Florian Bücklers

Wie man ein Backend-as-a-Service entwickelt: Lessons Learned

Architecture

Who is talking today?

Florian Bücklers

CTO & Co-Founder
Baqend Platform
Speed Kit Plugin

BaQend

Backend-as-a-Service

Overview

Backend-as-a-Service

Firebase

kinvey

Microsoft Azure

Parse

BaQend

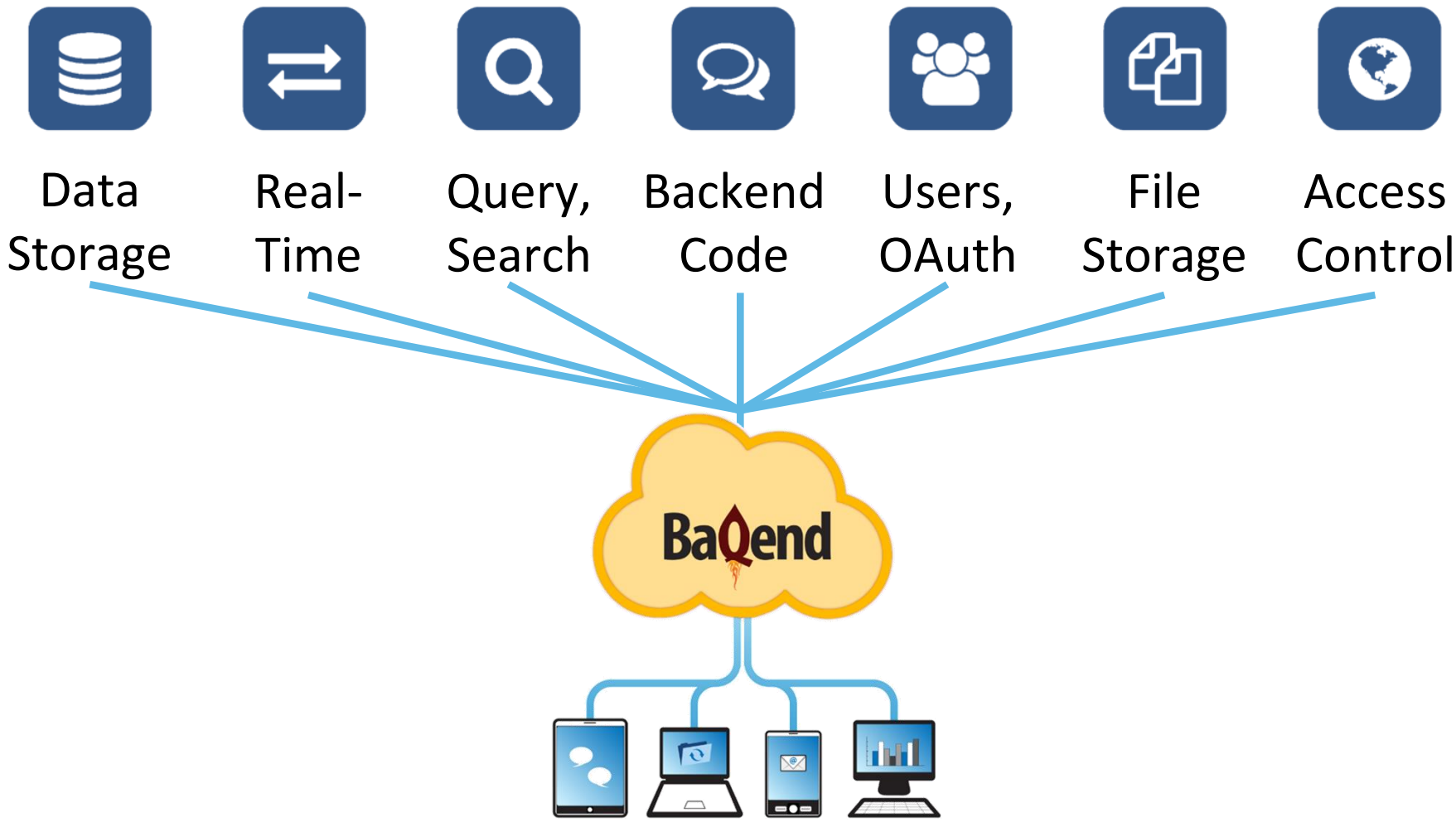
Backend-as-a-Service

Feature Sets

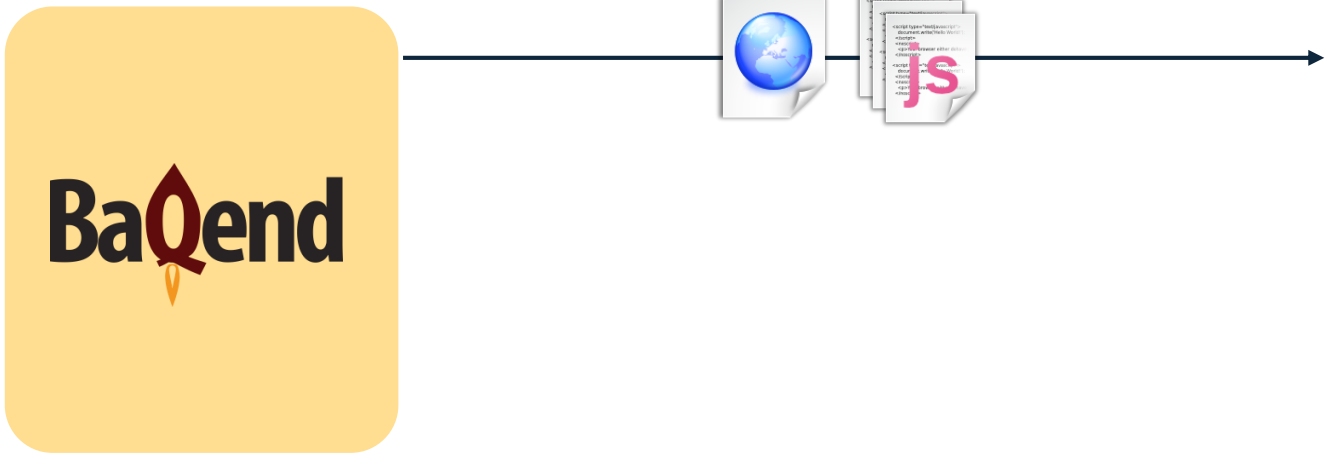
API for application features

Hosting and **Delivery**

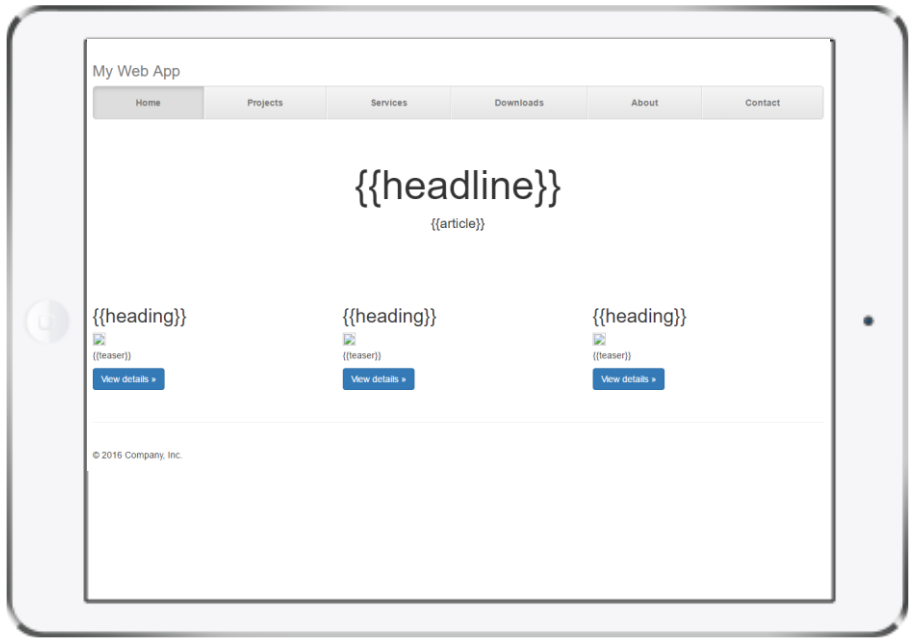
REST API and **JS SDK**



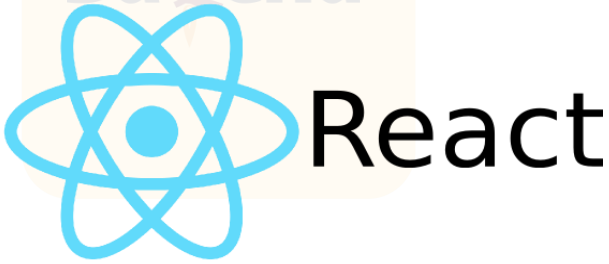
Frontend



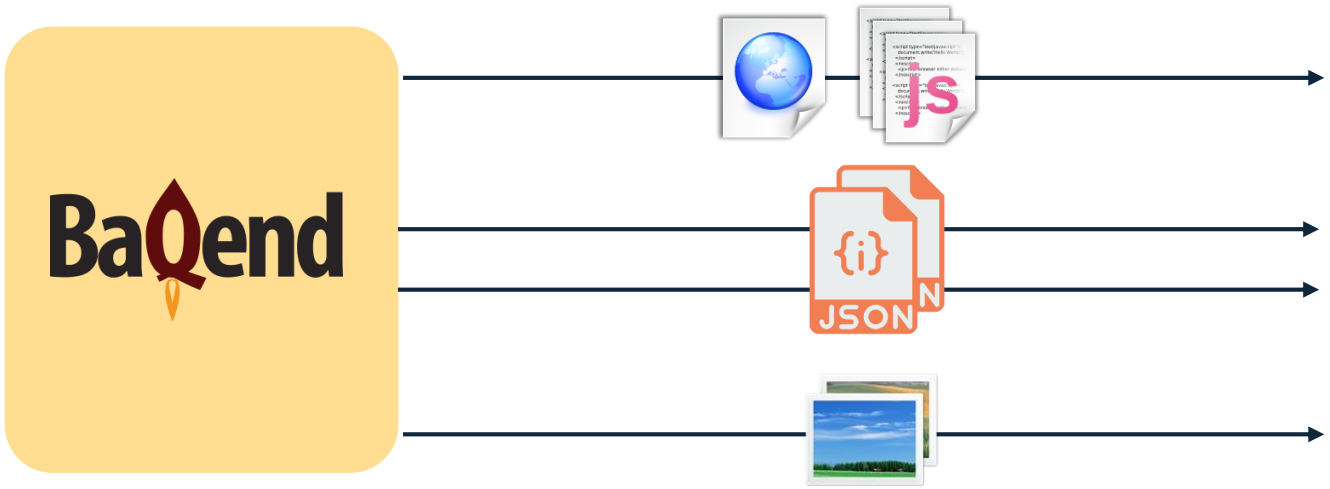
GET /app.html
GET /js/main-34da93.js
GET /css/main-9ad7ca3.css



