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From Spark Plug to Drive Train: Life of an App Engine Request

Fred Sauer
June 9, 2009

Based on original presentation by Alon Levi

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From Spark Plug to Drive Train: Life of an App Engine Request

This talk does not...

- ...tell you how to write an App Engine app
- ...provide any code samples
- ...include programming language specific material

What we will cover today...

- Overview of App Engine platform
- Understand components in the stack
- Explore our design motivations
- What this means for your apps

Agenda

- **How to design for Scale and Reliability**

- **App Engine: Design Motivations**

- **Life of a Request:**

1. Request for static content
2. Request for dynamic content
3. Requests accessing APIs

- **App Engine: Design Motivations (Recap)**

- **App Engine: The Numbers**

How to design for Scale and Reliability

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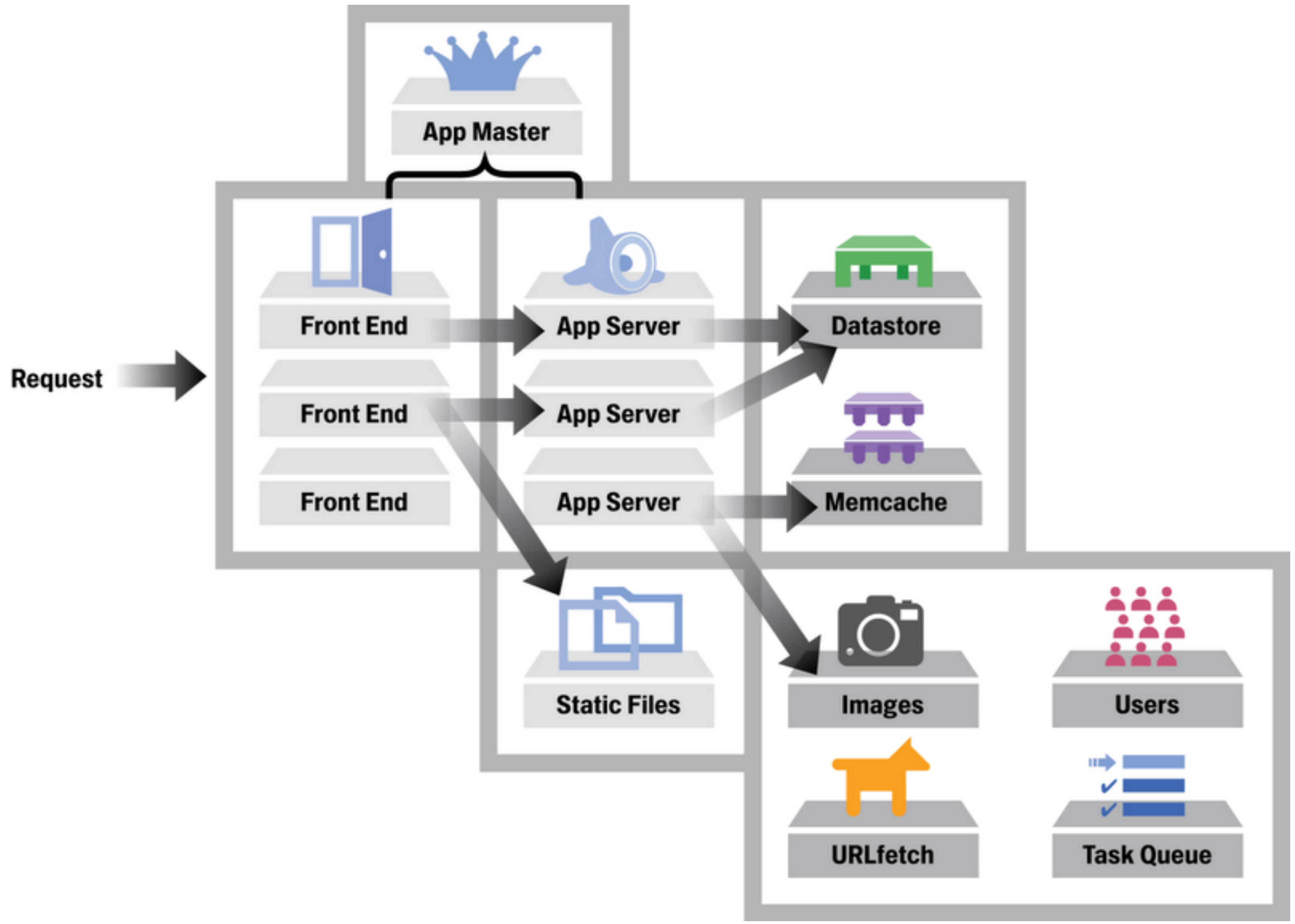
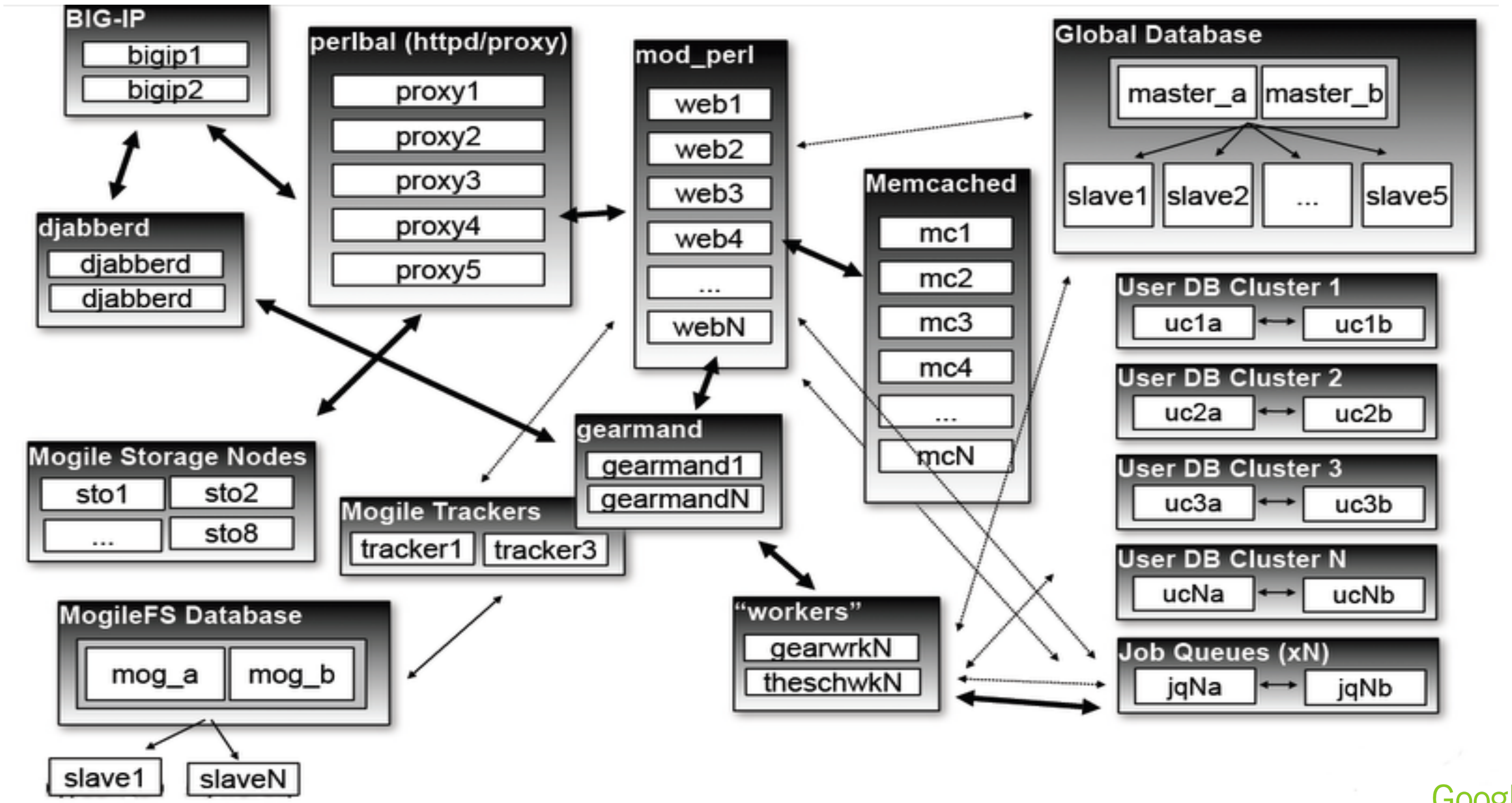
Google App Engine



LiveJournal circa 2007

From Brad Fitzpatrick's USENIX '07 talk:
"LiveJournal: Behind the Scenes"



