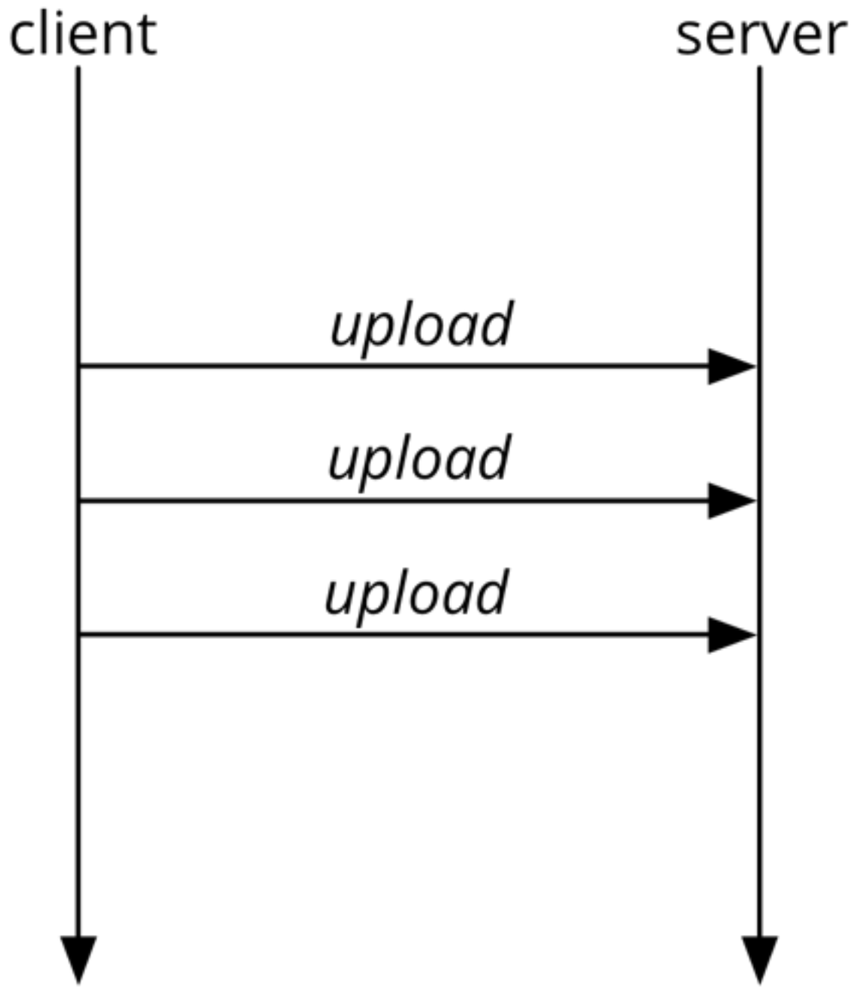

client
server


client
server
upload
upload
upload

Upload:

