Traffic Steering using RUM DNS

Abhijeet Rastogi

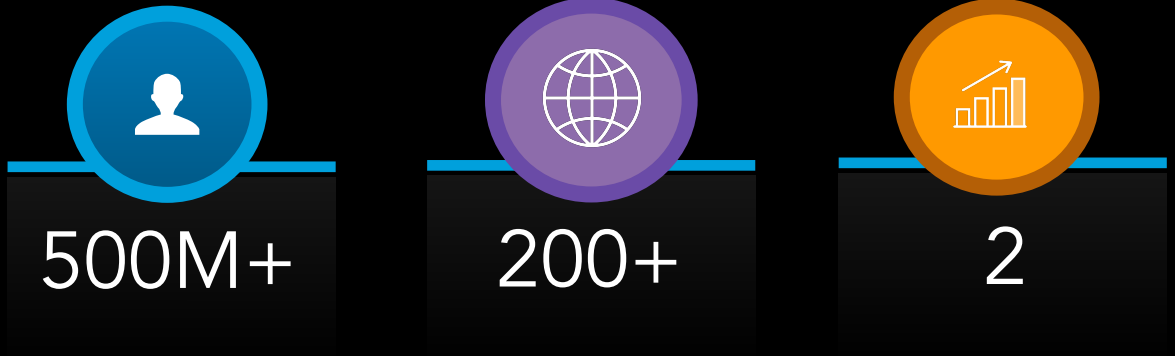
Senior SRE @ Linkedin

(Edge Performance & Traffic)

My Team

- **Public DNS**
- **CDN Operations**
- **Load balancer & reverse proxy at PoPs and DCs**

Largest Professional Network



Members

Countries

signups/second

Problem Statement

SiteSpeed

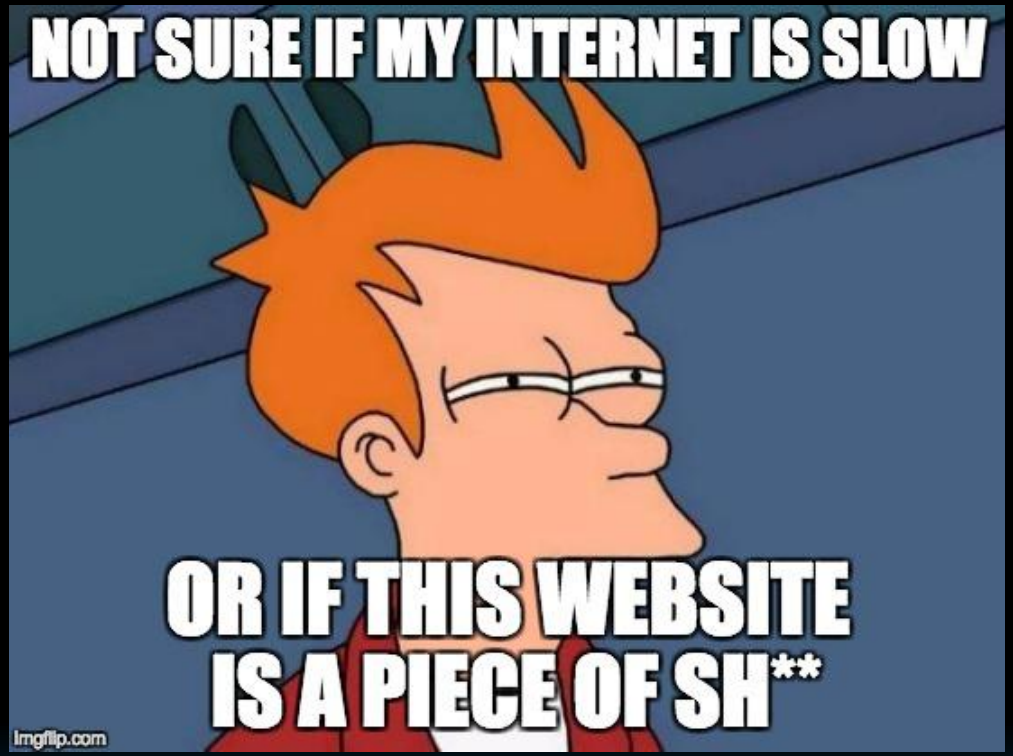
Problem Statement

Delay	User perception
0–100 ms	Instant
100–300 ms	Small perceptible delay
300–1000 ms	Machine is working
1,000+ ms	Likely mental context switch
10,000+ ms	Task is abandoned

- **User Engagement**

Problem Statement

Delay	User perception
0–100 ms	Instant
100–300 ms	Small perceptible delay
300–1000 ms	Machine is working
1,000+ ms	Likely mental context switch
10,000+ ms	Task is abandoned

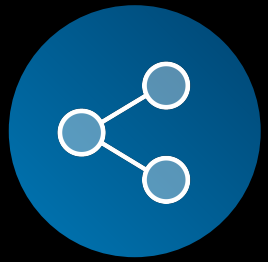


Problem Statement

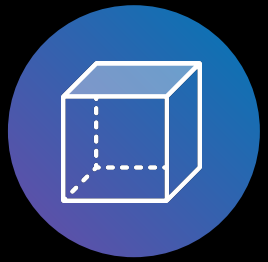
SiteSpeed

- **User Engagement**
- **Revenue**

Agenda



CDN strategy



POP Strategy

RUM Steering

Tooling

Agenda

CDN strategy

POP Strategy

RUM Steering

Tooling

LinkedIn CDN Stats

>80%

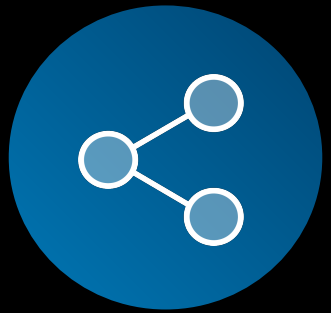
Cache Hit Rate

>85%

Origin bandwidth offloaded

LinkedIn CDN partners

Multi CDN Strategy



Benefits

- **Performance:** Having multiple options allows comparing and selecting the best CDN to each network in each geography in real time
- **Redundancy:** CDNs can be pulled out of rotation for planned & unplanned events
- **Capacity:** Traffic spikes of all shapes and sizes can be handled

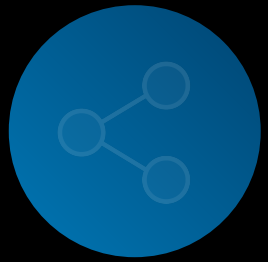
Multi CDN Strategy

(India CDN Performance)

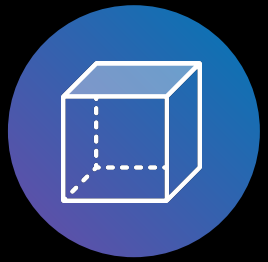
Multi CDN Strategy

(US CDN Performance)