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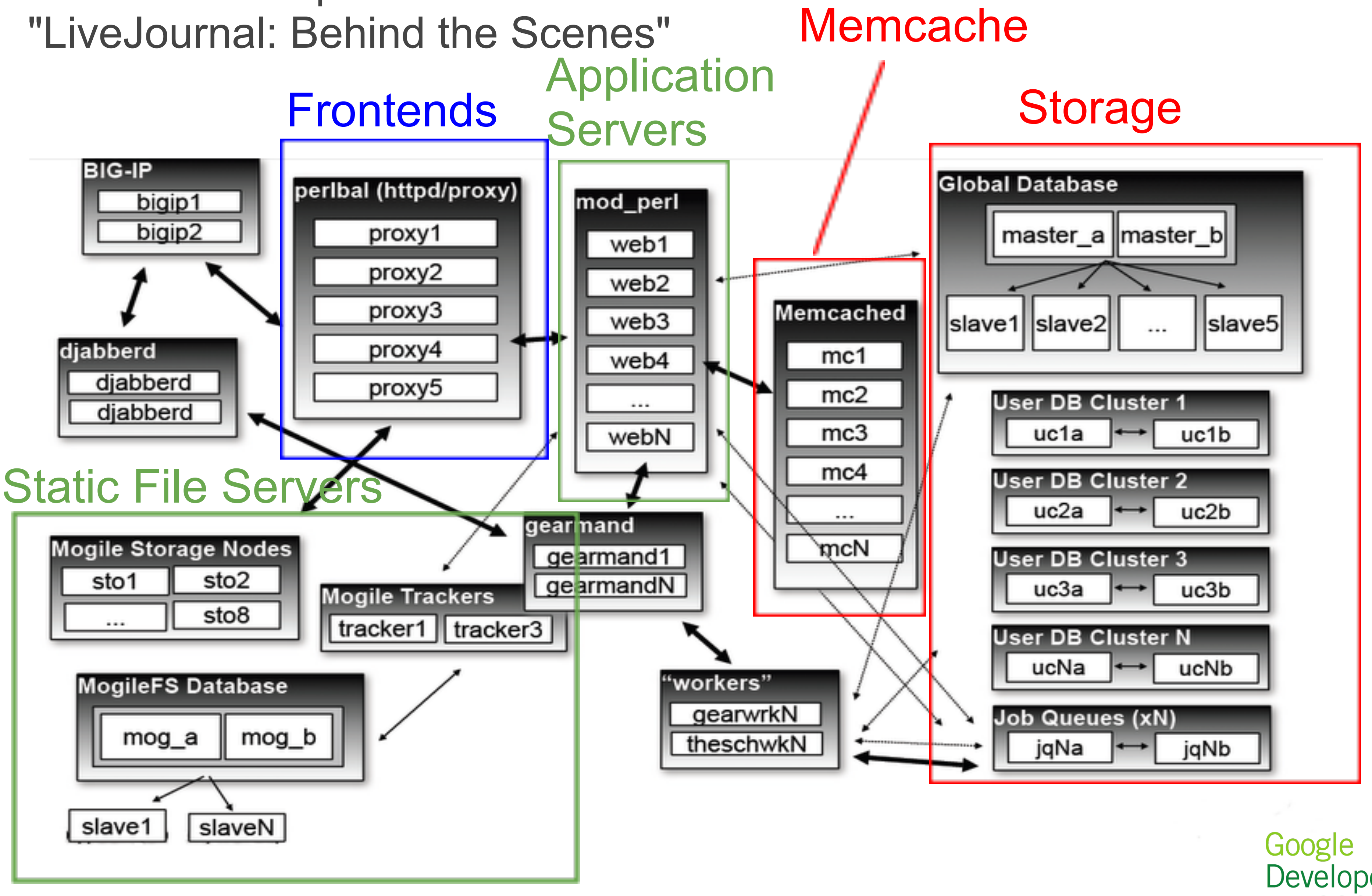

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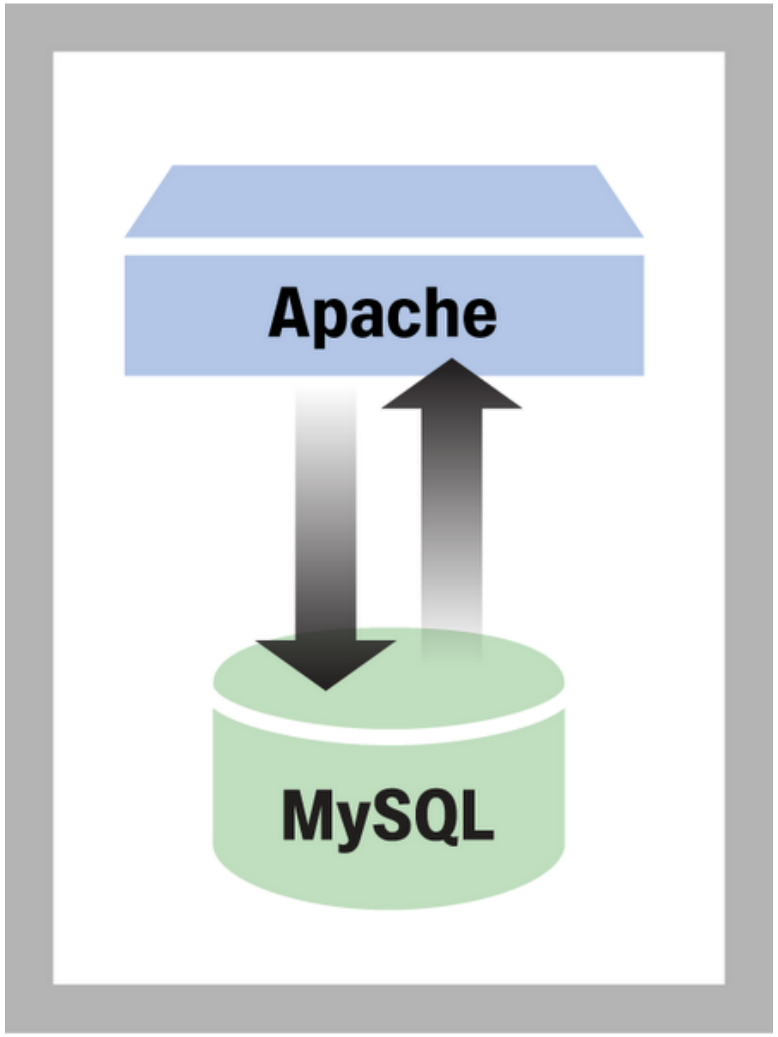
Basic LAMP

LAMP
- **L**inux
- **A**pache
- **M**ySQL
- **P**rogramming Language (**p**erl, **P**ython, **P**HP, ...)

Scalable?
- Shared machine for database and webserver

Reliable?
- Single point of failure (SPOF)



Dedicated Database

Database running on a separate server

Requirements:

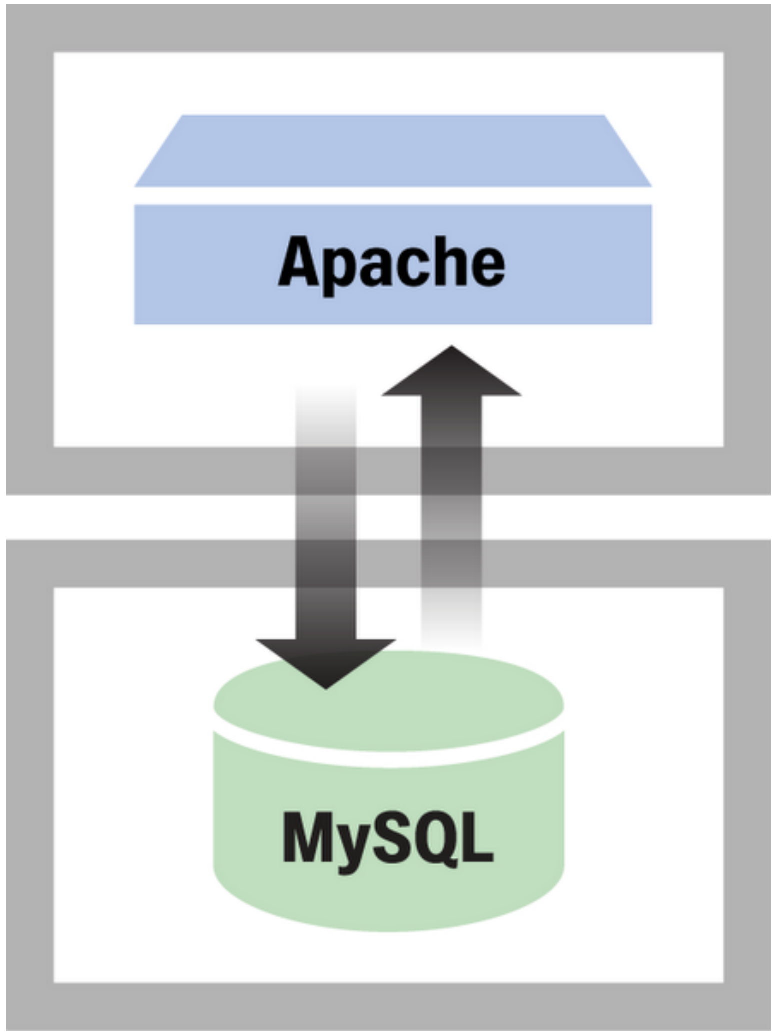
- Another machine plus additional management

Scalable?

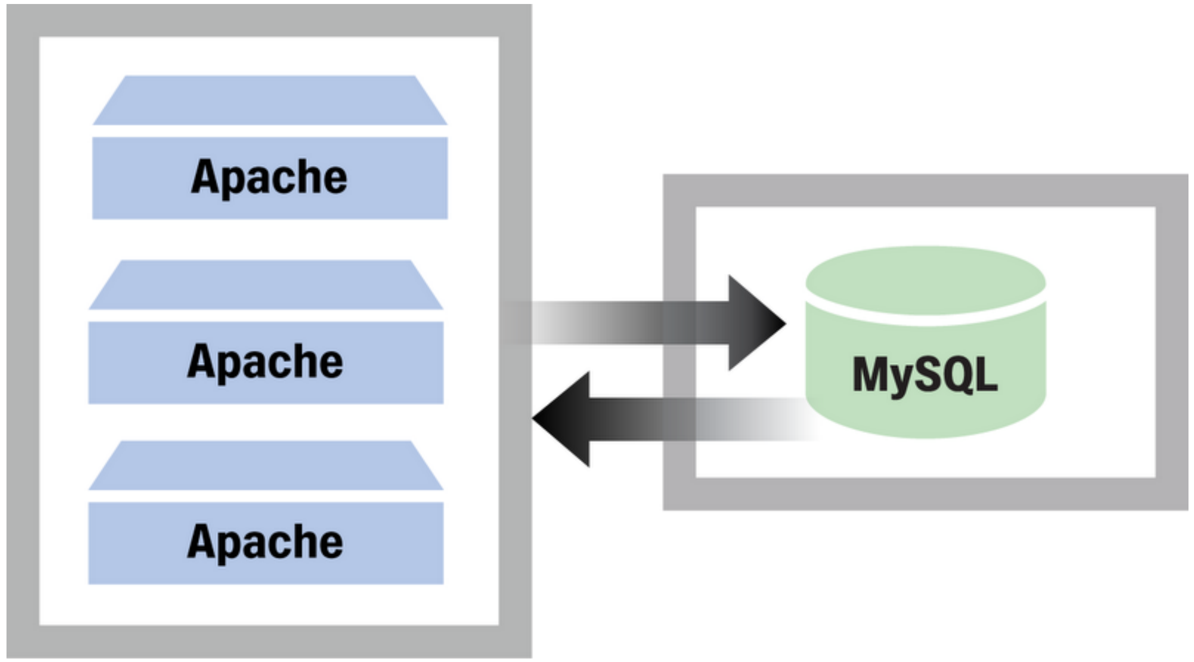
- Up to one web server

Reliable?