URL path
content type
data

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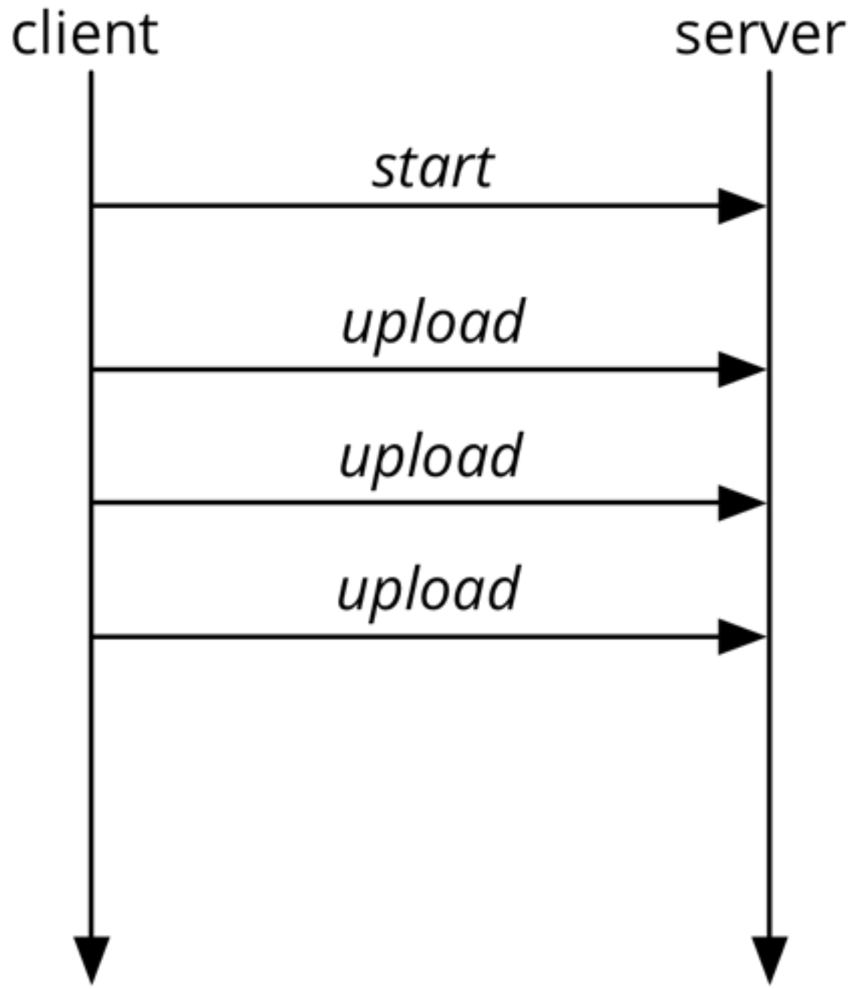
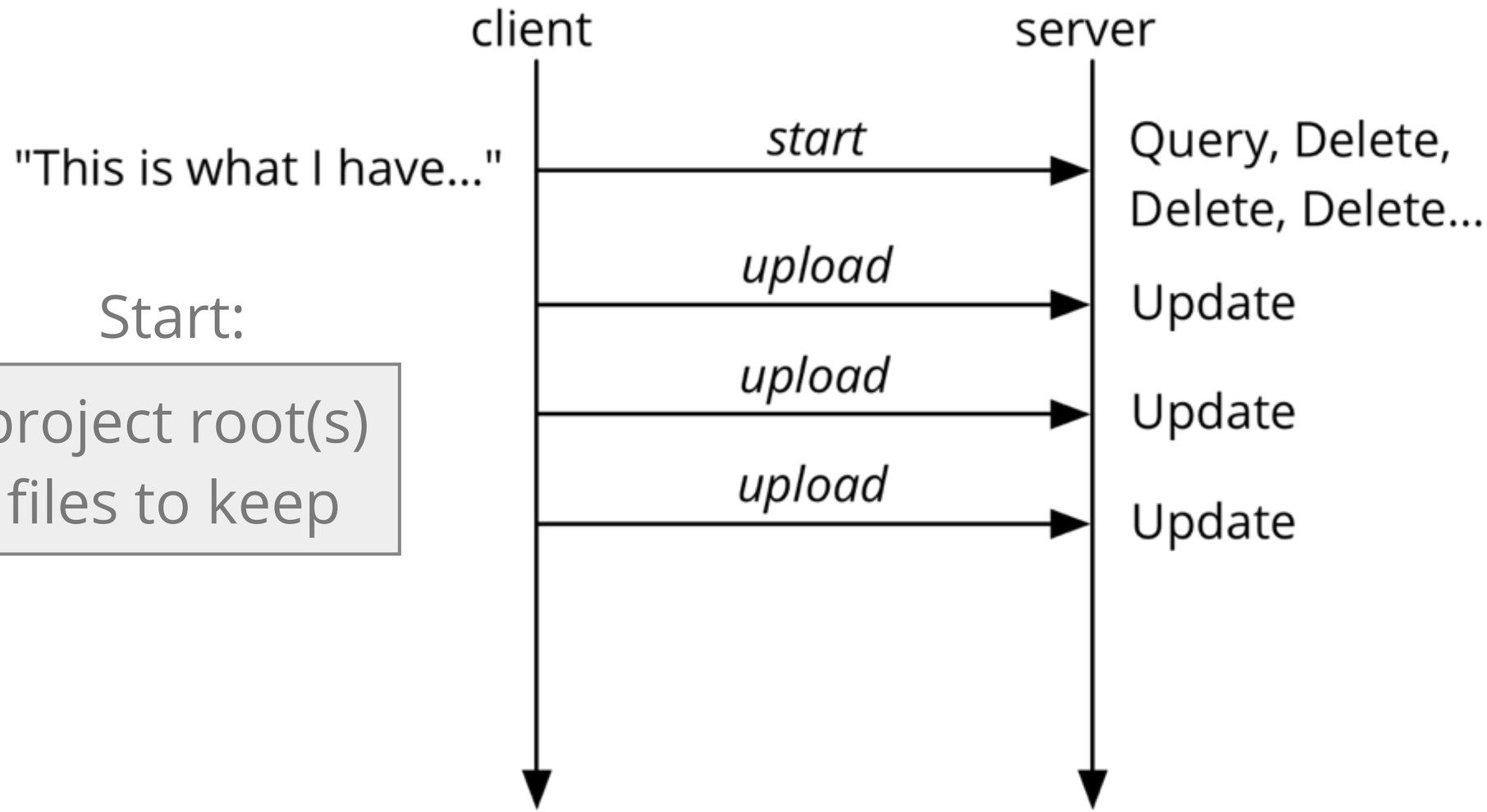
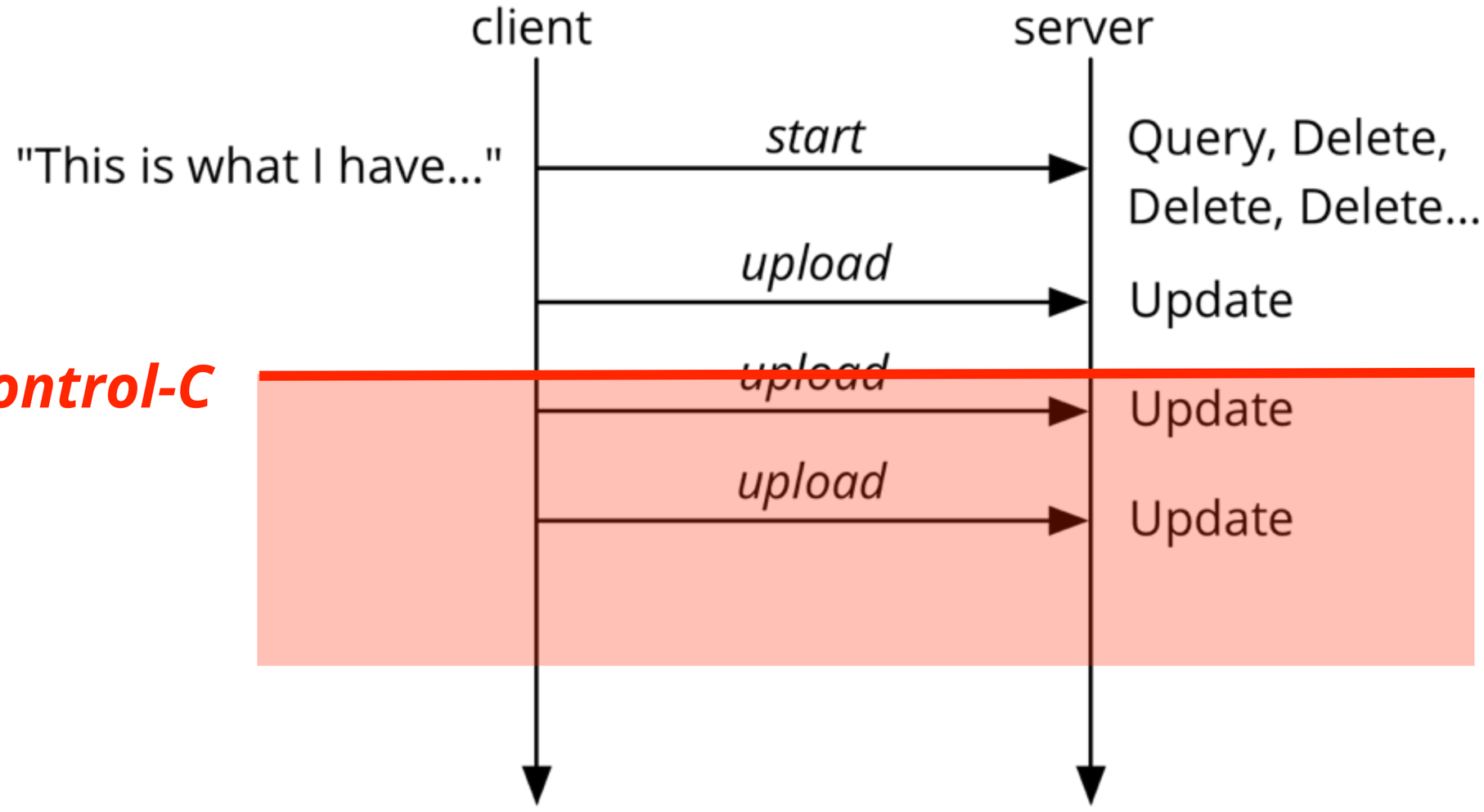
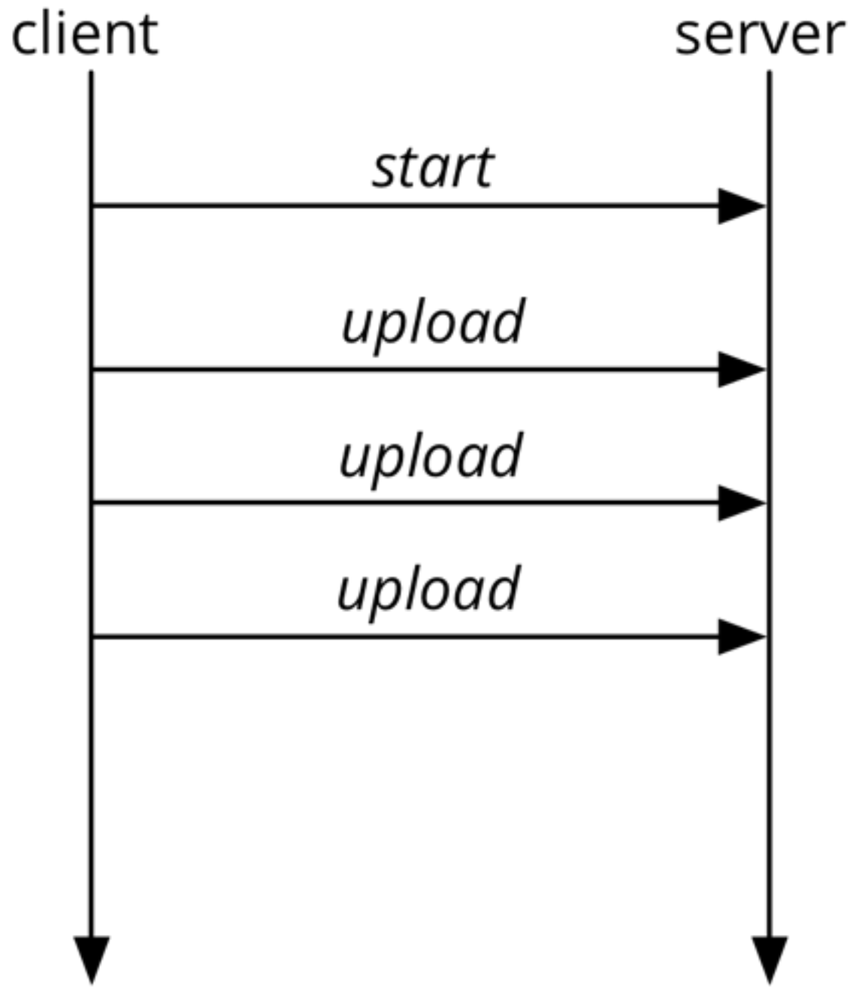

client
server
start
upload
upload
upload

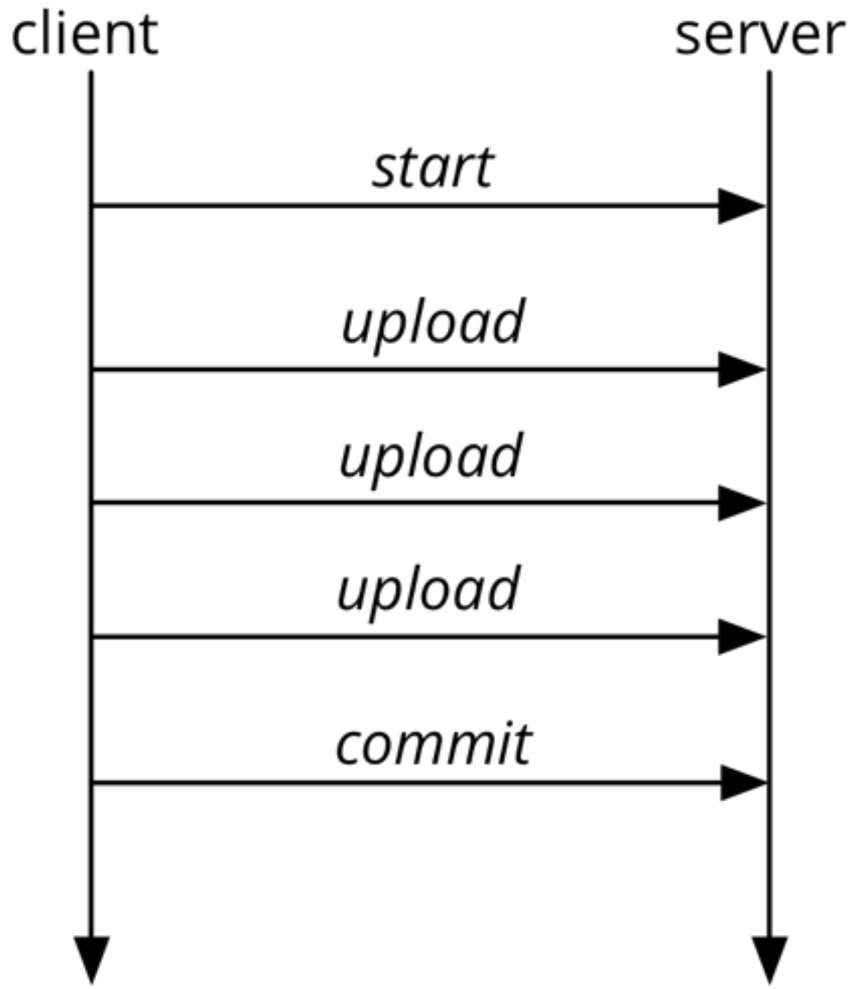
Start:

