APACHE TRAFFIC CONTROL

Routing CDN Traffic at Scale Using Apache Tomcat

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About Me

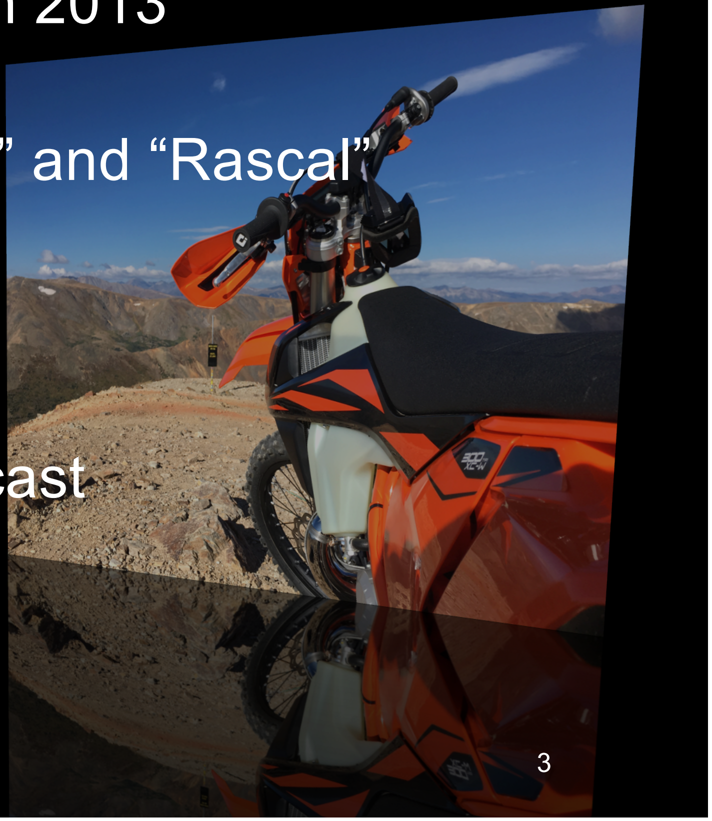
Joined Comcast in 2008, CDN Engineering in 2013

Led development of CDN components “CCR” and “Rascal”