- **Two** single points of failure



Multiple Web Servers



Benefits:

- Grow traffic beyond the capacity of one webserver

Requirements:

- More machines
- Set up load balancing

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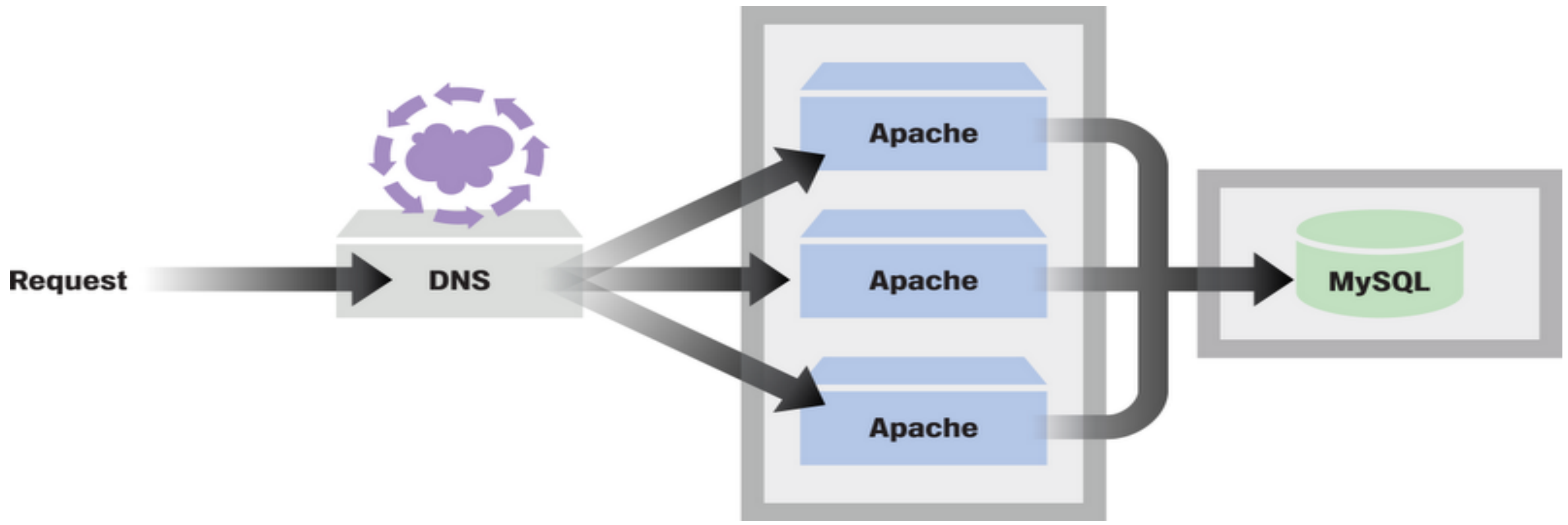
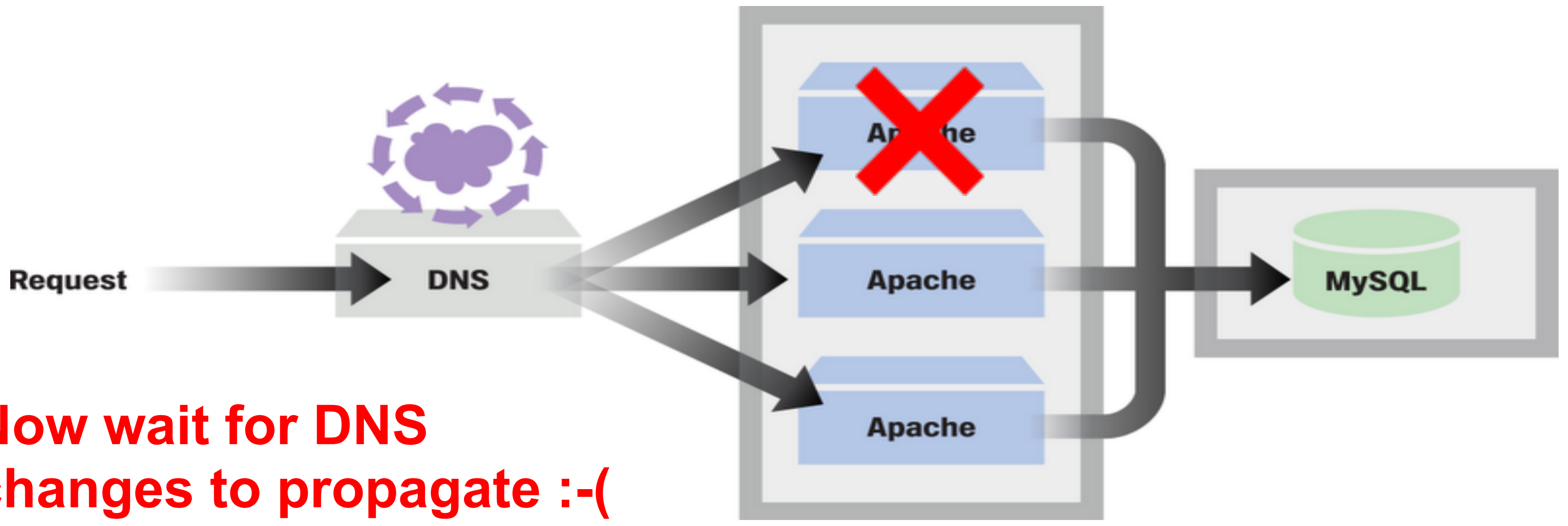
Load Balance: DNS Round Robin



- Register list of IPs with DNS
- Statistical load balancing
- DNS record is cached with a Time To Live (TTL)
    - TTL may not be respected

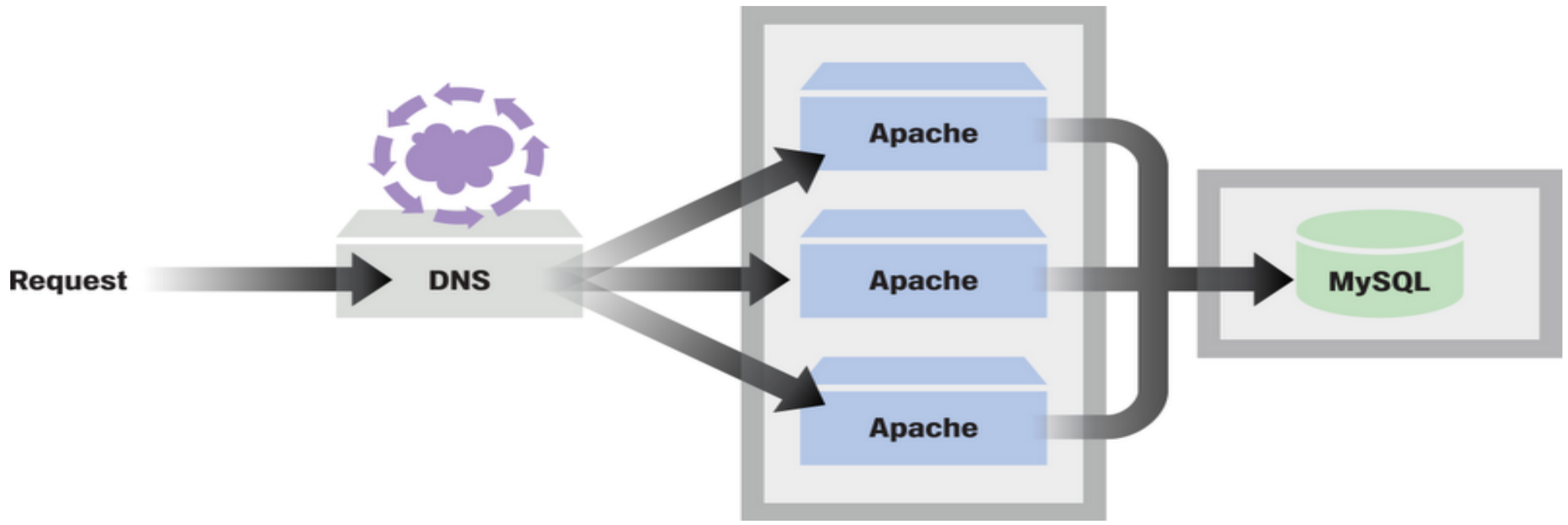
Load Balance: DNS Round Robin



Now wait for DNS changes to propagate :-(

- Register list of IPs with DNS
- Statistical load balancing
- DNS record is cached with Time To Live (TTL)
  - TTL may not be respected

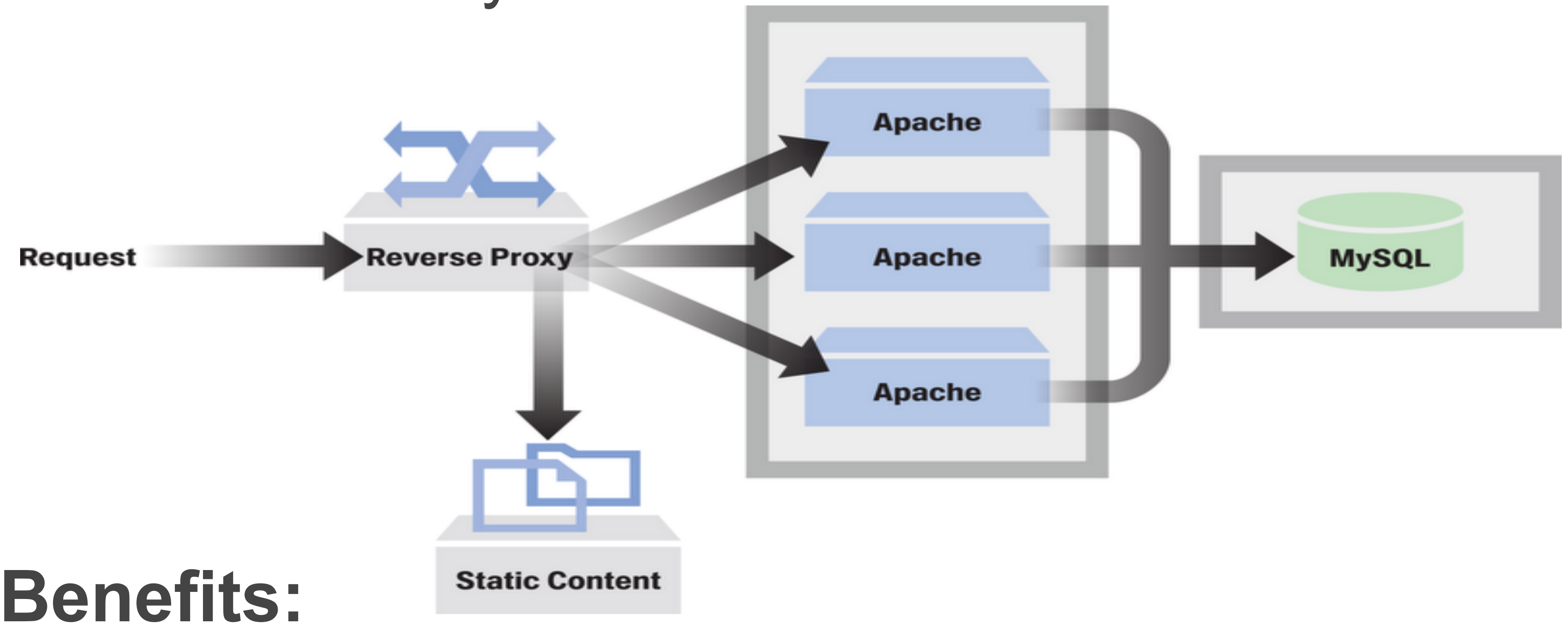
Load Balance: DNS Round Robin



Scalable?
- Add more webservers as necessary
- Still I/O bound on one database

Reliable?
- Cannot redirect traffic quickly
- Database still SPOF

Reverse Proxy



Benefits:

- Custom Routing
    - Specialization
    - Application-level load balancing

Requirements:

- More machines
- Configuration for reverse proxies

Reverse Proxy

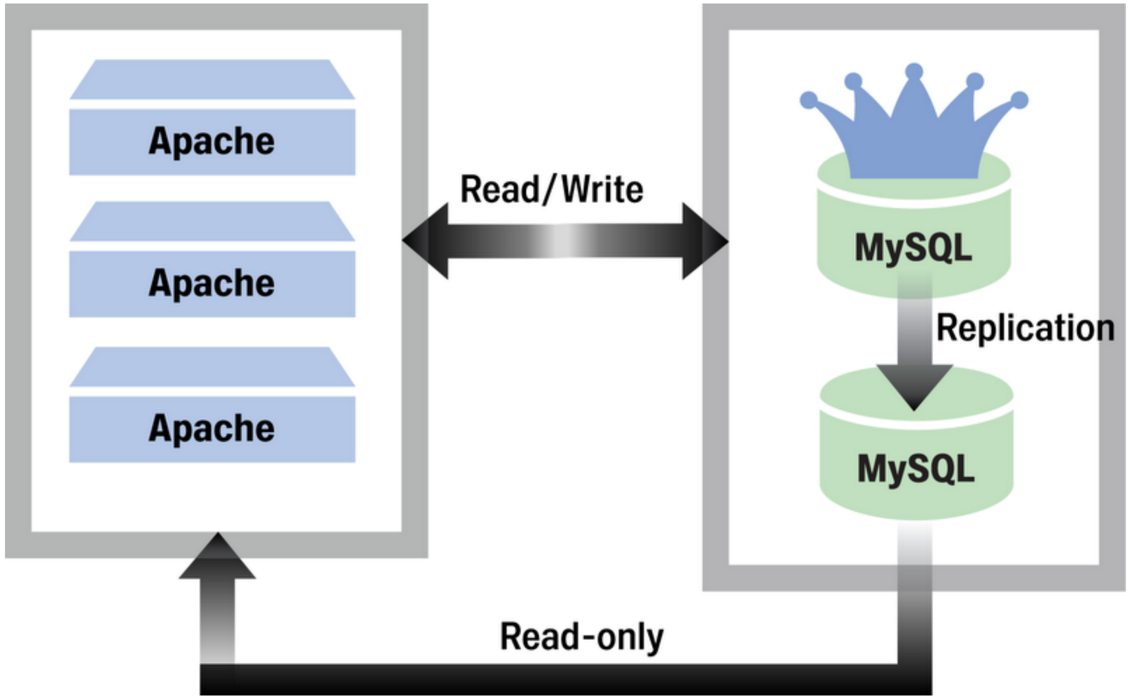
Scalable?

- Add more web servers
- Bound by
  - Routing capacity of reverse proxy
  - One database server

Reliable?

- Agile application-level routing
- Specialized components are more robust
- Multiple reverse proxies requires network-level routing
  - Fancy network routing hardware
- Database is still SPOF

Master-Slave Database



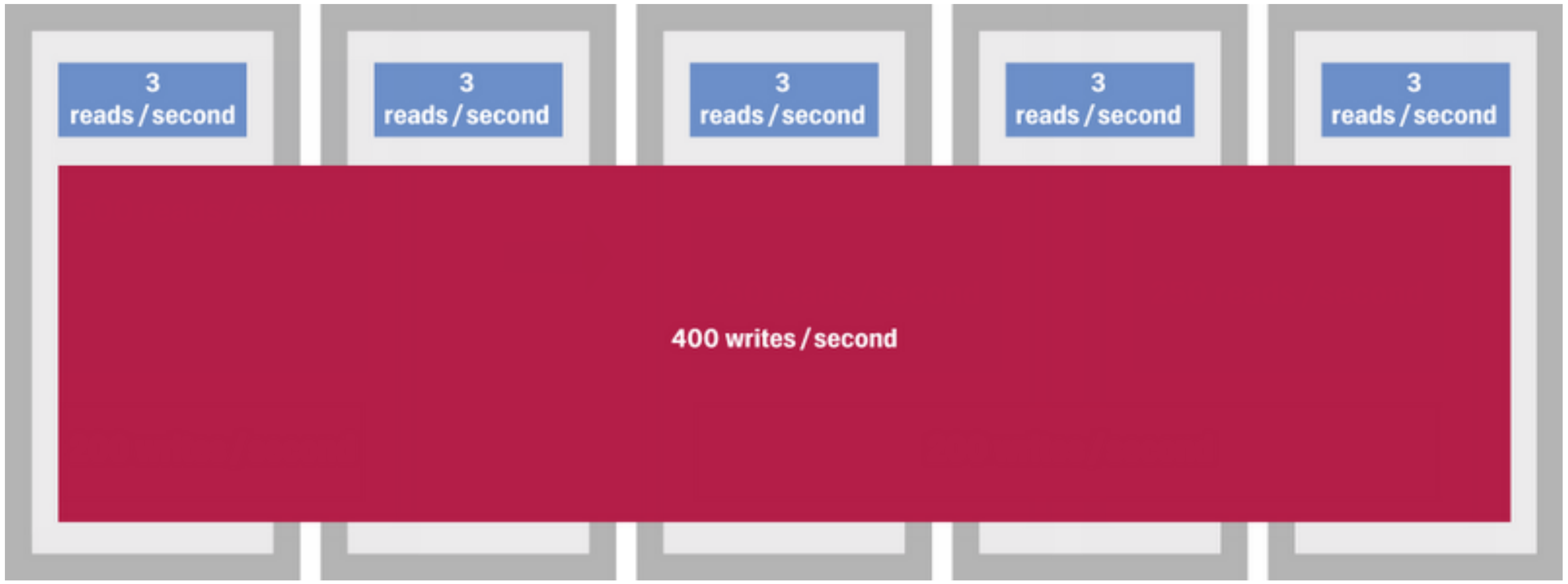
Benefits:
- Better read throughput
- Invisible to application

Requirements:
- Even more machines
- Changes to MySQL, additional maintenance

Master-Slave Database

Scalable?

- Scales read rate with # of servers
    - But not writes
- But what happens eventually?



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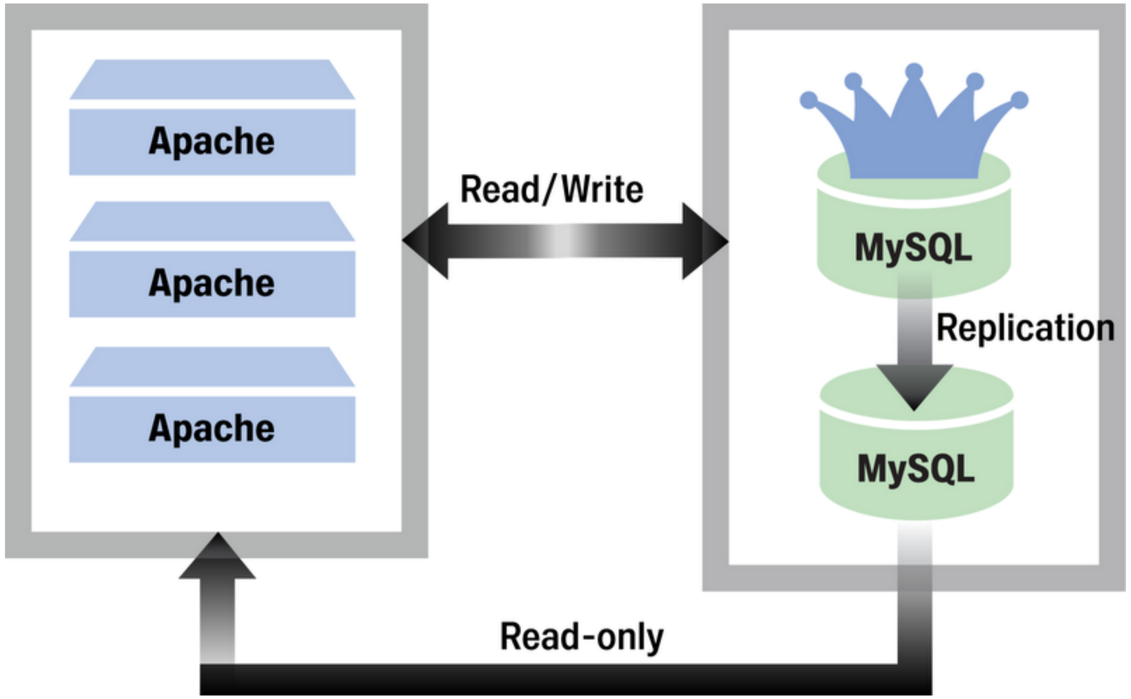
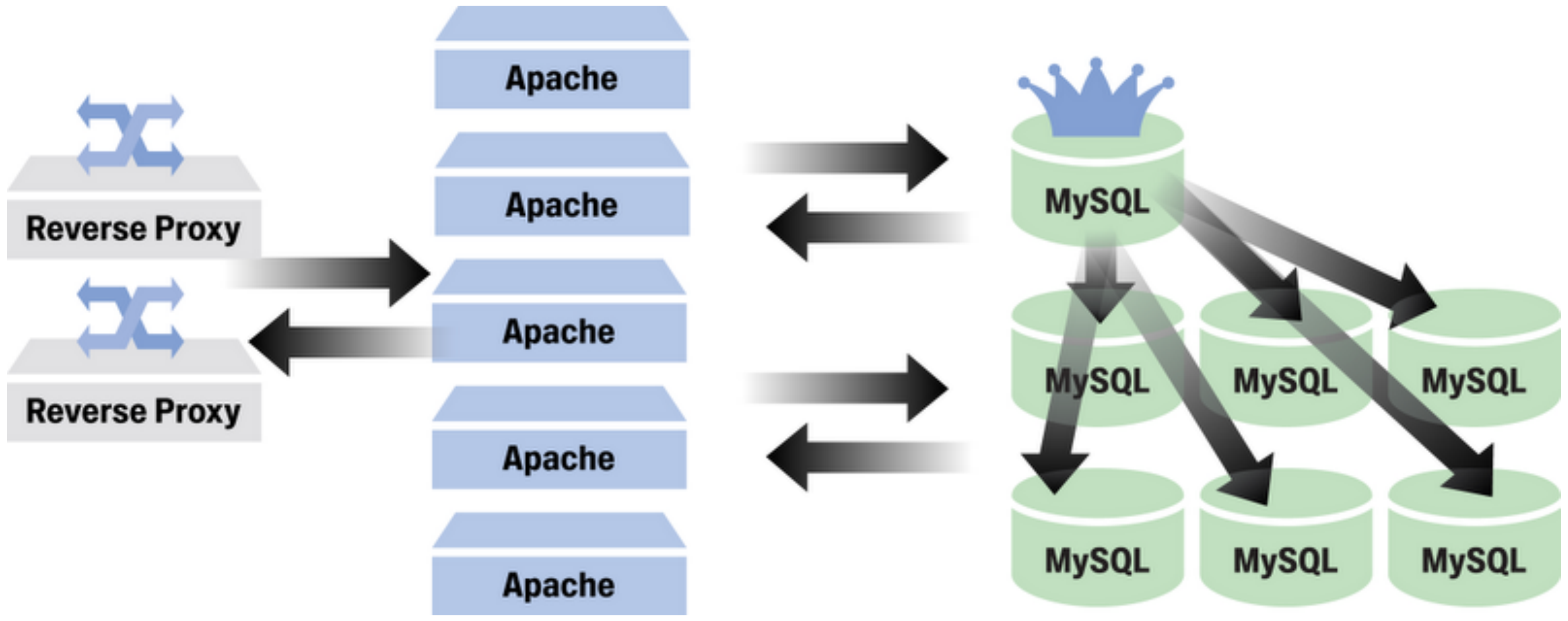
Master-Slave Database



