# the road to cloud native applications

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# cloud ready applications

single-tiered
monolithic
hardware specific

# cloud native applications

leverage cloud services
scalable
reliable

# Agenda

**Phase 1** | **Phase 2** | **Phase 3**

Follow the lecture

Profit

*Develop Cloud-Native Applications*

# Cloud Architecture Patterns

O'REILLY®

*Bill Wilder*

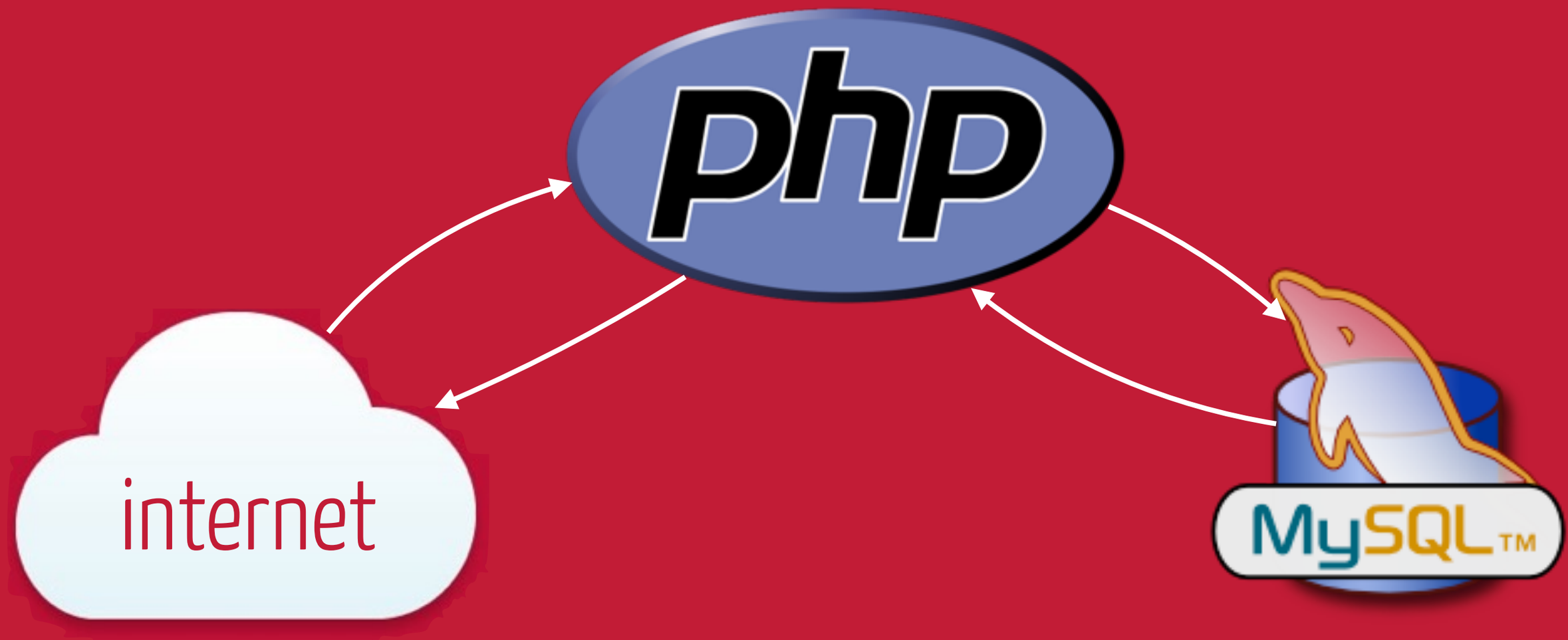
# live and prosper wo. downtime

upgrade

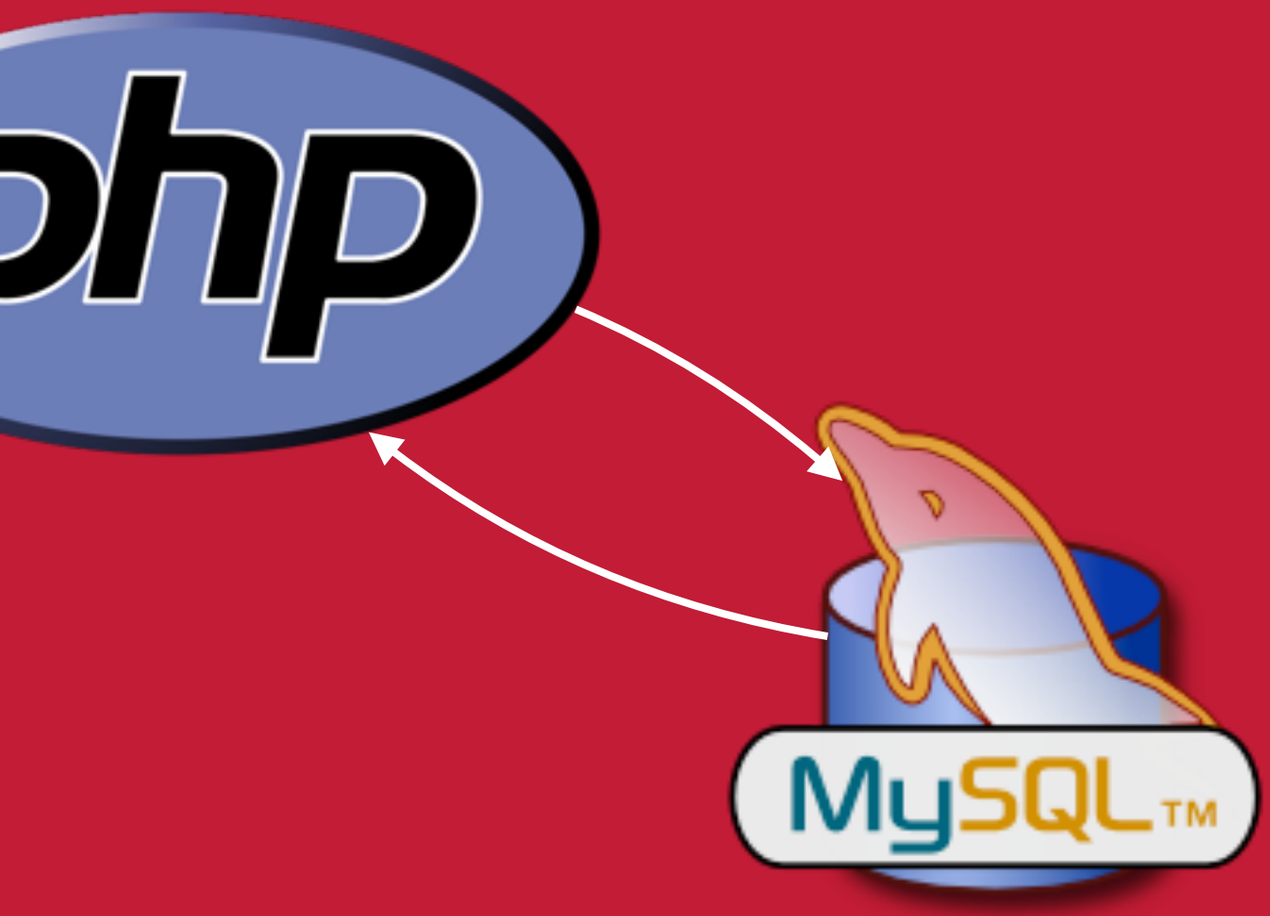
non-blocking, async communications

scale

# prehistorical times

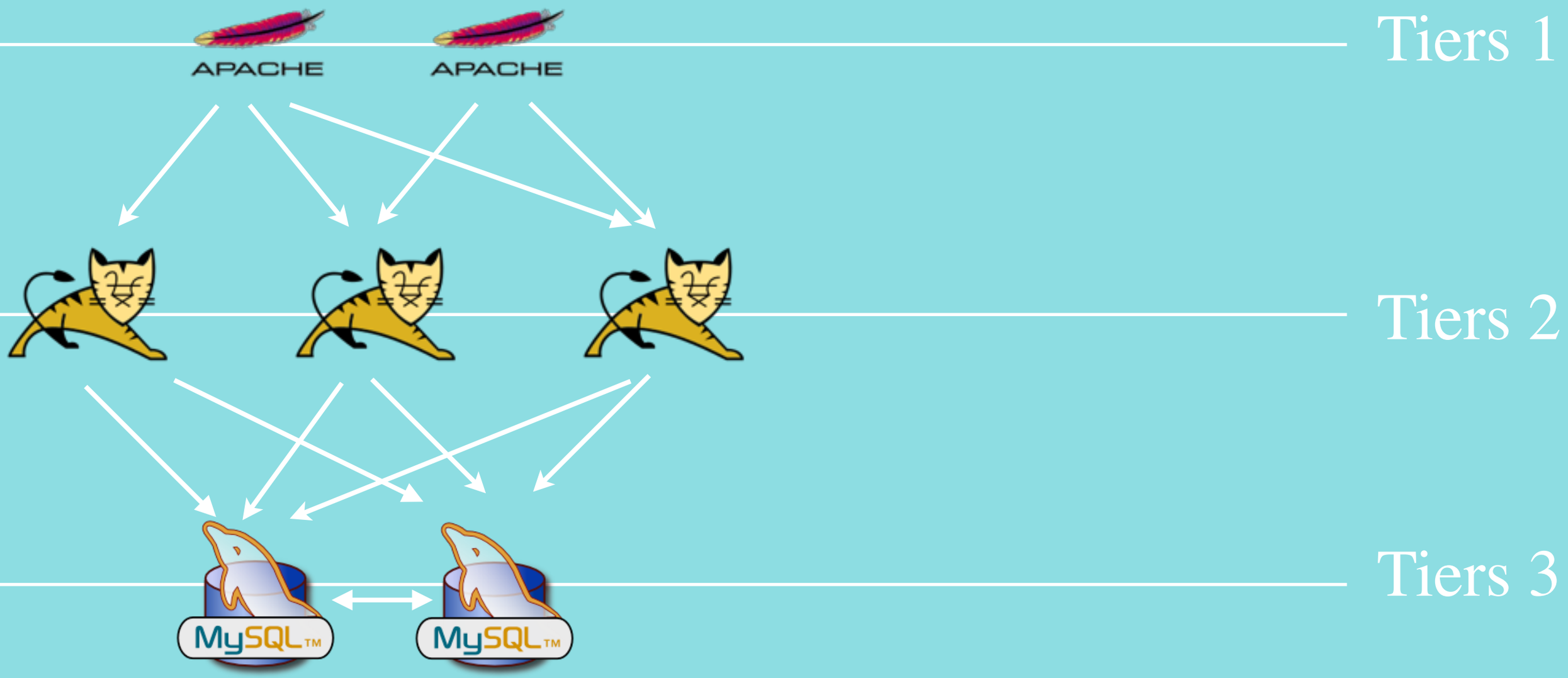


# prehistorical times




2 **S**ingle **P**oint **o**f **F**ailure
limited scalability
not scalable online
not upgradable online