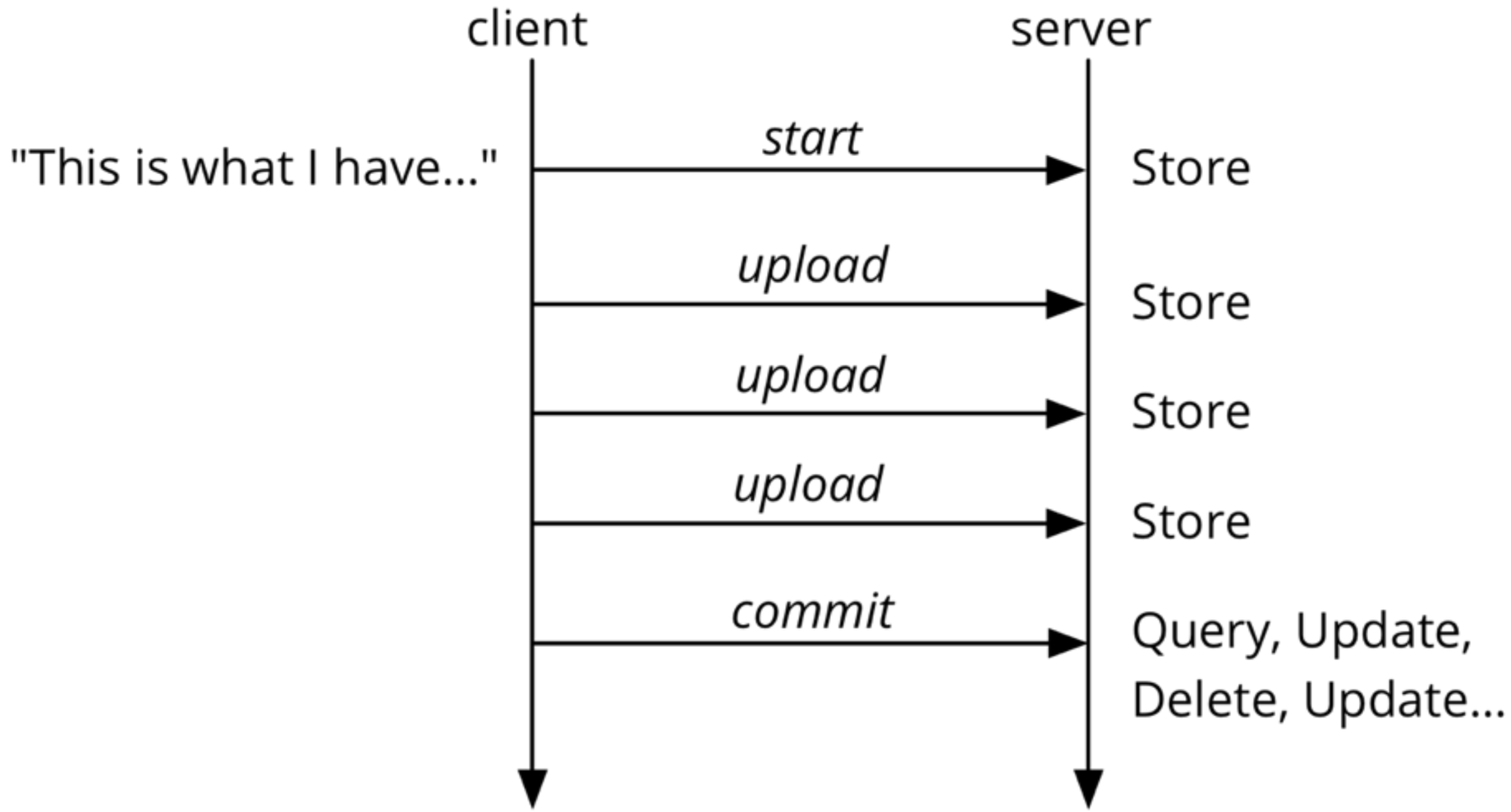
project root(s)
files to keep

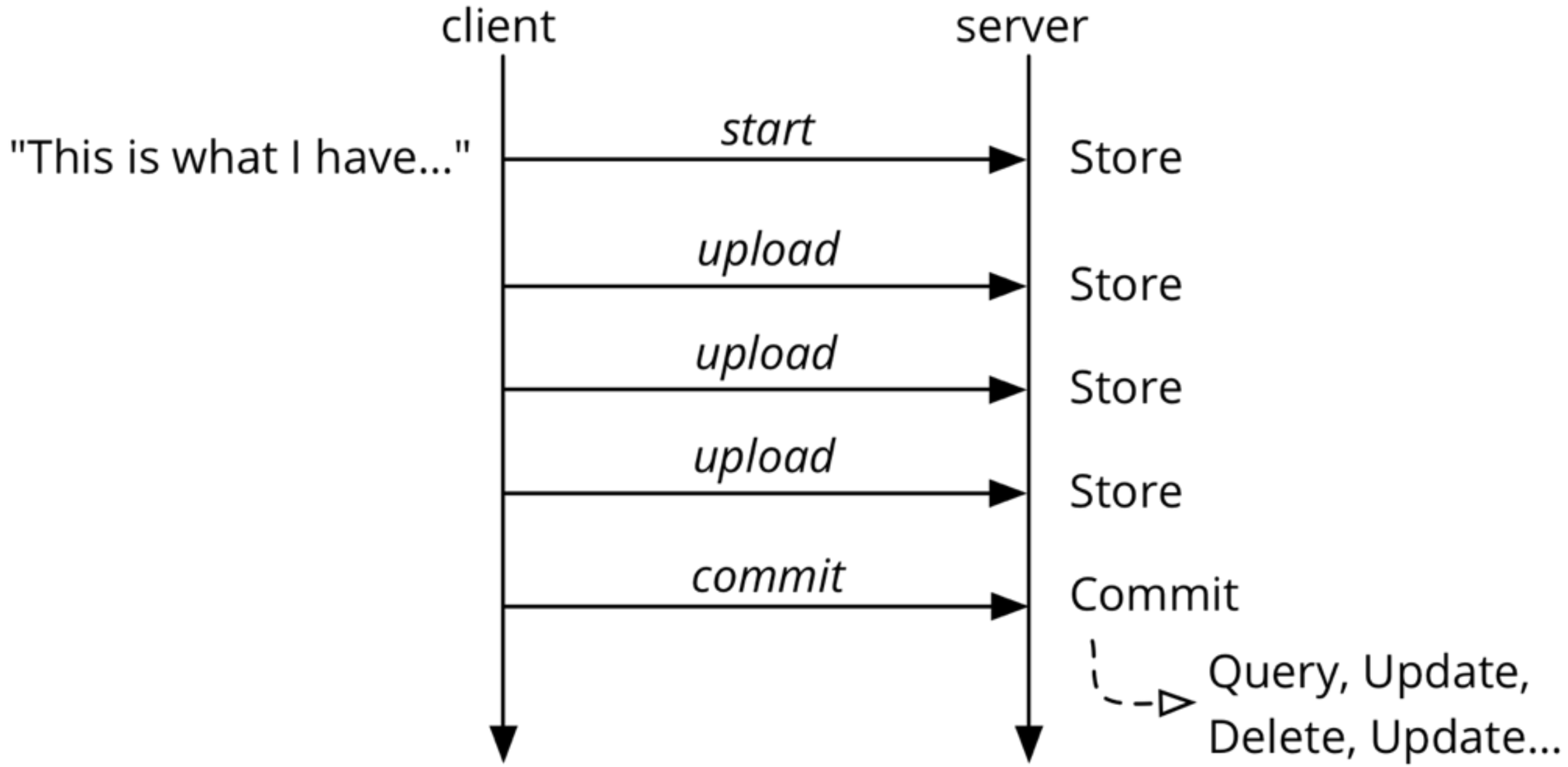



client
server
"This is what I have..."
start
Query, Delete,
Delete, Delete...
upload
Update
Control-C
upload
Update
upload
Update


client
server
start
upload
upload
upload


client
server
start
upload
upload
upload
commit


client
server
"This is what I have..."
start
Store
upload
Store
upload
Store
upload
Store
commit
Query, Update,
Delete, Update...


client
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start
Store
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Store
upload
Store
commit
Commit
Query, Update,
Delete, Update...