Agenda



CDN strategy



POP Strategy

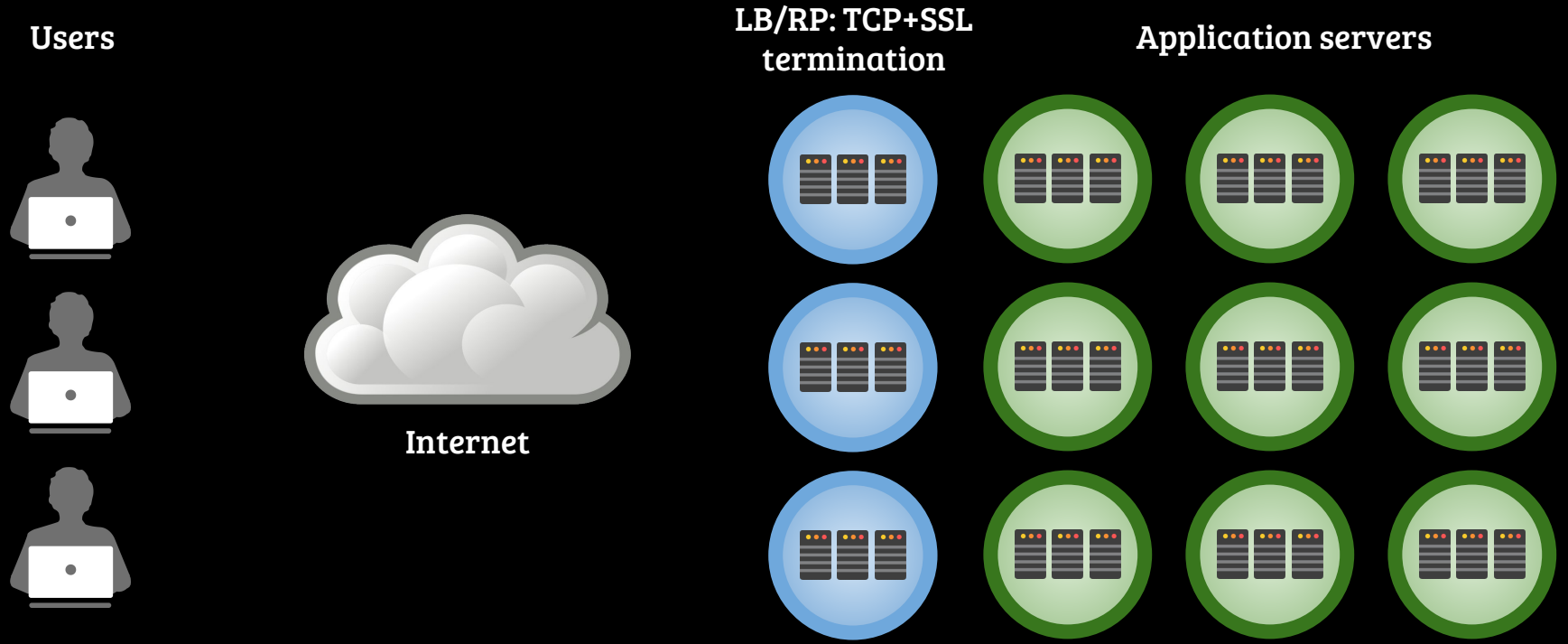
RUM Steering

Tooling

Point of Presence (POP)

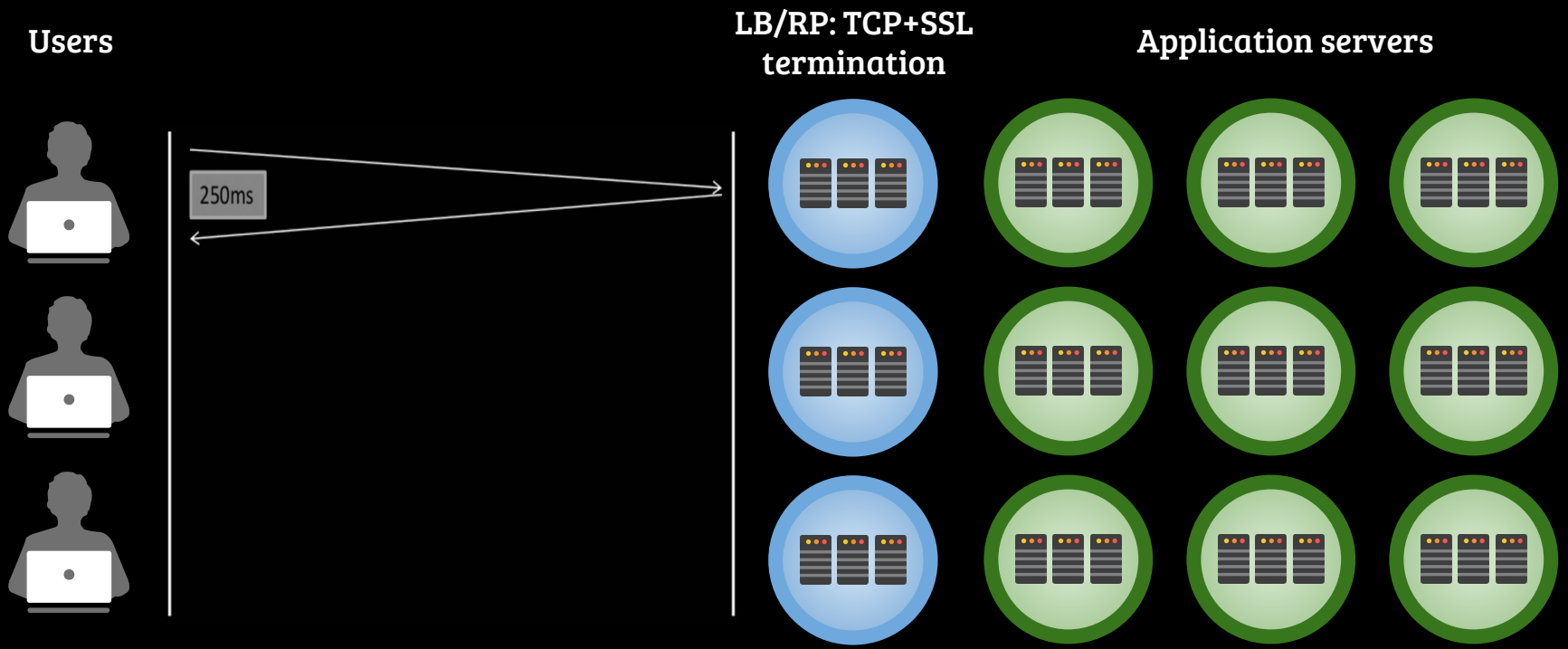
POP (Point of Presence)