# n-tiered apps to the rescue

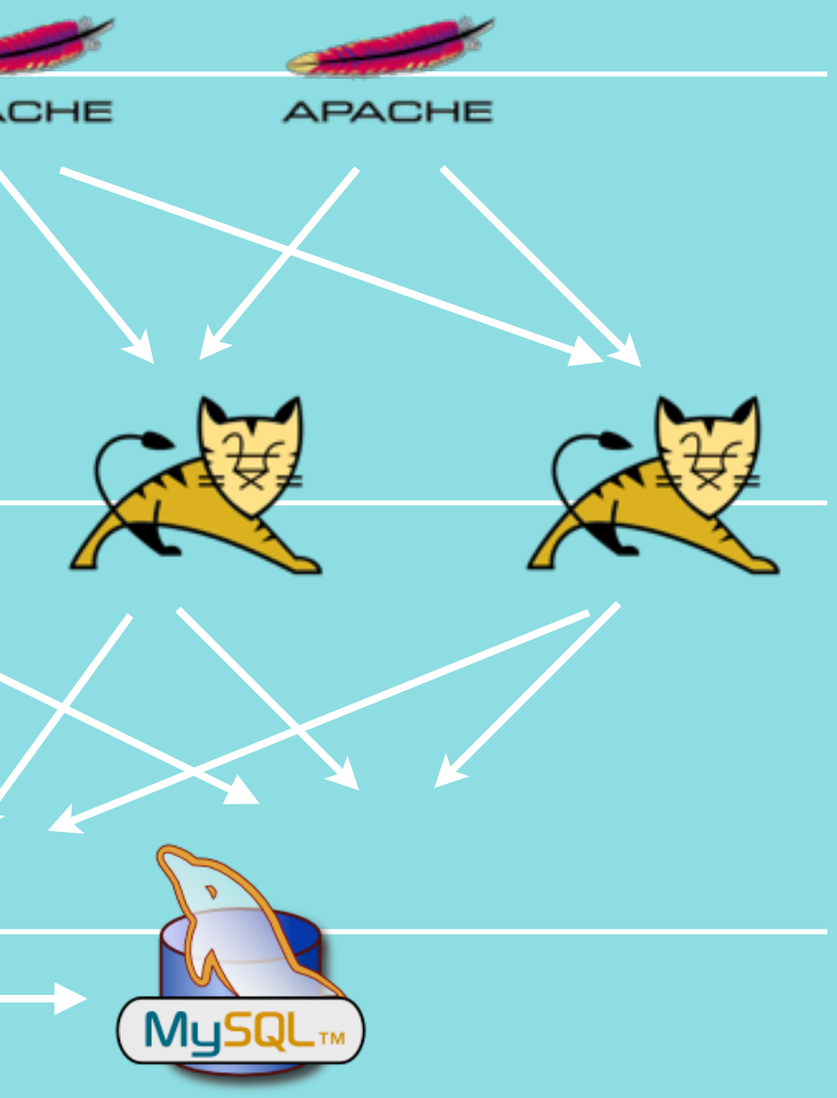



Tiers 1

Tiers 2

Tiers 3

# n-tiered apps to the rescue

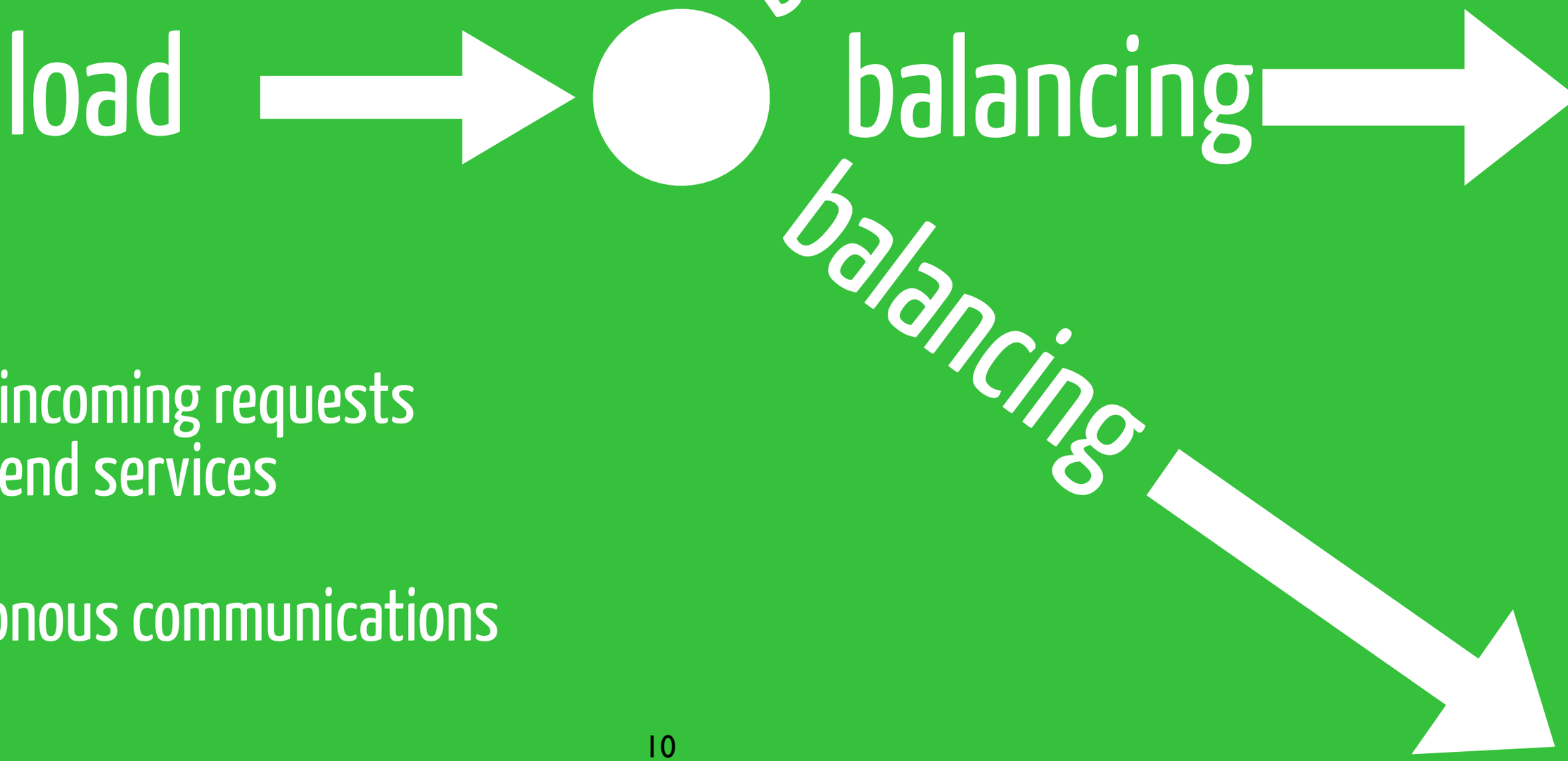



Tiers 1

Tiers 2

Tiers 3

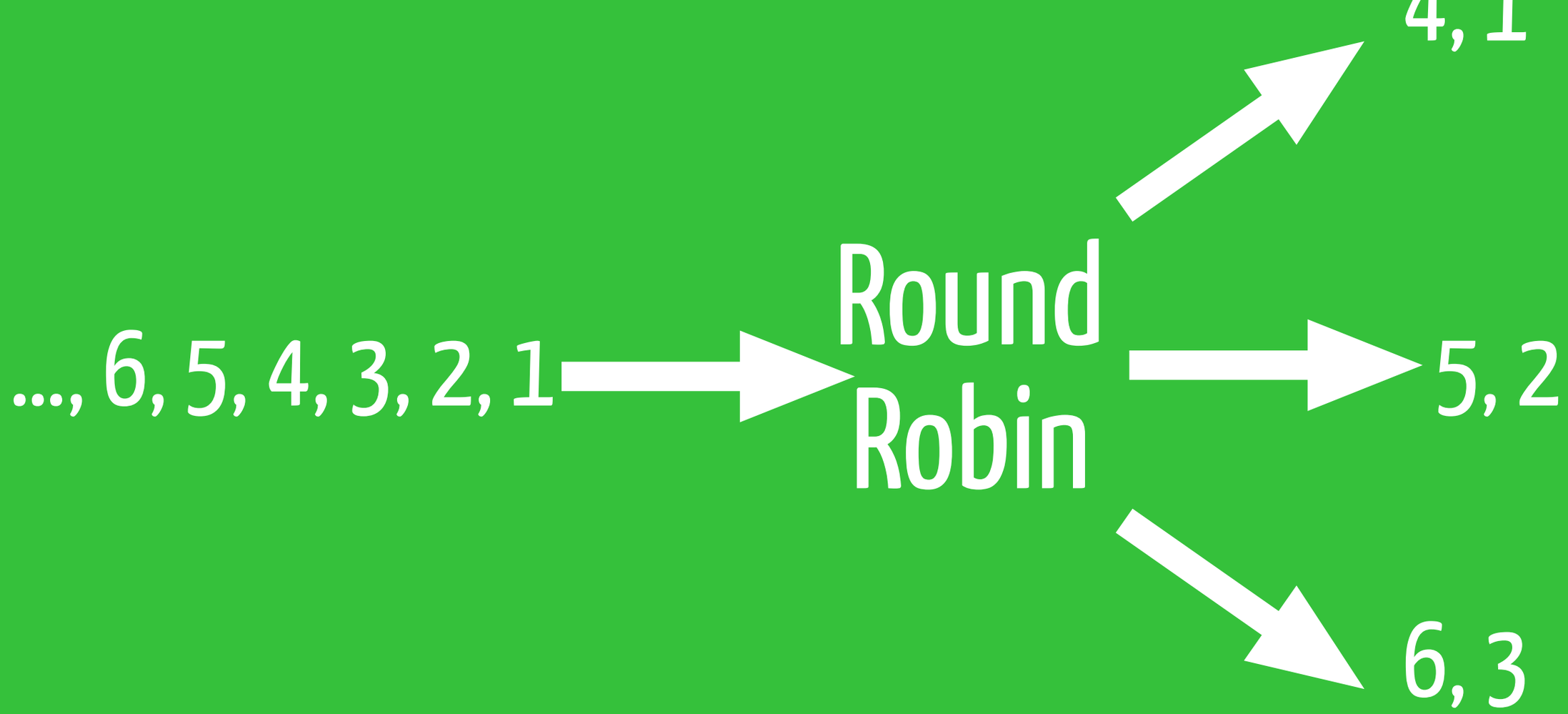
load balancing
horizontal scalability
upgradable online




spread incoming requests
to backend services

synchronous communications

# possible load balancing algorithms




nice on homogeneous nodes

# possible load balancing algorithms

6, 5, 3, 1

..., 6, 5, 4, 3, 2, 1 → weighted

4, 2

weight the nodes or the requests
depending on their size

“spread incoming requests
to backend services

synchronous communications”

