Building Scalable Web Applications with Google App Engine

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Google
Developers


Build and Run Scalable Web Apps on Google's Infrastructure
Programming
Google App Engine
O'REILLY
Google Press
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scalability

Each user gets the same quality of experience, regardless of how many users there are.

Google App Engine

- Platform for building scalable web applications
- Built on Google infrastructure
- Based on Google's internal best practices
- Pay for what you use
  - Apps, instance hours, storage, bandwidth, service calls
  - Free to start!
- Preview opened 2008; out of preview in 2011

Google App Engine

- Easy development
- Easy deployment
- No servers to manage, no OS to update; App Engine does this for you
- Based on standard technologies

Google App Engine

- Request handling infrastructure
- Application runtime environments
- Services
- Tools and libraries
- Administration Console

Demo

Request Handlers

Request Handlers

- Requests come in, responses go out
- Request handler computes the response for a request
- Call services to manipulate stored data, perform special tasks
- Handler created when request arrives, destroyed after response is sent
- “Stateless” → scalability

Request Handlers

- All code runs in a request handler
- Web hooks
- Unit of computation for larger jobs

Instances

- Longer-lived containers for request handlers
- Reduce initialization costs
- Maximize CPU utilization
- Exploit instance RAM
- Parameters to tune instance creation and destruction
- “Instance hours” are the billable unit for computation

Runtime Environments

Runtime Environments

- Python
  - Python 2.7; Python 2.5
  - WSGI; CGI
- Java
  - Full Java 6 JVM, J2EE servlet container
  - Java, Scala, Ruby (JRuby), PHP (Quercus), JavaScript (Rhino), Python (JPython)
- Go

Runtime Environments

```
import logging
import webapp2

class MainPage(webapp2.RequestHandler):
    def get(self):
        status = self.request.get(‘status’)
        if status not in ('running', 'error', 'success'):
            logging.warning('Invalid status')
            status = ‘error’

        template = template_env.get_template('home.html')
        context = {
            'status': status,
        }
        self.response.out.write(template.render(context))

application = webapp2.WSGIApplication([('/', MainPage)],
                                      debug=True)
```

Runtime Environments

```
import javax.servlet.http.*;

@SuppressWarnings("serial")
public class MainPageServlet extends HttpServlet {
    public void doGet(HttpServletRequest req,
                      HttpServletResponse resp)
        throws IOException, ServletException {
            String status = req.getAttribute("status");
            if (!status.equals("running") ||
                !status.equals("success"))
                status = "error";

            req.setAttribute("status", status);
            resp.setContentType("text/html");
            RequestDispatcher jsp =
                req.getRequestDispatcher("/WEB-INF/home.jsp");
            jsp.forward(req, resp);
        }
    }
```

Runtime Environments

- Sandboxing
  - Data isolation
  - Performance isolation
- Sandboxing → scalability

Runtime Environments

- Limits
  - Request timer
  - Restricted access to filesystem, sockets
  - More performance isolation: RAM, CPU
  - Data sizes: requests, responses, API calls, storage objects
- Limits → scalability

Services

Services

- Features with their own scalable infrastructure
- Architecturally distinct from the runtime environments
- Synchronous and asychronous calling APIs

Services

- Data storage
- Communication
- Data processing and manipulation
- Computation primitives

Datastore

- Scalable object storage
- Replication using Paxos
- Named properties, typed values
- “Schemaless;” data modeling libraries
- Keys, kinds, and indexed queries

Datastore

```
from google.appengine.ext import db

class UserPrefs(db.Model):
    user = db.UserProperty(auto_current_user_add=True)
    created_datetime = db.DateTimeProperty(auto_now_add=True)
    tz_offset = db.IntegerProperty(default=0)
    subscribed = db.BooleanProperty()
```

```
class NewUser(webapp2.RequestHandler):
    def post(self):
        new_user = UserPrefs()
        new_user.subscribed = \
            self.request.get('subscribed')) is not None
        new_user.put()

        self.redirect('/welcome')
```

Datastore

- Datastore queries
  - *All queries are pre-indexed*
  - Built-in indexes do most of the work
  - Custom indexes for complex queries; SDK helps you out
  - Cursors

Datastore

```
query = UserPrefs.all()
query.filter('subscribed =', True)

for userPref in query:
    # ... userPref.user ...
```

Datastore

Each user gets the same quality of experience, regardless of how many users there are.