Compatible with:



Frontend

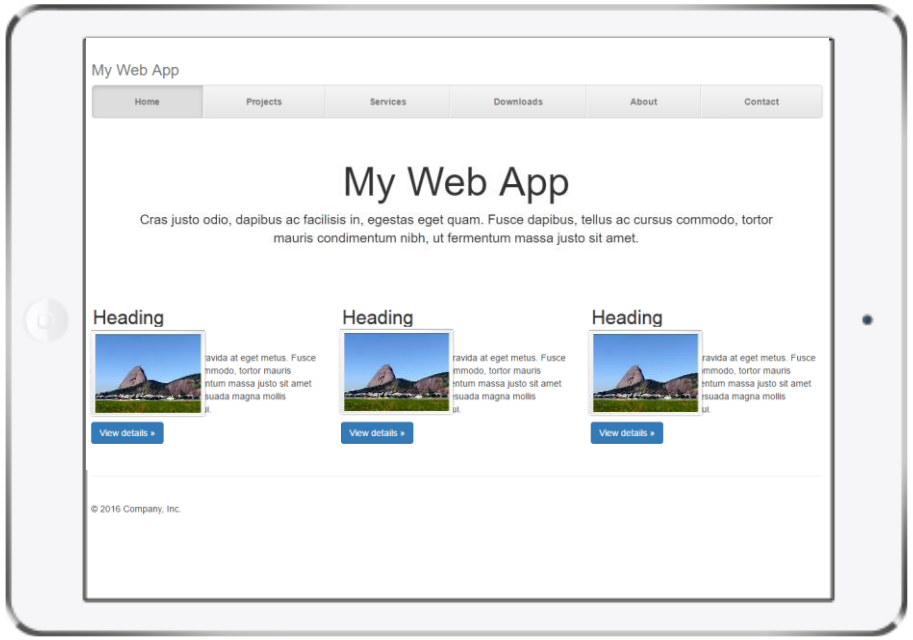


GET /app.html
GET /js/main-34da93.js
GET /css/main-9ad7ca3.css

```
db.Page.load('main')
  .done(...);
```

```
db.Page.find()
  .descending('published')
  .limit(3)
  .resultList(...);
```

GET /img/pic005.jpg
GET /img/pic017.jpg
GET /img/pic022.jpg

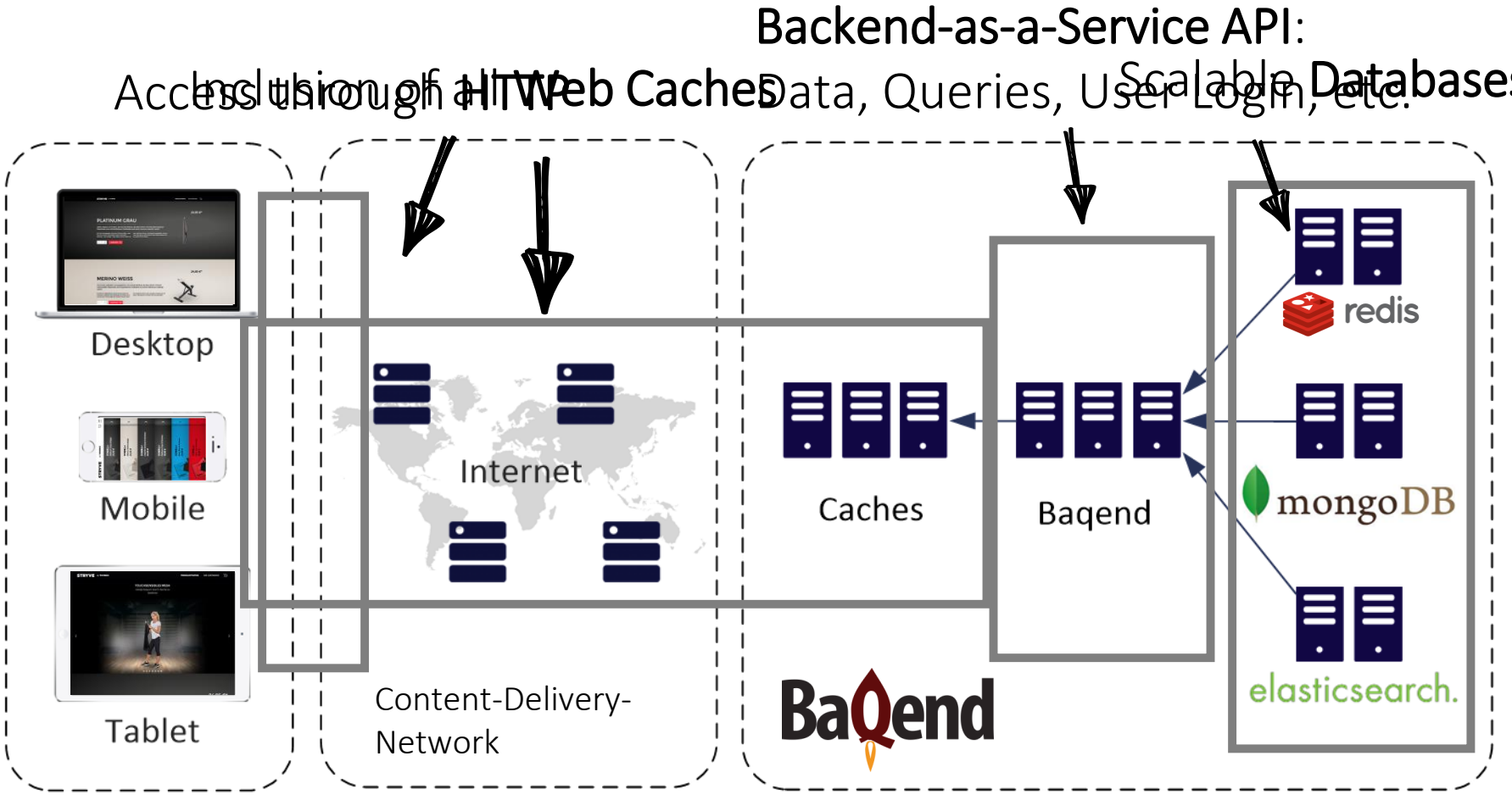


Challenges

- Multi-Tenancy
- Load-Balancing and Horizontal Scaling
- High Availability Deployments
- Rolling Updates without Downtime
- Session Handling and Authorization