Typical DataCenter



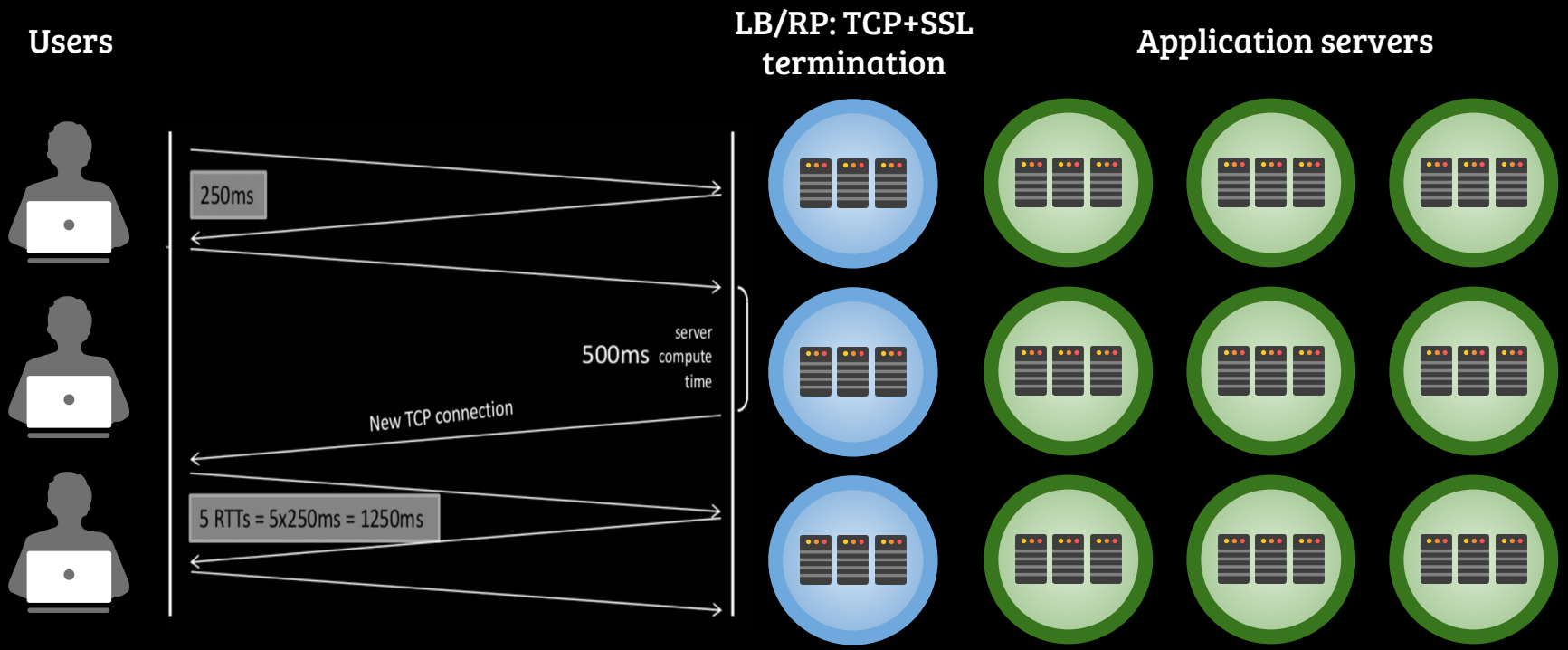
POP (Point of Presence)

Typical DataCenter



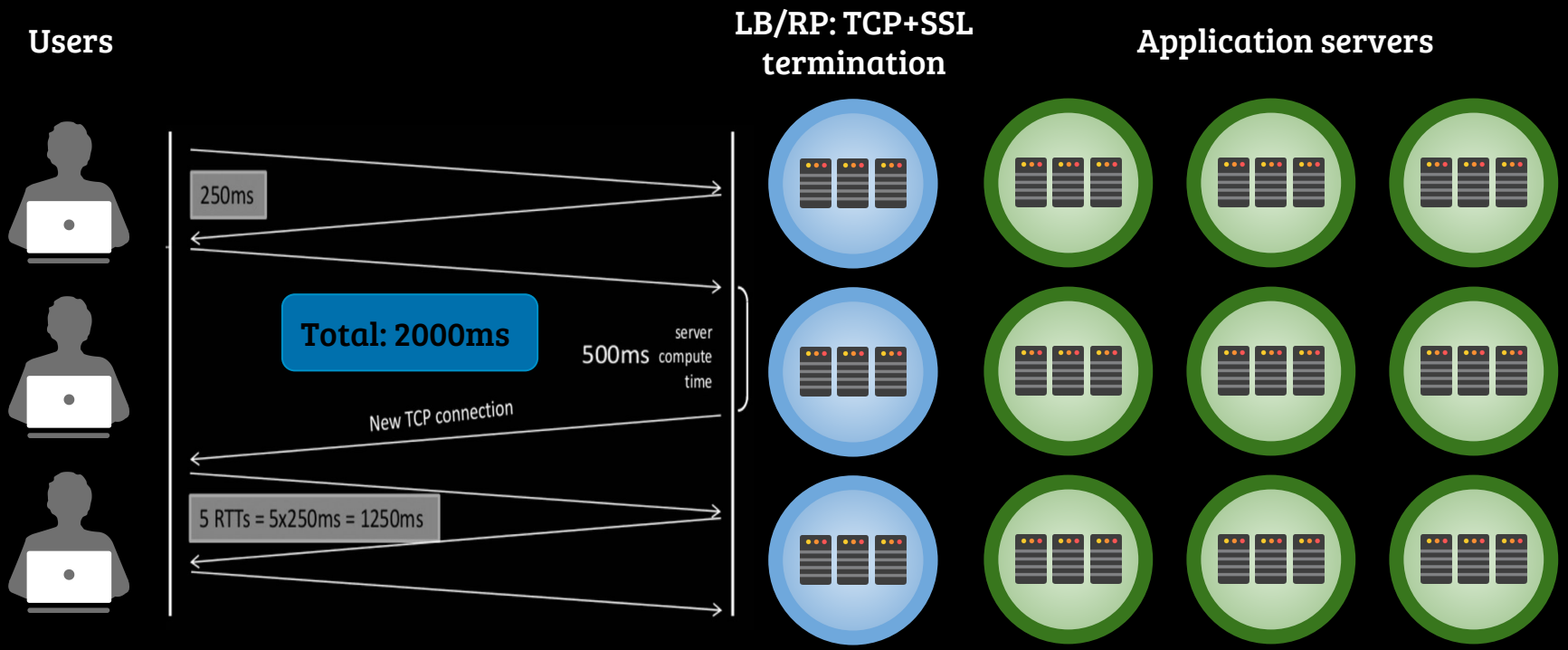
POP (Point of Presence)

Typical DataCenter



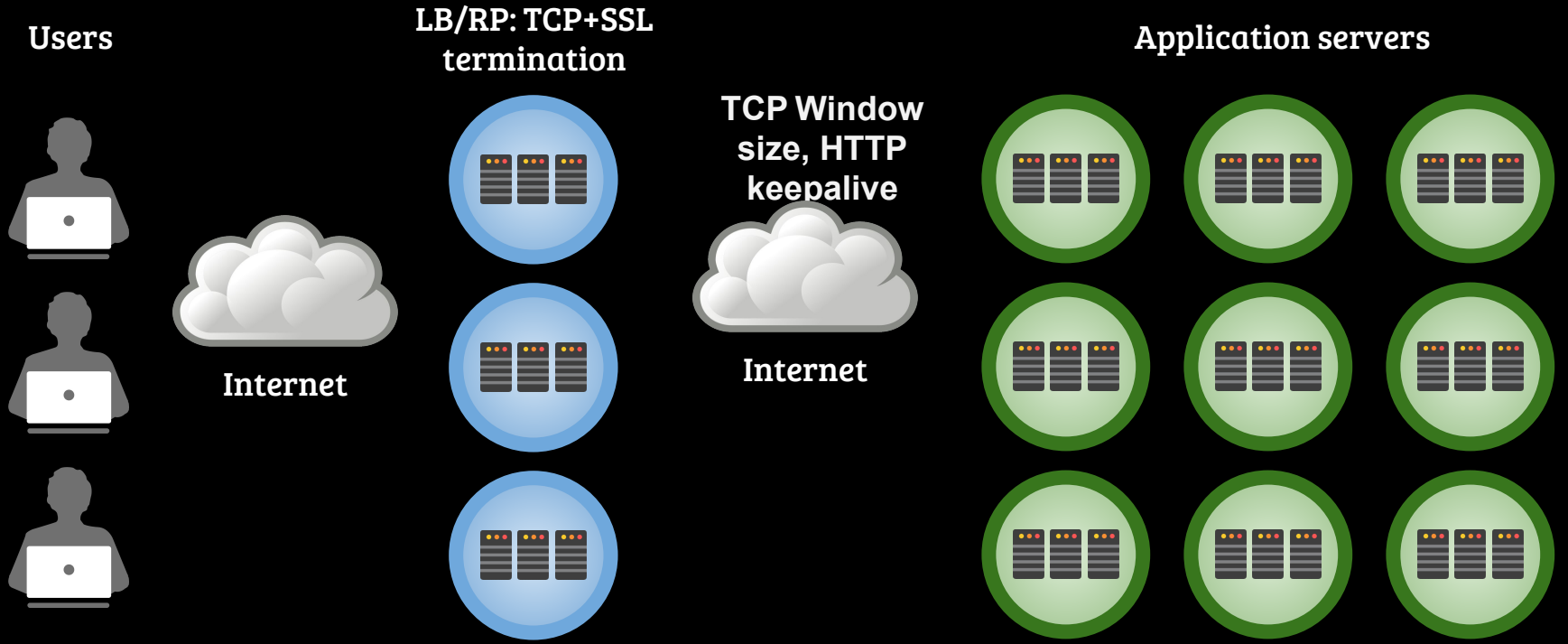
POP (Point of Presence)