The Publishing Protocol

- **Start** a new Change, with the given change description
- **Upload** data for new and updated files in the change
- **Commit** the change
- Or **Abort** the change
    - Cron job aborts stale Changes

Authenticated Web Services

- **Google Cloud Endpoints**
- Server libs for Python and Java
- Client libs for practically everything
- Especially easy for mobile (Android, iOS) and rich web (JavaScript)

Google Cloud Endpoints: Server

API Definition: Messages

Python

```python
from protorpc import messages

class StartRequest(messages.Message):
    project_prefixes = messages.StringField(1, repeated=True)
    upload_paths = messages.StringField(2, repeated=True)

class StartResponse(messages.Message):
    change_id = messages.IntegerField(1, required=True)
```

Google Cloud Endpoints: Server

- Messages can be defined as “ProtoRPC”s...
- ... or directly from **ndb** models, with **Endpoints Proto Datastore**
    - http://endpoints-proto-datastore.appspot.com/

Google Cloud Endpoints: Server

API Definition: Service

Python

```python
from google.appengine.ext import endpoints
from protorpc import remote

@endpoints.api(
    name='sitepublish',
    version='v1',
    description='Site Publish API',
    allowed_client_ids=CLIENT_IDS)
class SitePublishApi(remote.Service):

    # ...
```

Google Cloud Endpoints: Server

API Definition: Method

Python

```python
@endpoints.api(...)
class SitePublishApi(remote.Service):

    @endpoints.method(
         StartRequest,
         StartResponse,
         name='start', path='start')
    def start(self, request):

         # ...
```

Google Cloud Endpoints: Server

API Definition: Authorization

Python

```
@endpoints.method(
    StartRequest,
    StartResponse,
    name='start', path='start')
def start(self, request):

    user = endpoints.get_current_user()
    if user is None or user.email() not in CONTENT_DEVELOPERS:
        raise endpoints.UnauthorizedException()

    # ...
```

Google Cloud Endpoints: Server

API Definition: Request and Response

Python

```python
@endpoints.method(
    StartRequest,
    StartResponse,
    name='start', path='start')
def start(self, request):
    # ...

    change = start_change(
        request.project_prefixes,
        request.upload_paths,
        endpoints.get_current_user())
    response = StartResponse(change_id=change.get_change_id())
    return response
```

Google Cloud Endpoints: Server

API Definition: Service

Python

```python
@endpoints.api(...)
class SitePublishApi(remote.Service):
    # ...


app = endpoints.api_server([SitePublishApi], restricted=False)
```

Google Cloud Endpoints: Server

API Definition: Service

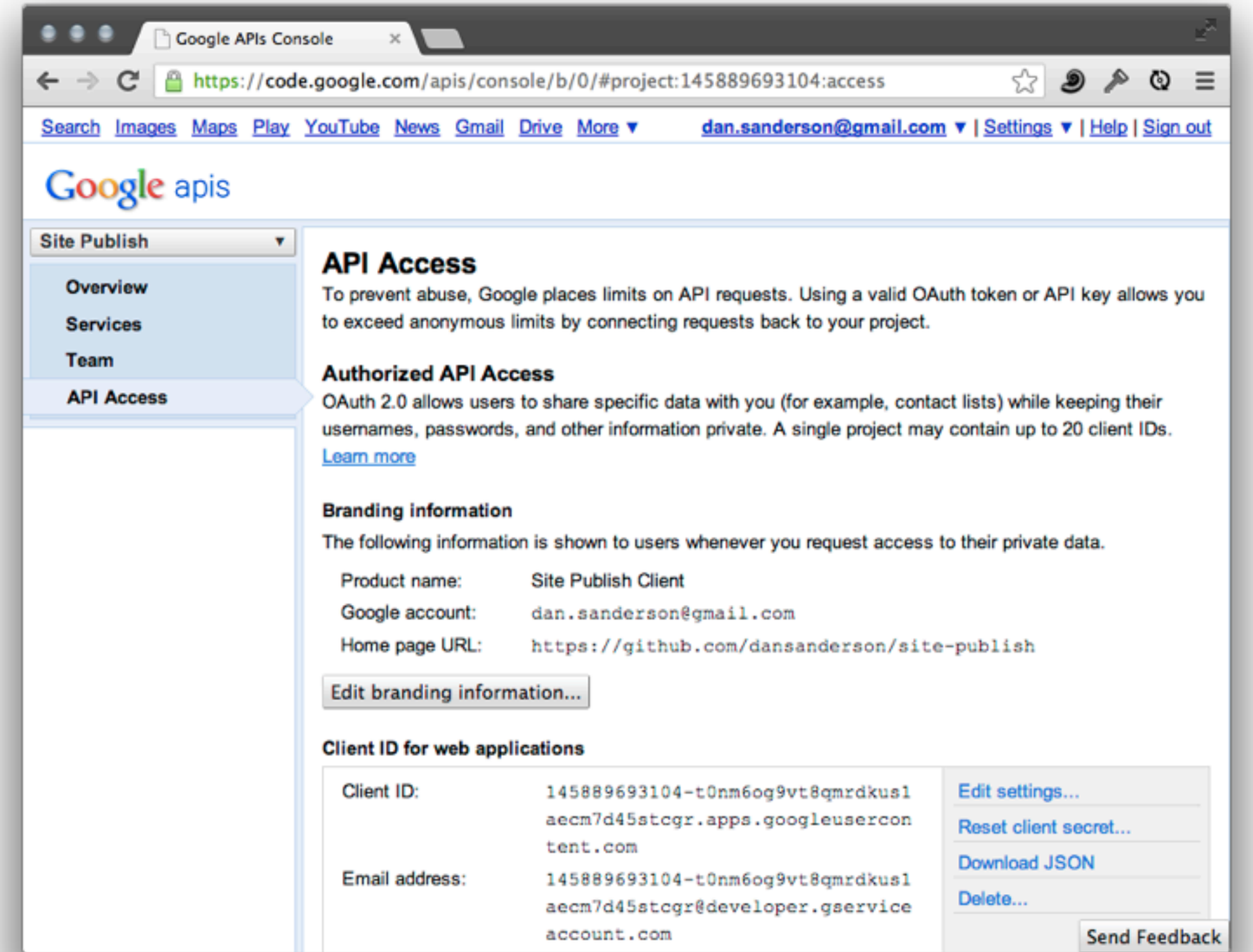
YAML

```
application: site-publish
version: 1
runtime: python27
api_version: 1
threadsafe: true

handlers:
- url: /_ah/spi/.*
  script: services.app
```

Google Cloud Endpoints: Server

- Authenticated endpoints use client IDs
    - user signs in to Google, client gets permission to act as user when calling service
- Manage client IDs with the Google API Console
    - https://developers.google.com/console/

Google Cloud Endpoints: Server



Google Cloud Endpoints: Server

- Create a project
- Under API Access, create a client
    - “Web application,” even though this is a command-line tool
- For the new client, Edit settings...
    - Authorized Redirect URIs:

```
http://localhost:8080/
http://localhost:8090/
http://your-site.com/
```

Google Cloud Endpoints: Server

Setting the client IDs

Python

```python
from google.appengine.ext import endpoints
from protorpc import remote

@endpoints.api(
    name='sitepublish',
    version='v1',
    description='Site Publish API',
    allowed_client_ids=CLIENT_IDS)
class SitePublishApi(remote.Service):

    # ...
```