# is everything balanceable ?

# load balancing stateful stuff

achievement unlocked

4

3, 2, 1

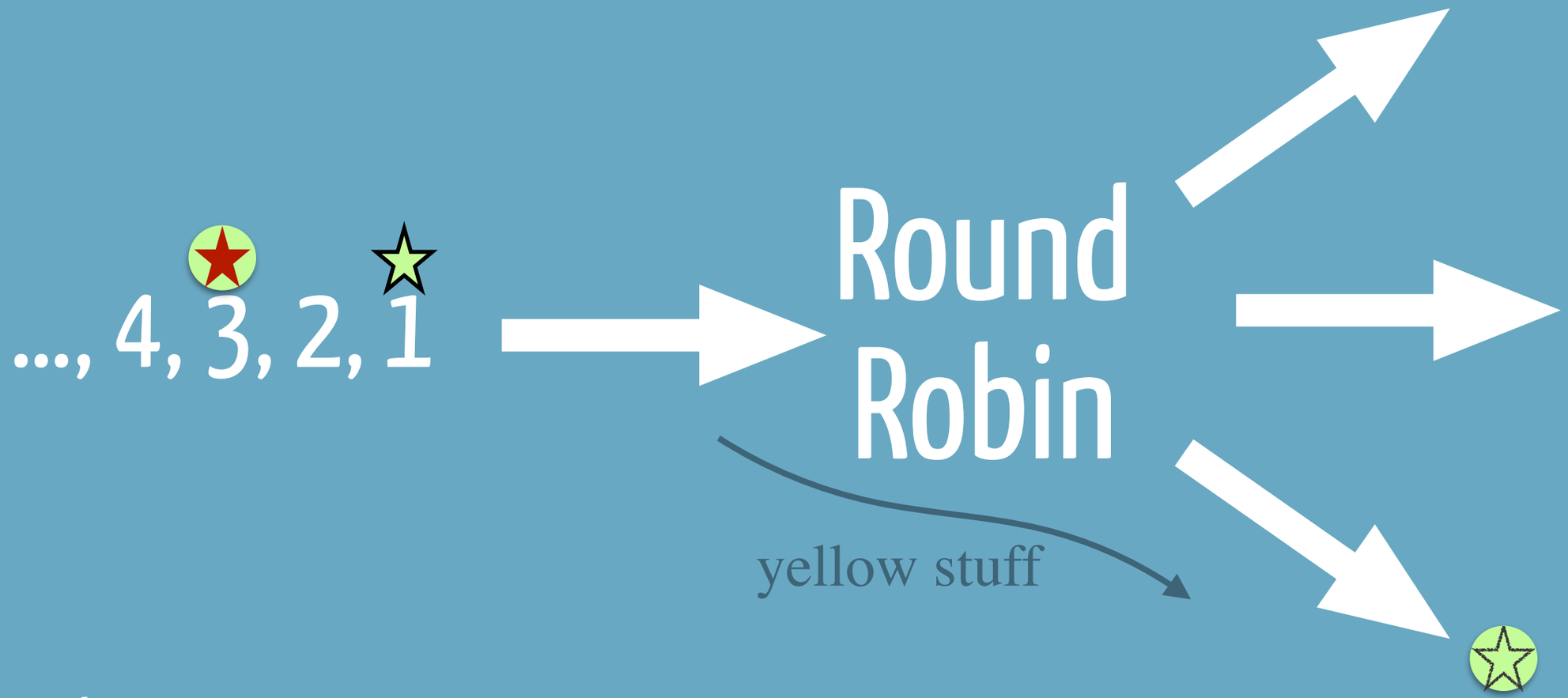
Round Robin

2

3

# load balancing stateful stuff

# load balancing stateful stuff + sticky sessions




IP based

not resilient to node failures

amazon
elastic load balancing

NGINX

APACHE mod_proxy_balancer

tc lb

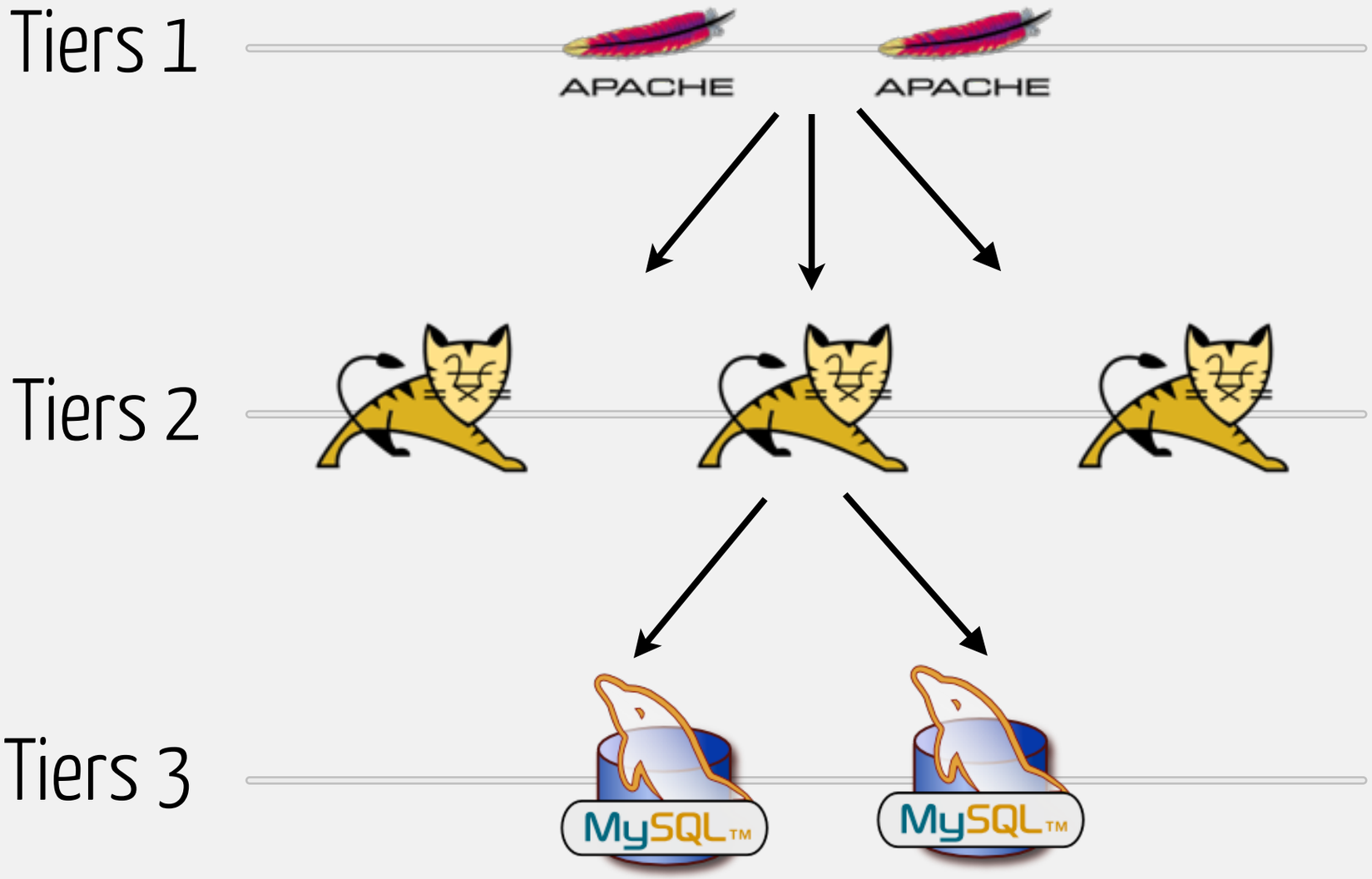
linux virtual server

MariaDB galera

# scaling

# scale up / down

## vertical sclaing



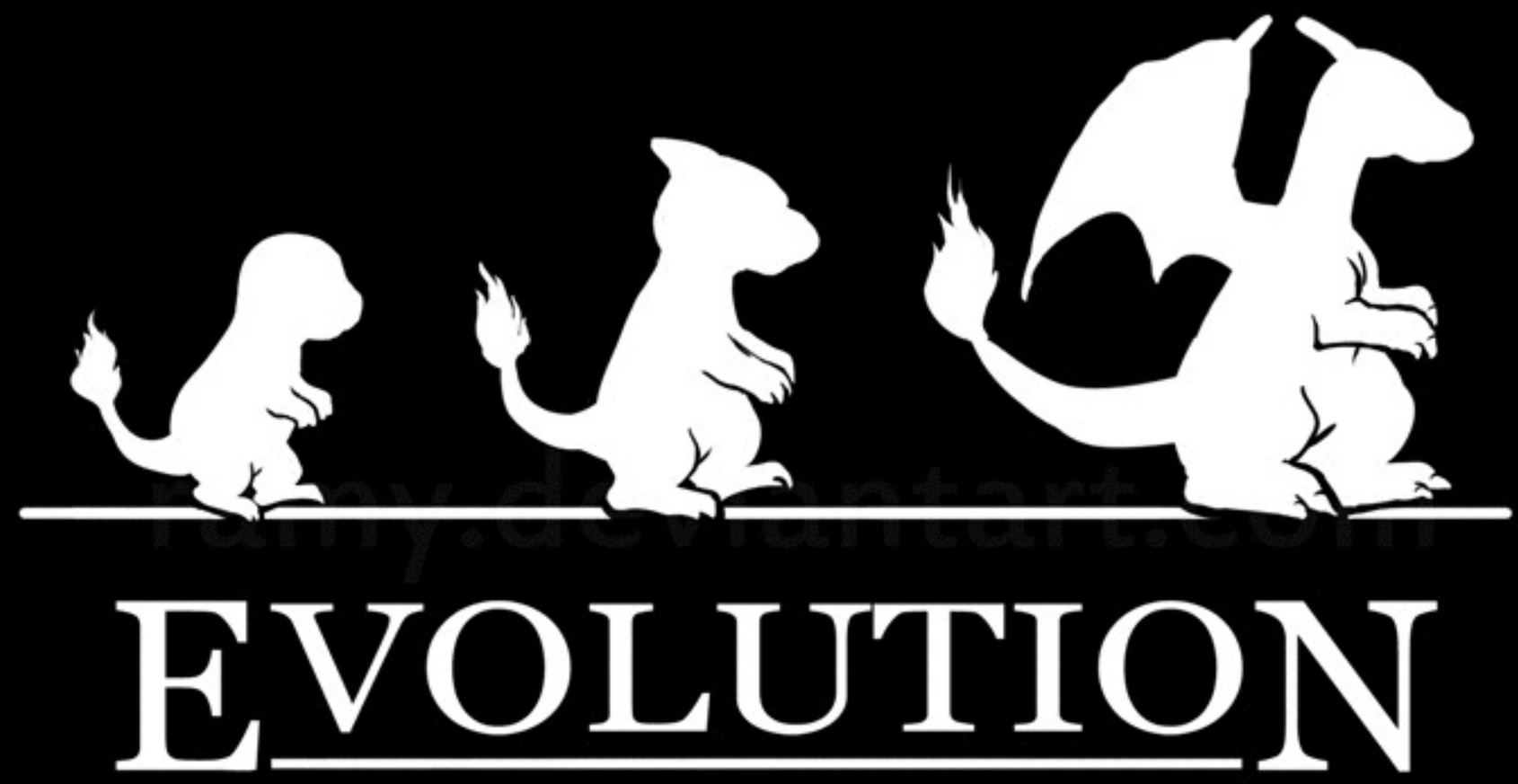
historical method (more powerful hardware)

mostly cold approaches

easy to implement coldly

hardware bounded

does not address reliability



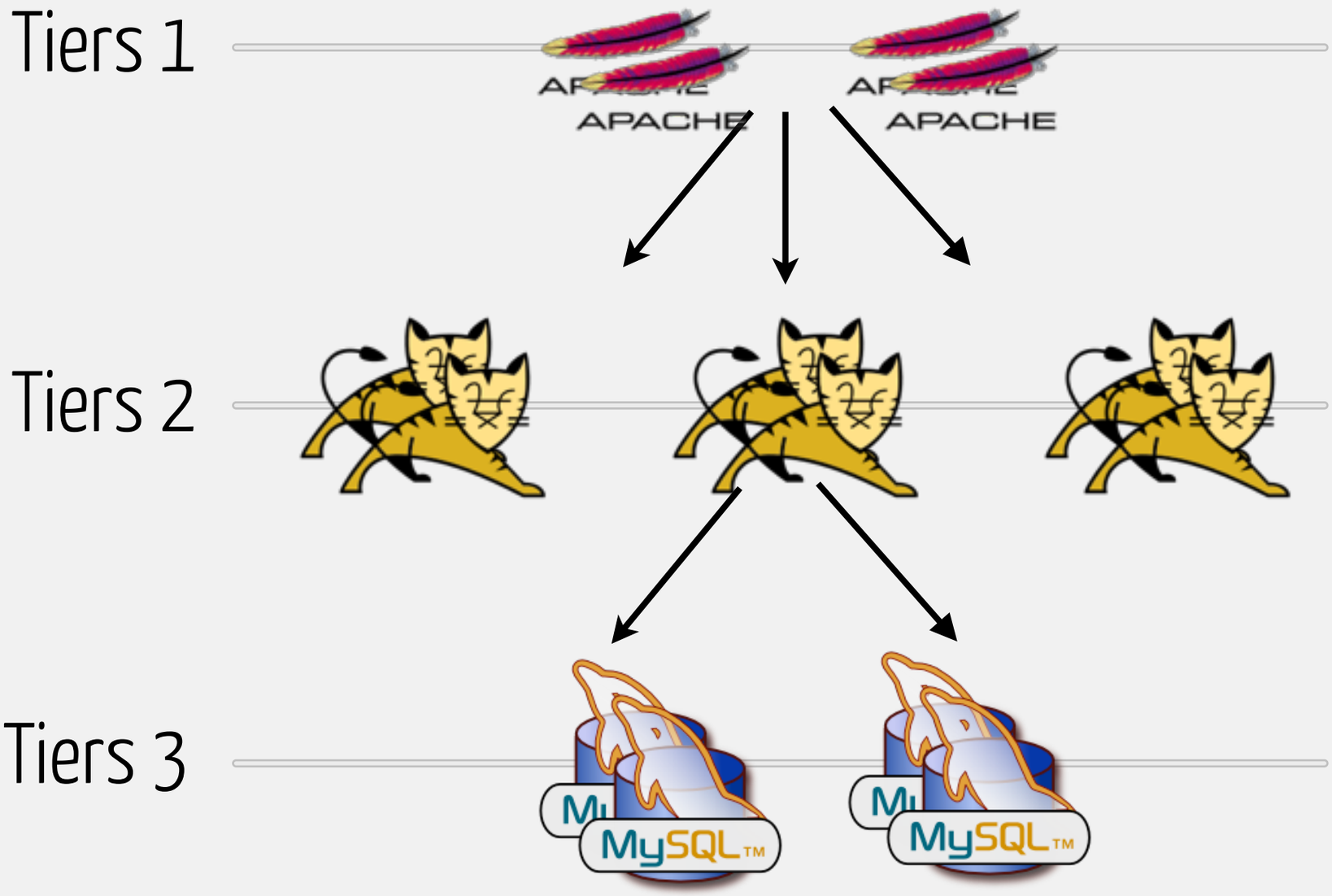

vertical scaling

# oVirt support for hot plug CPU

Guest OS Support Matrix

| OS | Version | Arch | Plug | Unplug |
|---|---|---|---|---|
| Red Hat Enterprise Linux 6.3 | | x86 | + | - |
| Red Hat Enterprise Linux 6.5 | | x86 | + | + |
| Microsoft Windows Server 2003 | All | x86 | - | - |
| Microsoft Windows Server 2003 | All | x64 | - | - |
| Microsoft Windows Server 2008 | All x86 | - | - | |
| Microsoft Windows Server 2008 | Standard, Enterprise | x64 | Reboot Required | Reboot Required |
| Microsoft Windows Server 2008 | Datacenter | x64 | + | ? |
| Microsoft Windows Server 2008 R2 | All | x86 | - | - |
| Microsoft Windows Server 2008 R2 | Standard, Enterprise | x64 | Reboot Required | Reboot Required |
| Microsoft Windows Server 2008 R2 | Datacenter | x64 | + | ? |
| Microsoft Windows Server 2012 | All | x64 | + | ? |
| Microsoft Windows Server 2012 R2 | All | x64 | + | ? |
| Microsoft Windows 7 | All | x86 | - | - |
| Microsoft Windows 7 | Starter, Home, Home Premium, Professional | x64 | Reboot Required | Reboot Required |
| Microsoft Windows 7 | Enterprise, Ultimate | x64 | + | ? |
| Microsoft Windows 8.x | All | x86 | + | ? |
| Microsoft Windows 8.x | All | x64 | + | ? |