Typical DataCenter



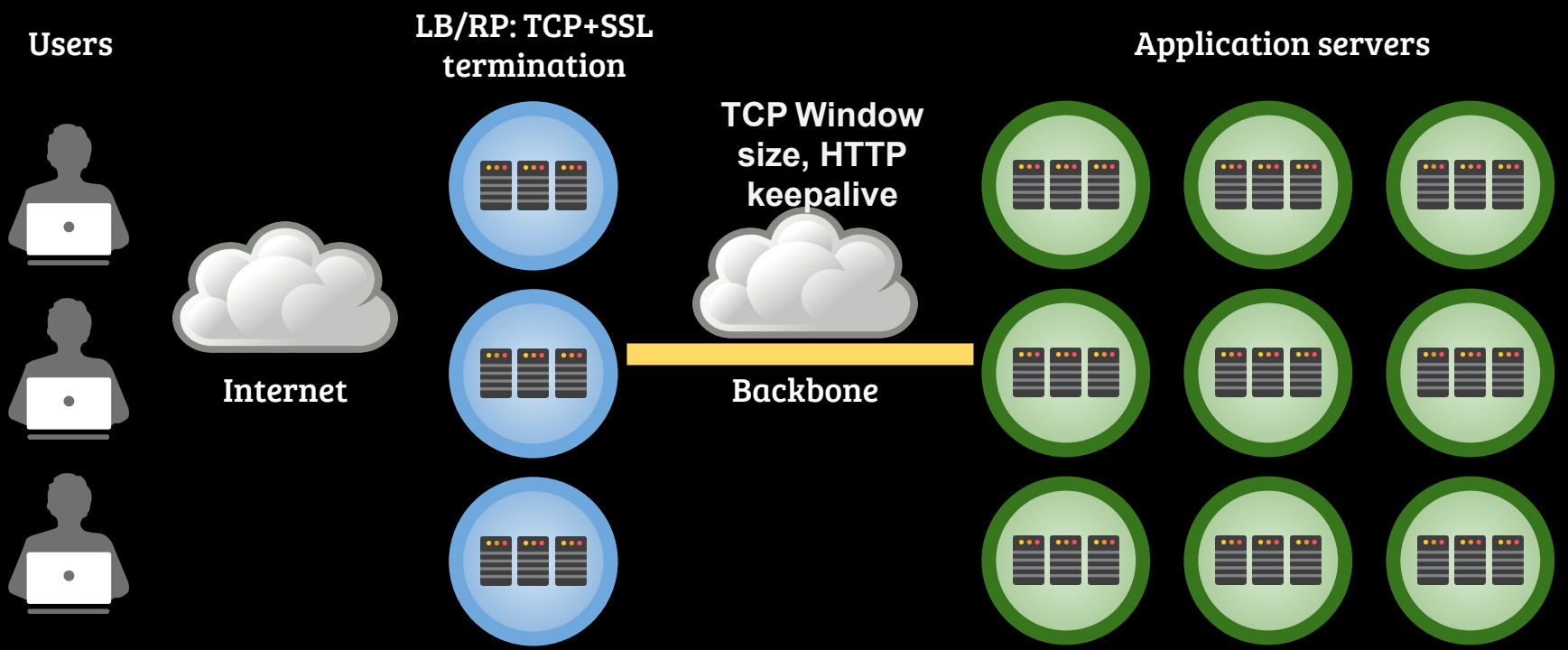
POP (Point of Presence)

Decouple LBs



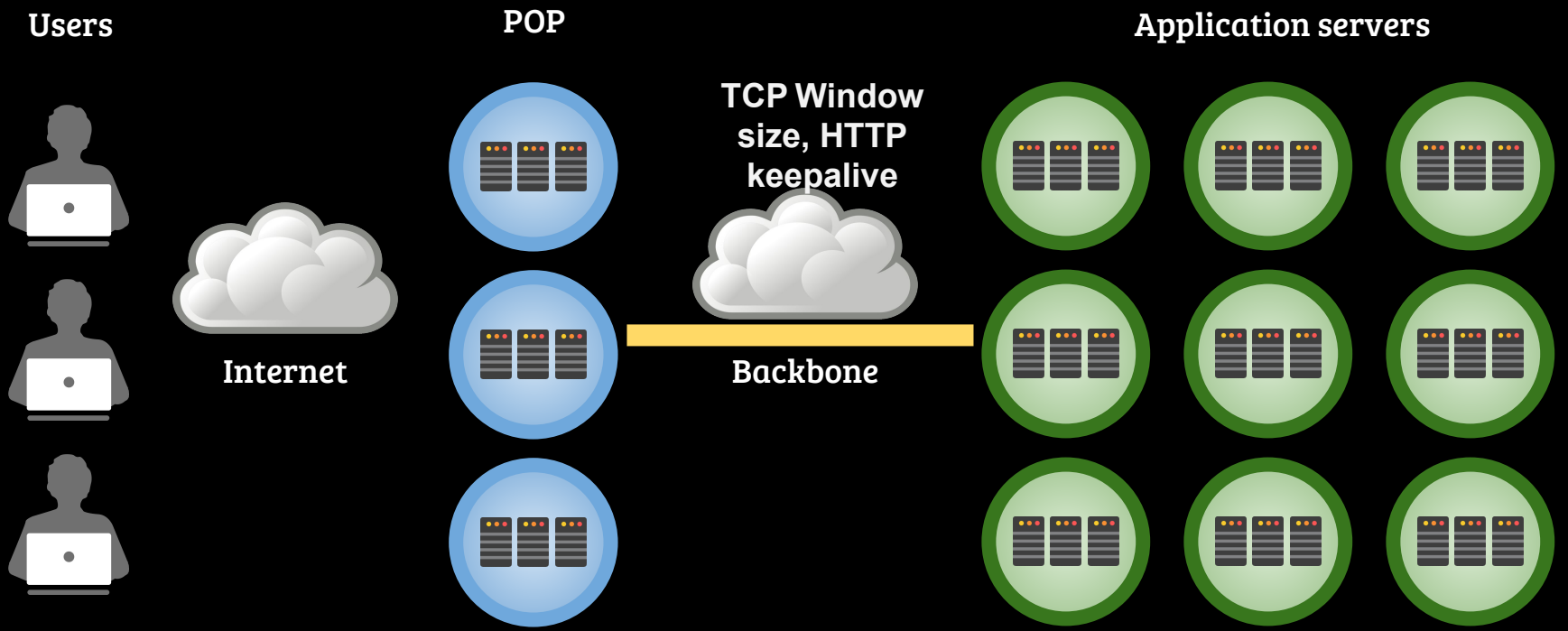
POP (Point of Presence)