Reliable?

- Master is SPOF for writes
- Master may die before replication

Partitioned Database



Benefits:

- Increase in both read and write throughput

Requirements:

- Even more machines
- Lots of management
- Re-architect data model
- Rewrite queries

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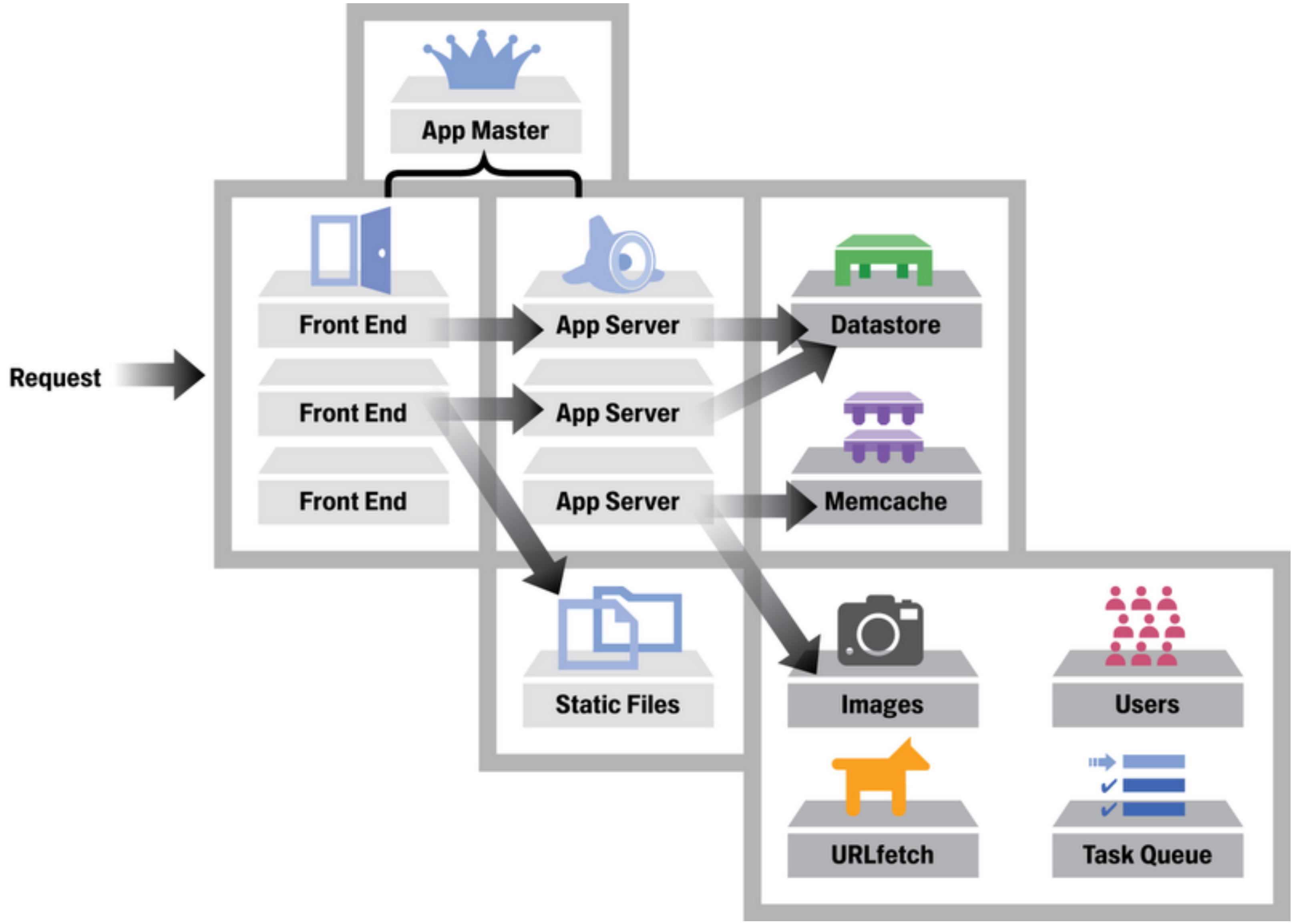
Why not use Google App Engine?



App Engine:
Design Motivations

Design Motivations

- **Build on Existing Google Technology**
- **Provide an Integrated Environment**
- **Encourage Small Per-Request Footprints**
- **Encourage Fast, Efficient Requests**
- **Maintain Isolation Between Applications**
- **Encourage Statelessness and Specialization**
- **Require Partitioned Data Model**

Life of an App Engine Request

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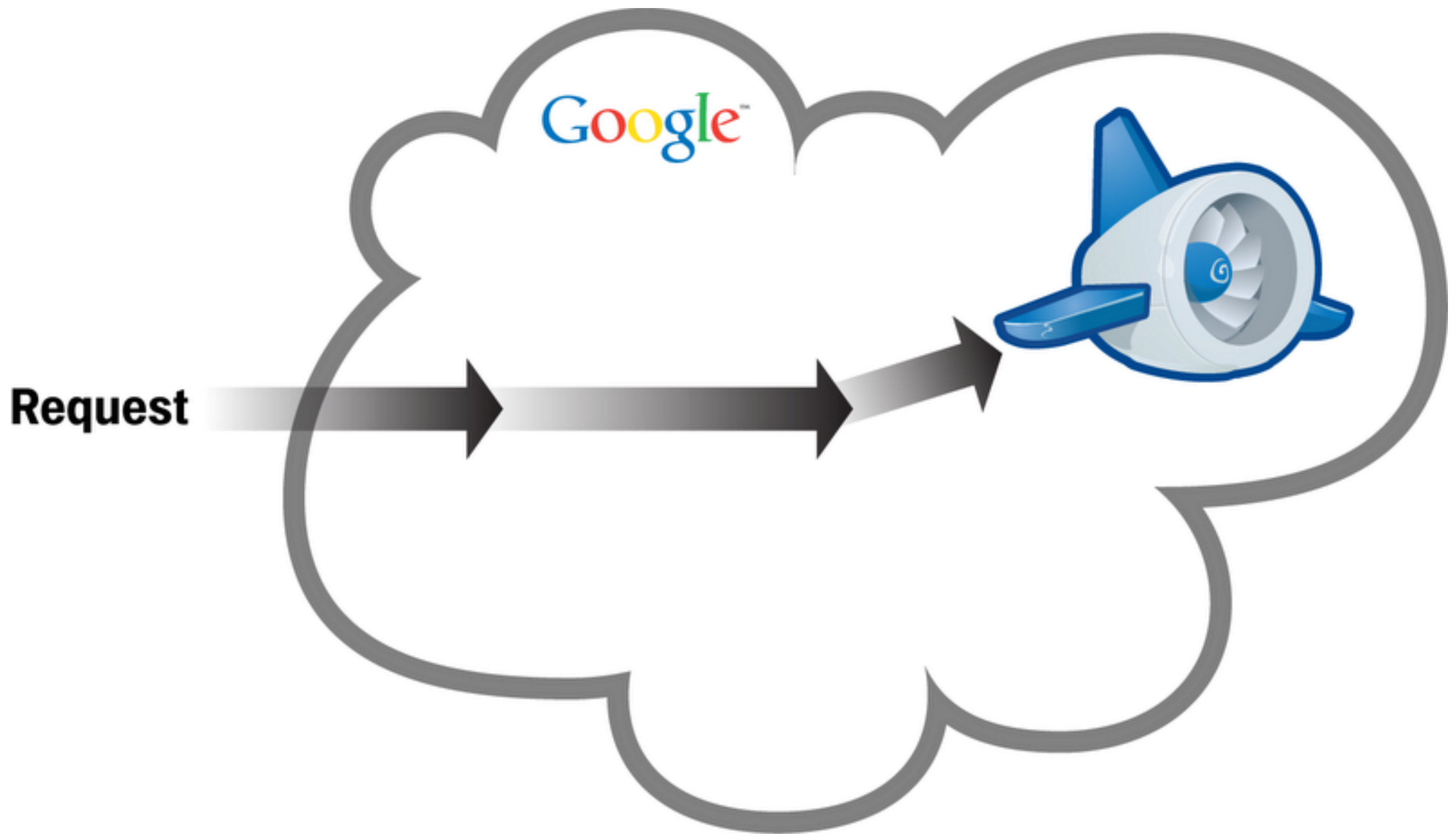
Life of an App Engine Request