## what about the runtime ?




# horizontal scaling

# horizontal scaling

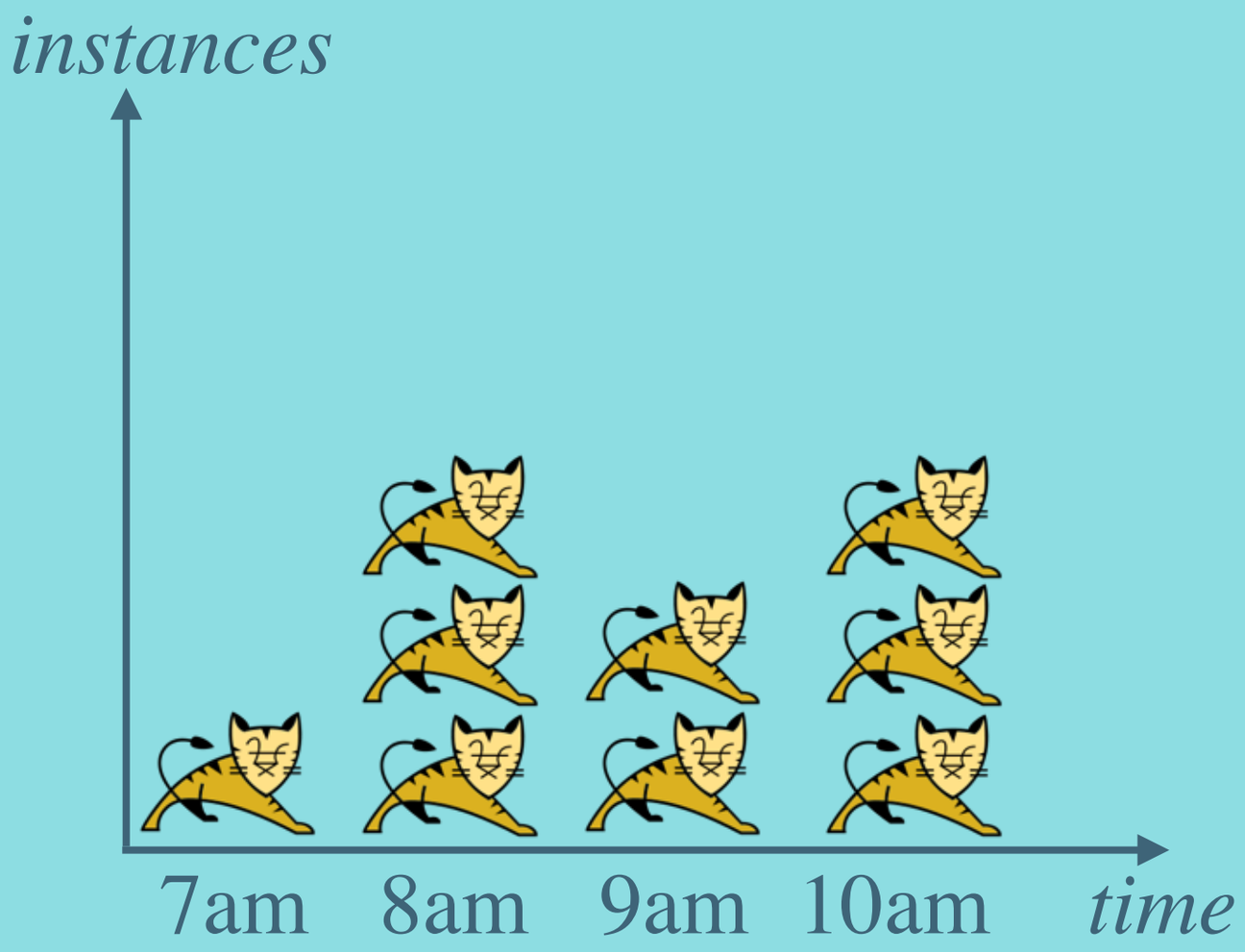
not application agnostic — require a load balancer / synchronisation — scale to the infinite in theory — support node failure

# Elasticity

optimize performance in live through
scaling requests

# static elasticity

initiated by the administrator




not feedback based

error prone
under/over-estimations

time-driven only ?

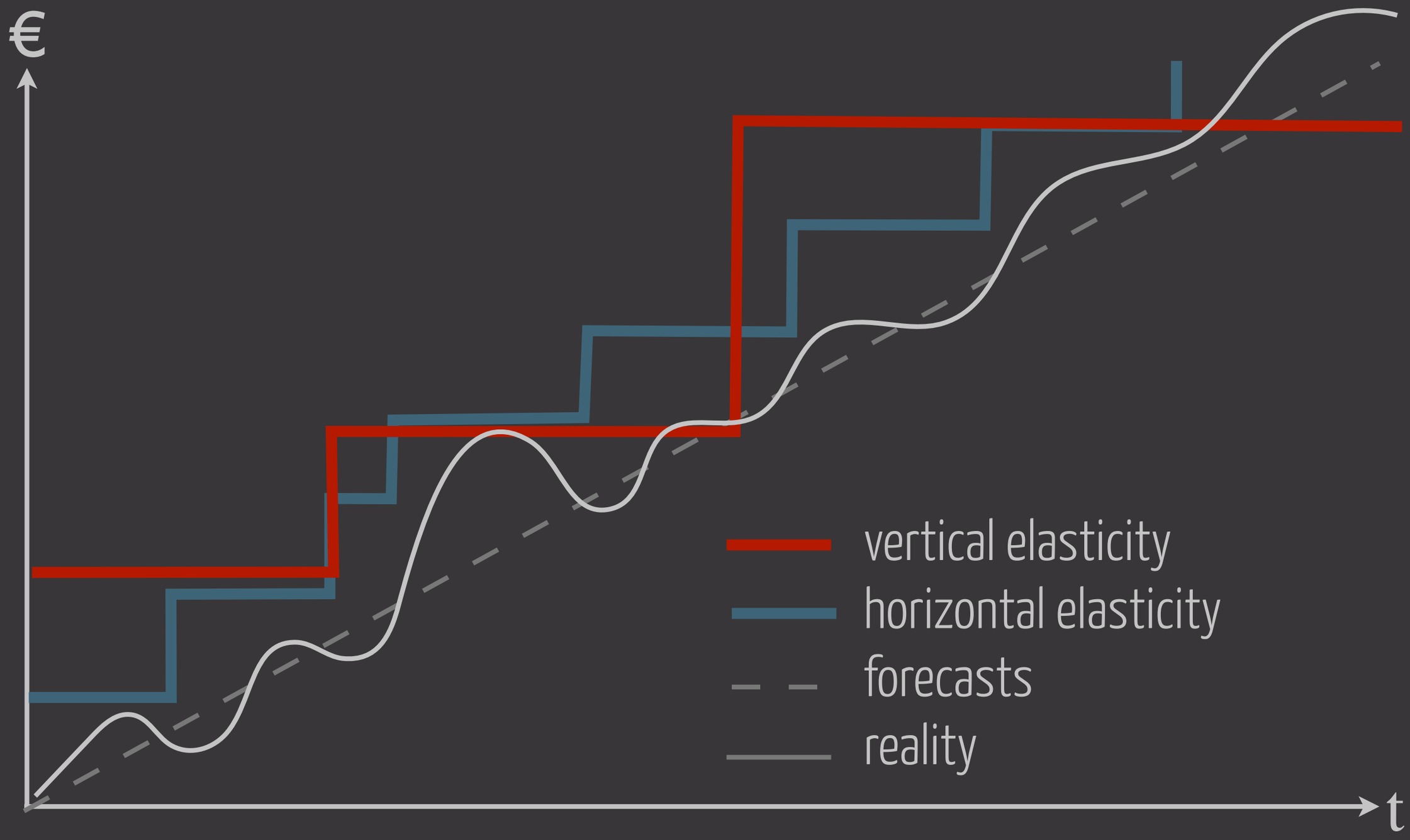
# latency-aware elasticity


getting a VM takes up to 5 minutes

think in terms of trends

spare space just in case

# static elasticity



# dynamic elasticity

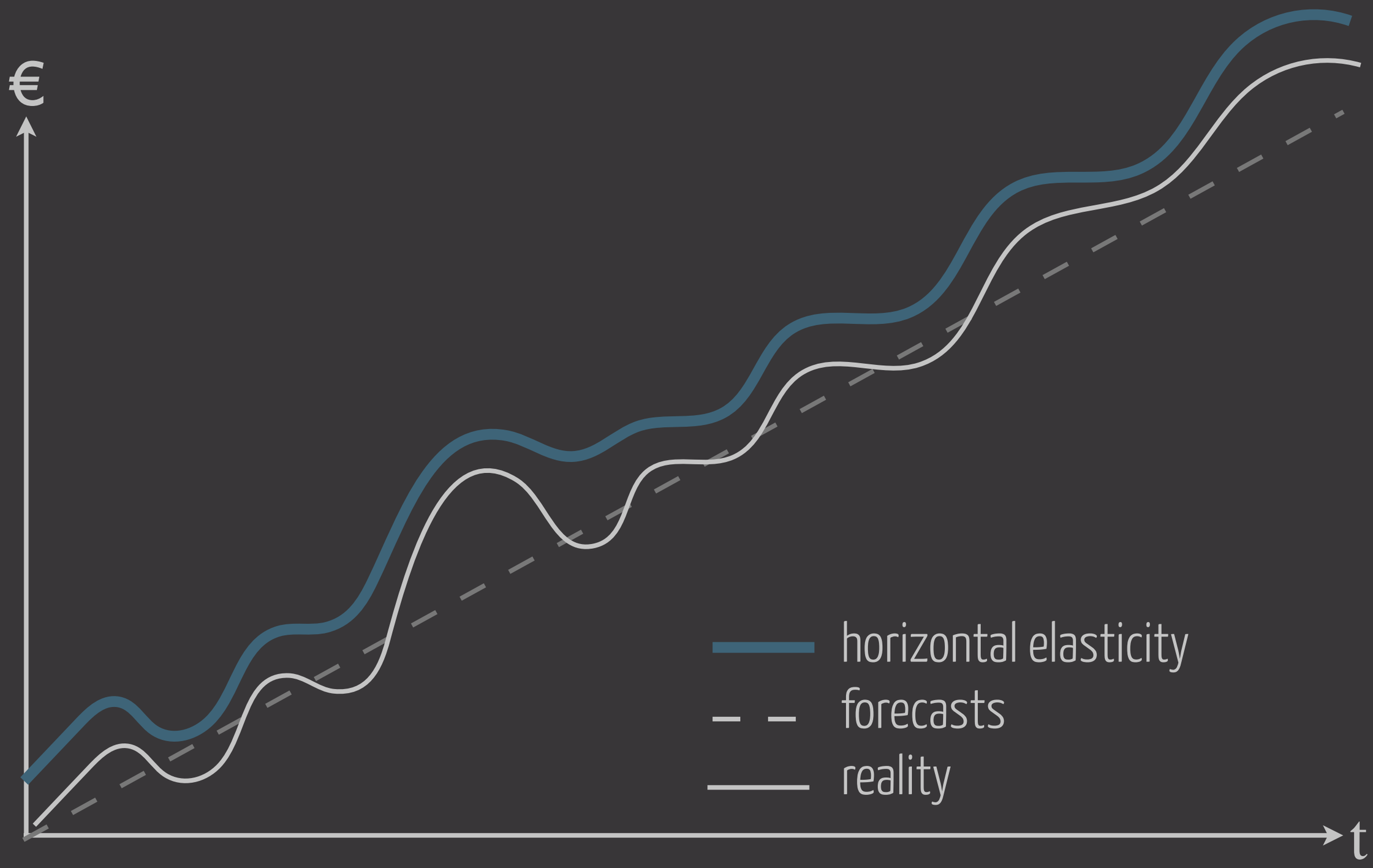
initiated by the app itself

rule based system

feedback from monitoring data

implemented inside/outside the app

# dynamic elasticity



Filter: Filter Auto Scaling groups... 1 to 2 of 2 Auto Scaling Groups

| Name | Launch Configuration | Instances | Desired | Min | Max | Availability Zones | Default C |
|---|---|---|---|---|---|---|---|
| awseb-e-dnma... | awseb-e-dnmaa76xme-... | 1 | 1 | 1 | 4 | eu-west-1a, eu-west-1b, eu-... | 360 |
| WWWELB | my | 1 | 1 | 1 | 10 | eu-west-1b | 100 |

## Decrease Group Size

Actions

**Execute policy when:** awsec2-WWWELB-High-CPU-Utilization
breaches the alarm threshold: CPUUtilization < 20 for 300 seconds
for the metric dimensions AutoScalingGroupName = WWWELB

**Take the action:** Remove 1 instances

**And then wait:** 100 seconds before allowing another scaling activity

## Increase Group Size

Actions

**Execute policy when:** awsec2-WWWELB-CPU-Utilization
breaches the alarm threshold: CPUUtilization >= 40 for 300 seconds
for the metric dimensions AutoScalingGroupName = WWWELB

**Take the action:** Add 1 instances

**And then wait:** 100 seconds before allowing another scaling activity

# dynamic elasticity

scale where its matter

monitor each tier to indentify the bottlenecks

scale out apache/tomcat/mysql ?