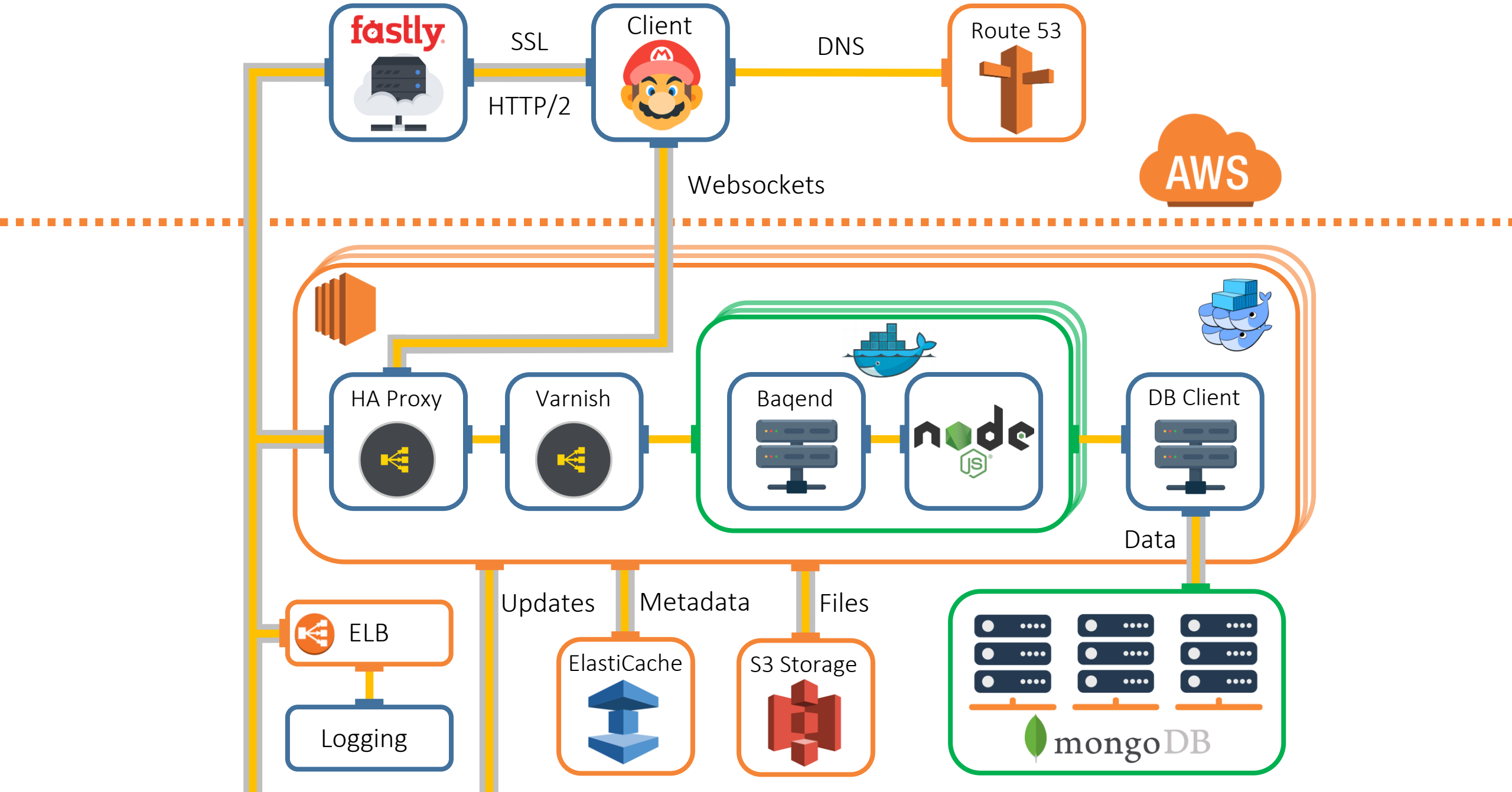
Backend Architecture

Baqend Cloud



Backend Architecture

Baqend Cloud


fastly
SSL
HTTP/2
Client
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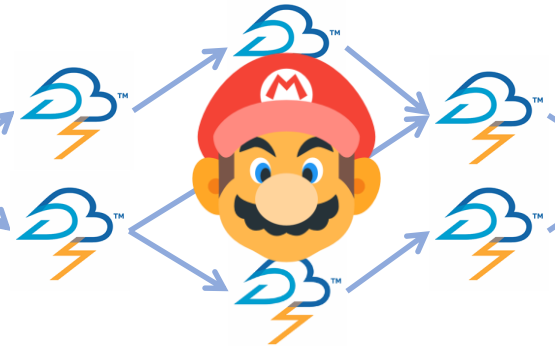
Route 53
AWS
Websockets
HA Proxy
Varnish
Baqend
node
DB Client
Data
ELB
Logging
Updates
Metadata
Files
ElastiCache
S3 Storage
mongoDB

Updates

Updated Query

Storm Query Matching



Pub/Sub

Pub/Sub

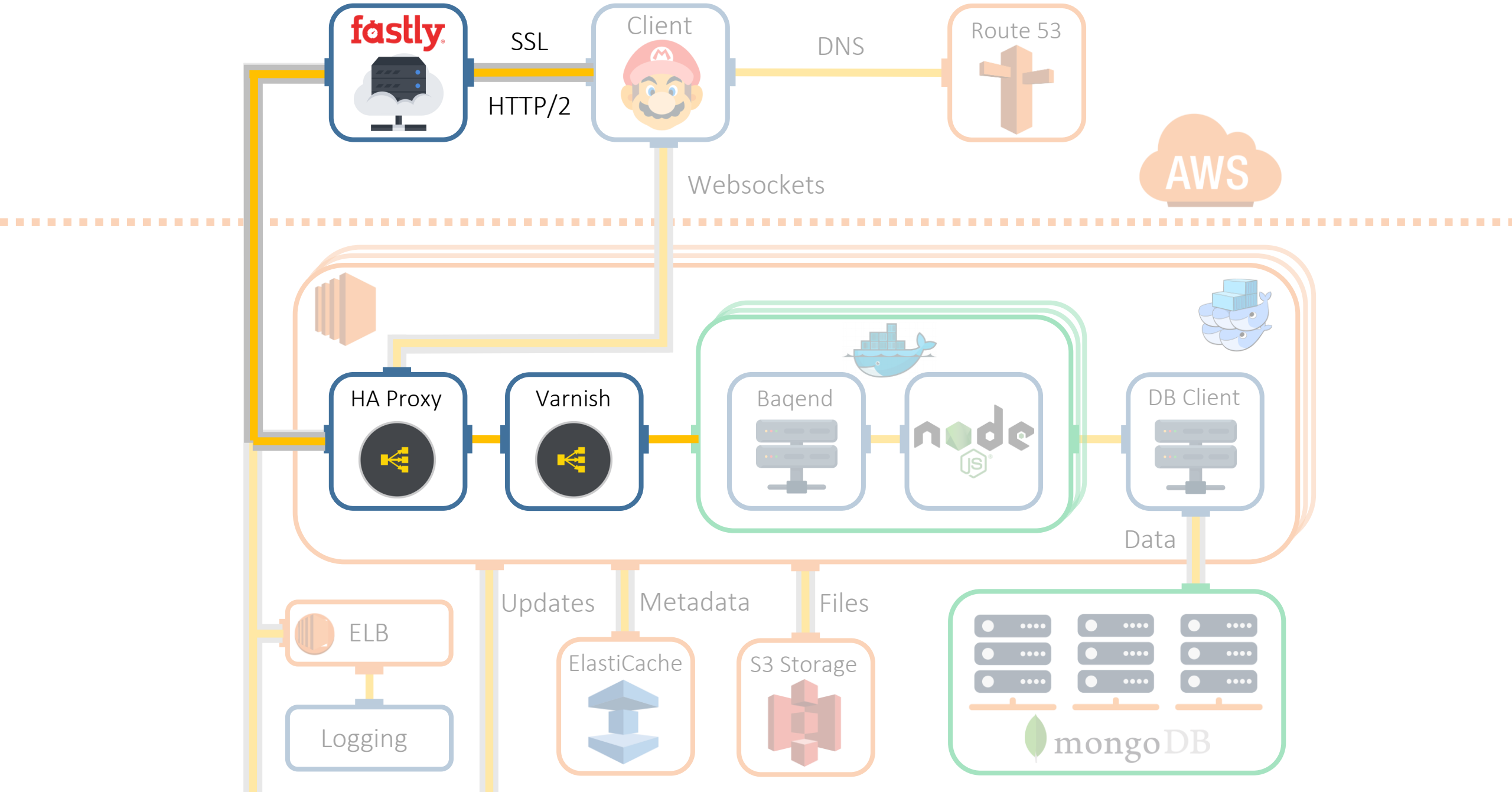
Management and Orchestration Server

Manager

Swarm

Nimbus

Zookeeper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DB Client
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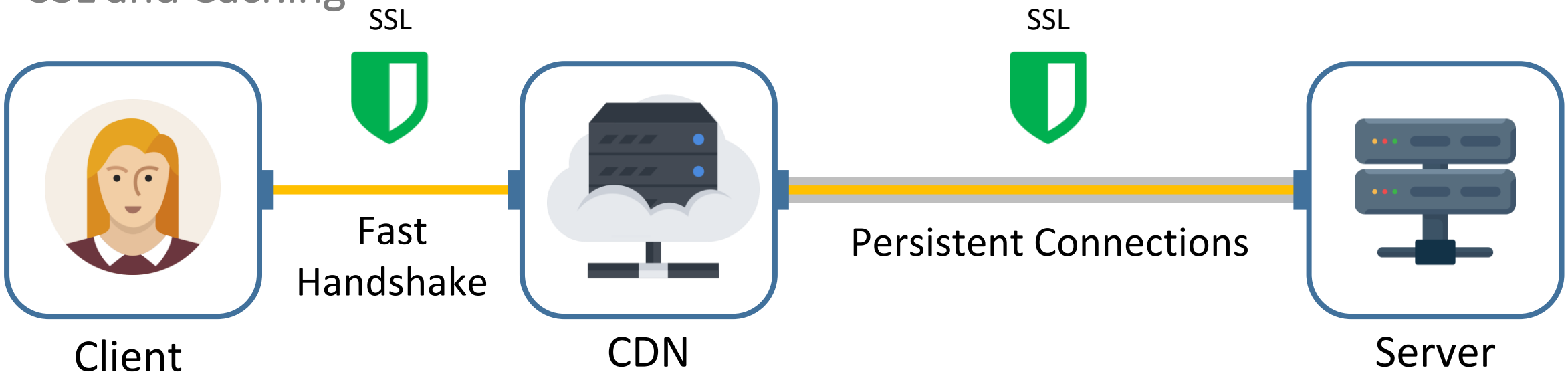
Content Delivery Network (CDN)