Google Cloud Endpoints: Server

Setting the client IDs

Python

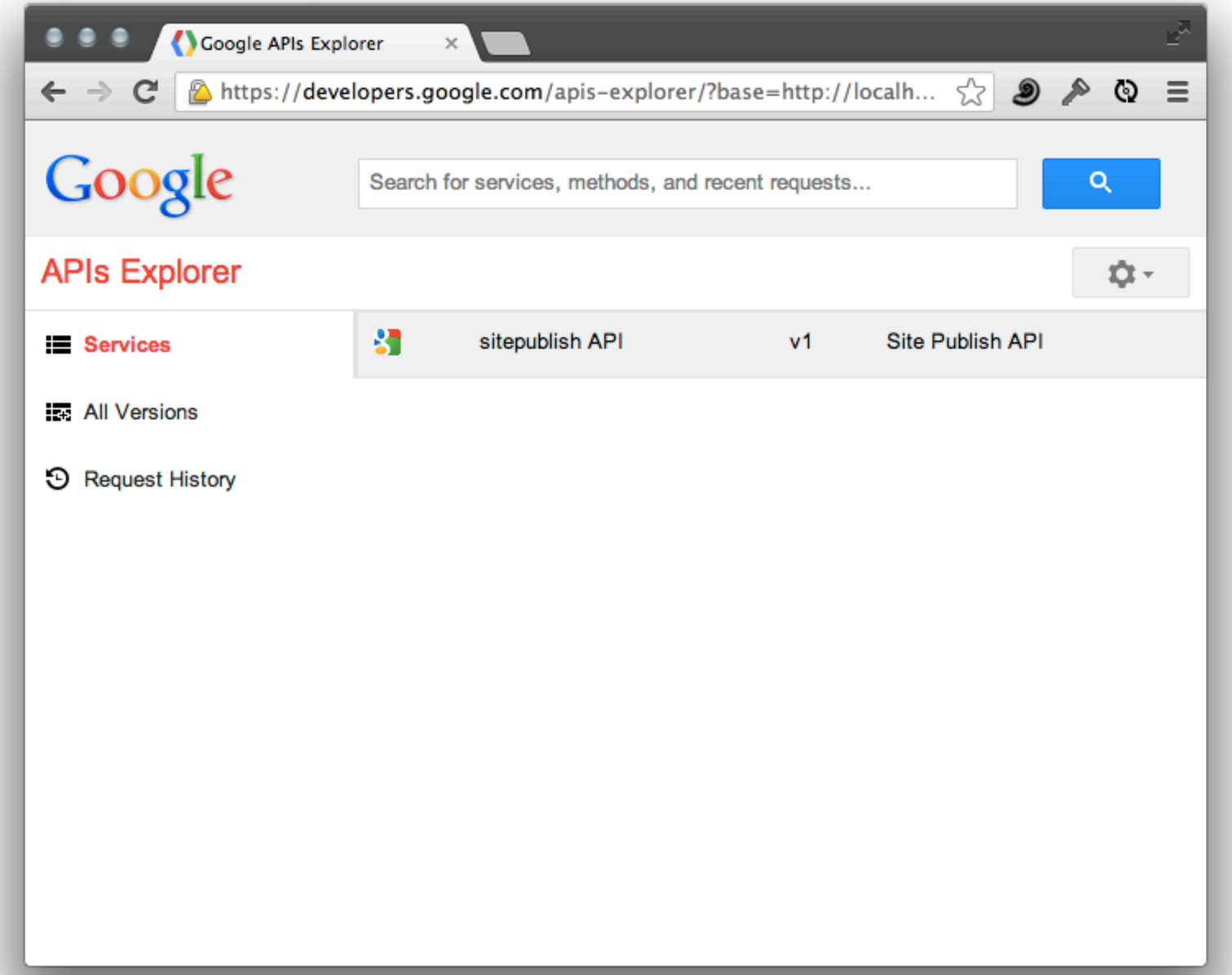
```
from google.appengine.ext import endpoints
from protorpc import remote

CLIENT_IDS = ['145889693104-t0nm6og9vt8qmrdkus1aecm7d45stcgr.apps.googleusercontent.com',
    endpoints.API_EXPLORER_CLIENT_ID]

@endpoints.api(
    name='sitepublish',
    version='v1',
    description='Site Publish API',
    allowed_client_ids=CLIENT_IDS)
class SitePublishApi(remote.Service):
```

Google Cloud Endpoints: Server

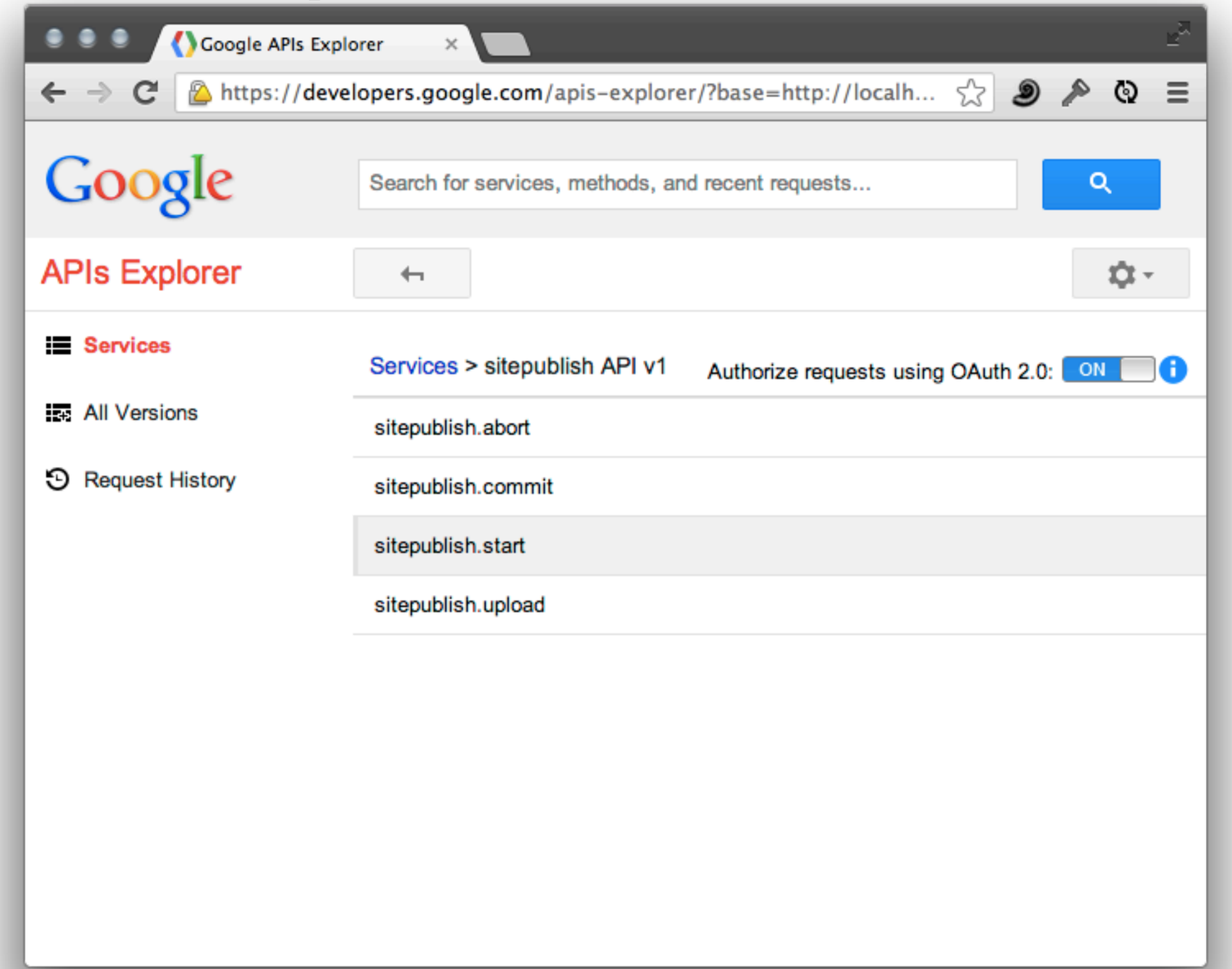
- Try it out in the development server, no client code needed!
  - `http://localhost:8080/_ah/api/explorer`