# cost model for elasticity

service cost

instance cost (hourly based)

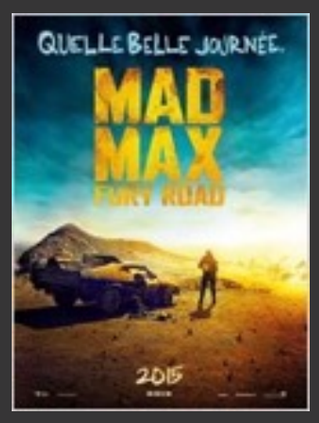
/!\ don't scale too often

# load balancing

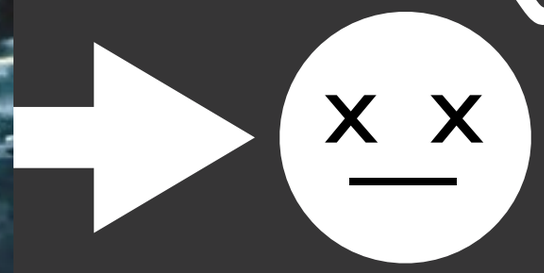
requests cannot stall in a load balancer

consequences with high response time ?







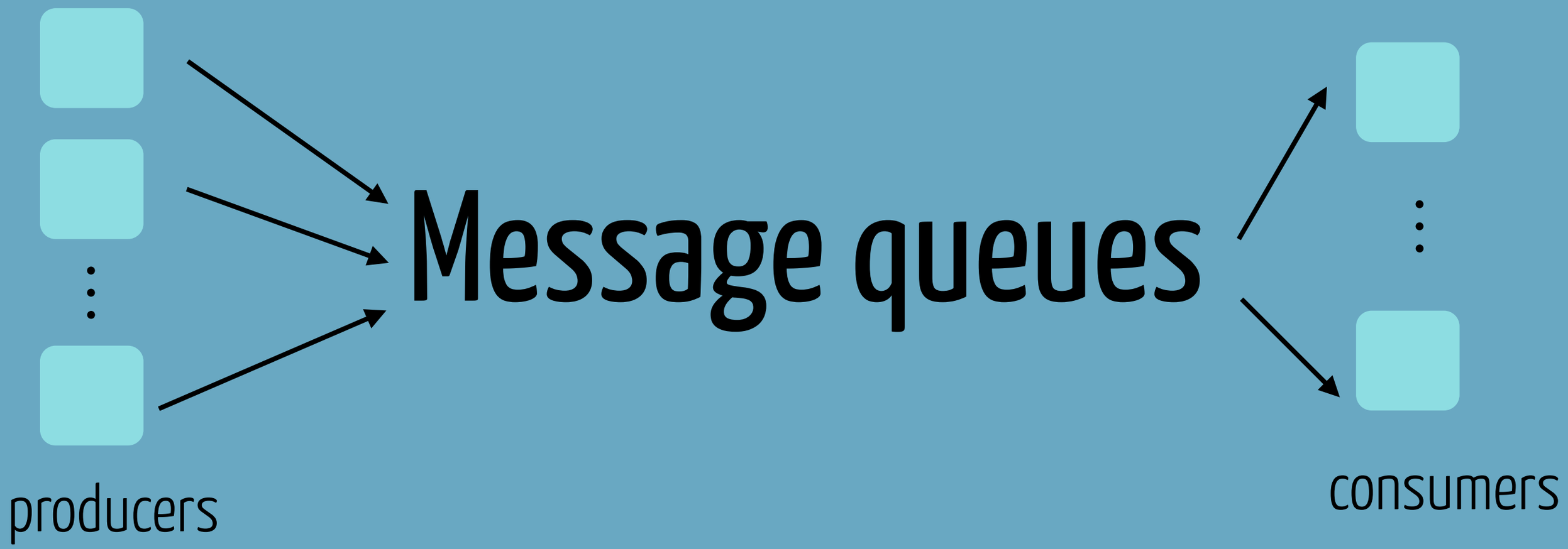


transcode

transcode

trans

asynchronous communication protocol
to transfer data




# benefits

shift time consuming tasks to workers

loose coupling

# queues are reliable

durable data

fault tolerant

eventual consistency

# queues are scalable

# workers

# internal components

# Programming model for workers

3 basic operations: dequeue — process — delete

1. ?
2. ?
3. ?

# Programming model for workers

1. dequeue/delete
2. process

message lost

# Programming model for workers

1. dequeue
2. process
3. delete

« at least 1 one read » ?

1. dequeue
2. process
3. delete

what is there is a node failure
while processing

# Programming model for workers

## invisibility window

messages are not definitely dequeued

hidden for a period (configurable)

removed once deleted

a timeout makes the message visible again

# Programming model for workers

1. dequeue
2. process
3. delete

invisibility window

realize eventual consistency

1. dequeue
2. process
3. delete

what if
processing time > invisibility window

# Programming model for workers

1. dequeue
2. process
3. delete

eventual consistency makes possible to process a message twice.

Take care !

# billing model for queues

#request

#Data transfered

/!\ pull mode

Amazon SQS
Simple Queuing System


# dealing with latency

# latency over business

>

Google search

+500 ms   -20% traffic

+100 ms 

-1% $$

# Latency numbers

L1 cache reference ..... 0.5 ns
Branch mispredict ..... 5 ns
L2 cache reference ..... 7 ns
Mutex lock/unlock ..... 25 ns
Main memory reference ..... 100 ns
Compress 1K bytes with Zippy ..... 3,000 ns = 3 µs
Send 2K bytes over 1 Gbps network ..... 20,000 ns = 20 µs
SSD random read ..... 150,000 ns = 150 µs
Read 1 MB sequentially from memory ..... 250,000 ns = 250 µs
Round trip within same datacenter ..... 500,000 ns = 0.5 ms
Read 1 MB sequentially from SSD* ..... 1,000,000 ns = 1 ms
Disk seek ..... 10,000,000 ns = 10 ms
Read 1 MB sequentially from disk .... 20,000,000 ns = 20 ms
Send packet CA->Netherlands->CA .... 150,000,000 ns = 150 ms

# colocate

same process, server, rack, datacenter


1 Gb/sec

reduce latency
reduce data transfer costs

# cache

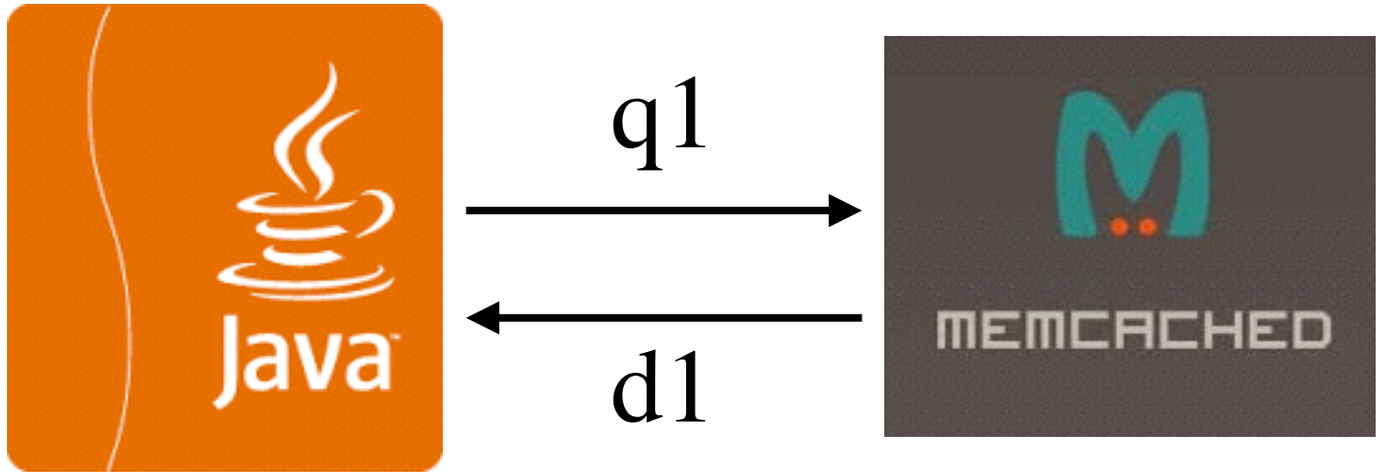
to store data closely
and speed up future accesses

cache miss

# cache

to store data closely
and speed up future accesses

cache hit



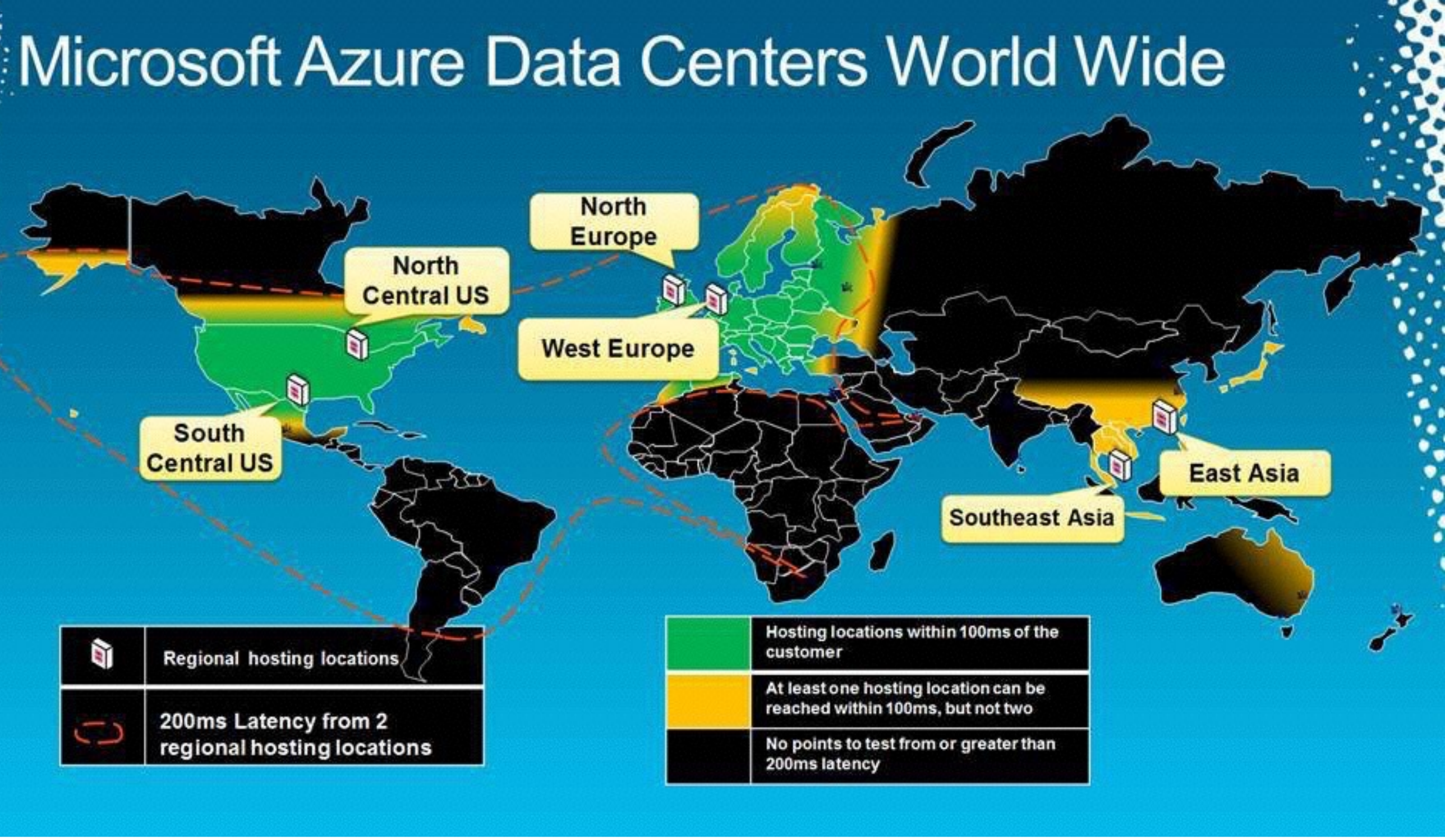

q1: d1

# cache everything everywhere

« Cache is the new RAM »