SSL and Caching

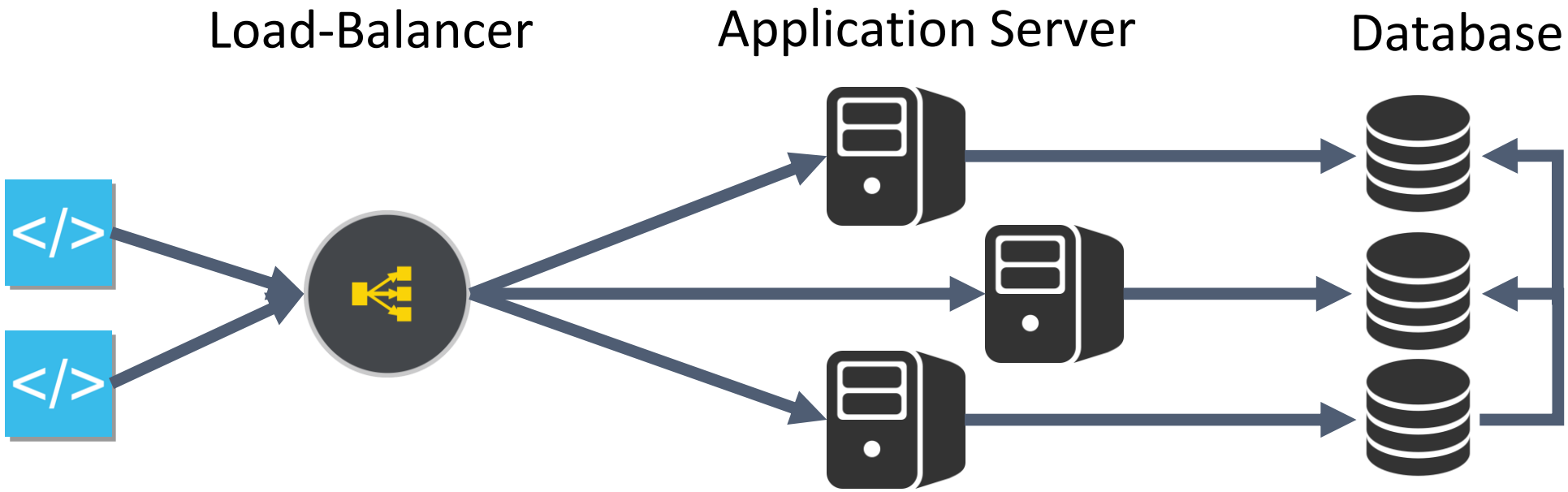


- Caching at **the Edge**
- **Low** Read **Latency**
- Early **SSL Termination**

- Warm **Backend Connections**
- Backend **Failover**
- Stale-on-error

Load Balancing

Best Practices



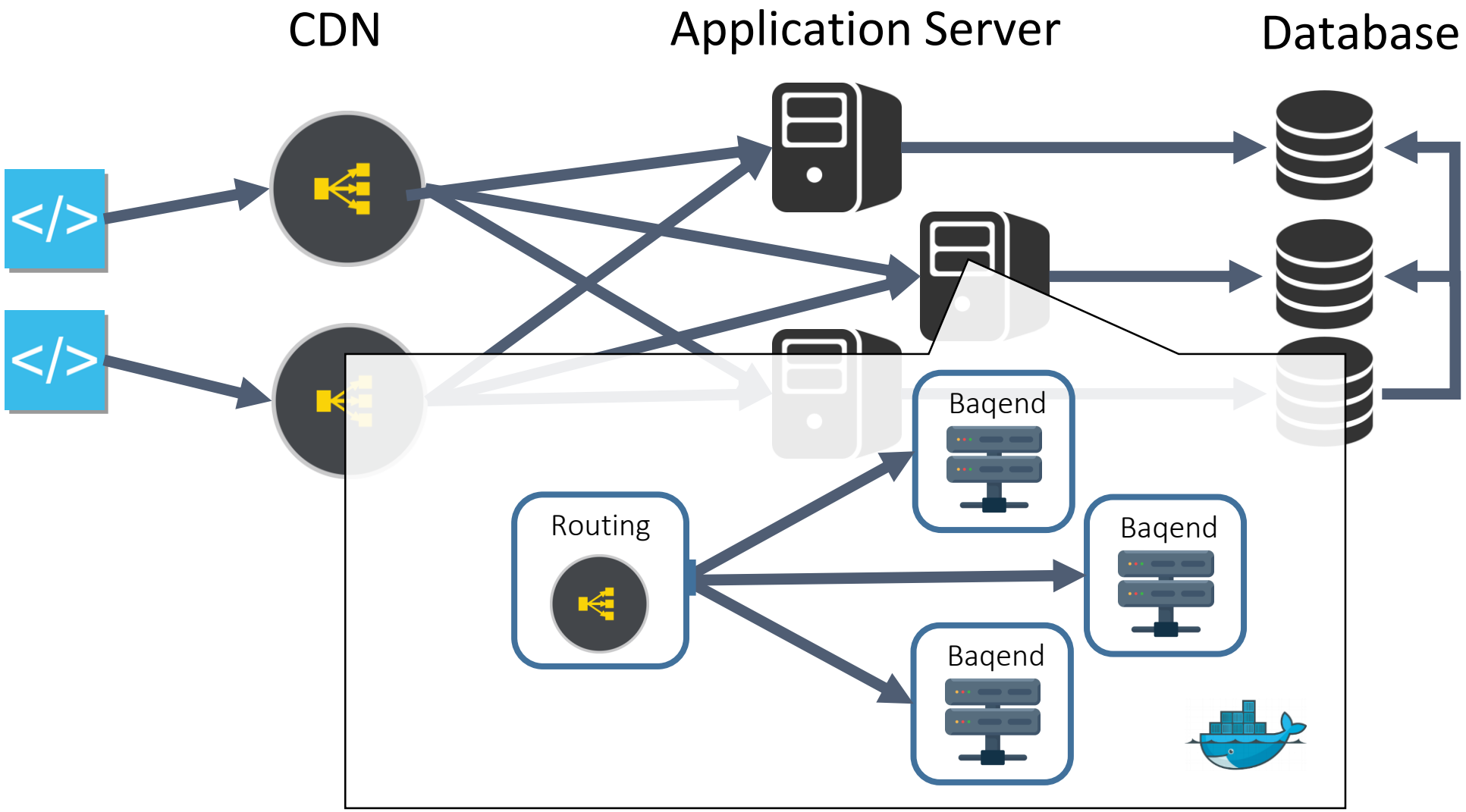
- Load-Balancing
- Auto-scaling
- Failover

- Minimize shared state

- Horizontally scalable databases (e.g. “NoSQL”)
  - Replication
  - Sharding
  - Failover