- Fetch by key: O(1)
- Create and update: O(1)
- Queries: O(*number of results*)
  - *not* the total number of entities!

Datastore

- Transactional
- Local transactions
- Strong consistency
- Eventually consistent cross-group transactions
- Local and global indexes

Memcache

- Non-durable key-value store
- Distributed global cache
- Atomic set/add/replace, get, incr/decr of a single value
- Essential technique for speeding up user requests

Blobstore

- Datastore and Memcache limited to 1MB objects
- Blobstore object size is *unlimited*
- Direct uploads and downloads
- Limited read/write app access

Communication

- HTTP
  - Out: URL Fetch
  - In: request handlers!
- *app-id*.appspot.com
- *www.your-domain.com*
- SSL: https://*app-id*.appspot.com/ ;
  custom domain support soon

Communication

- Email
  - Out: a simple service call
  - In: request handlers!
- *app-id*@appspotmail.com
- *anything*@*app-id*.appspotmail.com
- “From” addresses: administrator, receiving address, current user (Google Accounts)

Communication

- Instant messages (XMPP)
  - Out: a simple service call
  - In: request handlers!

- Addresses (“JIDs”)
  - *app-id*@appspot.com
    anything@*app-id*.appspotchat.com
  - (No custom domain support.)

Communication

- Channels
- Real-time push messages to browsers
- Comet connection
- JavaScript adapter provided

Data Processing

- Images
- Search *(experimental!)*
- Prospective search *(experimental!)*

Task Queues

- Defer work out of the user request
- Add a task to a queue, loosely FIFO
- Producers and consumers

Task Queues

- Push queues
  - A task is a request to your app!
    URL path + data
  - Processed at a configurable rate
  - Retried until “successful”
  - Task chains
  - App is both producer and consumer

Task Queues

- Pull queues
  - A task is any kind of payload
  - Consumer API can pull tasks individually or in batches
  - App API; useful with backends!
  - Authenticated REST API

Task Queues

You can enqueue tasks in a datastore transaction!

Tools and Libraries

Language-specific APIs

- Access services using the idioms of the language (Python, Java, Go)
- Manage synchronous and asynchronous calls
- Stubs for testing

Data Modeling

- Translate between datastore entities and program objects
- Enforce data schemas and structures
- Python: ext.db, ext.ndb
- Java: datastore API; JDO, JPA; Objectify

Pipelines

- Execute multiple tasks over large-scale data with parallelism
- Construct task dependencies
- Job status monitor
- http://code.google.com/p/appengine-pipeline

MapReduce

- Large-scale data processing
- Simple programming model
  - map(item) → (key, value)*
  - *shuffle*
  - reduce(key, values) → result
- Can chain multiple MapReduces using pipelines

MapReduce

- App Engine implementation mostly in application code!
  - http://code.google.com/p/appengine-mapreduce
- Primitive operations in services, e.g. Blobstore
- *Experimental*