Member of Apache Traffic Control PMC

Lead engineer for CDN Engineering at Comcast

Motorcycle enthusiast

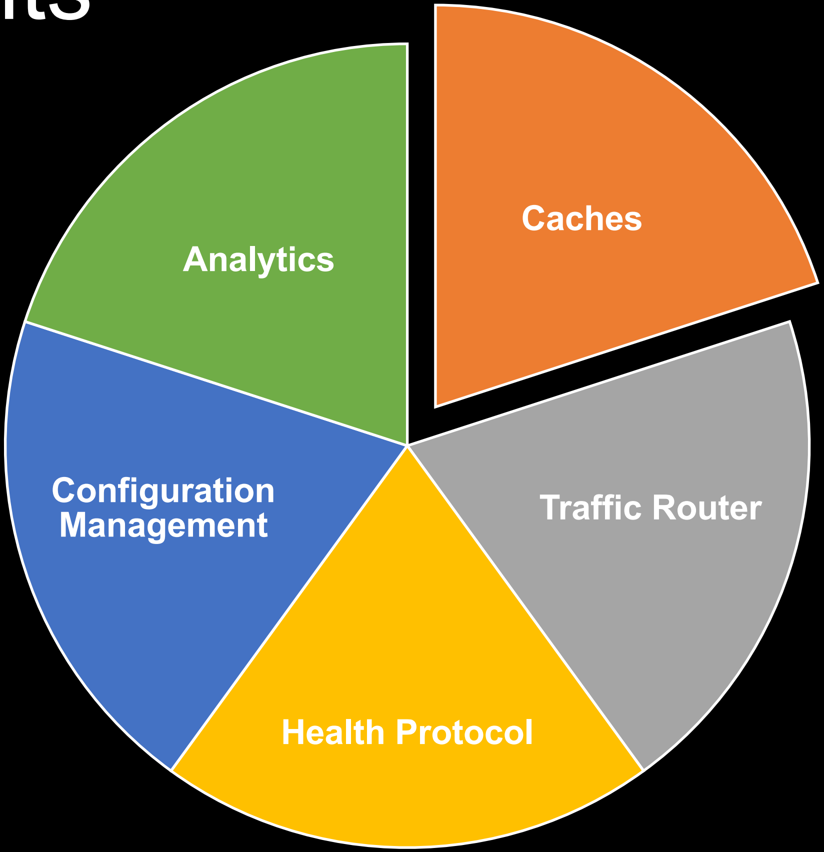


Content Delivery Networks

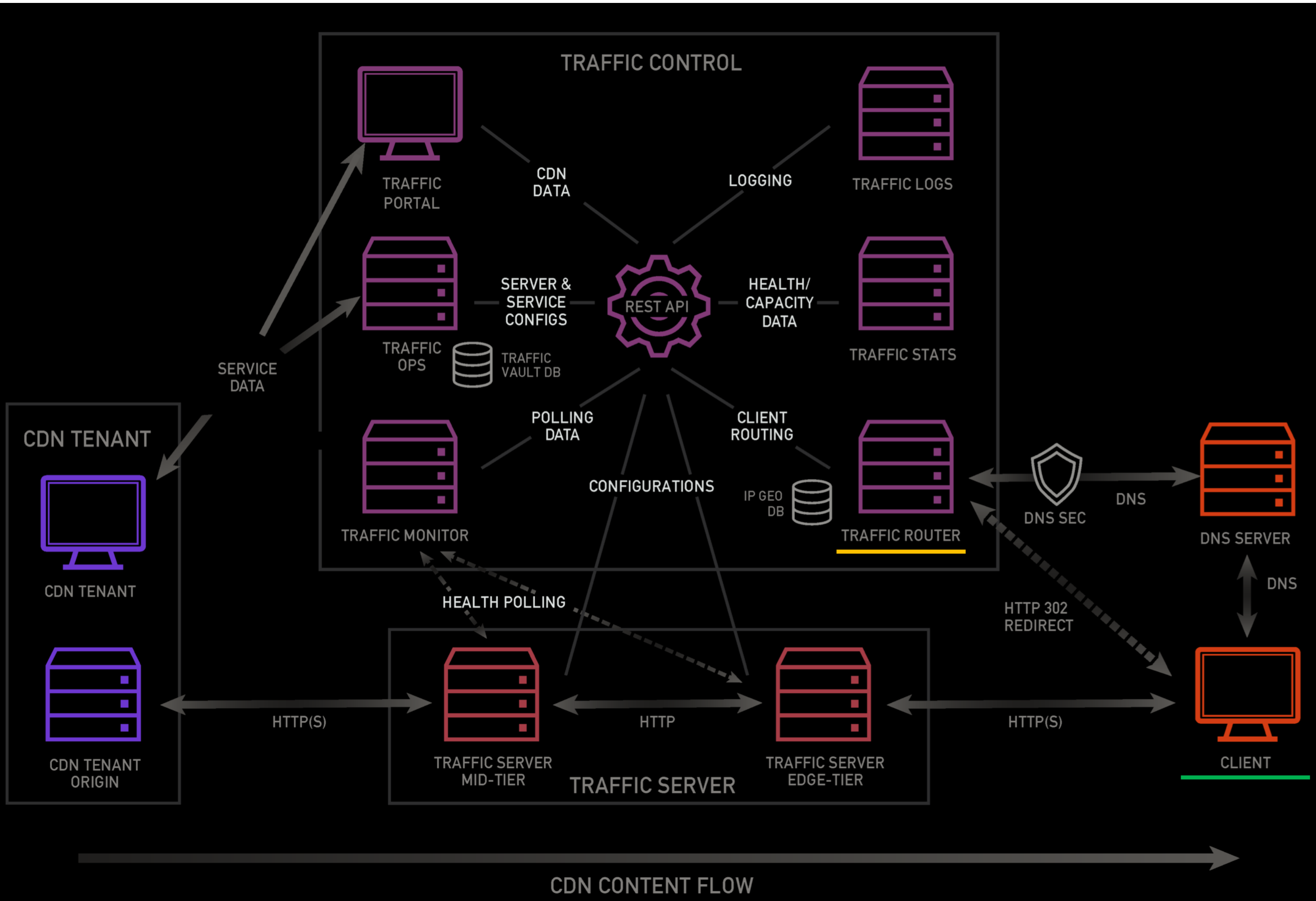
improve user experience

and network efficiency

Components


Caches
Analytics
Configuration Management
Traffic Router
Health Protocol

TRAFFIC PORTAL	User Interface
TRAFFIC OPERATIONS	Business logic with RESTful API
TRAFFIC STATS	Collect and aggregate metrics
TRAFFIC MONITOR	Monitor CDN health
TRAFFIC ROUTER	Route traffic to healthy caches



TRAFFIC CONTROL

TRAFFIC PORTAL

CDN DATA

LOGGING

TRAFFIC LOGS

TRAFFIC OPS

TRAFFIC VAULT DB

SERVER & SERVICE CONFIGS

REST API

HEALTH/ CAPACITY DATA

TRAFFIC STATS

SERVICE DATA

POLLING DATA

CLIENT ROUTING

TRAFFIC MONITOR

CONFIGURATIONS

IP GEO DB

TRAFFIC ROUTER

DNS SEC

DNS

DNS SERVER

DNS

CDN TENANT

CDN TENANT

CDN TENANT ORIGIN

HEALTH POLLING

HTTP 302 REDIRECT

HTTP(S)