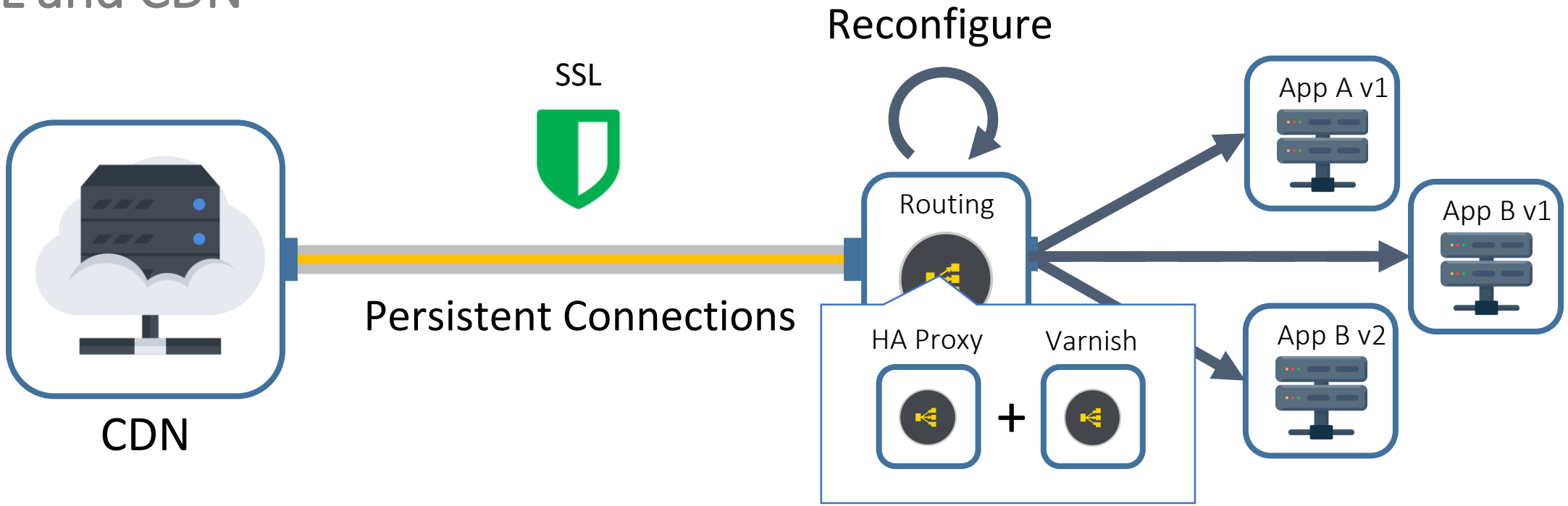
Load-Balancing

at CDN Edge Nodes



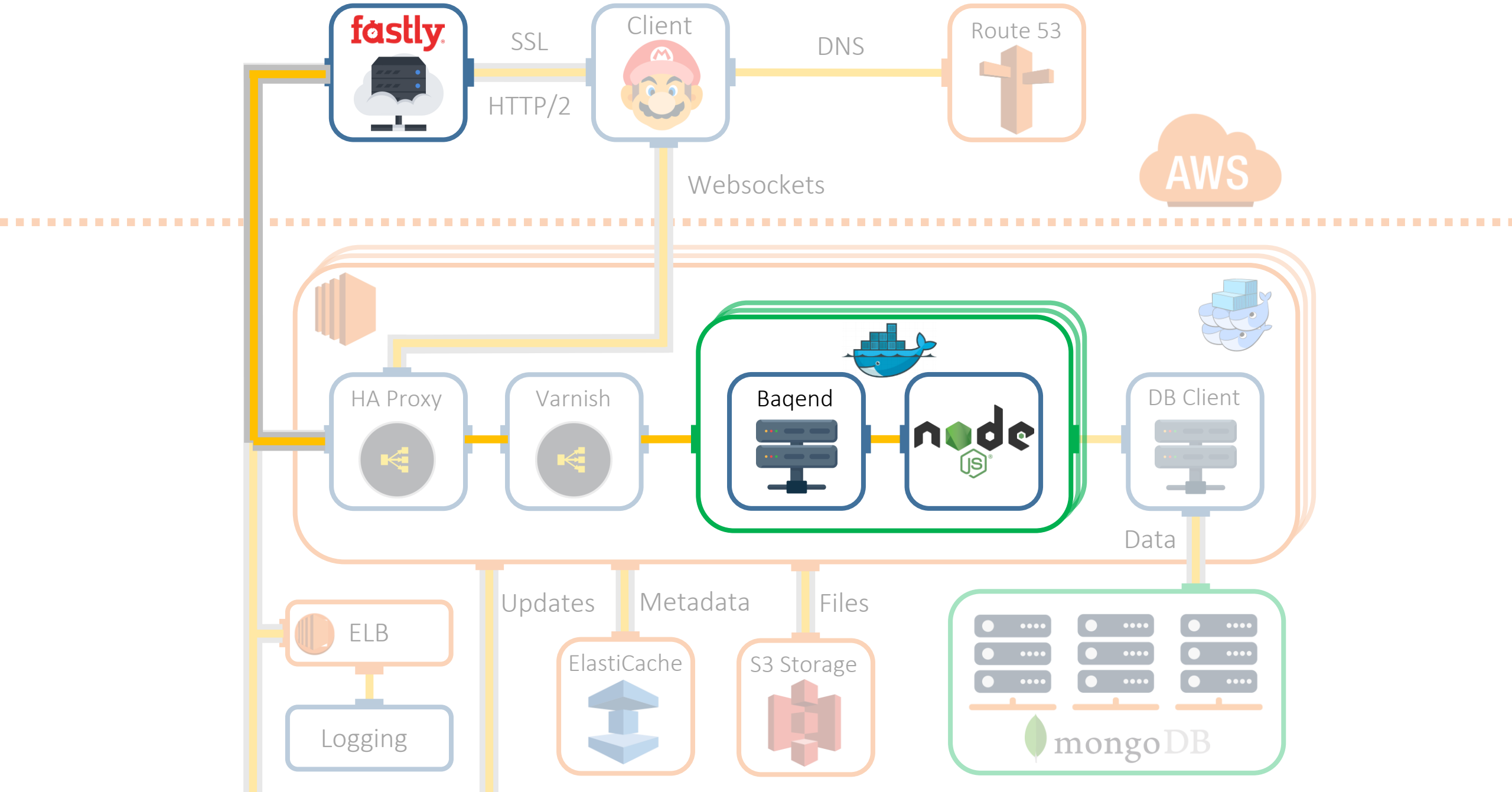
Persistent Connections and Containerization

SSL and CDN



App containers often moving / updated

- New app servers will be registered
- Most load-balancers need a reload (Nginx/HAProxy)
- Old connections kept alive and served with old configuration
  →Requests will be sent to removed app servers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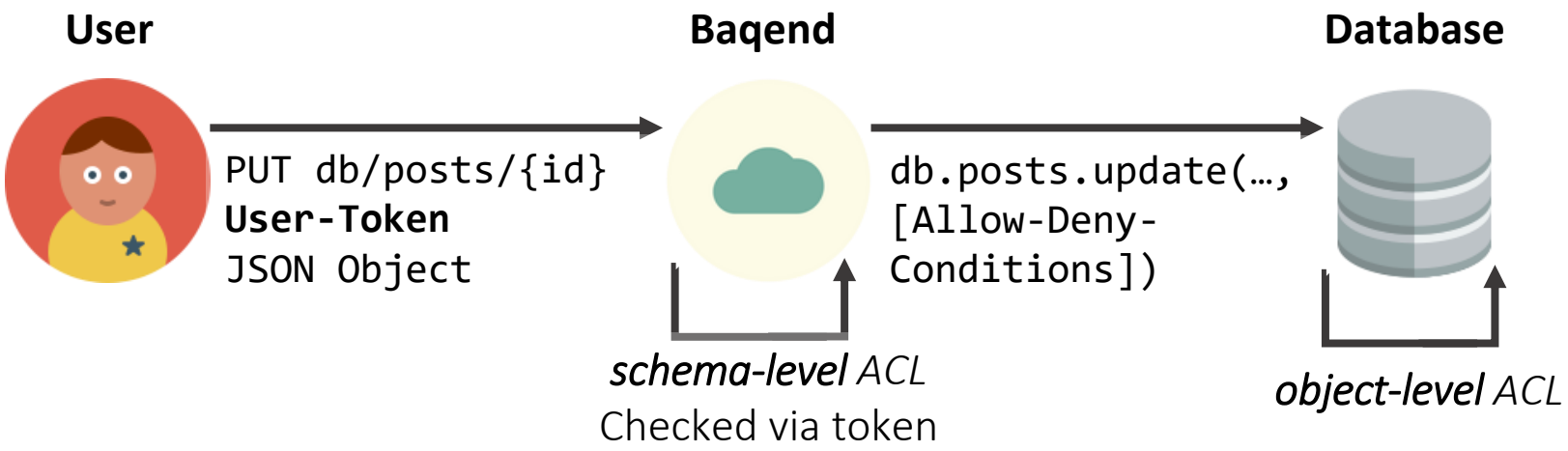
S3 Storage
mongoDB

Access Control

Authorization

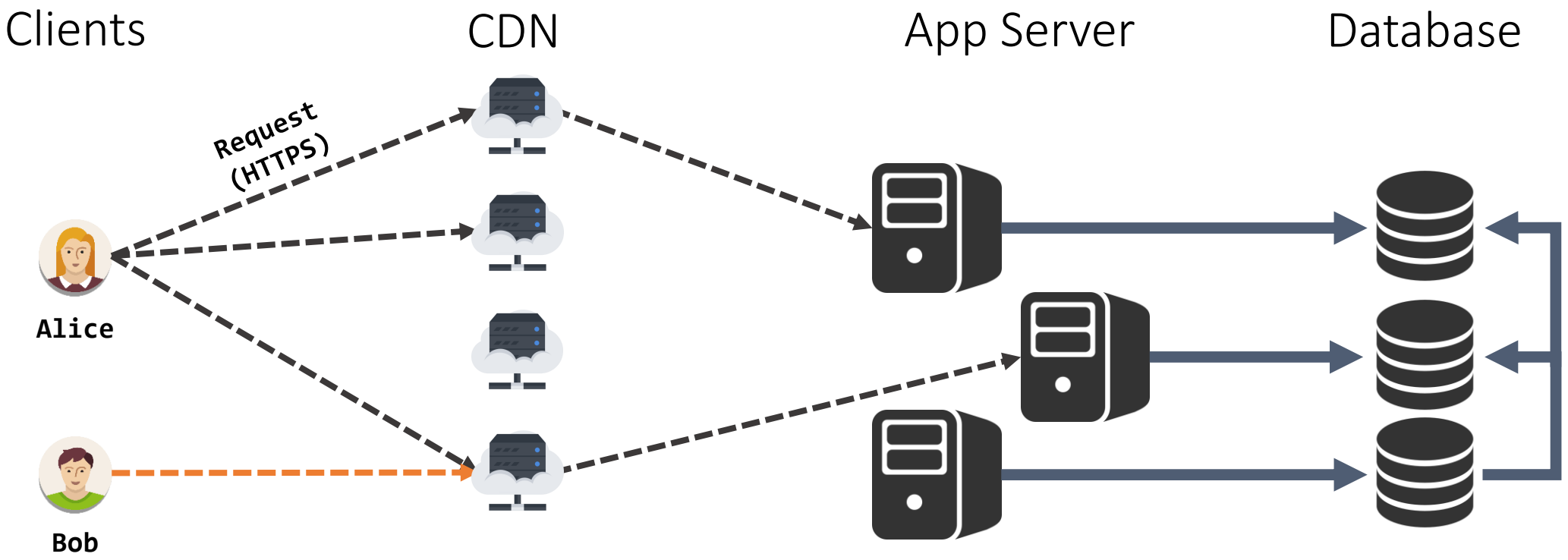
	Load	Insert	Update	Delete	Query
Public	✔	✖	✖	✖	✔
admin (/db/Role/1)	✔				✔
node (/db/Role/2)	✔	✔	✔	✔	✔
+ felix-					