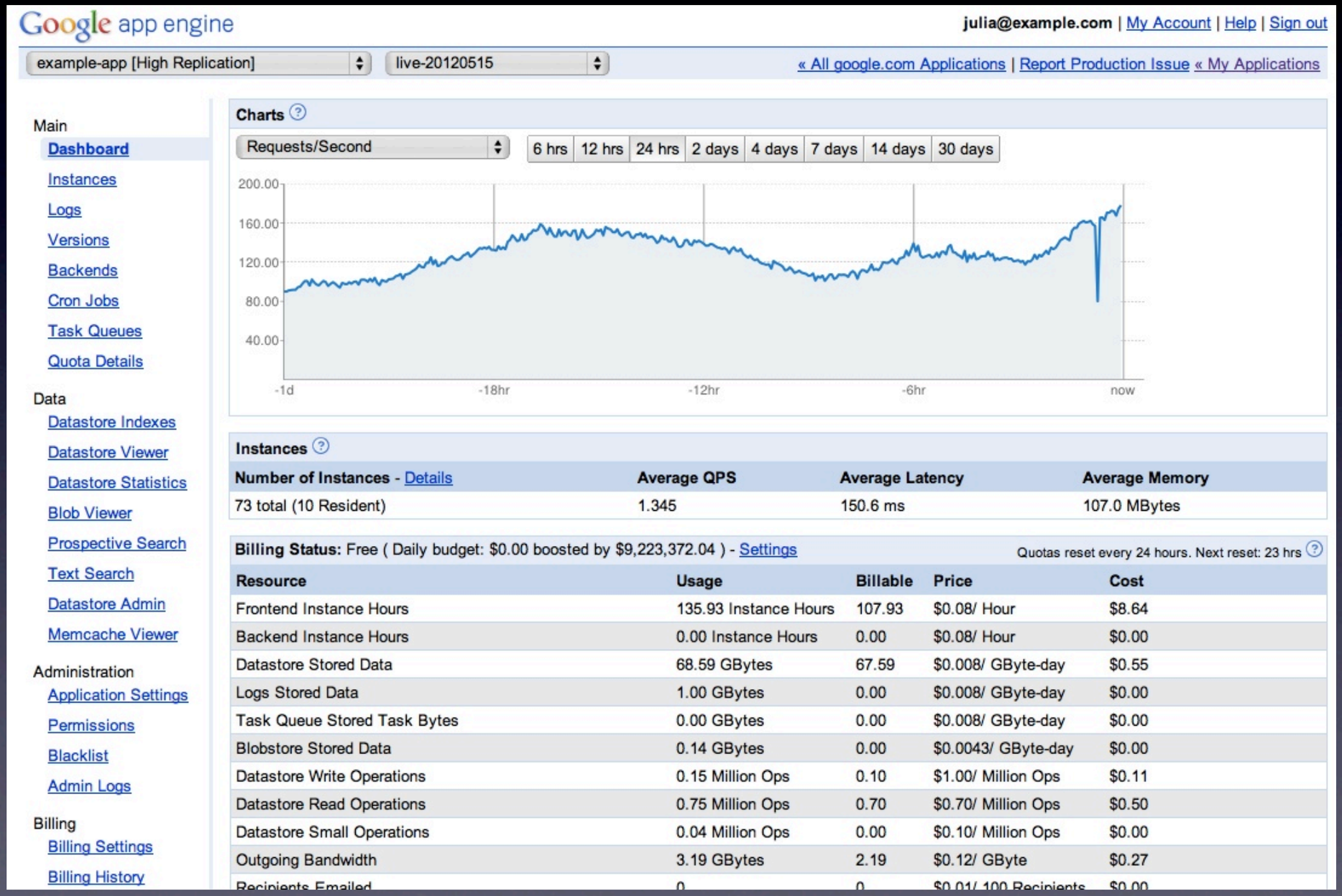
Development Server

- Simulates runtime environment and services on your local computer
- Suitable for functional testing
- Python: Launcher, dev_appserver.py
- Java: Eclipse plugin, dev_appserver.sh

Deployment Tools

- Deploy software, files, configuration
- Download logs for offline analysis
- Python: Launcher, appcfg.py
- Java: Eclipse plugin, appcfg.sh

Administration Console



Administration Console

- View traffic graphs
- Browse and search logs
- Inspect live data; backup/restore
- Manage instances
- Adjust budget and billing settings

Google App Engine

- Request handling infrastructure
- Computation infrastructure
- Storage: fast, durable, arbitrarily large
- Simple development model,
  high productivity
- Managed infrastructure: just add code

developers.google.com/appengine

appengine.google.com

ae-book.appspot.com

Programming Google App Engine, 2nd ed.
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