Establish Backbone



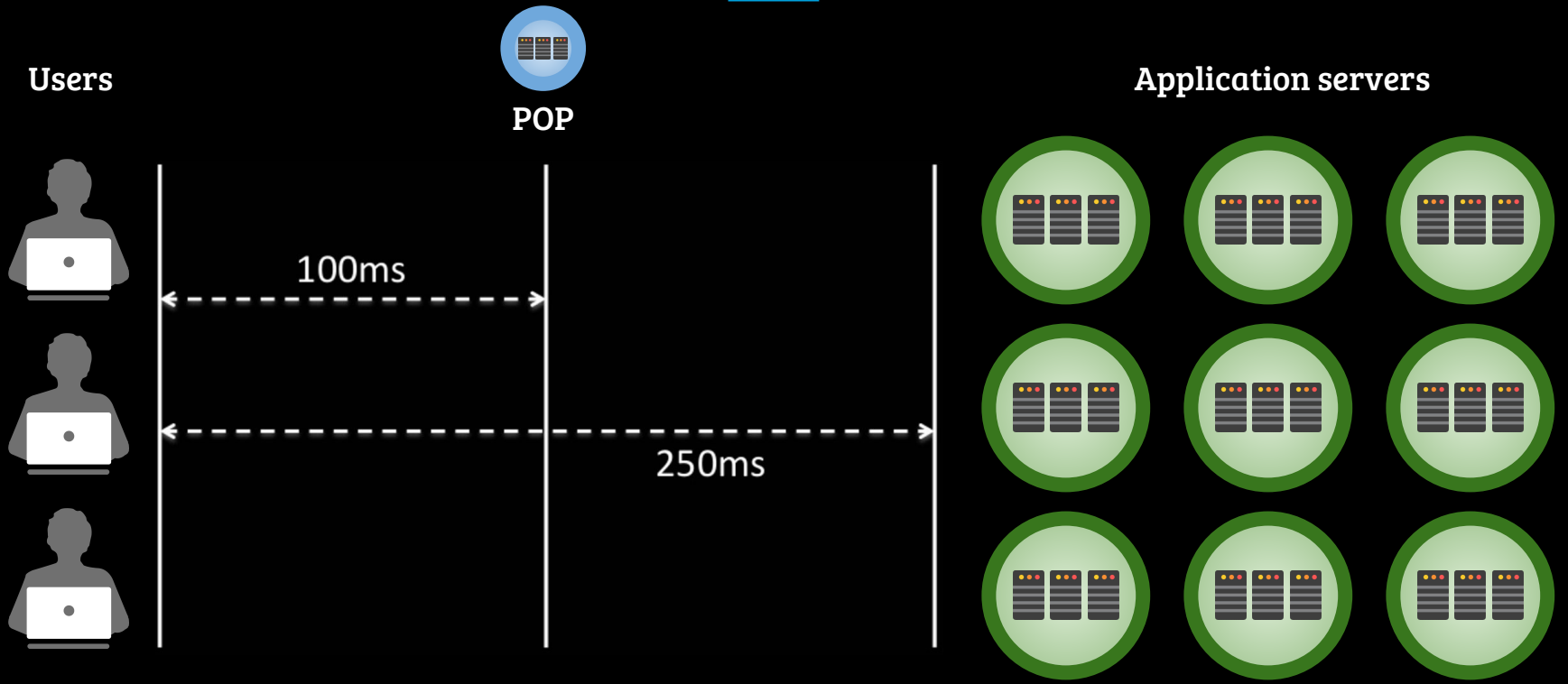
POP (Point of Presence)

LBs become POP



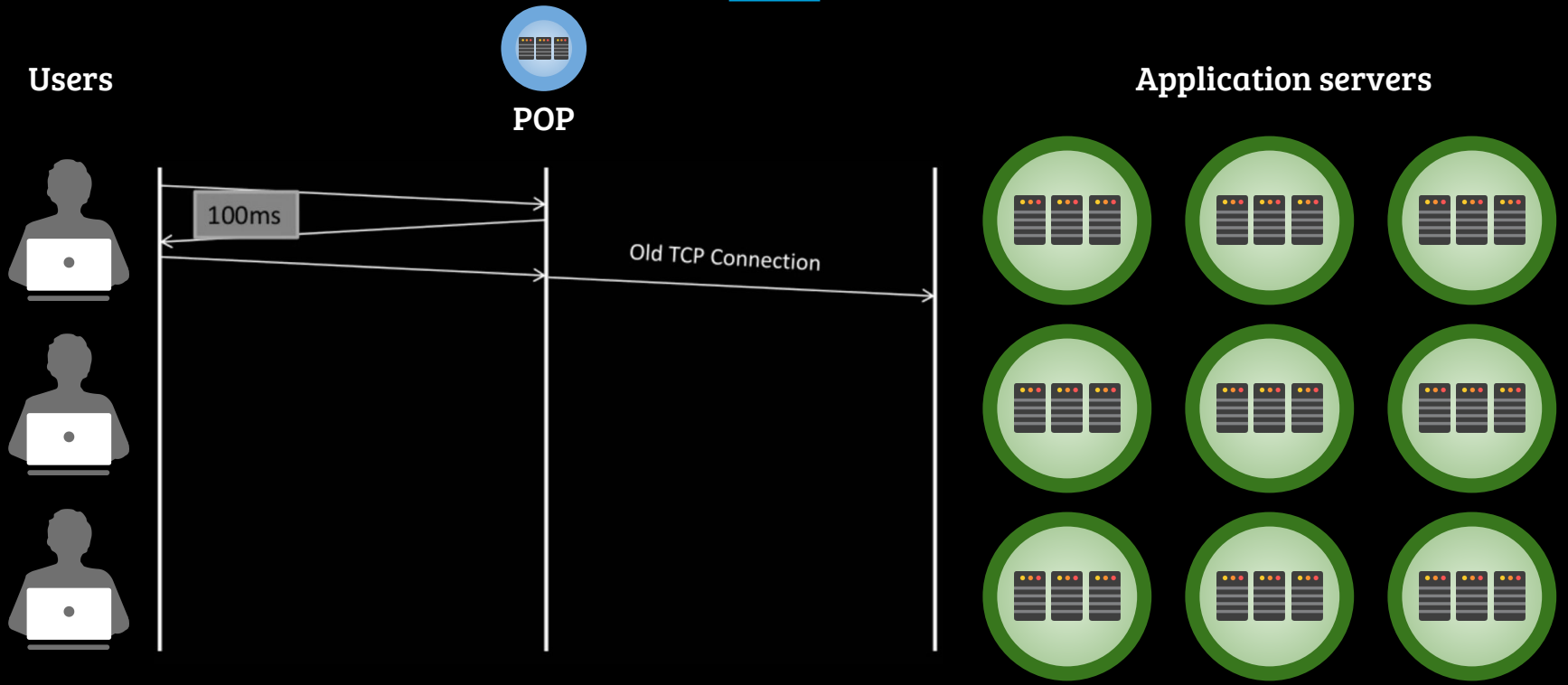
POP (Point of Presence)