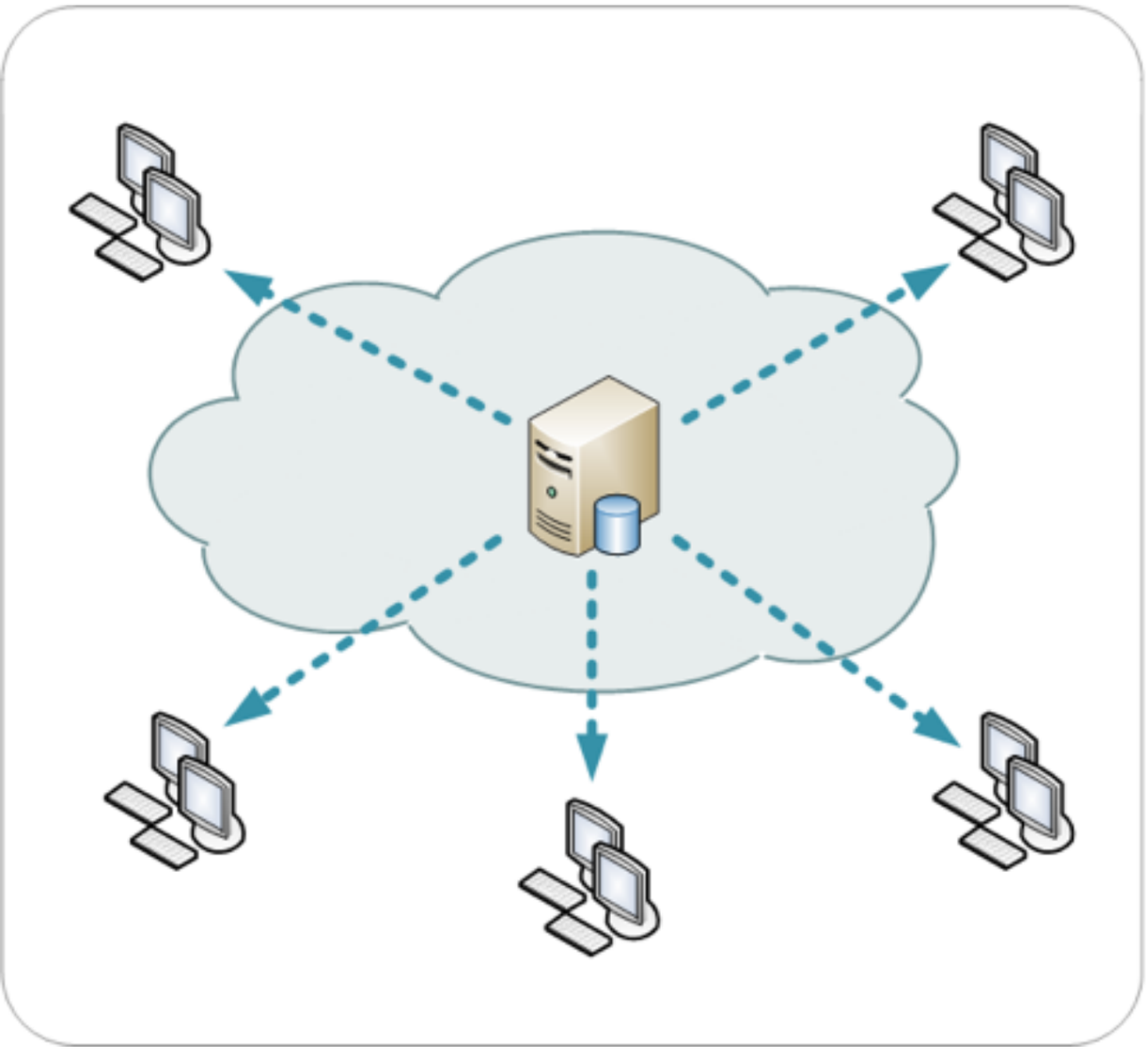
# Getting close to clients

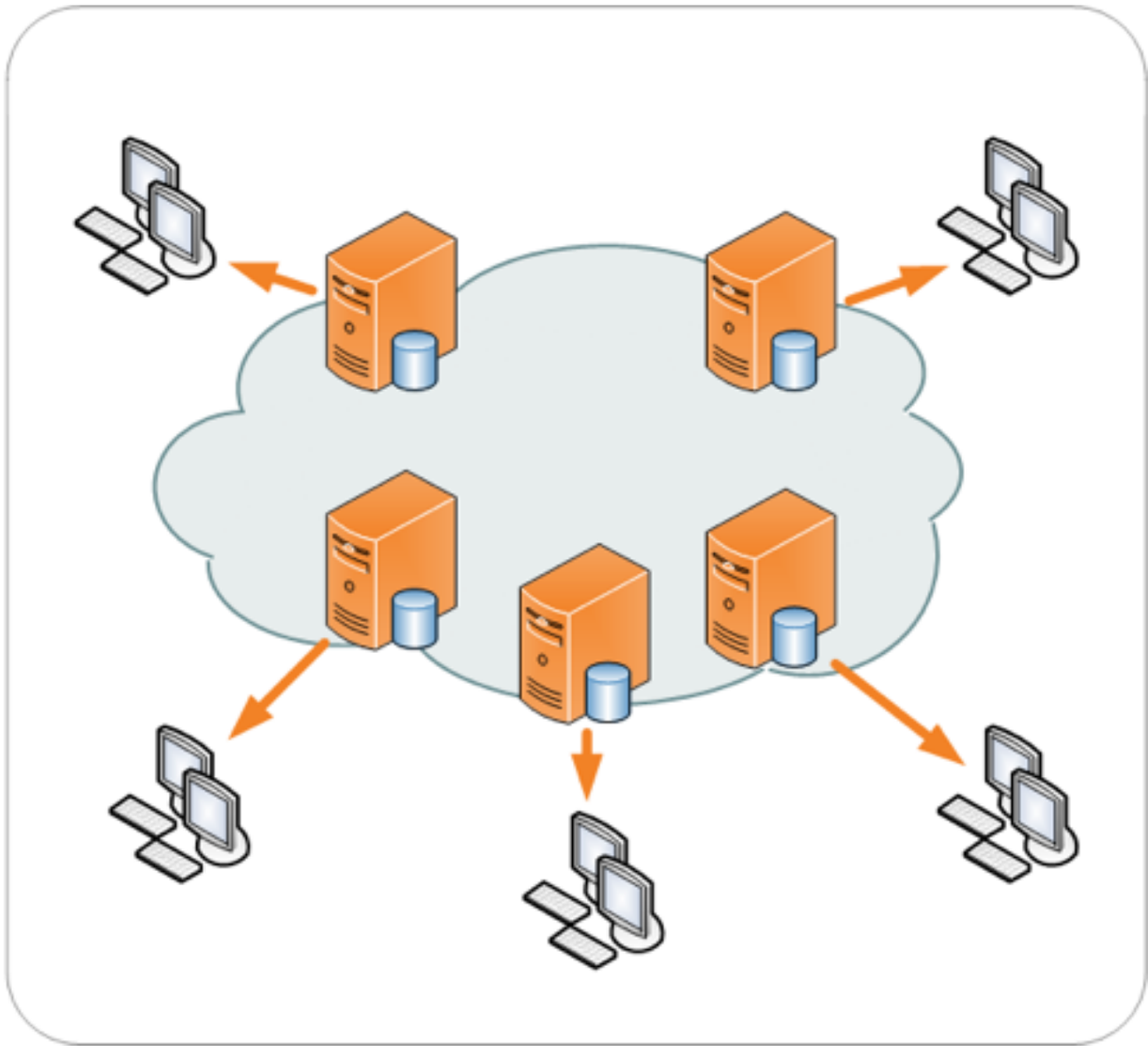
Microsoft Azure




# Getting close to the clients

# Content Delivery Networks (CDN)





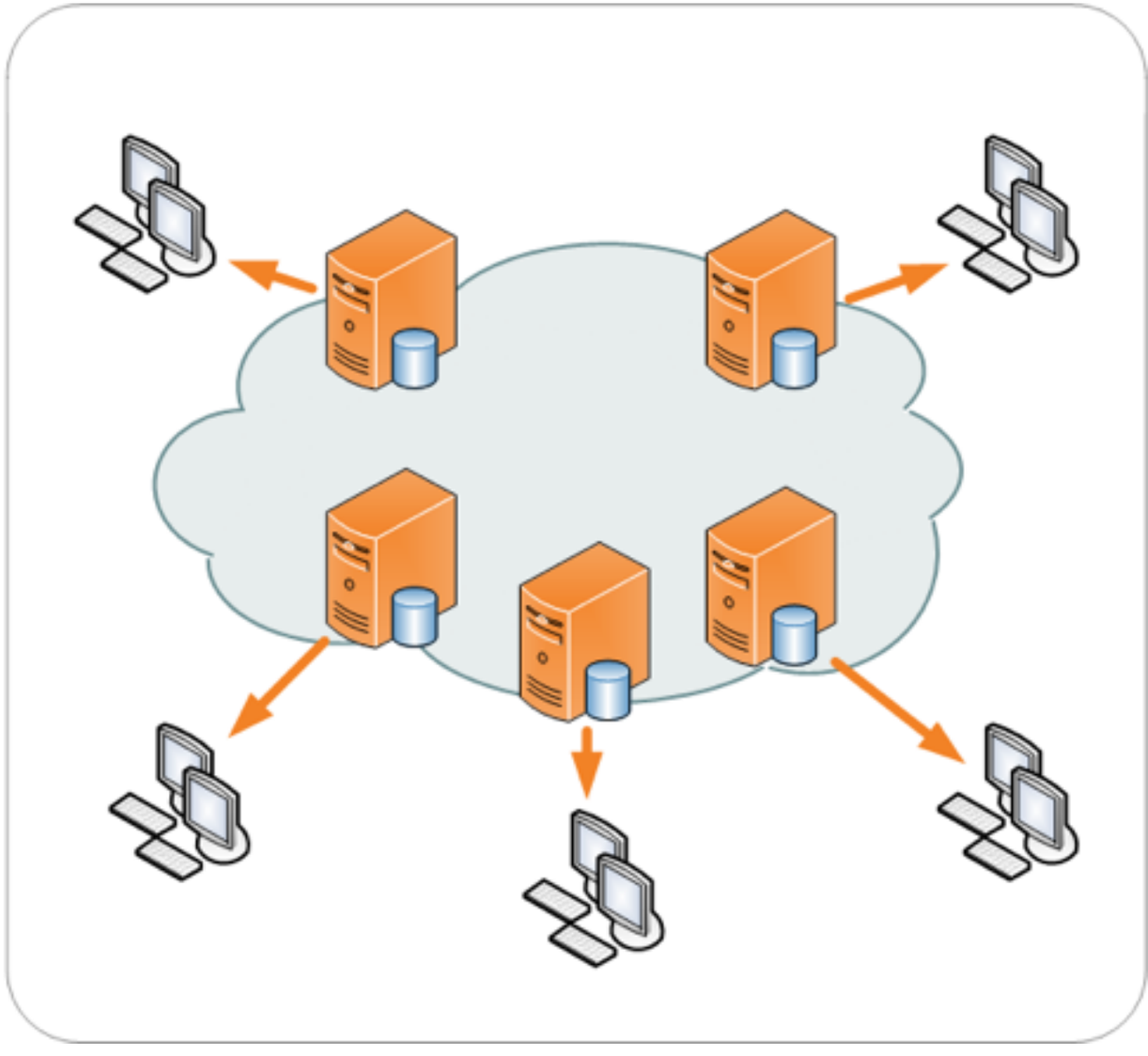
# Content Delivery Networks (CDN)

available at network edges

data are injected into the CDN

the CDN spreads the data where it matters

user requests are redirected to the closest Point of Presence (PoP)




Deploy

# Zero Downtime Deployment

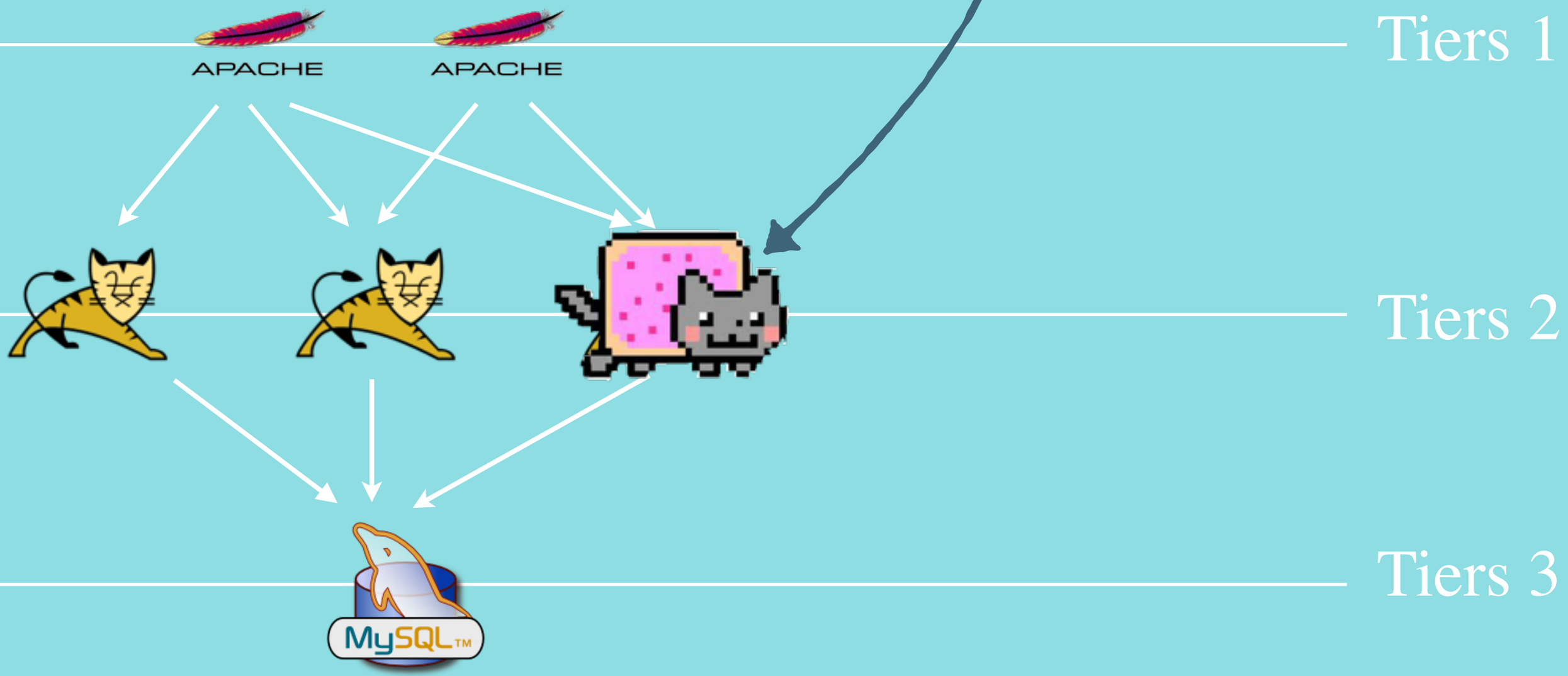
# What to deploy

new features

internal changes

fixes

# how-to upgrade gracefully ?




(that guy make good talks about github processes)