felix-test



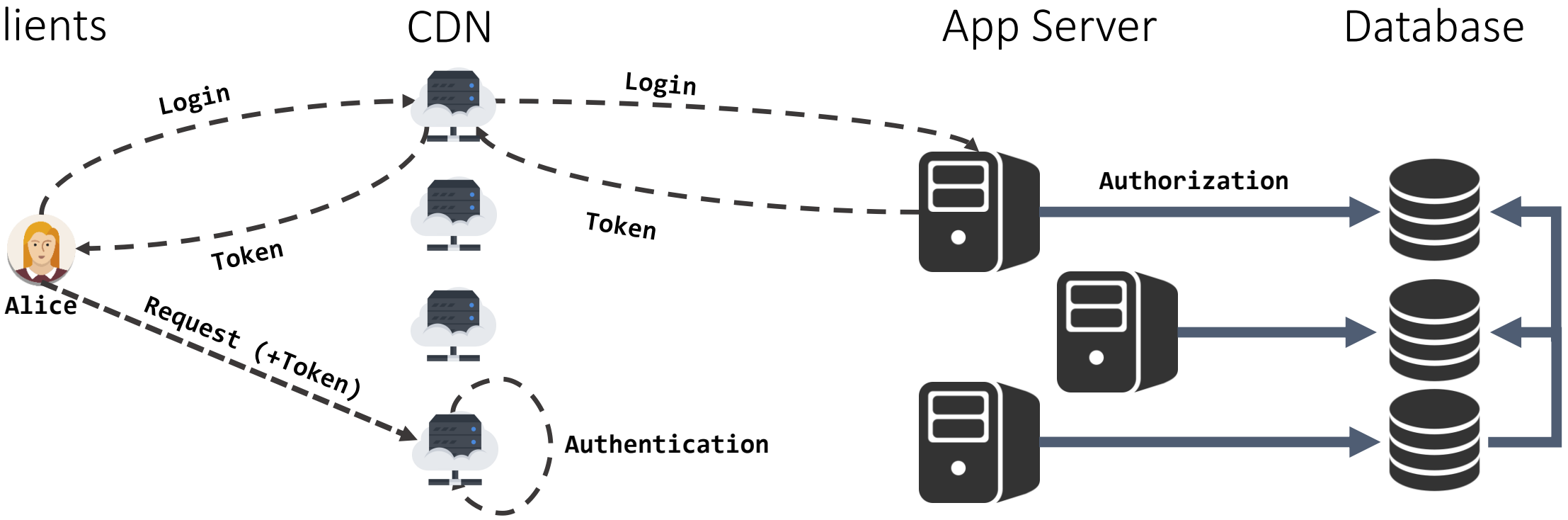
Problem: Sessions ↔ Stateless

Authorization and Authentication in Distributed Systems



Solution: Signed Tokens

Stateless Sessions



Token in Detail

Creation Date

590c965e590c978aAAAAABgAAAABgAAAADda0f7ebbf0ba76b66c97432a886d26895ad669ee

1493997150

05.05.17 17:12:30

Token in Detail

Renew Time

590c965e590c978aAAAAABgAAAABgAAAADda0f7ebbf0ba76b66c97432a886d26895ad669ee

1493997450

05.05.17 17:17:30

Token in Detail

User ID and Role IDs

590c965e590c978aAAAAABgAAAACgAAAADda0f7ebbf0ba76b66c97432a886d26895ad669ee

User ID: 1

Role ID: 2

Role ID: 3

Token in Detail

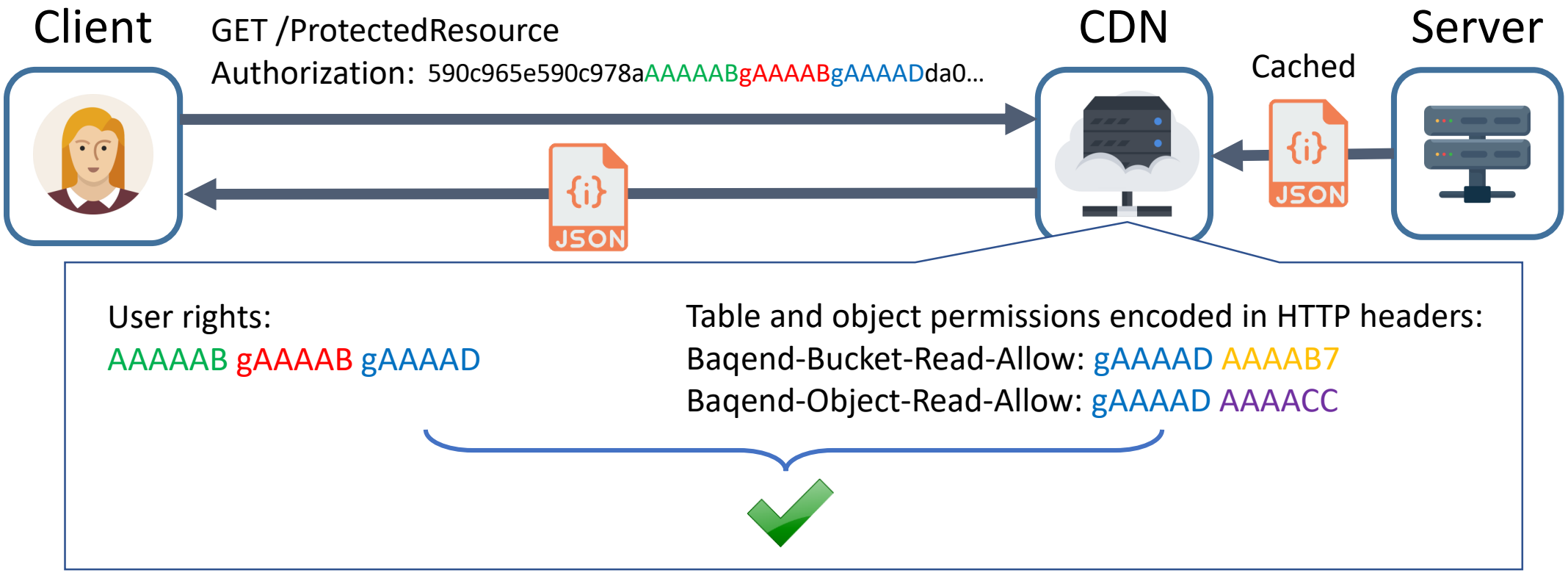
Signature

590c965e590c978aAAAAABgAAAABgAAAADda0f7ebbf0ba76b66c97432a886d26895ad669ee

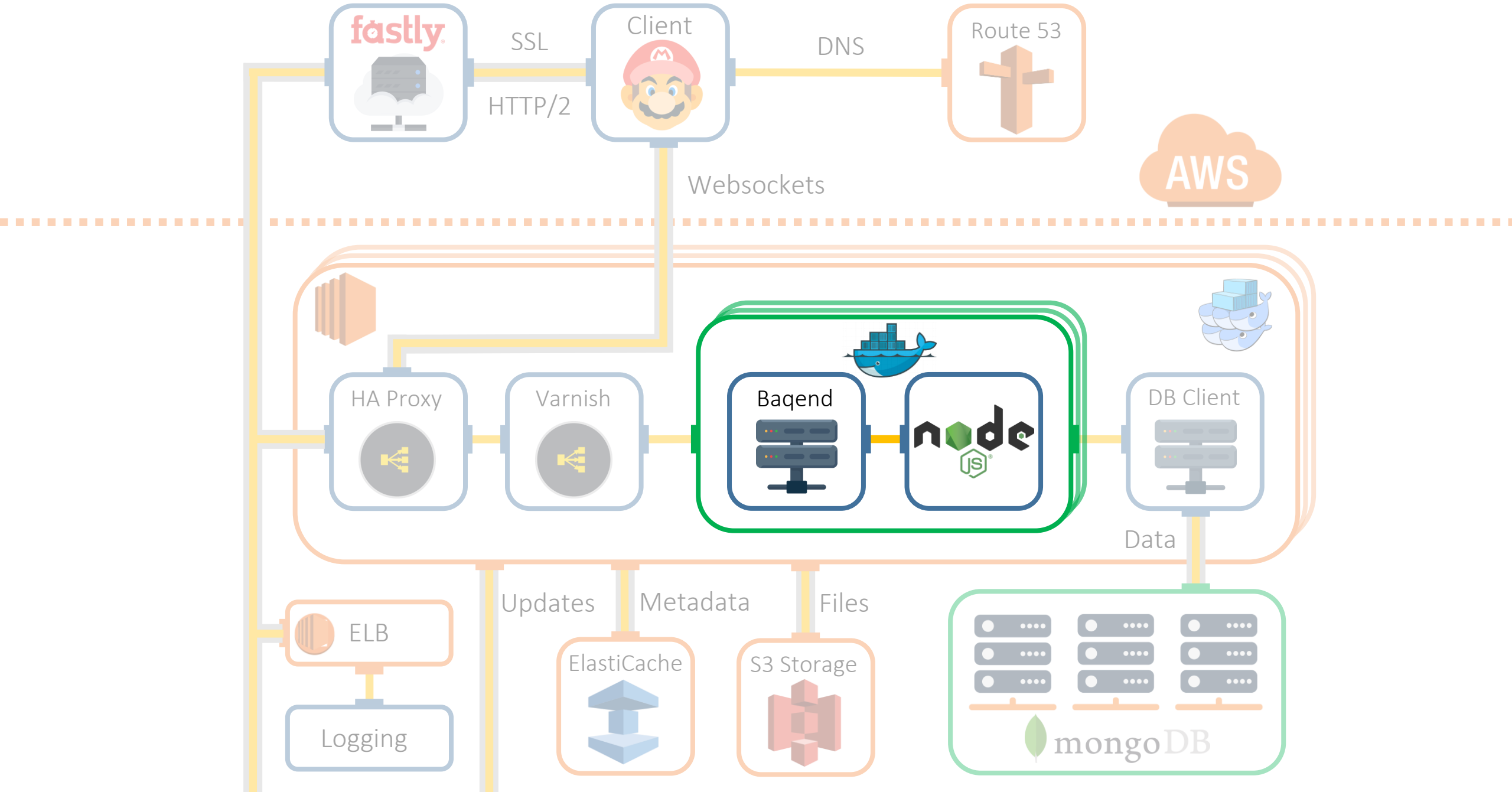
HMAC Signature

Access Control in the CDN

Permissions at the Edge



- Required permissions cached at the edge
- Can be checked in VCL (Varnish Configuration Language)
- No backend communication at all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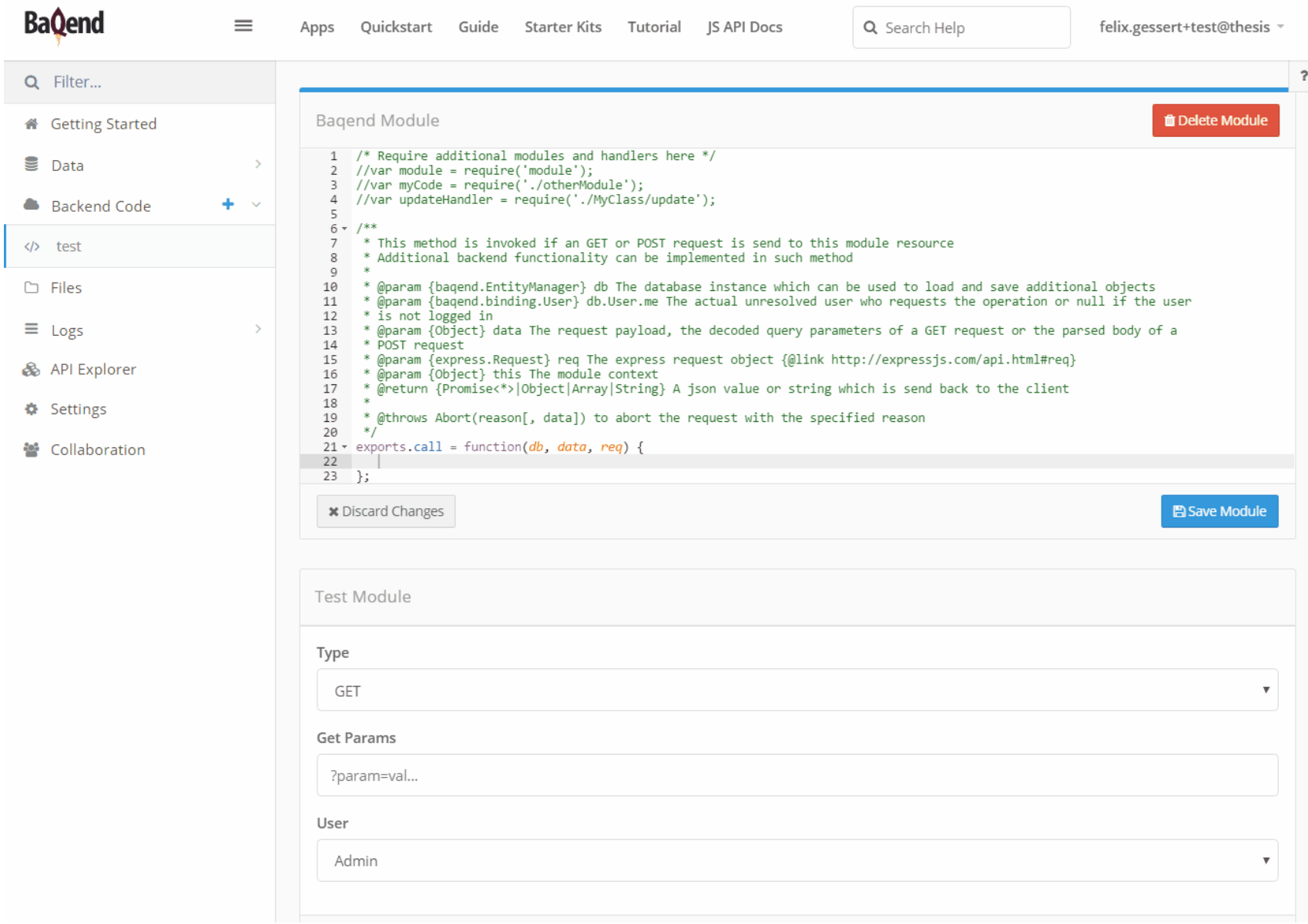
Backend Code

Trusted Business Logic

- Callable methods
- For **microservices** and custom **web APIs**

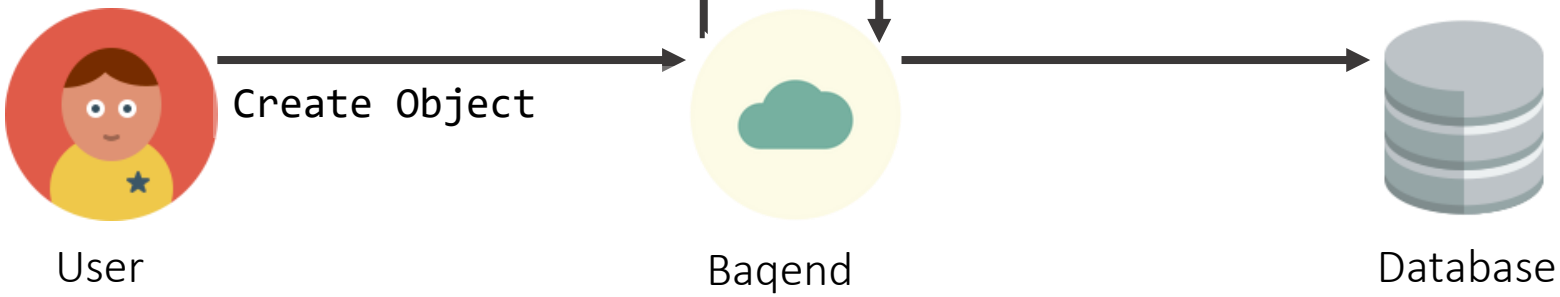


Backend Handler

Hooking Into Updates

- **Handler**: OnUpdate, OnDelete, OnInsert, OnValidate
- Node.js code, same SDK

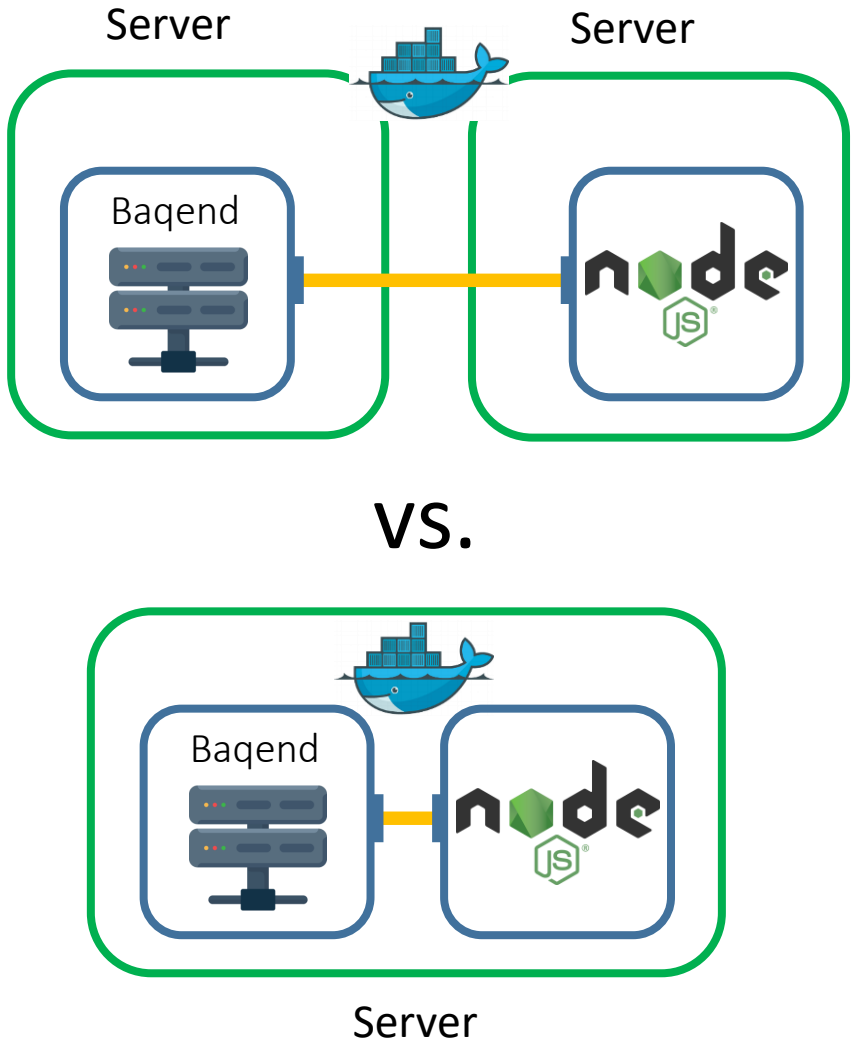
```
function onInsert(DB, obj) {
    var post = new DB.Post(
        {message : "New Data: " + this.name + "."});
    post.save();
}
```



How to Schedule App & Node Server