LBs become POP



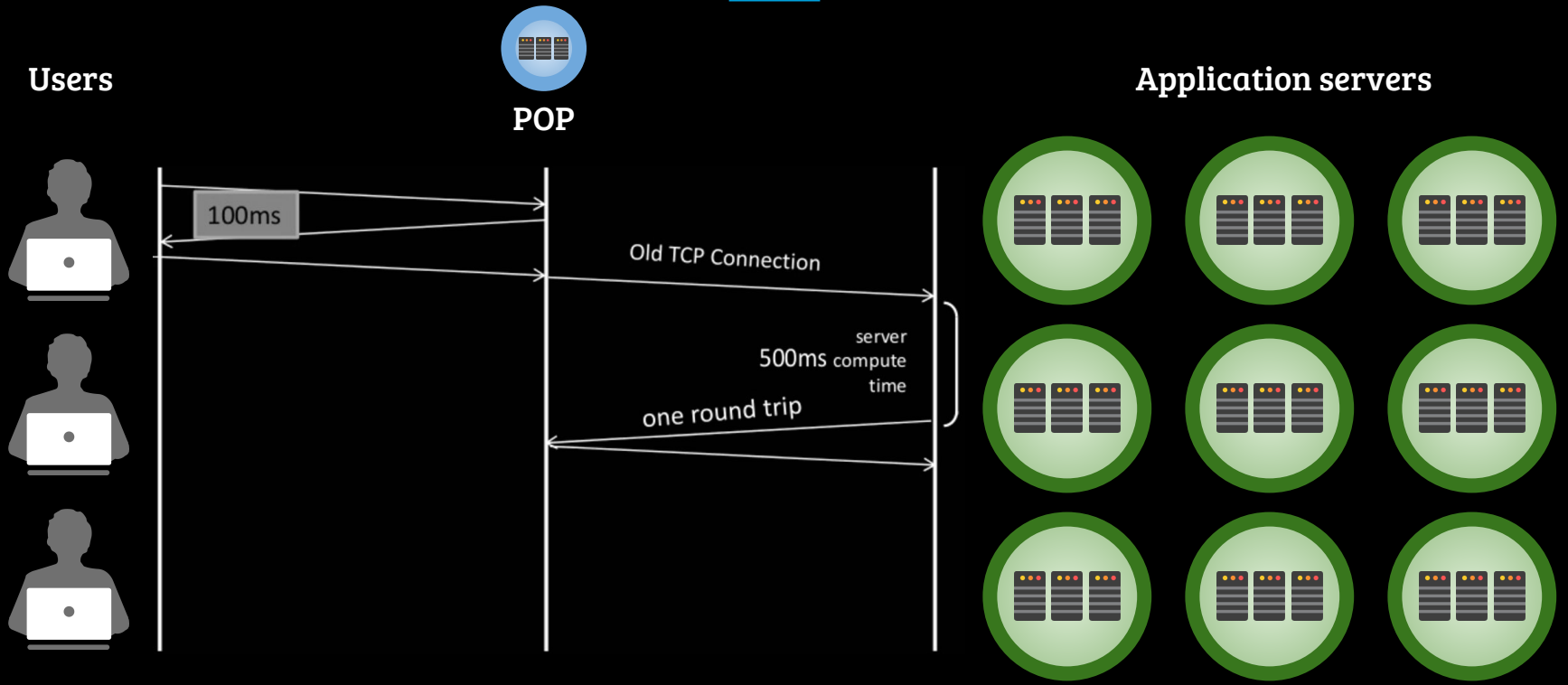
POP (Point of Presence)

LBs become POP



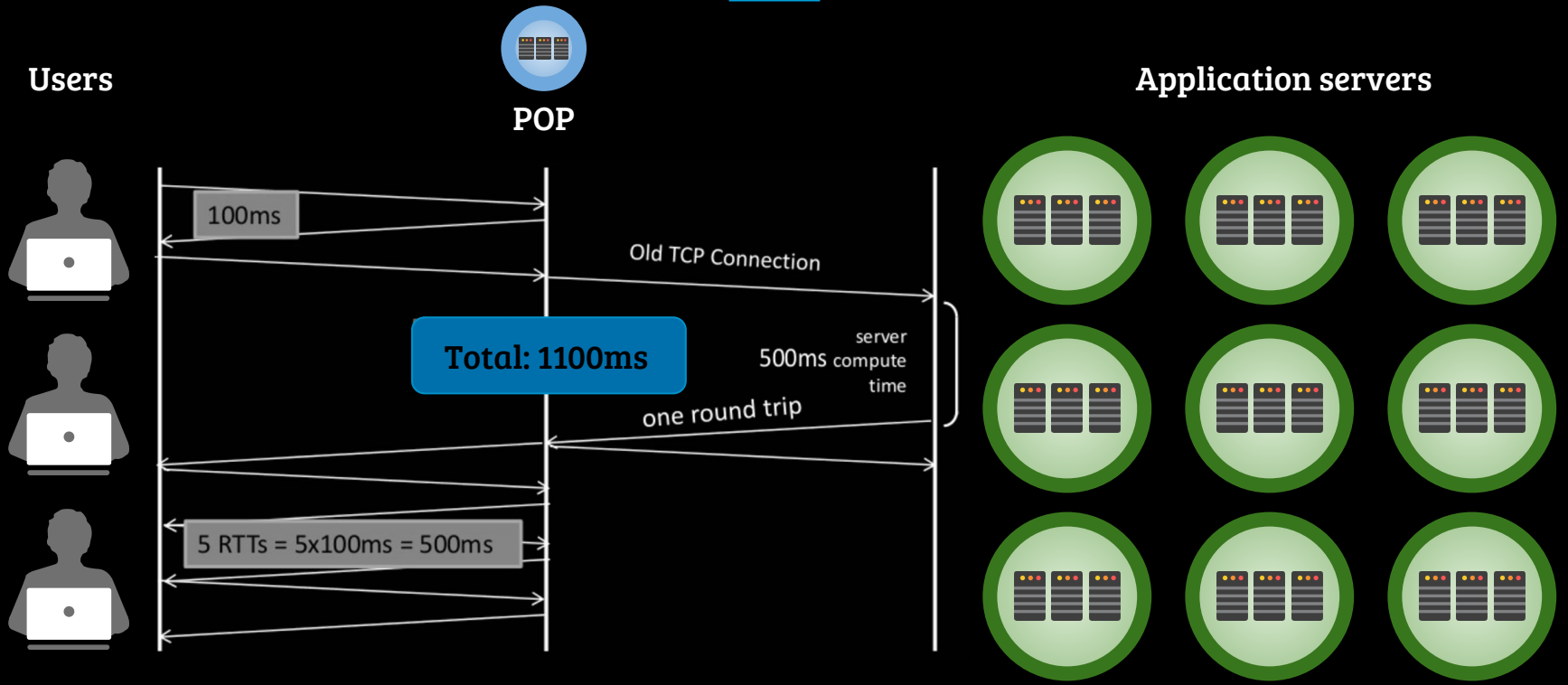
POP (Point of Presence)