- Routed to the nearest Google datacenter
- Travels over Google's network
  - Same infrastructure other Google products use
  - Lots of advantages for free

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Life of an App Engine Request:

1) Request for Static Content

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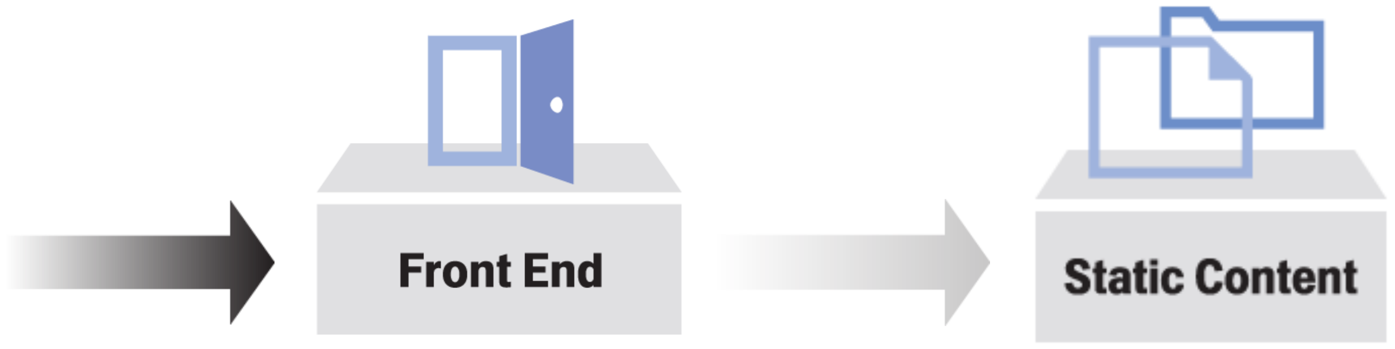
Request for Static Content

Routing at the Front End



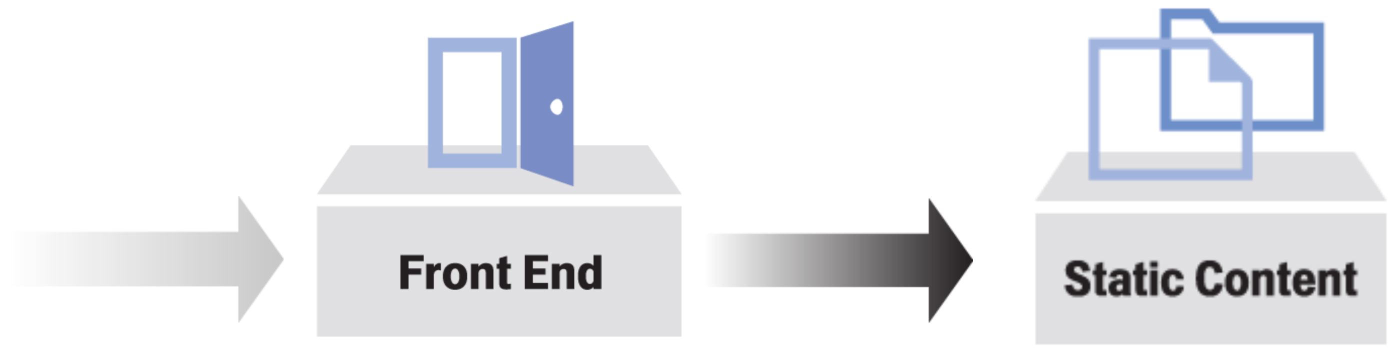
Google App Engine Front Ends

- Load balancing
- Routing

- Front Ends route static requests to specialized serving infrastructure

Request for Static Content

Static Content Servers



Google Static Content Serving

- Built on shared Google Infrastructure
- Static files are physically separate from code files

How are static files defined?

Request for Static Content

Defining static content

Java Runtime: appengine-web.xml

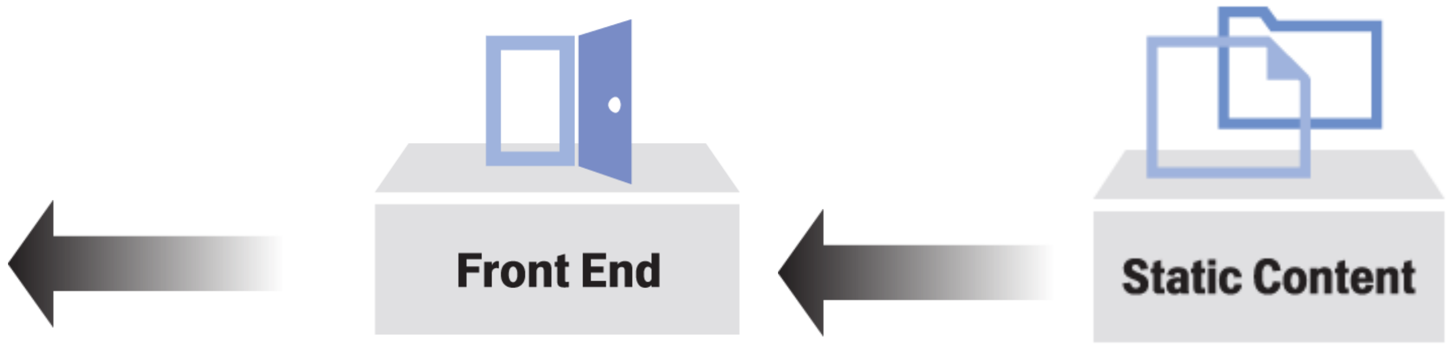
```
...
<static>
  <include path="/**.png" />
  <exclude path="/data/**.png />
</static>
...
```

Python Runtime: app.yaml

```
...
- url: /images
static_dir: static/images
OR
- url: /images/(.*)
static_files: static/images/\1
upload: static/images/(.*)
...
```

Request For Static Content

Response to the user



- Back to the Front End and out to the user
    - Front End handles connection to the user
    - Frees up Static Content server

- Specialized infrastructure
    - App Server runtimes don't serve static content

Life of an App Engine Request:

2) Request for Dynamic Content

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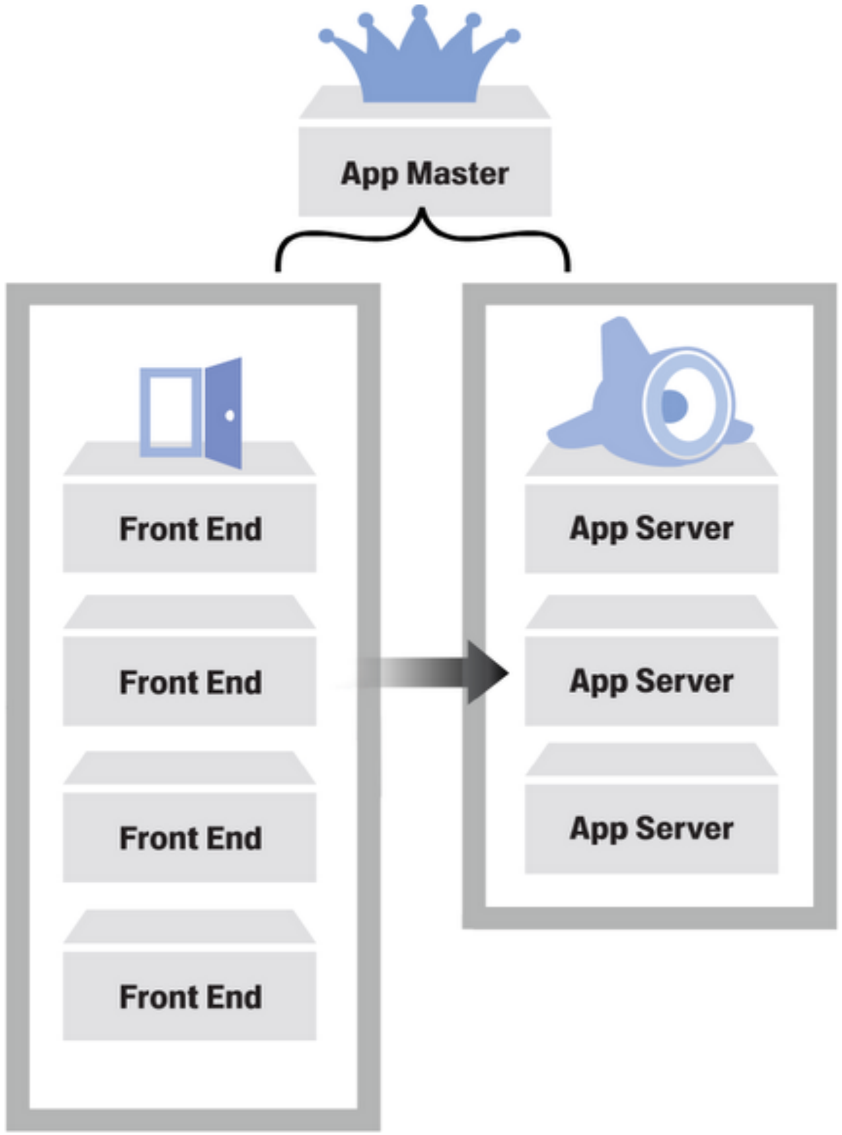
Request for Dynamic Content

Front Ends, App Servers and App Master

Front Ends
- Route dynamic requests to **App Servers**

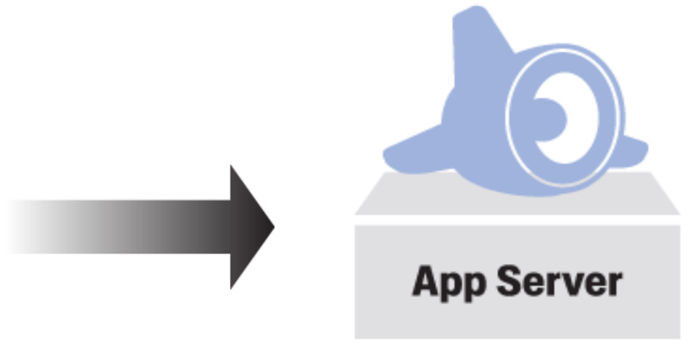
App Servers
- Serve dynamic requests
- Where your code runs

App Master
- Schedules applications
- Informs Front Ends



Request for Dynamic Content

App Server

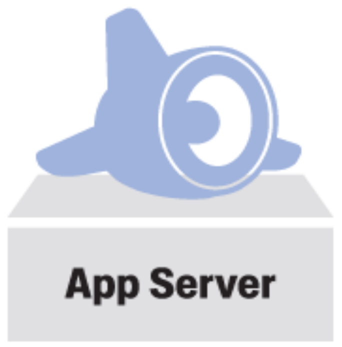


1. Checks for cached runtime
    - ○ If it exists, no initialization
2. Execute request
3. Cache the runtime

Consequences / Opportunities

- Slow first request, faster subsequent requests
- Optimistically cache data in your runtime!