User Code Isolation & Placement

- Internal access (DB/Storm/Redis/S3)
- Isolation
- Public-only access for user code
- Strong coupling between Node and App server
  - High throughput
  - Low latency



How to Schedule App & Node Server

Container Schedulers

AWS ECS 

+ Automated Server and Service scheduling
- No Docker network isolation
- Only Spread and Binpack as scheduling strategies
- Service definitions can’t be templated

Kubernetes 

+ Automated Service scheduling
+ Complex scheduling strategies
- No network isolation within Pods

Swarm (standalone) 

- No Services
+ Custom scheduling strategies
+ All Docker features
  - Networking
  - Isolation
  - Resource constraints

Docker

```
ubuntu@ip-10-0-0-105:~$ docker ps -a
CONTAINER ID        CREATED             STATUS

d53e07a0f144        33 minutes ago      Exited (128) 292 years ago

0f8e468a1845        47 minutes ago      Up 47 minutes

c6cec3578628        50 minutes ago      Up 50 minutes
0.255:34512->8443/tcp
83135b3529cd        50 minutes ago      Up 50 minutes

3a0589022e7d        52 minutes ago      Up 52 minutes
0.255:34510->8443/tcp
d866ce3f6aca        53 minutes ago      Up 52 minutes

765d35dfe29c        55 minutes ago      Up 55 minutes
0.255:34508->8443/tcp
3691b6b77c46        55 minutes ago      Up 55 minutes
```

Many Docker Containers on one Host

We are starting 183 Containers

→All works as expected

Starting the 184th container …

oci runtime error: could not synchronise with container process: could not create session key: disk quota exceeded

Nope, the disk is not full!