TRAFFIC SERVER MID-TIER

HTTP

TRAFFIC SERVER EDGE-TIER

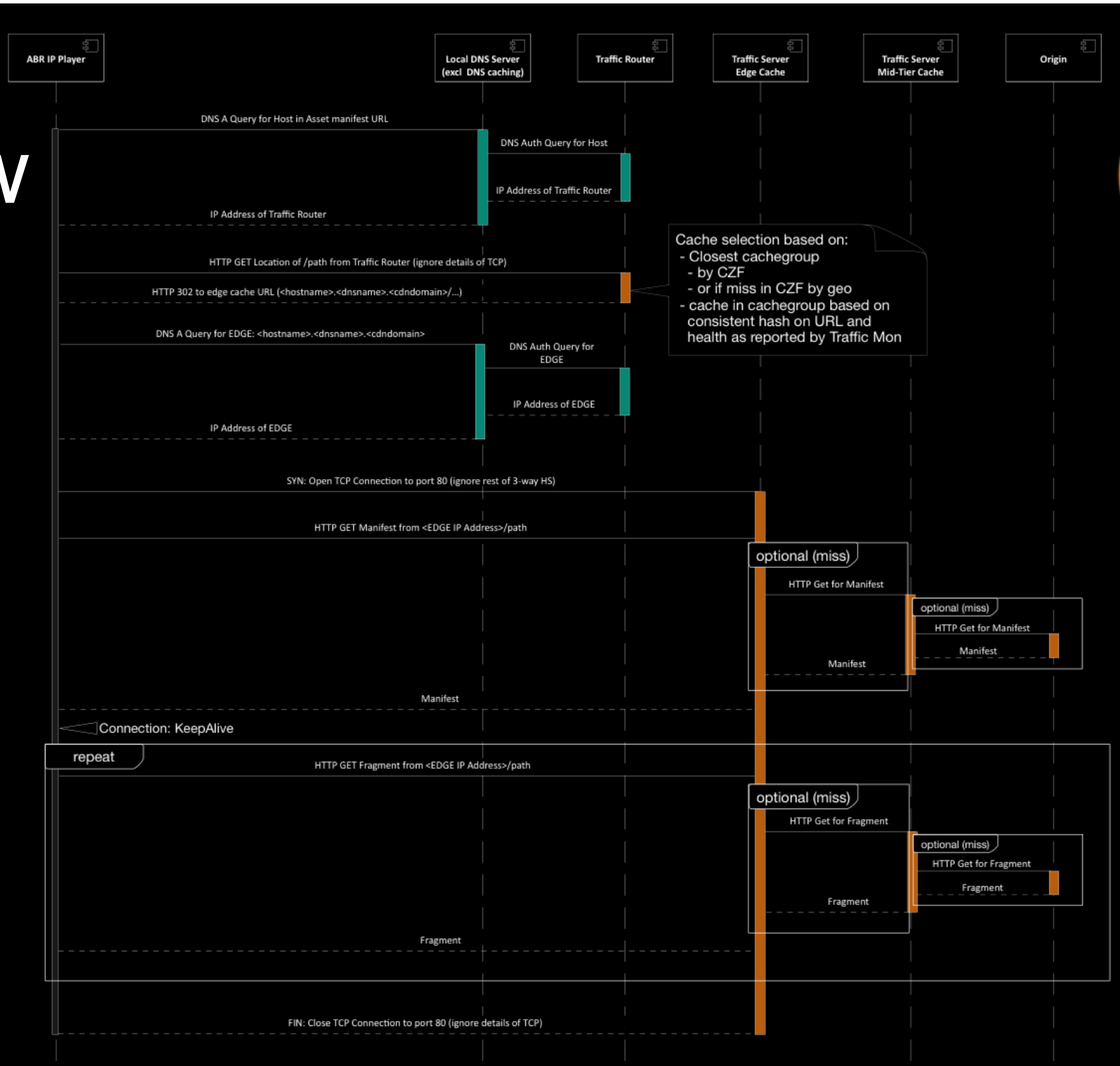
HTTP(S)

CLIENT

TRAFFIC SERVER

CDN CONTENT FLOW

Request Flow



ABR IP Player

Local DNS Server (excl DNS caching)

Traffic Router

Traffic Server Edge Cache

Traffic Server Mid-Tier Cache

Origin

DNS A Query for Host in Asset manifest URL

DNS Auth Query for Host

IP Address of Traffic Router

IP Address of Traffic Router

HTTP GET Location of /path from Traffic Router (ignore details of TCP)

HTTP 302 to edge cache URL (<hostname>.<dnsname>.<cdndomain>/...)

Cache selection based on:
- Closest cachegroup
  - by CZF
  - or if miss in CZF by geo
- cache in cachegroup based on consistent hash on URL and health as reported by Traffic Mon

DNS A Query for EDGE: <hostname>.<dnsname>.<cdndomain>

DNS Auth Query for EDGE

IP Address of EDGE

IP Address of EDGE

SYN: Open TCP Connection to port 80 (ignore rest of 3-way HS)

HTTP GET Manifest from <EDGE IP Address>/path

optional (miss)

HTTP Get for Manifest

optional (miss)

HTTP Get for Manifest

Manifest

Manifest

Manifest

Connection: KeepAlive

repeat

HTTP GET Fragment from <EDGE IP Address>/path

optional (miss)

HTTP Get for Fragment

optional (miss)