Demo

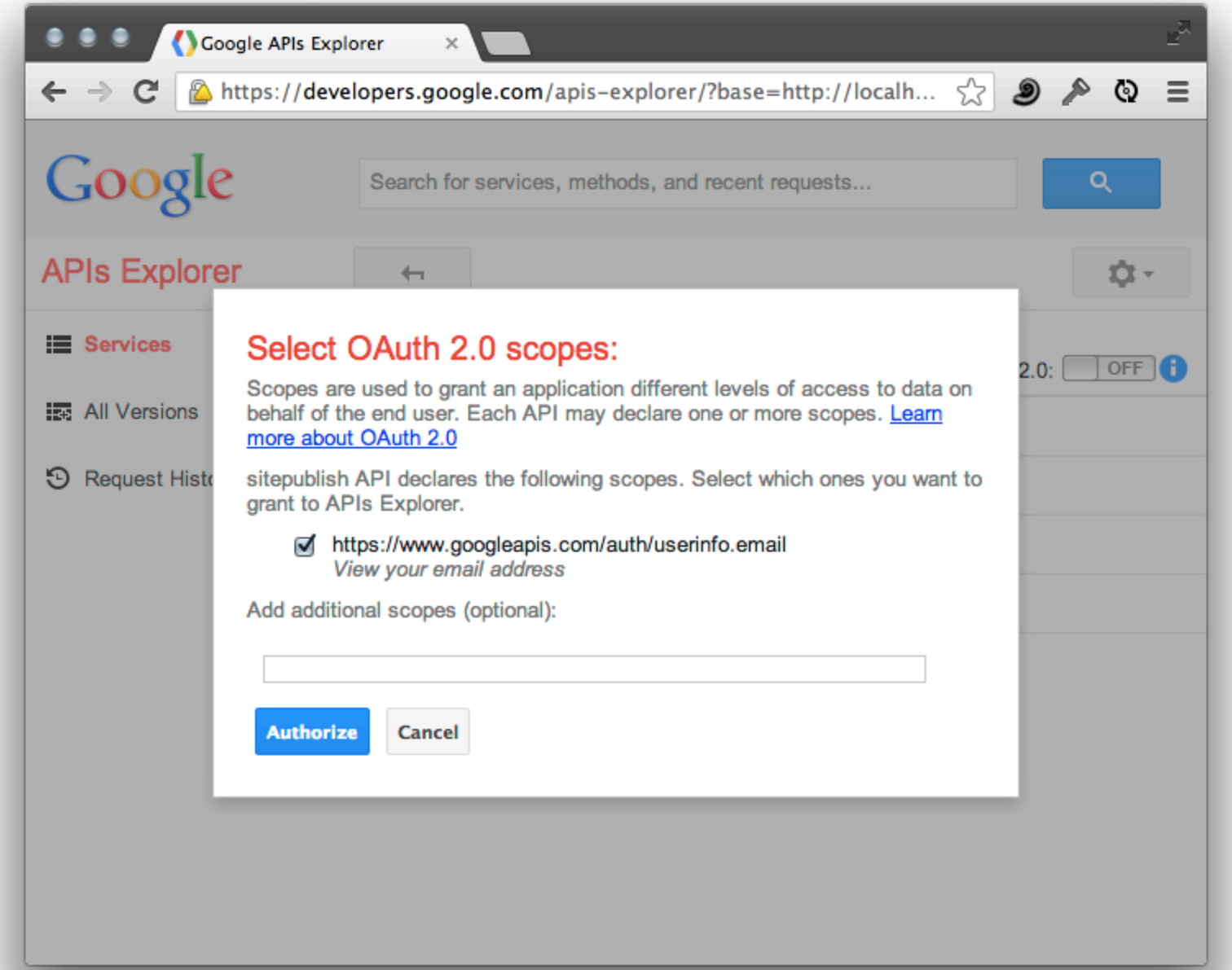
Google Cloud Endpoints: Server



Google Cloud Endpoints: Server



Google Cloud Endpoints: Server



Google APIs Explorer

https://developers.google.com/apis-explorer/?base=http://localhos...

Google

Search for services, methods, and recent requests...

APIs Explorer

Services

All Versions

Request History

Services > sitepublish API v1 > sitepublish.start

Authorize requests using OAuth 2.0: ON

fields

Selector specifying which fields to include in a partial response.
Use fields editor

Request body

```
{
  "project_prefixes":
  [
    "/foo/"
  ]
  "upload_paths":
  [
    "/foo/bar.html"
    "/foo/baz.html"
  ]
}
```

Execute

Google

Search for services, methods, and recent requests...

APIs Explorer

Services

All Versions

Request History

sitepublish.start executed moments ago time to execute: 849 ms

Request

```
POST http://localhost:8080/_ah/api/sitepublish/v1/start

Content-Type:  application/json
Authorization:  Bearer ya29.AHES6ZTvOeRu8RrPZpTuU-
tyzAYtZUdnPYAjYcQ2ZNia4IEt
X-JavaScript-User-Agent:  Google APIs Explorer

-{
 -"project_prefixes": [
    "/foo/"
  ],
 -"upload_paths": [
    "/foo/bar.html",
    "/foo/baz.html"
  ]
 }
```

Response

```
200 OK

 - Show headers -

-{
  "change_id": 2
 }
```

Google Cloud Endpoints: Client

- google-api-python-client
    - https://developers.google.com/api-client-library/
- Client uses a “discovery document” that describes the service API
- Looks like a language-native API to the client code
- Library contains tools for making OAuth easy

Google Cloud Endpoints: Client

- Generate the discovery document for the service: endpointscfg.py

```
- ~/google_appengine/endpointscfg.py gen_discovery_doc \
  -o . -f rest --hostname=localhost:8080 \
  services.SitePublishApi
```

- Make a one for testing, and one for real, using hostname parameter
  - Hand-edit localhost version to replace “https” with “http”

Google Cloud Endpoints: Client

Loading the Discovery Document

Python

```
import os
from apiclient import discovery

discovery_doc_fname = os.path.join(
    os.path.dirname(__file__),
    'SitePublishApi.discovery')
discovery_doc = open(discovery_doc_fname).read()

site_publish_service = discovery.build_from_document(discovery_doc)
```

Google Cloud Endpoints: Client

Authenticating the User

Python

```
import httplib2
import oauth2client

storage = oauth2client.file.Storage(CREDENTIALS_FILENAME)
credentials = storage.get()

if credentials is None or credentials.invalid:
    flow = oauth2client.client.OAuth2WebServerFlow(
        client_id=CLIENT_ID,
        client_secret=CLIENT_SECRET,
        scope='https://www.googleapis.com/auth/userinfo.email')

    credentials = oauth2client.tools.run(flow, storage)

http = credentials.authorize(httplib2.Http())
```

Google Cloud Endpoints: Client

Calling the Service

Python

```
request = site_publish_service.start(
    body={
        'project_prefixes': ['/foo/'],
        'upload_paths': ['/foo/bar.html', '/foo/baz.png']})

response = request.execute(http=http)

change_id = response['change_id']
```

Demo

Data Modeling with ndb

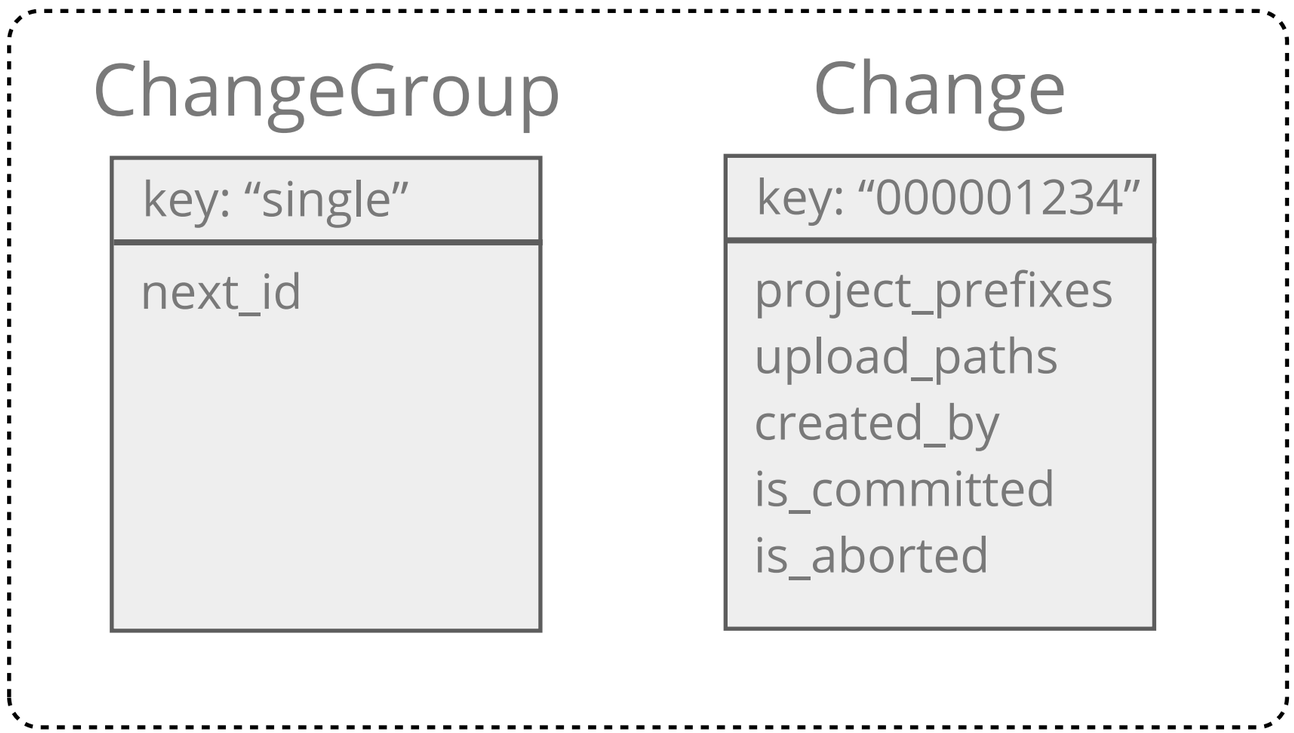
- Modeling changes
- Strict ordering of changes
  - Datetimes?
  - System IDs?