App Servers - What do they do?



- Many applications
- Many concurrent requests
  - Smaller footprint + faster requests = more apps
- Enforce Isolation
  - Keeps apps safe from each other
- Enforce statelessness
  - Allows for scheduling flexibility
- Service API requests
  - Provides access to other services

Life of an App Engine Request:

3) Requests accessing APIs

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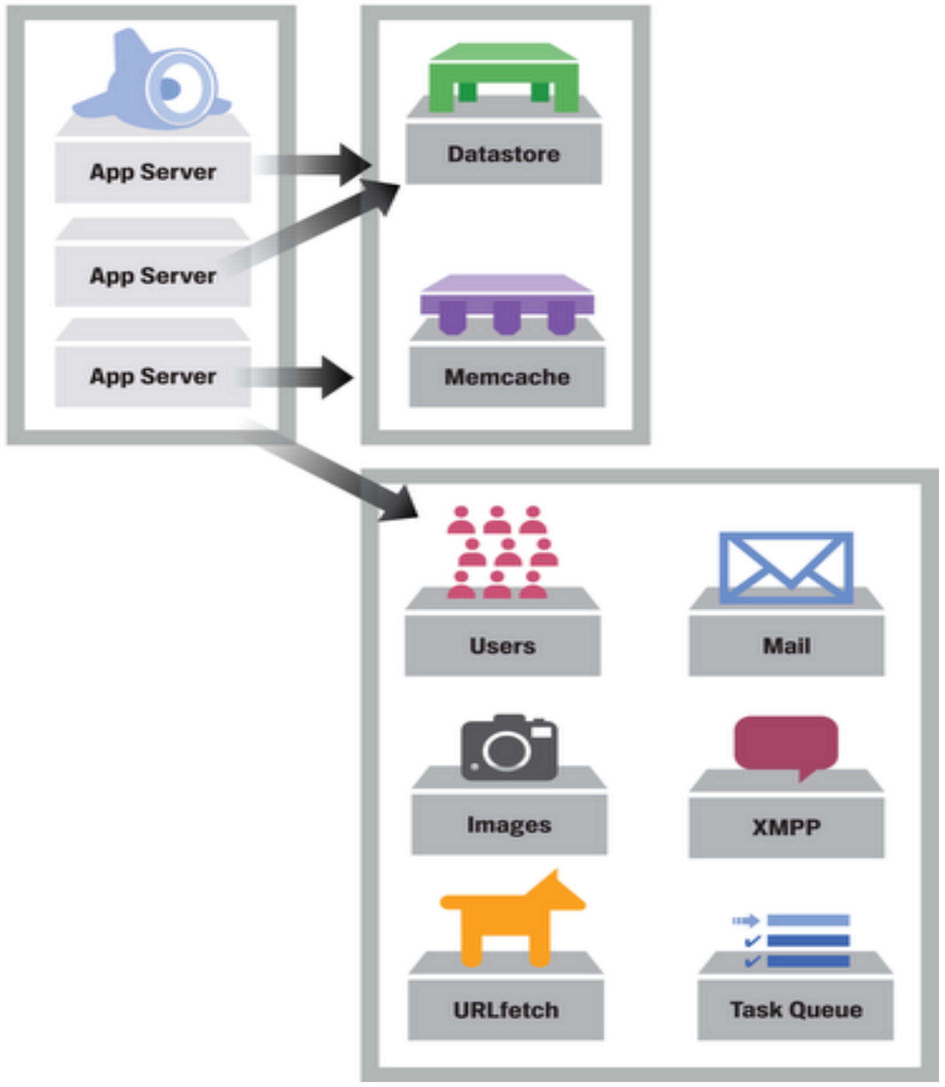
Requests accessing APIs

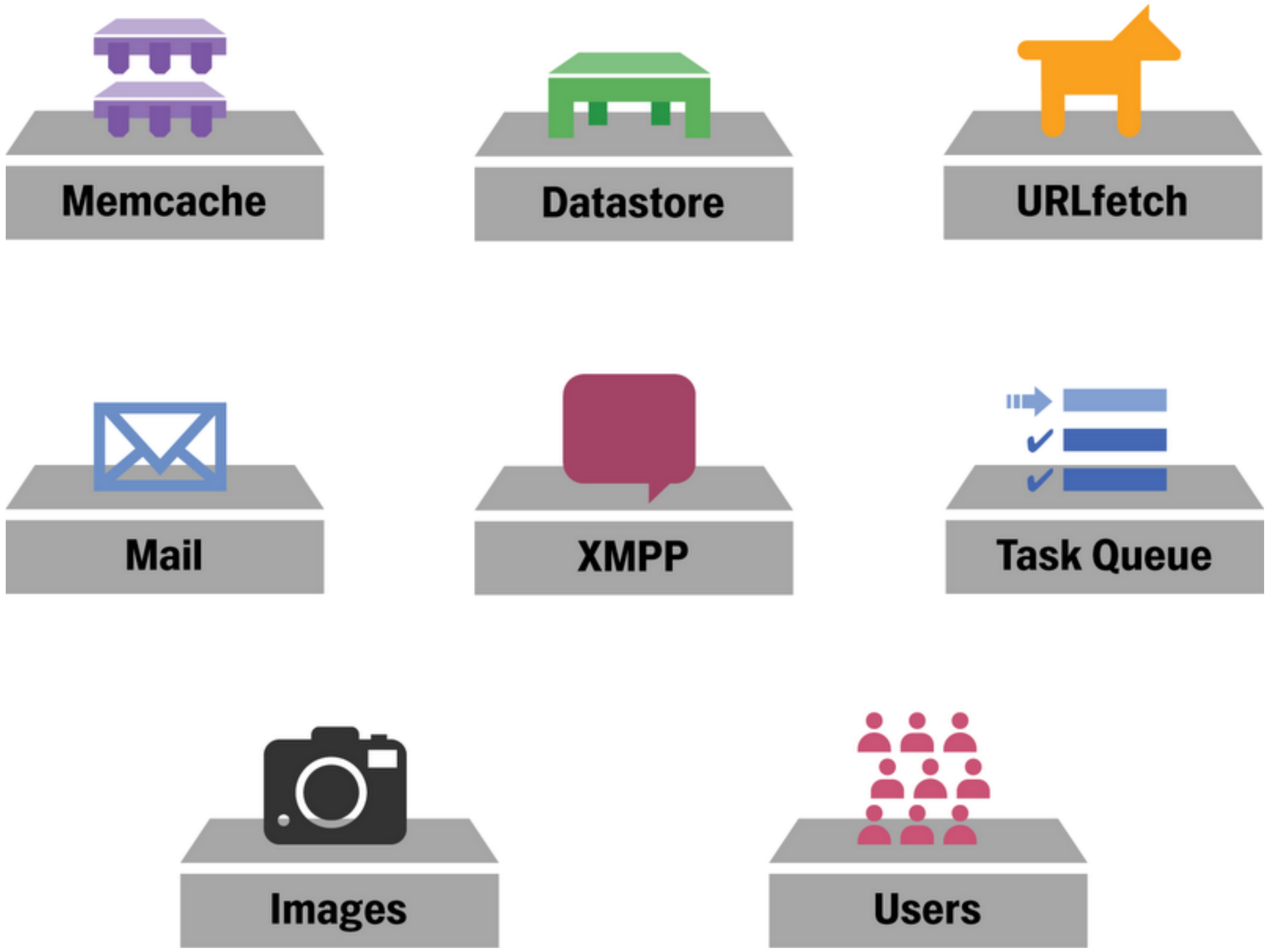
App Servers

1. App issues API call
2. App Server accepts
3. App Server blocks runtime
4. App Server issues call
5. Returns the response

- Use APIs to do things you don't want to do in your runtime, such as...