There is some code you can't break

permission - billing - upgrades - maintenance

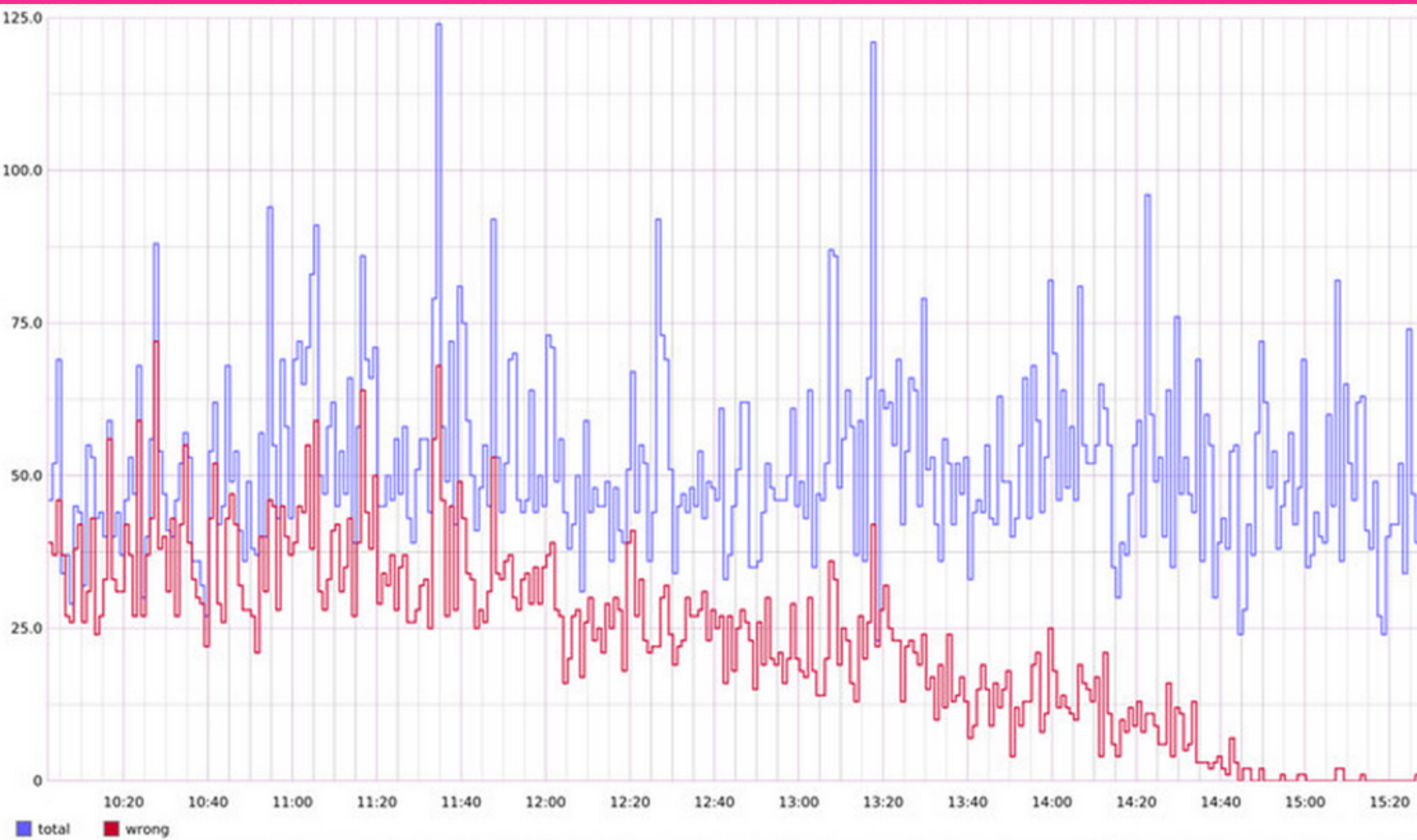
tests are not enough

new code can't change production code behavior

# parallel paths

```
science « new auth » do |e|
    e.control{user.slow_auth}
    e.candidate{user.fast_auth}
end
```

# monitor progress



# at facebook

## 2 releases a day

the frontend is a standalone 1.5GB executable

deployment over bitorrent

no downtime

see Push: tech talk

# at facebook

## canary release

dev fenced to the next release
(6 private servers)

over 2% of the production servers

over 100% of the production servers

# at facebook

## decoupling

stateless sessions

backward & forward compatible UI

dark launches & feature flag

# integration tests

test if images are ok

test if every files are in a cdn

test if css is clean

everything is automated

CI + grunt

tumblr.

500 M page views a day

Peak rate of ~40k req/sec

1+ TB/day into Hadoop cluster

Posts: 50GB a day

Follower list updates: 2.7TB a day

Dashboard: 1M w/sec, 50K r/sec

# tumblr. origin

simple LAMP application on rackspace
everything on a single server

backend service in C
memcache
CDN

HA-proxy
MySQL sharding for the blog

Redis for the dashboard

tumblr.

# moved to high-concurrency oriented frameworks

JVM centric approach — for hiring and dev. speed
PHP just for request authentication and presentation
scale, finaggle — support from the big guys

HBase + Redis but still MySQL for bulk data

Redis for the dashboard notification

tumblr.

# dynamic isolation of users into cells

standalone app with its database
once logged, a cell is assigned to the user,
populated with data
cell are populated for live events by a stream

isolation eases parallelism
small isolated components isolate failures

tumblr.

500 web servers
200 database servers
47 pools
30 shards
30 memcache servers
22 redis servers
15 varnish servers
25 haproxy nodes
8 nginx
14 job queue servers

# RECAP

always

available

# performant at any scale

cost

effective

PaaS to create and push a cloud application

support for multiple software stacks

Ruby, PHP, Pyhon, Java, Node.js, Docker, Go

deployment method

git, files

EC2, S3, SNS, CloudWatch, AutoScaling,
Elastic load balancers, SQS

a low-level HTTP API

official  binding for popular languages


official eclipse plugin

tons of documentation, tutorial
on AWS website

runtimes on top of EC2

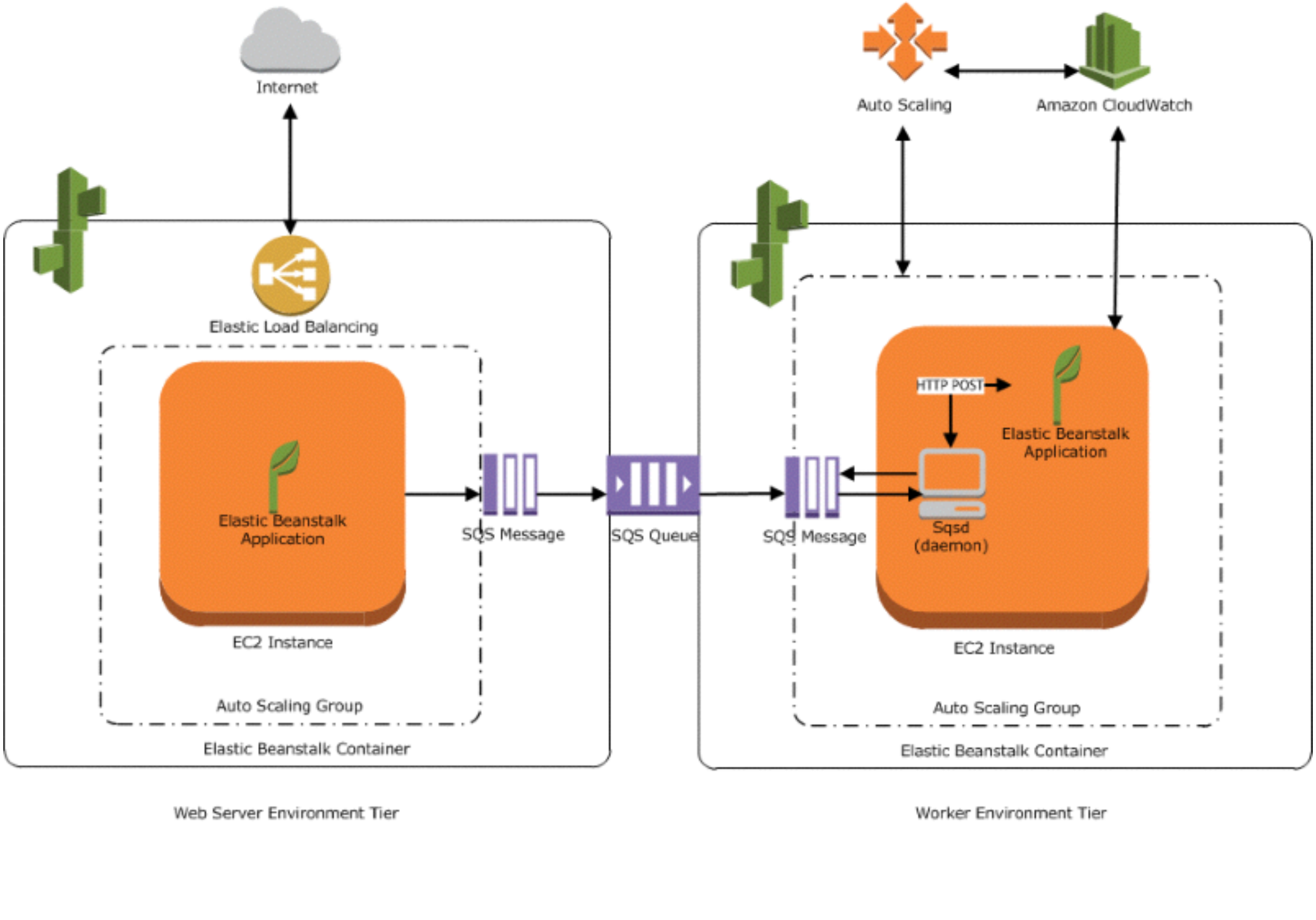
multiple environments
(web, worker, data)