Data Modeling with ndb

- Idea: Store the “next change ID,” update it transactionally when creating changes
- Singleton entity for the change ID
- Use a cross-group transaction

Data Modeling with ndb

- Idea: Store the “next change ID,” update it transactionally when creating changes
- Singleton entity for the change ID
- Use a cross-group transaction (or just put all changes in the same entity group)



Data Modeling with ndb

Change Model and ChangeGroup Singleton

Python

```python
from google.appengine.ext import ndb

class ChangeGroup(ndb.Model):
    next_id = ndb.IntegerProperty(required=True)

class Change(ndb.Model):
    upload_paths = ndb.StringProperty(repeated=True)
    project_prefixes = ndb.StringProperty(repeated=True)
    created_by = ndb.UserProperty()
    is_committed = ndb.BooleanProperty(default=False)
    is_aborted = ndb.BooleanProperty(default=False)

    def get_change_id(self):
        return int(self.key.string_id())

    @classmethod
    def get_key(cls, change_id):
        return ndb.Key(ChangeGroup, '1', cls, '%012d' % change_id)
```

Data Modeling with ndb

- Modeling the content
  - View request can access its data using a `get()` by key = URL path
  - Publishing needs to be able to store new content separately from live content, then “switch”
- Idea: Path entity keyed by URL path, with pointer to Content entity

Data Modeling with ndb

- Modeling the content
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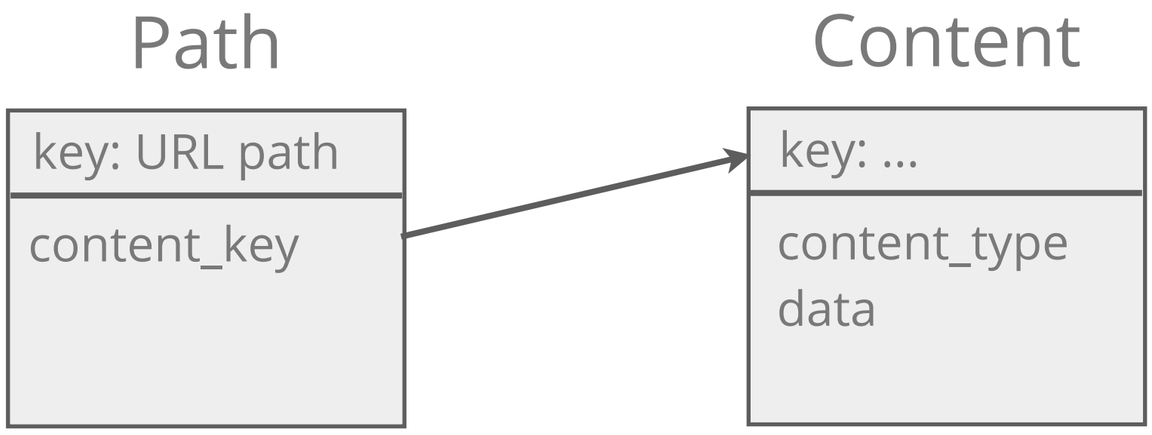
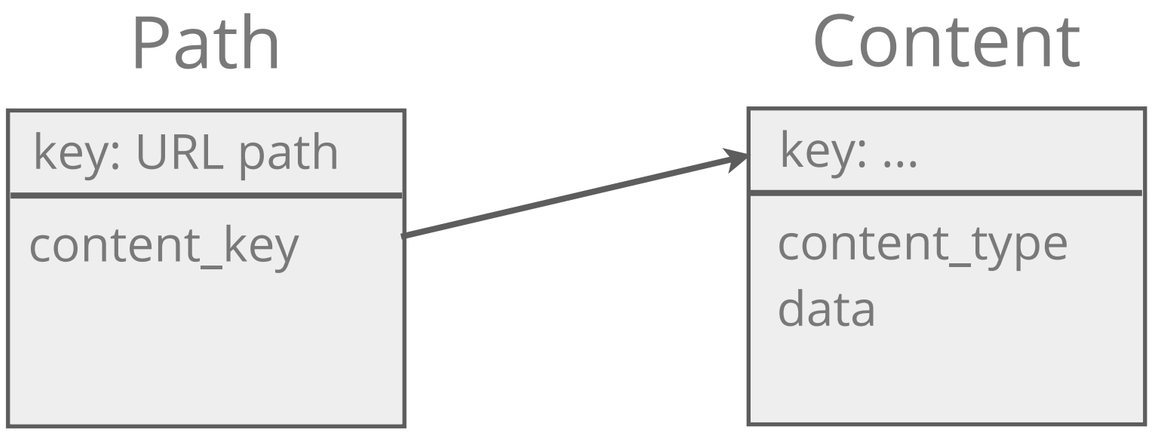
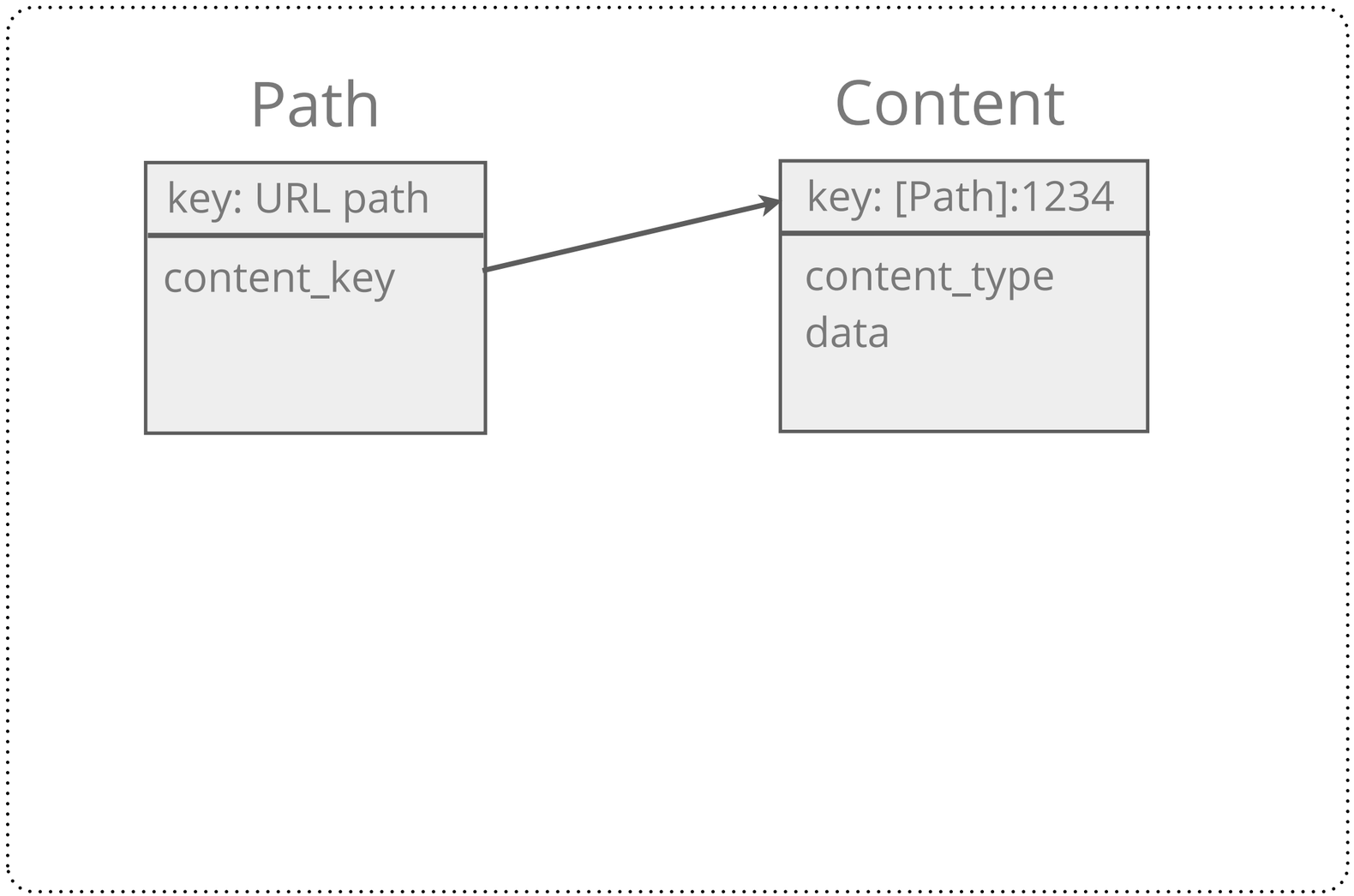