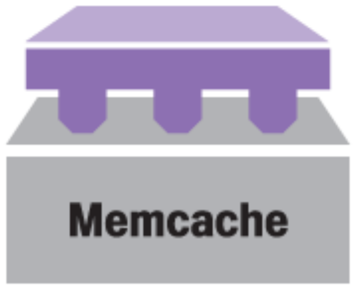


APIs


Memcache
Datastore
URLfetch
Mail
XMPP
Task Queue
Images
Users

Memcacheg

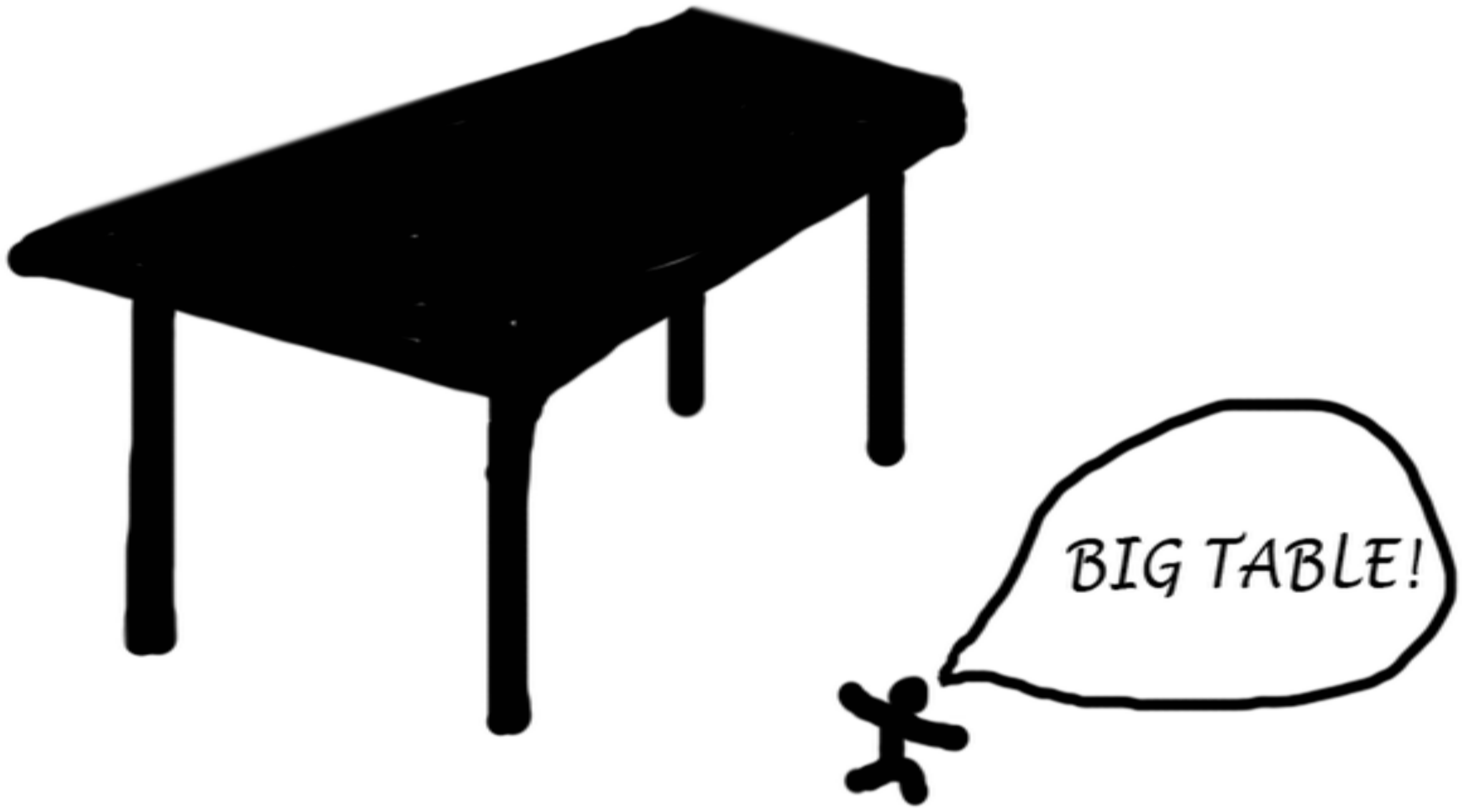
A more persistent in-memory cache



- Distributed in-memory cache
- Very fast
- memcacheg
  - Like memcached
  - Also written by Brad Fitzpatrick
  - adds: set_multi, get_multi, add_multi
- Optimistic caching
- Very stable, robust and specialized

The App Engine Datastore

Persistent storage



http://labs.google.com/papers/bigtable.html

The App Engine Datastore

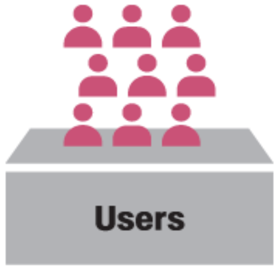
Persistent storage

- Your data is already partitioned on day one
  - Use Entity Groups
- Explicit Indexes make for fast reads
  - But slower writes
- Replicated and fault tolerant
  - On commit: ≥3 machines
  - Geographically distributed (shortly thereafter)
- Bonus: Keep globally unique IDs for free

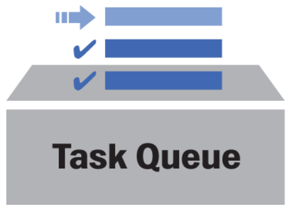
Other APIs

- GMail

- Gadget API

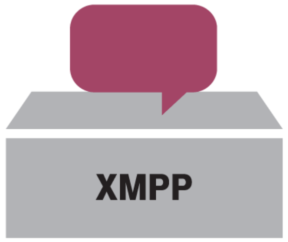


- Google Accounts



- On roadmap

- Picasaweb



- Google Talk

App Engine:
Design Motivations (Recap)

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Build on Existing Google Technology

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Provide an Integrated Environment

Why?

- Manage all apps together

What it means for your app:

- Encouraged to follow best practices
- Some restrictions
- Use our tools

Benefits:

- Use our tools
- Admin Console
- All of your logs in one place
- No machines to manage or count
- Easy deployment

Encourage Small Per-Request Footprints

Why?

- Better utilization of App Servers
- Fairness

What it means for your app:

- Less Memory Usage
- Limited CPU and wall clock time

Benefits:

- Better use of resources

Encourage Fast, Efficient Requests

Why?

- Better utilization of App Servers
- Fairness between applications
- Routing and scheduling agility

What it means for your app:

- Use runtime caching
- Request deadlines

Benefits:

- Optimistically share state between requests
- Better throughput
- Fault tolerance
- Better use of resources

Maintain Isolation Between Apps

Why?

- Safety
- Predictability

What it means for your app:

- Certain system calls unavailable

Benefits:

- Security
- Performance

Encourage Statelessness and Specialization

Why?

- App Server performance
- Scheduling flexibility
- Load balancing
- Fault tolerance

What this means for you app:

- Use API calls

Benefits:

- Automatic load balancing
- Fault tolerance
- Less code for you to write
- Better use of resources

Require Partitioned Data Model

Why?

- The Datastore is distributed

What this means for your app:

- Data model + Indexes
- Reads are fast, writes are slower
- Design for writes, enjoy fast reads

Benefits:

- Design your schema once
- No need to re-architect for scalability
- **More efficient use of CPU and memory**

App Engine:

The Numbers

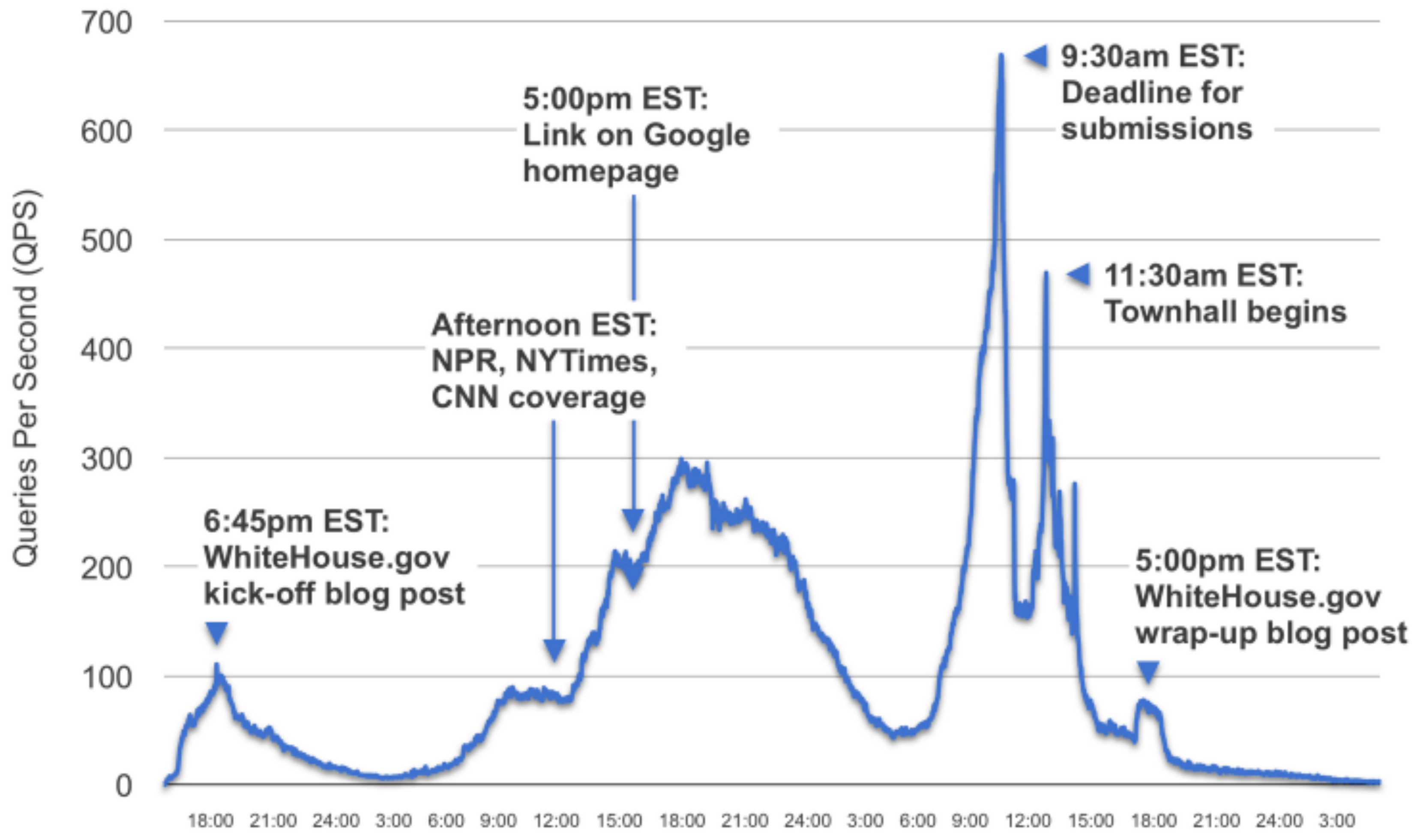
Google App Engine

- Currently, over **80K** applications
- Serving over **140M** pageviews per day
- Written by over **200K** developers
- **Two** supported languages: Python and Java
  - See also JRuby, Groovy, Scala, ...

http://groups.google.com/group/google-appengine-java/web/will-it-play-in-app-engine

Open For Questions

- The White House's "Open For Questions" application accepted **100K** questions and **3.6M** votes in under **48** hours



Thank You

Read more

http://code.google.com/appengine/

Contact info

Fred Sauer (twitter: @fredsa)Developer Advocate
fredsa@google.com

Questions

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