HTTP Get for Fragment

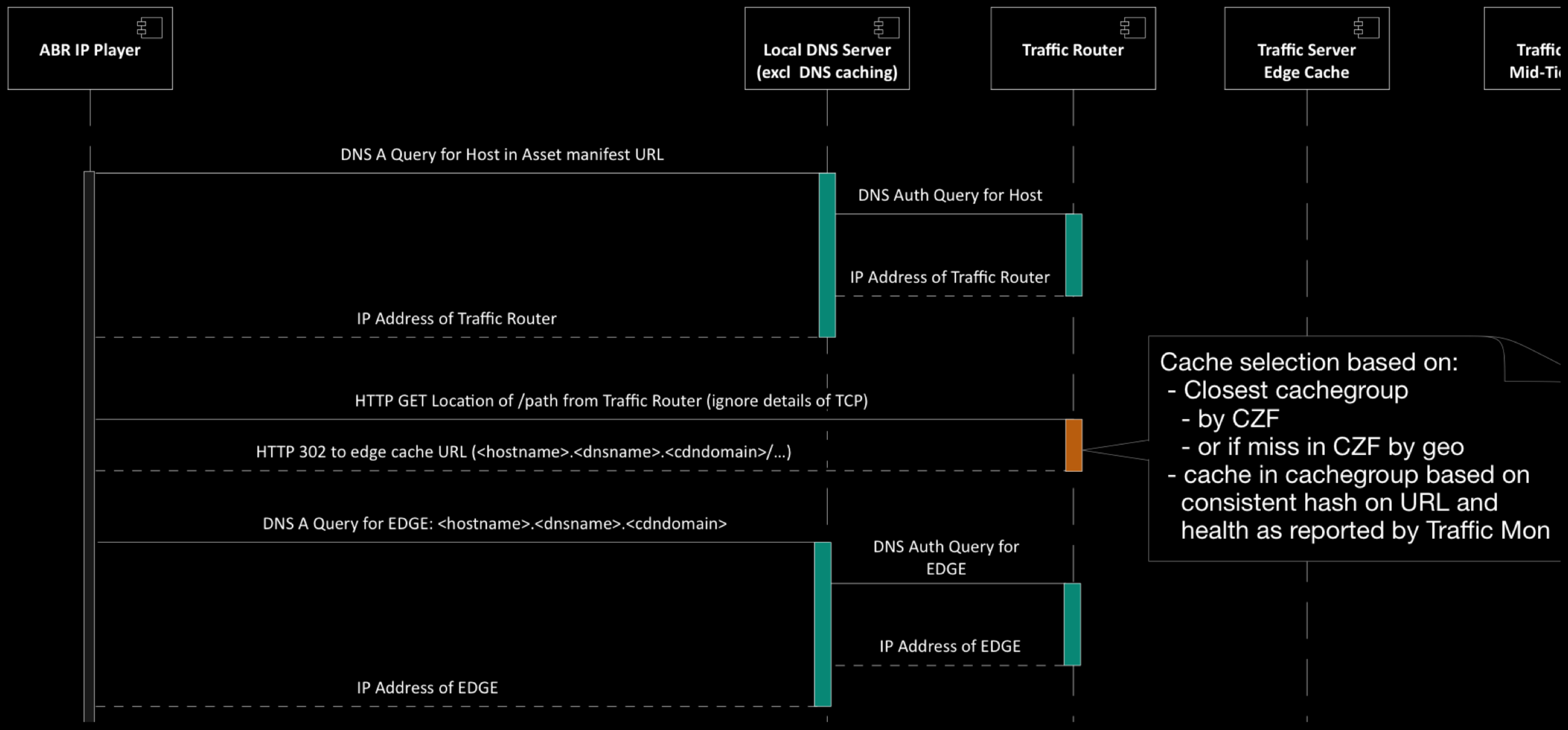
Fragment

Fragment

Fragment

FIN: Close TCP Connection to port 80 (ignore details of TCP)

DNS and Localization



ABR IP Player

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IP Address of EDGE

IP Address of EDGE

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- cache in cachegroup based on consistent hash on URL and health as reported by Traffic Mon

Consistent Hashing

The mechanism that provides cache efficiency within a CDN

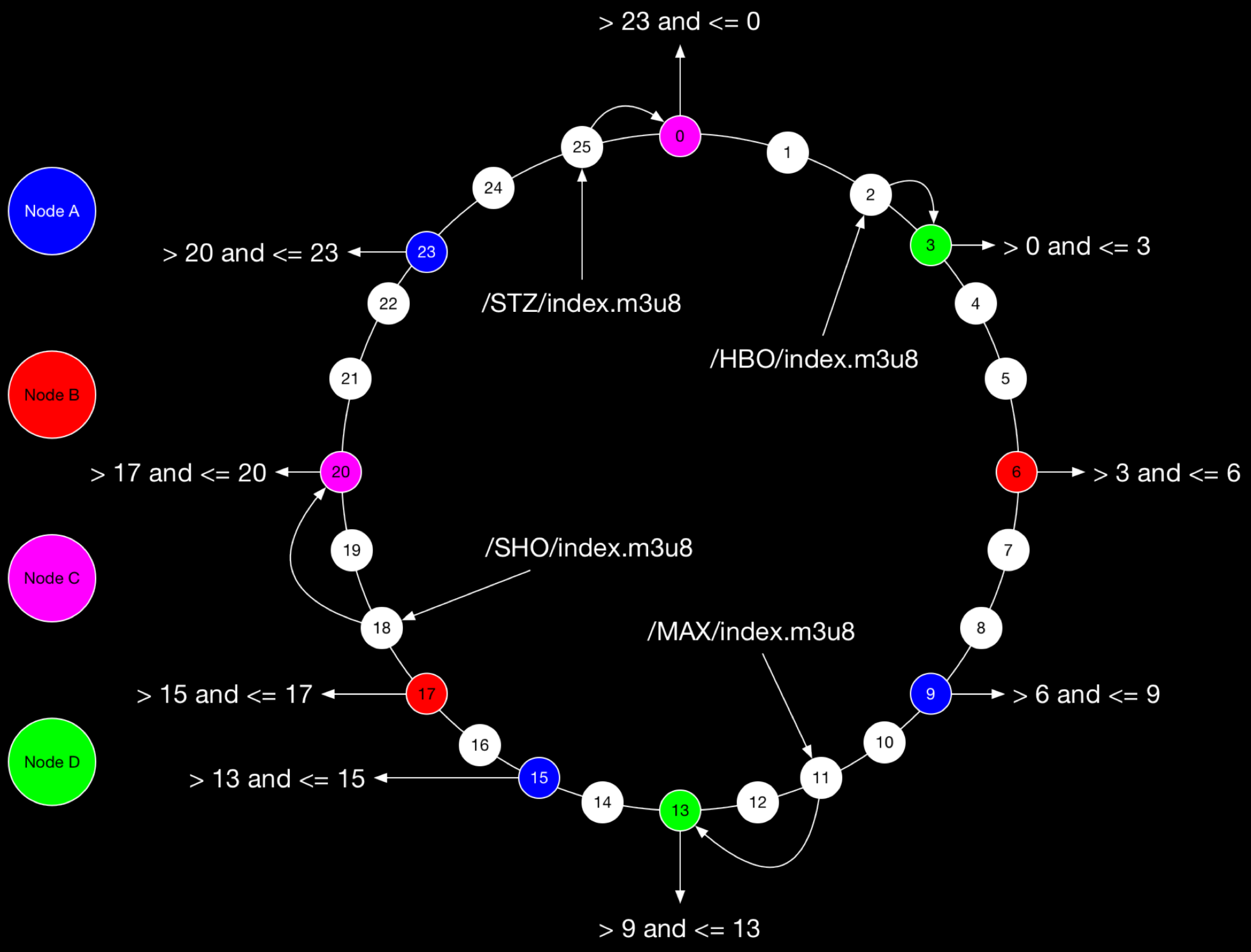
Created by Daniel Lewin and F. Thomson Leighton at MIT[1]