Data Modeling with ndb

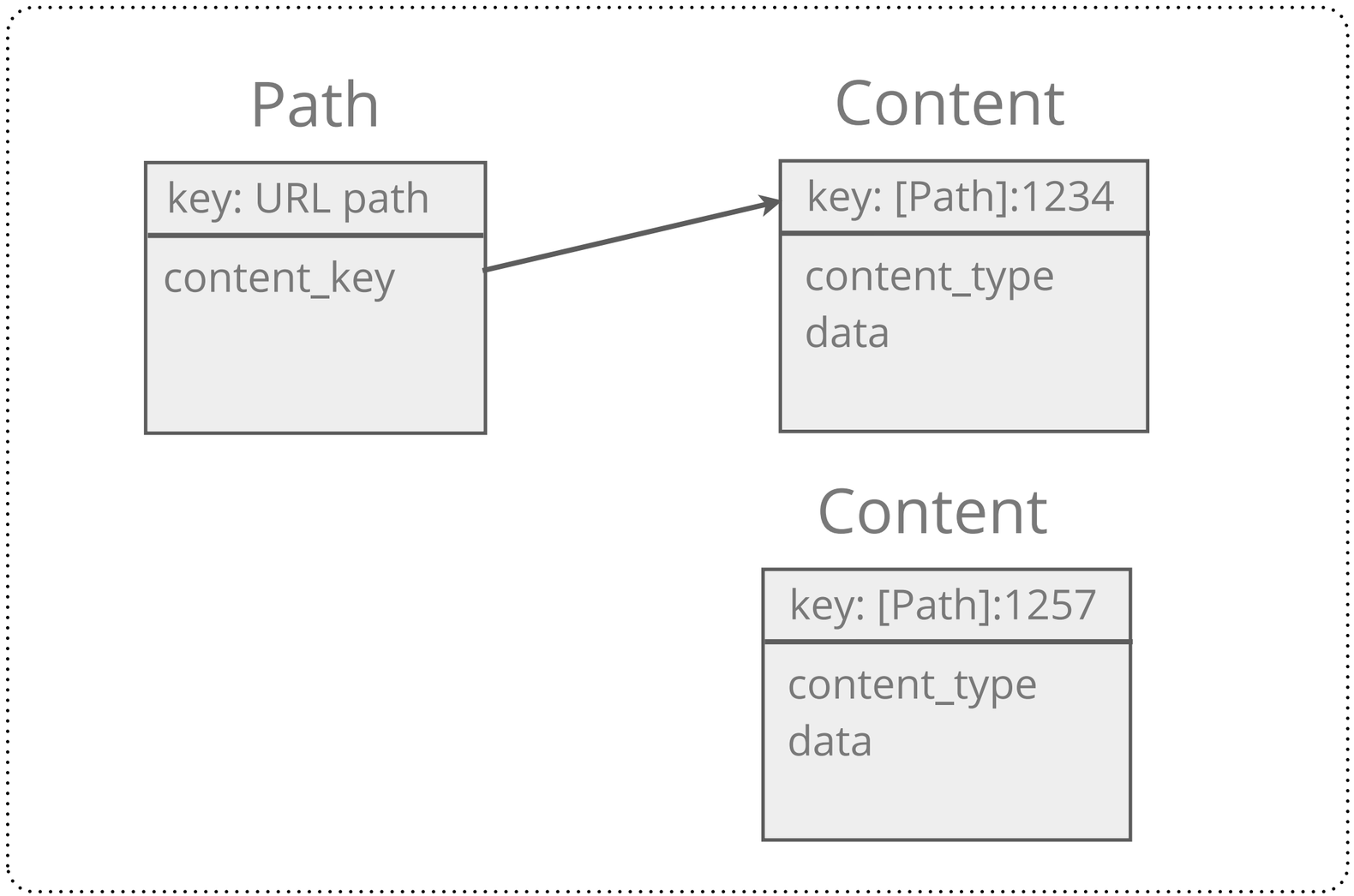
- Entity grouping for content objects?
- Idea: One group per Path, containing the Path and multiple Content objects
- Can set content_key and delete old Content entity in one transaction



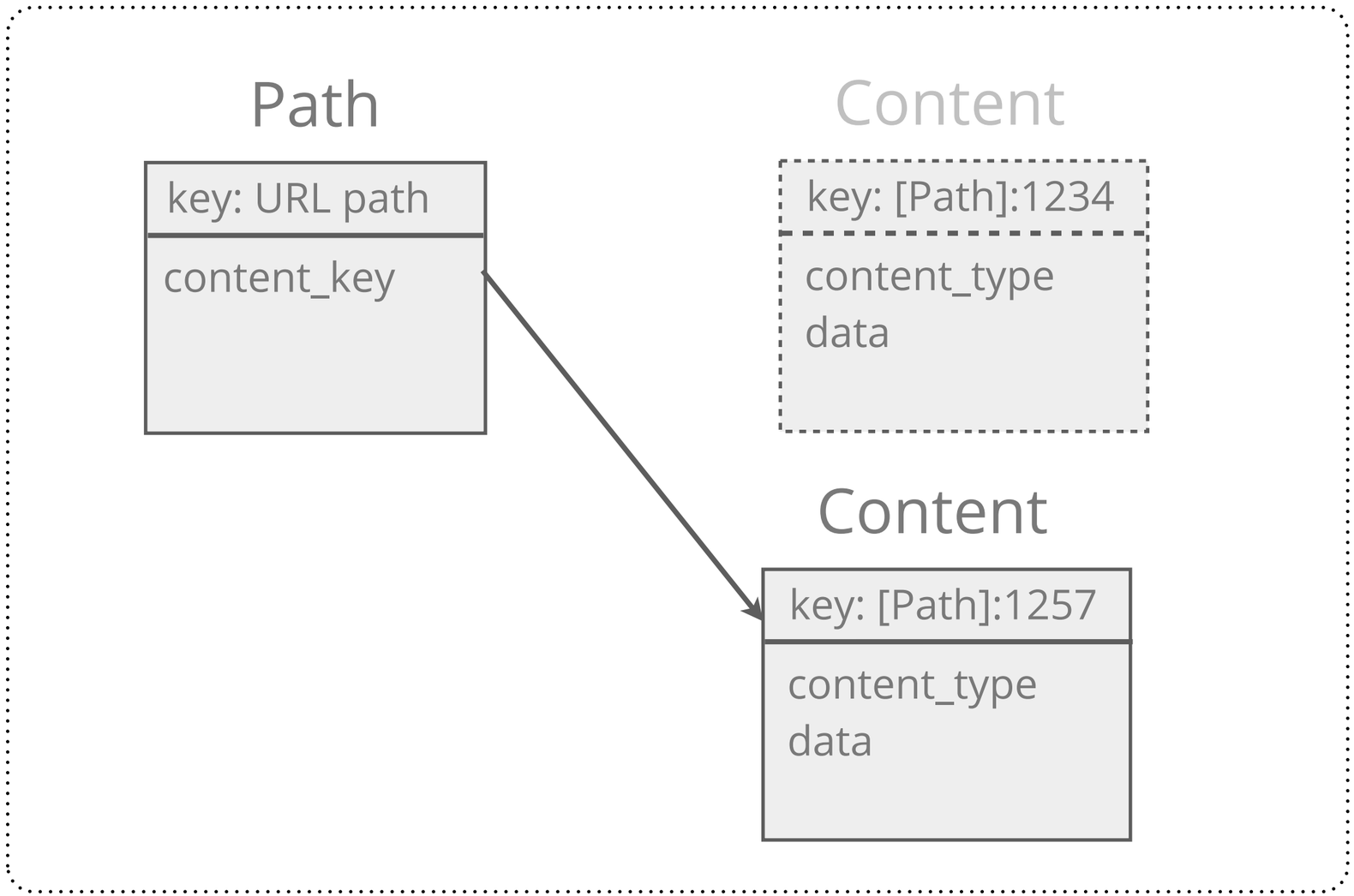
Data Modeling with ndb



Data Modeling with ndb



Data Modeling with ndb



Data Modeling with ndb

Path and Content Models

Python

```
class Path(ndb.Model):
    content_key = ndb.KeyProperty()
    is_deleted = ndb.BooleanProperty(default=False)
    last_applied_change_id = ndb.IntegerProperty()

    @classmethod
    def get_key(cls, path):
        return ndb.Key(cls, path)

class Content(ndb.Model):
    data = ndb.BlobProperty()
    content_type = ndb.StringProperty()

    @classmethod
    def get_key(cls, path, change_id):
        return ndb.Key(Path, path, cls, str(change_id))
```

Applying a Change

- Client calls the `commit()` method with the change ID
- Server updates the Change record and initiates the “apply” task
- Commit and apply task are stored transactionally
  - If either fails, neither occurs, and client sees the error
- Apply task spawns more tasks to paint the changes onto the website
- Any failed tasks get retried

Conflict Resolution

- What happens when two changes are applied out of order?
- Changes are ordered
- Store the last change ID with the Path
- Apply phase only “rolls forward”
- Deletes leave “tombstones,” so later deletes stick
  - `p.is_deleted = True, p.last_change_id = 1234`
  - can delete Content, but don’t delete Paths

Conflict Resolution

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- Changes are ordered
- Store the last change ID with the Path
- Apply phase only “rolls forward”
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  - `p.is_deleted = True, p.last_change_id = 1234`
  - can delete Content, but don’t delete Paths

Path

key: URL path
content_key=None is_deleted=True last_change_id=1234

Summary

- CMS with remote transactional publishing, arbitrary change size, eventual consistency
- Easy authenticated web services: **Google Cloud Endpoints**
- Transactional data storage: **Google Cloud Datastore**
- Data modeling: **ndb for Python**
- Background tasks: **App Engine Task Queue**
- Caching layer: **Memcache, ndb**
- Large object storage: **Google Cloud Storage**

Thanks!

developers.google.com

github.com/dansanderson
/site-publish

ae-book.appspot.com

Dan Sanderson
Programming Google App Engine, 2nd ed.

Large Asset Support

- Blobstore / Google Cloud Storage
- Uploading:
    - Client calls new endpoint for generating a Blobstore upload URL
    - Client makes MIME multipart POST to that URL
    - Server gets the Blobstore key, stores it in the Path
- Serving:
    - Server gets the Blobstore key in Path instead of Content key
    - Server puts Blobstore key in response, App Engine serves the file

Memcache

- Avoid hitting the datastore twice for every view request
- Use ndb to cache datastore entities automatically; just set a cache policy!
- Per-entity caching vs. result caching
- Don’t forget etags and cache controls

Faster Uploads

- Multi-threaded uploading
    - Be sure to use a separate `httplib2.Http()` instance per thread.
- Batched uploads in the upload API
- Not-modified check at start time
- Compressed payloads