deploy: env version + env configuration

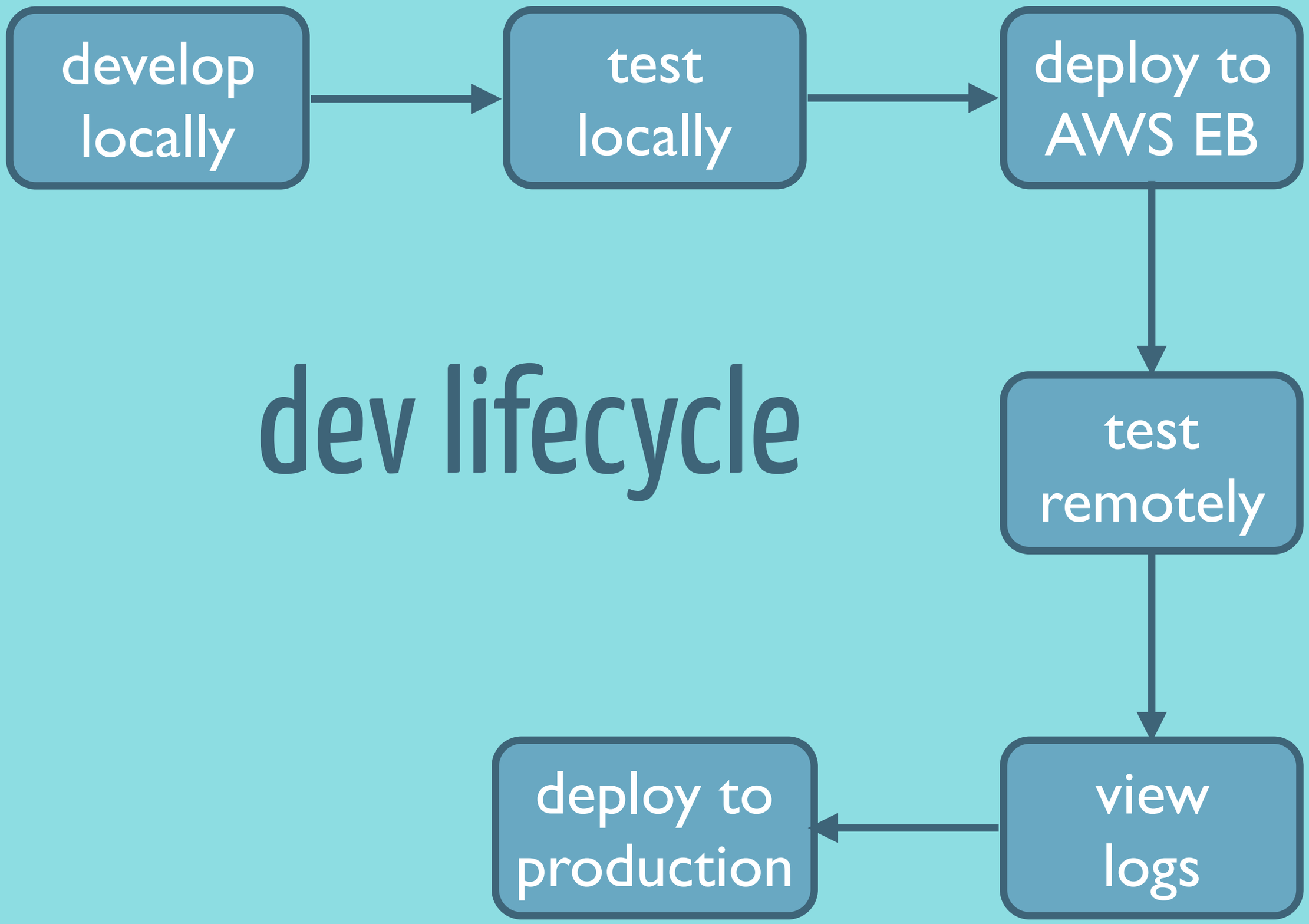
env version comes from S3


Elastic HTTP balancers
between the envs.

security, security, security,


Internet
Auto Scaling
Amazon CloudWatch
Elastic Load Balancing
HTTP POST
Elastic Beanstalk Application
Elastic Beanstalk Application
SQS Message
SQS Queue
SQS Message
Sqsd (daemon)
EC2 Instance
EC2 Instance
Auto Scaling Group
Auto Scaling Group
Elastic Beanstalk Container
Elastic Beanstalk Container
Web Server Environment Tier
Worker Environment Tier

# dev lifecycle



Go online !!

# Developing within a PaaS

# The standard environment
(General Availability)

containers on top of Google's infrastructure

App Engine > Documentation

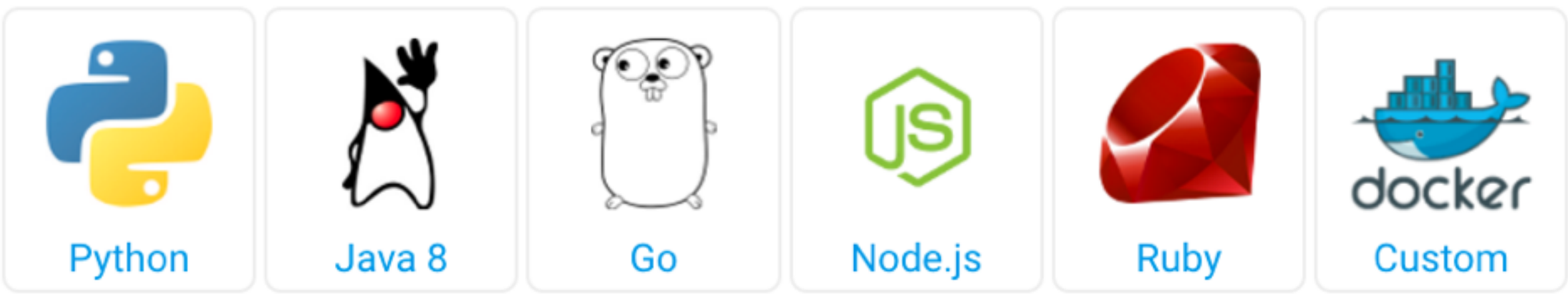
# Download and Install the SDK for App Engine

The SDK for App Engine includes a local development server as well as the tooling for deploying and managing your applications in App Engine.

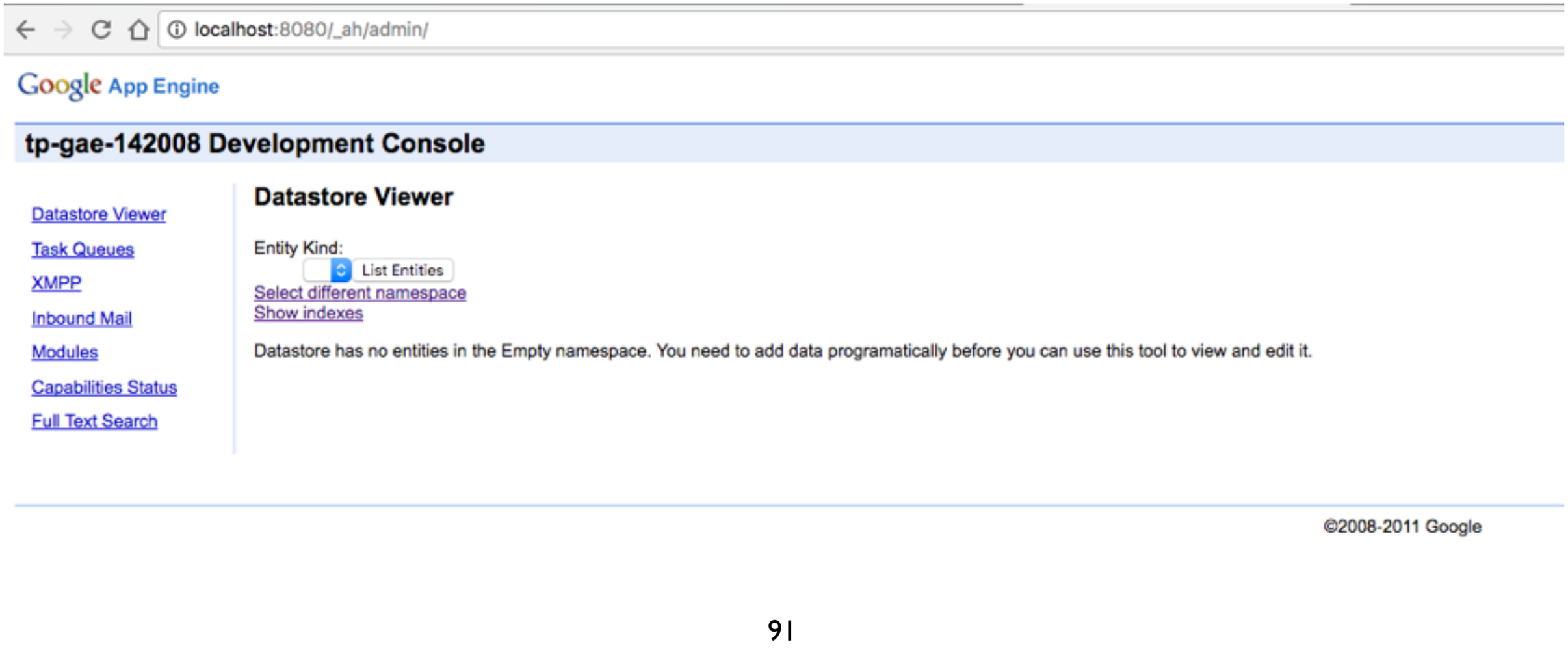
Go | Java | PHP | Python

# The flexible environment
(beta)

VMs on top of Google compute engine



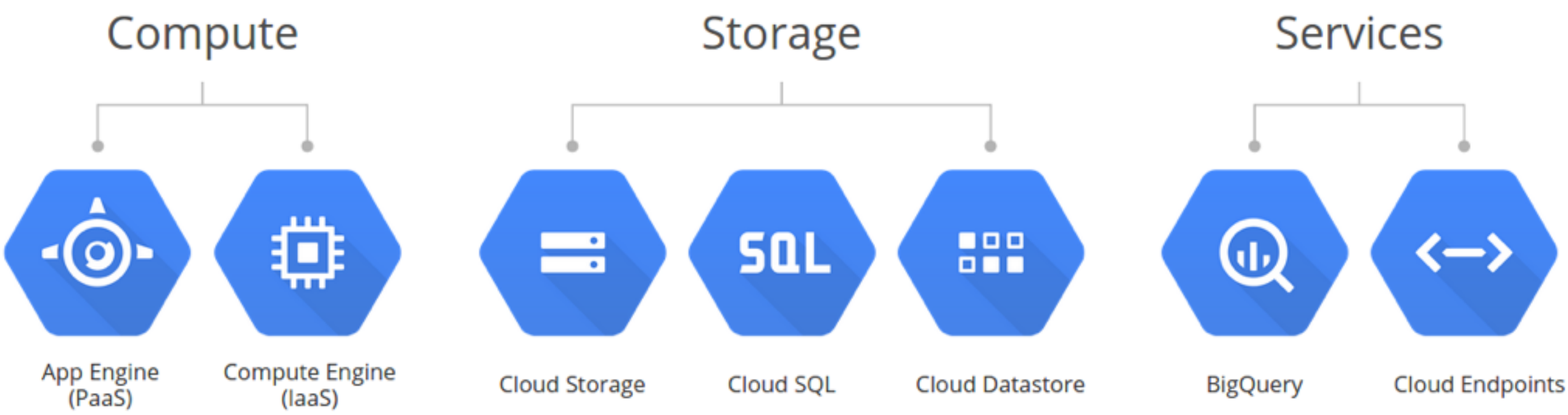
# app-engine is emulated locally



# Deployment methods

| Feature | Standard environment | Flexible environment |
| --- | --- | --- |
| Instance startup time | Milliseconds | Minutes |
| Maximum request timeout | 60 seconds | 60 minutes |
| Background threads | Yes, with restrictions | Yes |
| Background processes | No | Yes |
| SSH debugging | No | Yes |
| Scaling | Manual, Basic, Automatic | Manual, Automatic |
| Writing to local disk | No | Yes, ephemeral (disk initialized on each VM startup) |
| Customizable serving stack | No | Yes (built by customizing a Dockerfile) |
| Automatic in-place security patches | Yes | Yes |
| Network access | Only via App Engine services (includes outbound sockets) | Yes |
| Supports installing third-party binaries | No | Yes |
| Location | United States or European Union | While in Beta, United States only. European Union-hosted applications should not deploy apps to the flexible environment. |
| Pricing | Based on Instance hours | While in Beta, based on Compute Engine Pricing for each VM. Pricing will change in the future. |

| | FREE *LIMIT PER DAY* | PRICE *ABOVE FREE LIMIT* |
|---|---|---|
| Instances | 28 instance hours | $0.05 / instance / hour |
| Cloud Datastore *(NoSQL)* | • 50k read/write/small<br>• 1 GB storage | • $0.06 / 100k read or write ops<br>• Small operations free*<br>• $0.18 / GB / month |
| Network Traffic *(Outgoing)* | 1 GB | $0.12 / GB |
| Network Traffic *(Incoming)* | 1 GB | FREE |
| Cloud Storage | 5 GB | $0.026 / GB / month |
| Memcache | • Free Usage of Shared Pool<br>• No free quota for Dedicated Pool | • Free Usage of Shared Pool<br>• Dedicated Pool: $0.06 / GB / hour |
| Search | • 1000 basic operations<br>• 0.01 GB indexing documents<br>• 0.25 GB document storage<br>• 100 searches | • $0.50 / 10k searches<br>• $2.00 / GB indexing documents<br>• $0.18 / GB / month Storage |
| Email API | 100 recipients | Contact Sales |
| Logs API | 100 MB | $0.12 per GB |
| Task Queue | 5 GB | $0.026 / GB / month |
| Logs Storage | 1 GB | $0.026 / GB / month |
| SSL Virtual IPs | - | $39 / virtual IP / month |
| Bundled Services | Cron, Image Manipulation, SNI SSL Certificates, Socket API, Task Queue API, URLFetch, Users API | |


Compute
Storage
Services
App Engine (PaaS)
Compute Engine (IaaS)
Cloud Storage
Cloud SQL
Cloud Datastore
BigQuery
Cloud Endpoints

# Queues

## Pull queues

dequeue, lease, delete. Dev side tasks can be tagged

## Push queues

dequeues at a given rate
elasticity handled automatically

## cron

tasks at a given recurrence