Creators founded Akamai Technologies

Allows `K/n` rehashed `Keys` for add/removals of `nodes`

Minimizes impact to CDN during health events, maintenance, etc

[1] https://en.wikipedia.org/wiki/Consistent_hashing


> 23 and <= 0
Node A
Node B
Node C
Node D
> 20 and <= 23
> 0 and <= 3
/STZ/index.m3u8
/HBO/index.m3u8
> 17 and <= 20
> 3 and <= 6
/SHO/index.m3u8
/MAX/index.m3u8
> 15 and <= 17
> 6 and <= 9
> 13 and <= 15
> 9 and <= 13
0
1
2
3
4
5
6
7
8
9
10
11
12
13
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16
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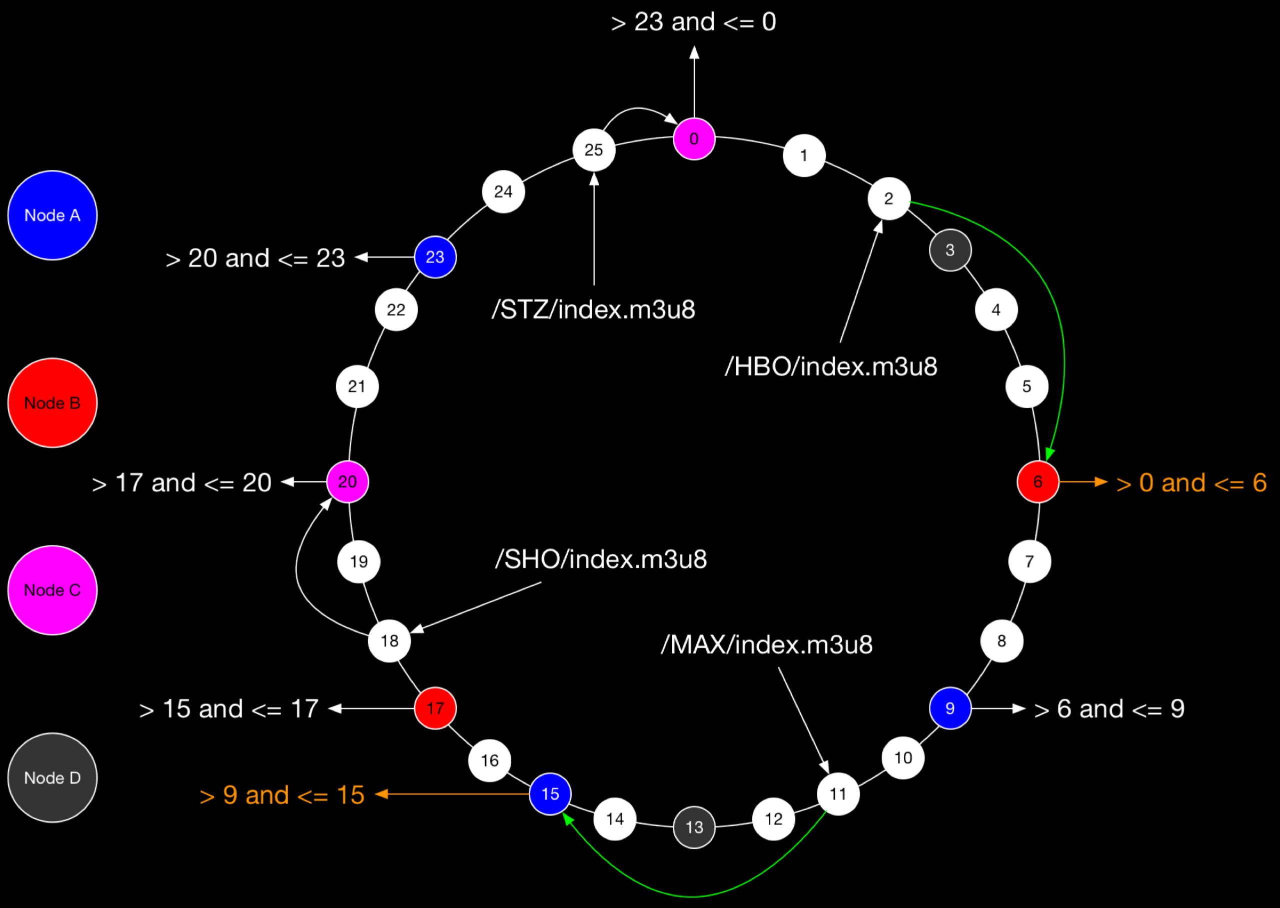

> 23 and <= 0

> 20 and <= 23

/STZ/index.m3u8

/HBO/index.m3u8

> 17 and <= 20

> 0 and <= 6

/SHO/index.m3u8

/MAX/index.m3u8

> 15 and <= 17

> 6 and <= 9

> 9 and <= 15

TRAFFIC PORTAL	User Interface
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TRAFFIC
ROUTER
+
=

Traffic Router

Java Application deployed in Tomcat 8.5.x

Horizontally scalable and stateless

DNS authoritative for CDN domain name

Routes traffic over DNS and HTTP using consistent hashing

Consumes health state published by Traffic Monitor

Entry point for all requests into a CDN

Core Features

HTTP

- TLS / SNI
- 302 or JSON
- (Client) Steering
- Dispersion
- Response headers
- Request header logging