LBs become POP



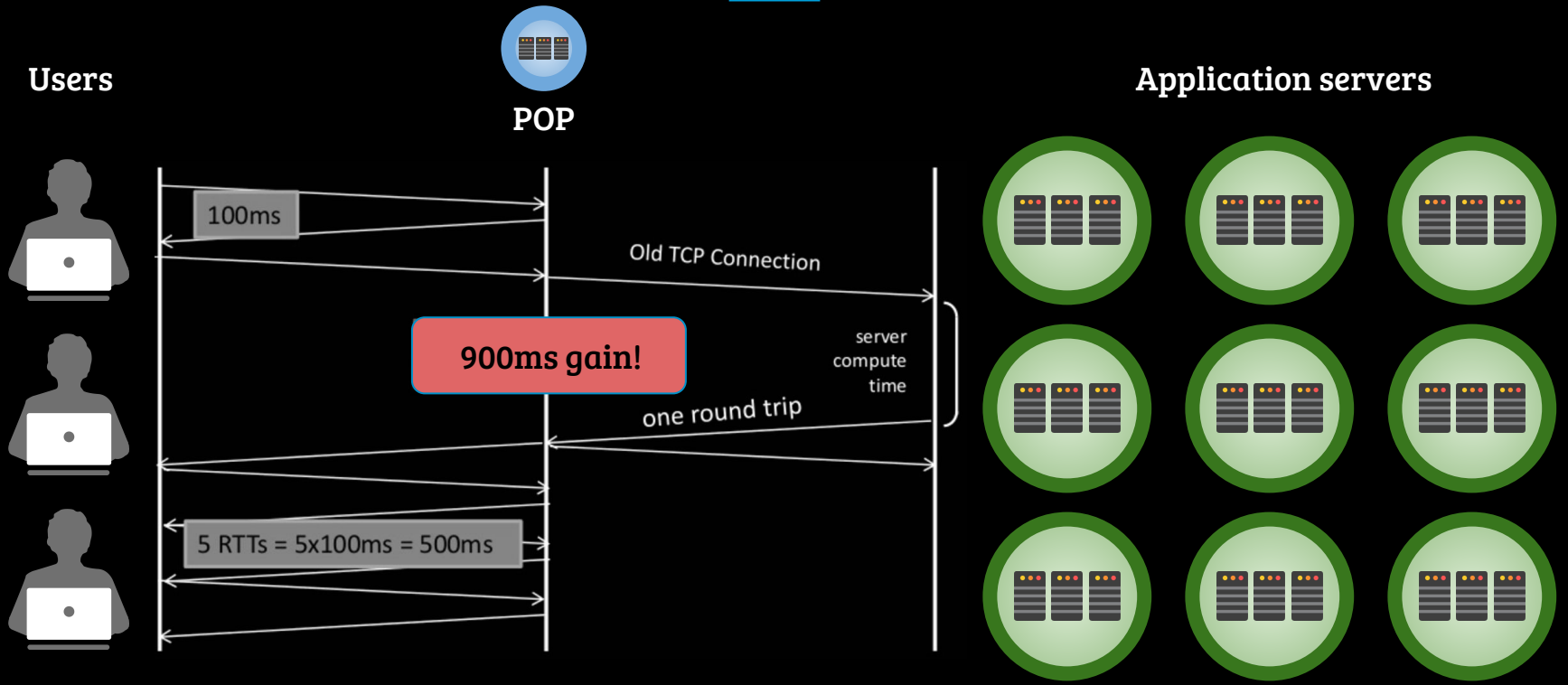
POP (Point of Presence)

LBs become POP



POP (Point of Presence)