Many Docker Containers on one Host

- Tune the kernel parameters!

```
#https://github.com/docker/docker/issues/22865
sysctl -w kernel/keys/root_maxkeys=1000000
sysctl -w kernel/keys/root_maxbytes=25000000
sysctl -w kernel/keys/maxkeys=1000000
sysctl -w kernel/keys/maxbytes=25000000
```

- Used by docker for container session handling
- Known issue and fixed in newer distributions/kernels

Docker Swarm & AWS

Node Drops

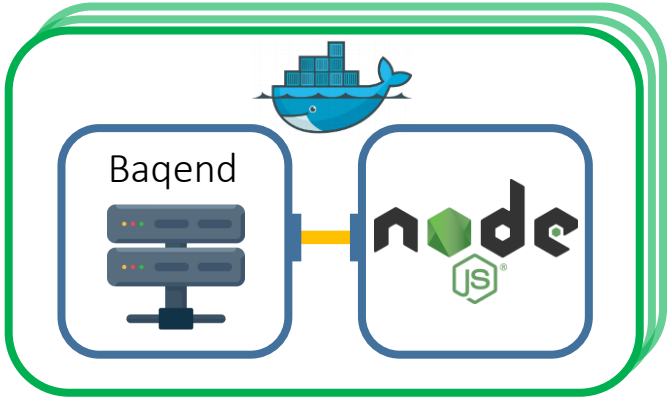
- AWS introduces random network errors occasionally

```
time="2017-09-23T12:33:48Z" level=info msg="Removed Engine ip-10-0-15-21“
time="2017-09-23T12:36:00Z" level=info msg="Registered Engine ip-10-0-15-21 at 10.0.15.21:2375"
```

- Swarm drops a node
  - →Swarm drops all containers
  - →Status checks will fail, since running containers are missing
- You must live with this behavior, if you run a swarm cluster on AWS!

Docker Networks

- Containers can be isolated in docker networks
- Docker creates two iptable entries for each pair of containers
- This results in **$O(n^2)$** iptable entries



→ Adding the 10th container → 100 rules → wait <1s

→ Adding the 100th container → 10 000 rules → wait 30s

→ …

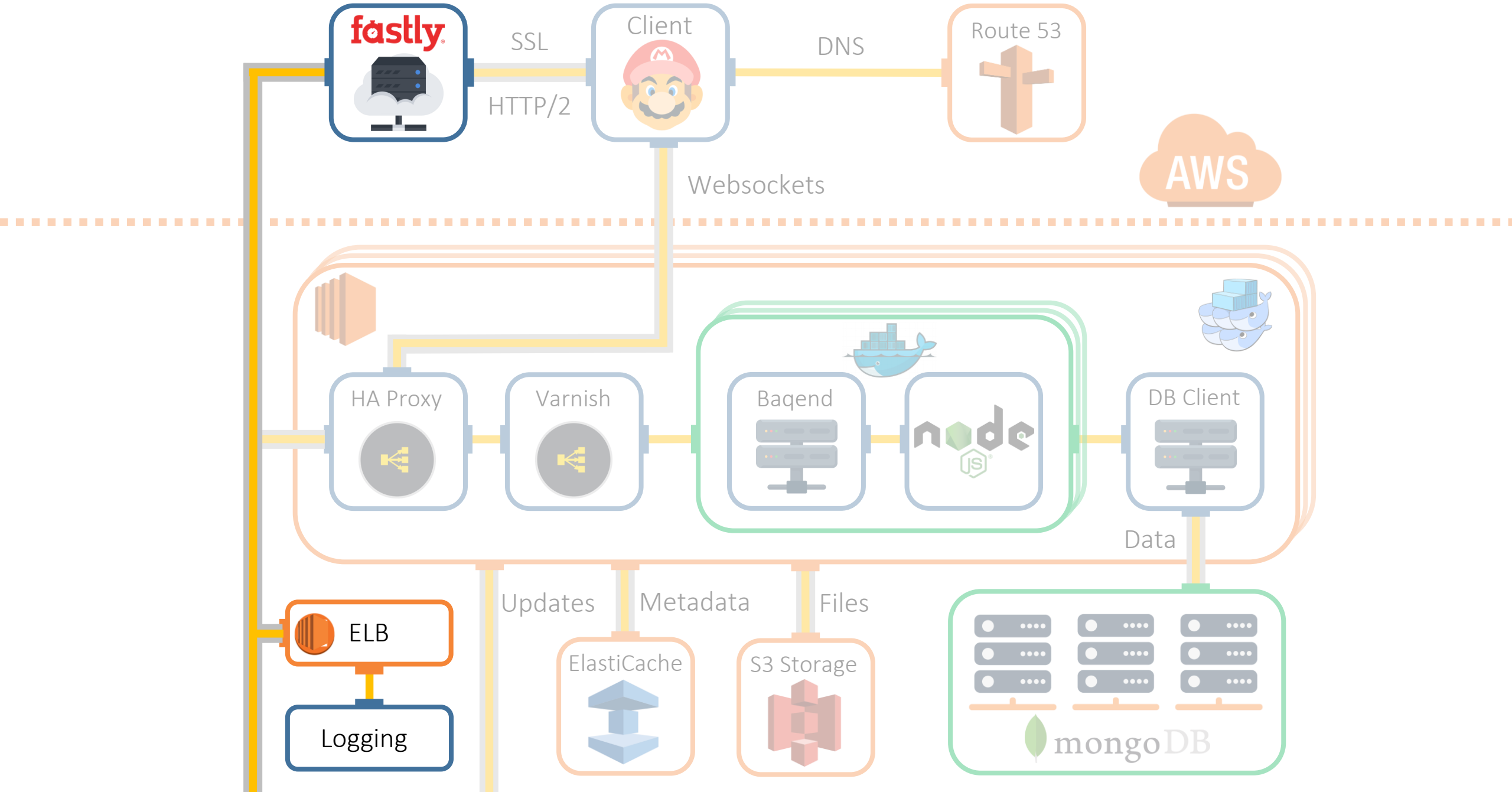
Docker & EBS Volumes

Docker Maintenance vs. EBS Rate-Limiting

- Docker stores all its content in /var/lib/docker
  - Images
  - Volumes
  - Containers
  - Networks
- Docker writes on EBS Volume per default
- Container creation and removal → many IOPS

EBS: Network, rate-limited!

→ Causes many creation and removal issues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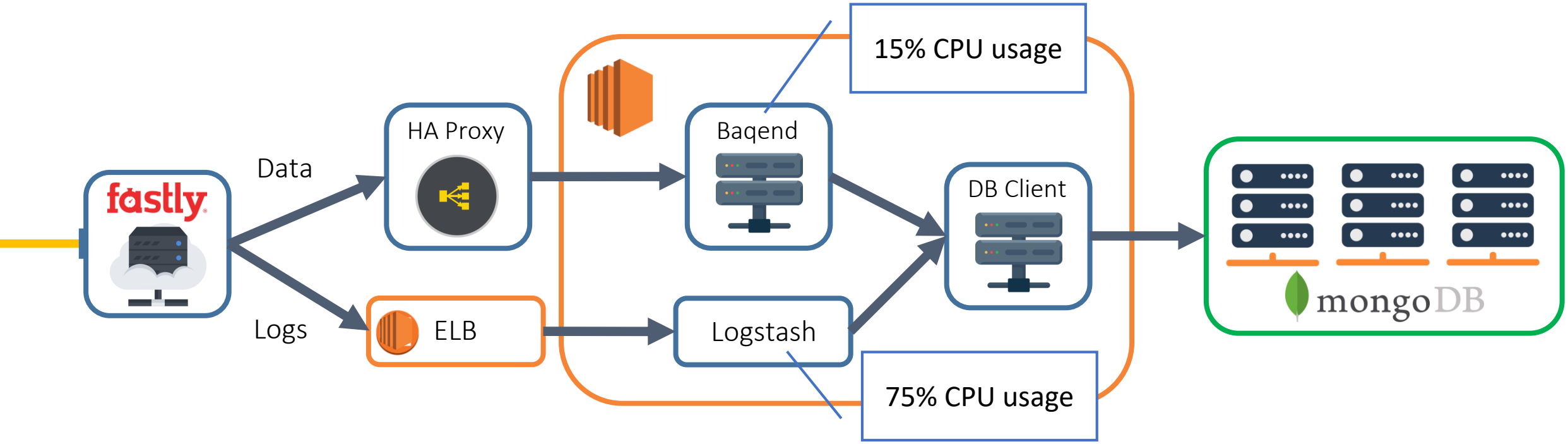
Files
ElastiCache
S3 Storage
mongoDB

Logstash “Perfomance”

Streaming Logs



- Solution: custom Node.js server → 5% CPU usage!

Wrap-Up

- Persistent connections and zero-downtime deployments are tricky
- Sessions should be stateless, to be horizontally scalable
- Docker has powerful tools to isolate untrusted components in a secured infrastructure
- Many Docker issues are caused by wrong defaults
- Test performance of each component of your infrastructure

We are hiring.

Frontend Developers
Mobile Developers
Java Developers
Web Performance Engineers

Contact us.

BaQend

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Questions?

Our other talks:

Th. 16:00 Real-Time Databases Explained: Why Meteor, RethinkDB, Parse and Firebase Don't Scale

Fr. 10:00 Real-Time Anwendungen mit React und React Native entwickeln

Fr. 14:00 AMP, PWAs, HTTP/2 and Service Workers: A new Era of Web Performance?

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