Localization

- (Deep) Coverage Zone
- Geolocation by delivery service
- Anonymous proxy blocking
- Configurable

DNS

- DNSSEC
- Configurable TTLs
- Static DNS entries
- “Federation”
- EDNS0 client subnet extensions

Consistent Hashing

Delivery service limits

Bypass destinations

API and metrics

Tomcat Integration

Languid Connector

Delays when sockets are opened by Tomcat

TCP resets are better than timeouts or layer 7 errors

Traffic Router uses JMX MBean to communicate when ready

Connector listens for message to complete startup

Custom Key Manager

Integrates with Traffic Ops RESTful API

No Java keystore required

Seamless deployment of certificates without restarting

Integrates with OpenSSL implementation in Tomcat 8.5

Packaging Tomcat 8.5.x

All ATC components are built for CentOS 7.x

Downloaded and packaged when Traffic Router is built

Application’s Tomcat configuration outside of Tomcat’s defaults

`traffic_router` requires `tomcat`, `tomcat-native` and `apr`

`traffic_router` systemd configuration in `startup.properties`

Tomcat Configuration

```
...
<Connector connectionTimeout="10000" maxThreads="10000" port="80" sendReasonPhrase="True"
    mbeanPath="traffic-router:name=languidState" readyAttribute="Ready" portAttribute="Port"
    protocol="com.comcast.cdn.traffic_control.traffic_router.protocol.LanguidNioProtocol"/>
<Connector connectionTimeout="10000" maxThreads="10000" port="443" sendReasonPhrase="True"
    mbeanPath="traffic-router:name=languidState" readyAttribute="Ready" portAttribute="SecurePort"
    protocol="com.comcast.cdn.traffic_control.traffic_router.protocol.LanguidNioProtocol"
    scheme="https" secure="True" SSLEnabled="True" sslProtocol="TLS" clientAuth="False"
    sslImplementationName="com.comcast.cdn.traffic_control.traffic_router.protocol.RouterSslImplementation"/>
<Connector connectionTimeout="10000" maxThreads="10000" port="3333"
    mbeanPath="traffic-router:name=languidState" readyAttribute="Ready" portAttribute="ApiPort"
    protocol="com.comcast.cdn.traffic_control.traffic_router.protocol.LanguidNioProtocol"/>
...
```

Tuning

Large minimum and max heap values

G1 garbage collector, lowered heap occupancy percentage

System tuning via sysctl, limits via systemd

Tomcat and application timeouts and thread pools

Traffic Router at work

An Average Day

Over 200 million DNS transactions served or routed to the edge

Over 300 million HTTP transactions routed to the edge

Over 35 PB served, or 1.5 LOCPM at the edge

Over 100 billion edge transactions

Over 1 million edge transactions per second

Over 18 Exabytes (1,000,000,000,000,000,000 bytes) since 2012

DNS Decisions

Locate zone

Locate static records, or…

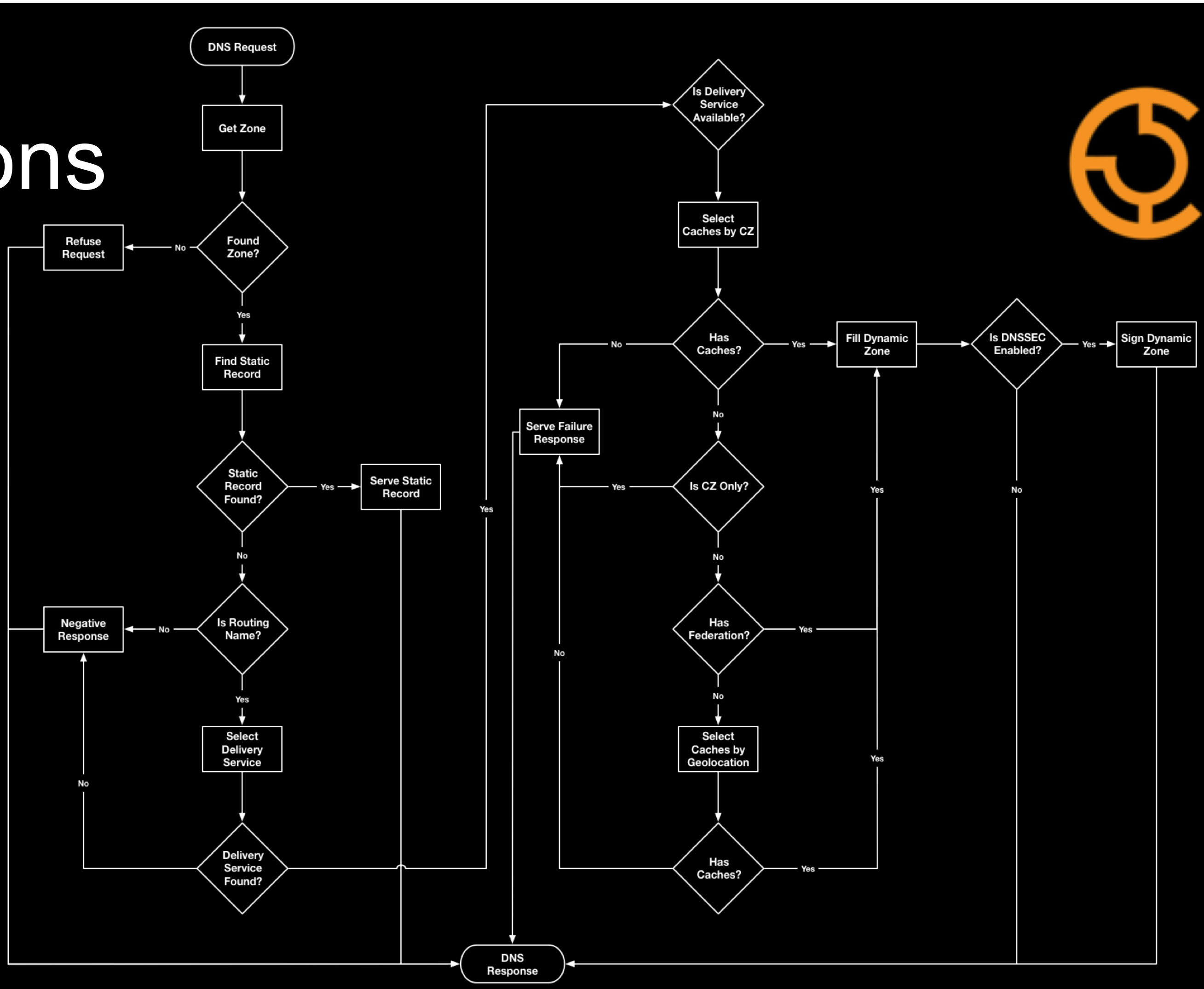
Match Delivery Service

Localize client

Select healthy caches

Fill dynamic zone

Serve response



DNS Request

Get Zone

Found Zone?

Refuse Request

Find Static Record

Static Record Found?

Serve Static Record

Is Routing Name?

Negative Response

Select Delivery Service

Delivery Service Found?

Is Delivery Service Available?

Select Caches by CZ

Has Caches?

Serve Failure Response

Fill Dynamic Zone

Is DNSSEC Enabled?

Sign Dynamic Zone

Is CZ Only?

Has Federation?

Select Caches by Geolocation

Has Caches?

DNS Response

DNS Delivery Service

```
$ dig edge.images.cdn.example.com
edge.images.cdn.example.com.  30 IN        A         192.168.12.10
edge.images.cdn.example.com.  30 IN        A         192.168.175.10
edge.images.cdn.example.com.  30 IN        A         192.168.115.31
edge.images.cdn.example.com.  30 IN        A         192.168.10.64
edge.images.cdn.example.com.  30 IN        A         192.168.29.16
edge.images.cdn.example.com.  30 IN        A         192.168.72.6
```

…or the same request made from San Francisco:

```
$ dig edge.images.cdn.example.com
edge.images.cdn.example.com.  30 IN        A         10.59.132.53
edge.images.cdn.example.com.  30 IN        A         10.18.190.53
edge.images.cdn.example.com.  30 IN        A         10.16.119.92
edge.images.cdn.example.com.  30 IN        A         10.27.117.38
edge.images.cdn.example.com.  30 IN        A         10.29.116.17
edge.images.cdn.example.com.  30 IN        A         10.68.51.89
```

HTTP Decisions

What type of request?

Match Delivery Service(s)

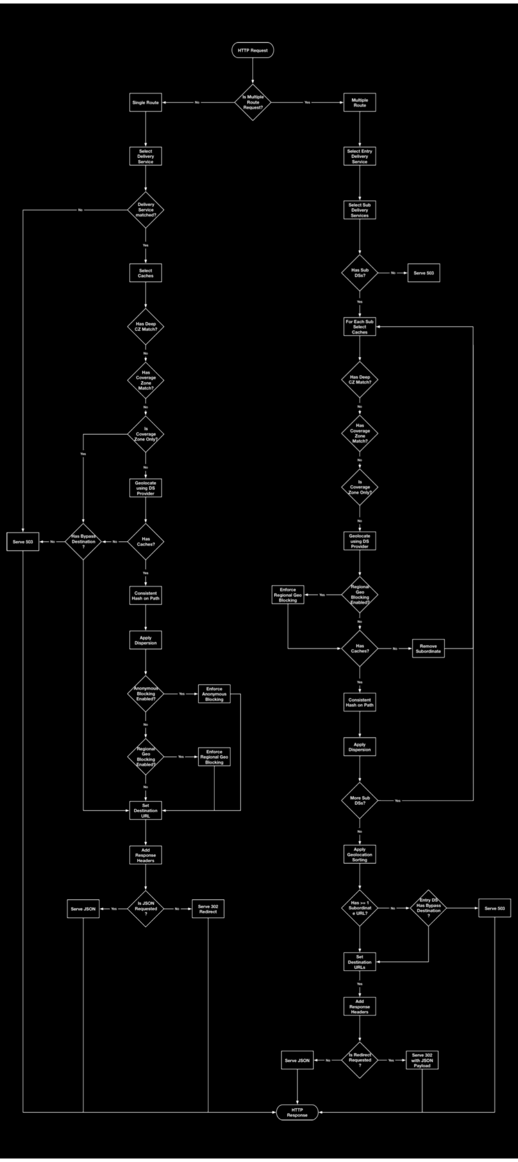
Localize Client

Select healthy caches

Consistent hash on path

Order Subordinates if necessary

Serve response (302 or JSON)



HTTP Delivery Service

Default Response

```
> GET /foo.m3u8 HTTP/1.1
> Host: tr.linear.cdn.example.com
>
< HTTP/1.1 302 Found
< Location: http://edge-den-02.linear.cdn.example.com/foo.m3u8
< Content-Length: 0
< Date: Thu, 20 Sep 2018 16:53:57 GMT
```

…or the same request made from San Francisco:

```
< HTTP/1.1 302 Found
< Location: http://edge-sfb-10.linear.cdn.example.com/foo.m3u8
< Content-Length: 0
< Date: Thu, 20 Sep 2018 16:57:38 GMT
```

HTTP Delivery Service

No Redirect Response

```
> GET /foo.m3u8?format=json HTTP/1.1
> Host: tr.linear.cdn.example.com
>
< HTTP/1.1 200 OK
< Content-Type: application/json
< Content-Length: 99
< Date: Thu, 20 Sep 2018 16:59:46 GMT
<
* Connection #0 to host tr.linear.cdn.example.com left intact
{
   "location" : "http://edge-den-02.linear.cdn.example.com/foo.m3u8?format=json"
}
```

Client Steering Delivery Service

Default Response

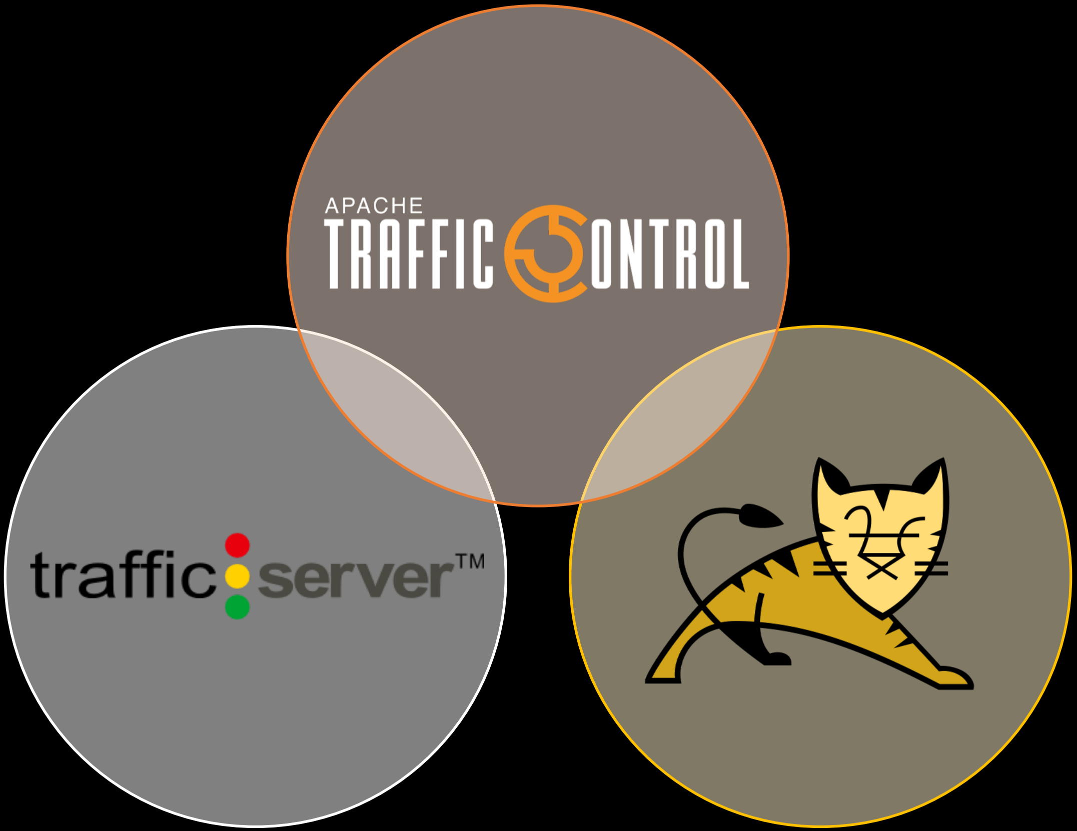
```
< HTTP/1.1 302 Found
< Access-Control-Allow-Origin: *
< Location: https://edge-den-02.linear-a.cdn.example.com/foo.m3u8
< Content-Type: application/json
< Content-Length: 206
< Date: Mon, 17 Sep 2018 16:38:18 GMT
<
* Connection #0 to host tr.linear.cdn.example.com left intact
{
   "locations" : [
      "https://edge-den-02.linear-a.cdn.example.com/foo.m3u8",
      "https://edge-den-20.linear-b.cdn.example.com/foo.m3u8",
      "https://edge-den-02.linear-c.cdn.example.com/foo.m3u8"
   ]
}
```

Client Steering Delivery Service

No Redirect Response

```
< HTTP/1.1 200 OK
< Access-Control-Allow-Origin: *
< Content-Type: application/json
< Content-Length: 242
< Date: Mon, 17 Sep 2018 16:46:13 GMT
<
* Connection #0 to host tr.linear.cdn.example.com left intact
{
   "locations" : [
      "https://edge-den-02.linear-a.cdn.example.com/foo.m3u8?trred=false",
      "https://edge-den-20.linear-b.cdn.example.com/foo.m3u8?trred=false",
      "https://edge-den-02.linear-c.cdn.example.com/foo.m3u8?trred=false"
   ]
}
```

Retrospective


APACHE TRAFFIC CONTROL
traffic server™

The Apache Way

Traffic Control is successful because of the community

Tomcat development community is active and full of talented engineers

Traffic Router benefits from the Tomcat community's expertise

Traffic Control relies heavily on Traffic Server, another excellent community

Path to Tomcat 8.5

Attended Tomcat TLS talks at ACNA 2017

Met Mark Thomas who demonstrated performance gains

Began development after ACNA 2017

Development completed and deployed to production this summer

1-2 orders of magnitude improvement with TLS traffic

Lessons Learned

Stay as current as possible

TLS client certificate authentication, `clientAuth="False"`

HTTP reason phrase, `sendReasonPhrase="True"`

Content-Type encoding, `ENFORCE_ENCODING_IN_GET_WRITER=false`

Thanks

David Neuman, Comcast, ATC chair

Andrew Schmidt, Comcast

Dewayne Richardson, Comcast, ATC PMC

Mark Thomas and the Apache Tomcat team