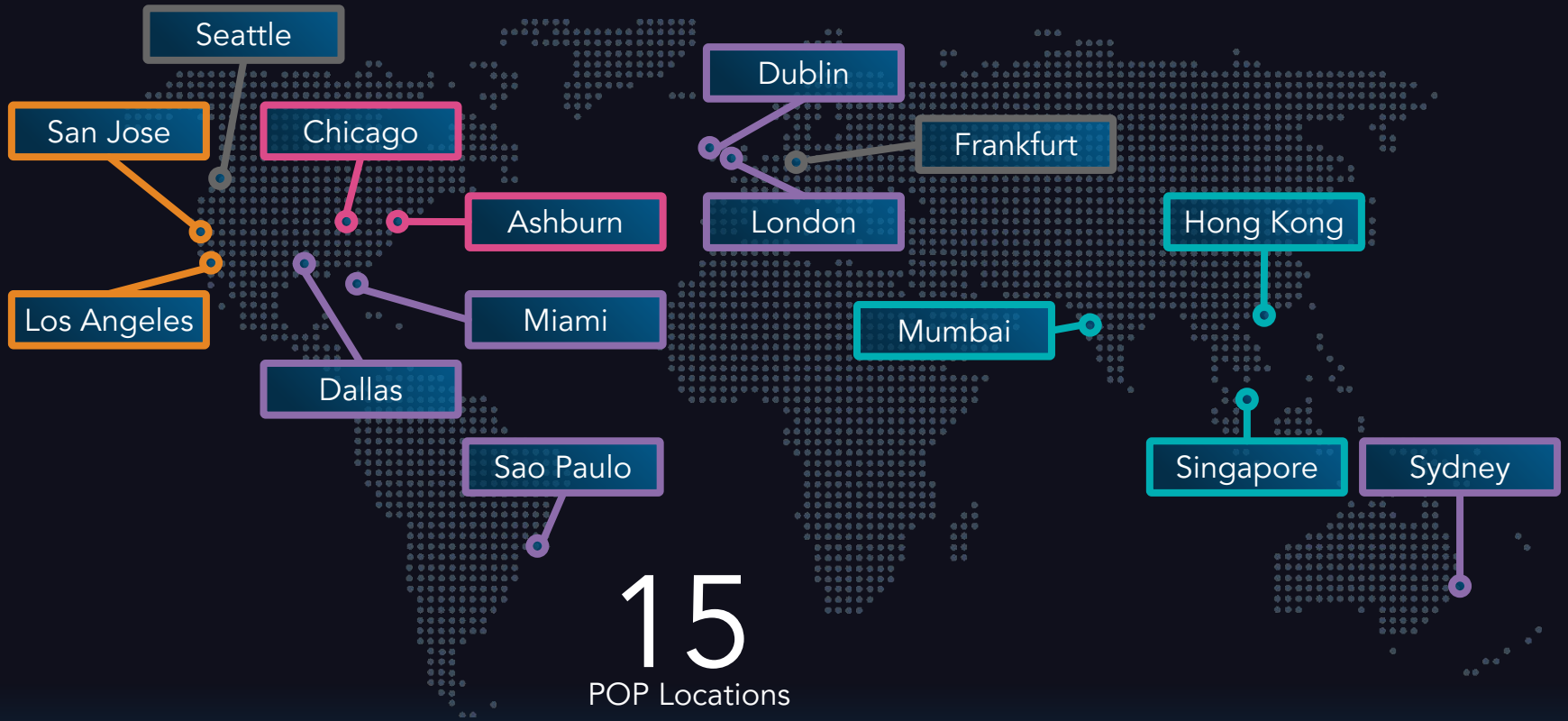
LBs become POP



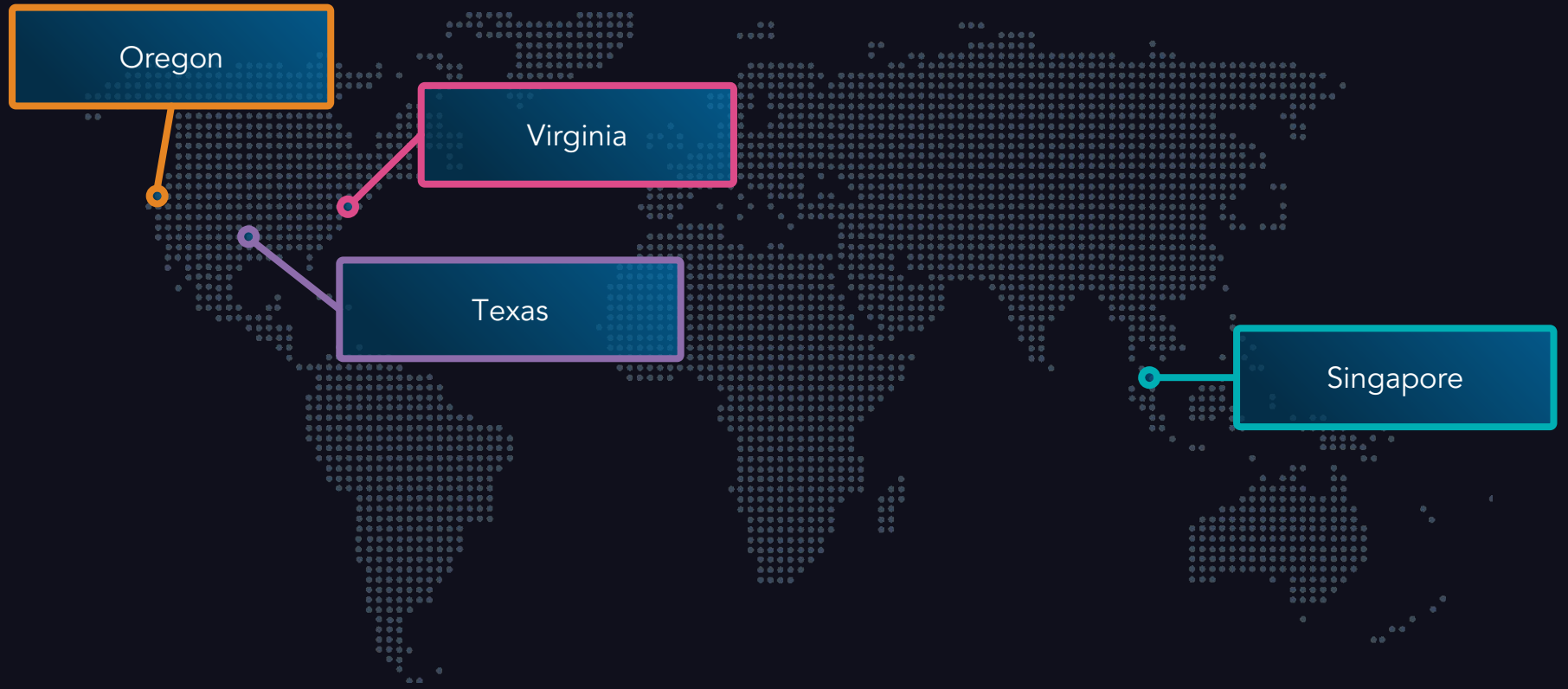
POP (Point of Presence)

Cost effective

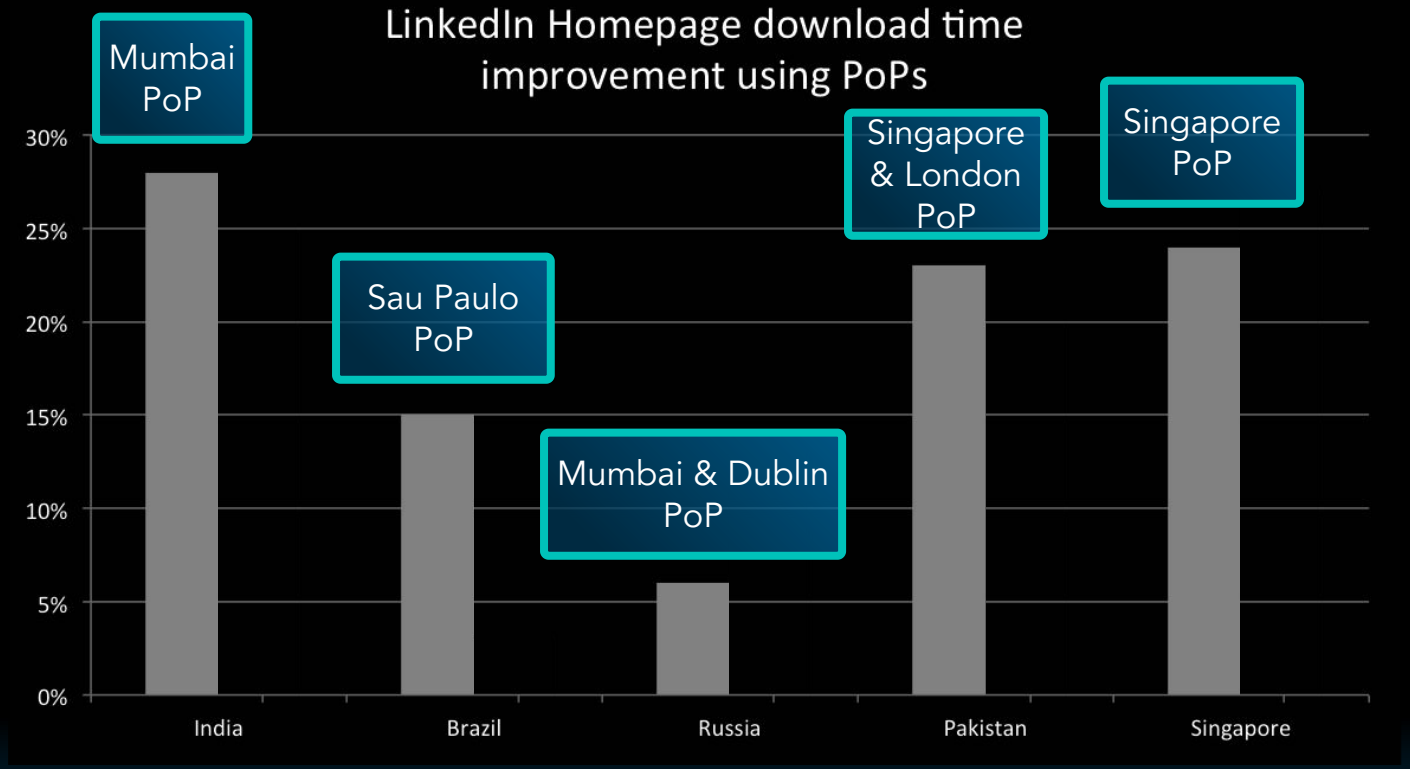
LinkedIn POP **Footprint**



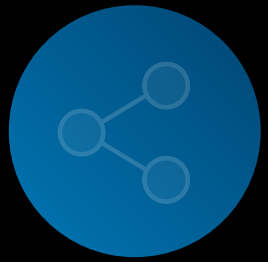
LinkedIn DataCenter Footprint



POP Benefit


LinkedIn Homepage download time improvement using PoPs
Mumbai PoP
Sau Paulo PoP
Mumbai & Dublin PoP
Singapore & London PoP
Singapore PoP
30%
25%
20%
15%
10%
5%
0%
India
Brazil
Russia
Pakistan
Singapore

Agenda



CDN strategy

POP Strategy

RUM Steering

Tooling

Multi DNS
Root Servers

```
$ dig +short +noshort NS linkedin.com | sort
linkedin.com.           58808   IN      NS      dns1.p09.nsone.net.
linkedin.com.           58808   IN      NS      dns2.p09.nsone.net.
linkedin.com.           58808   IN      NS      dns3.p09.nsone.net.
linkedin.com.           58808   IN      NS      dns4.p09.nsone.net.
linkedin.com.           58808   IN      NS      ns1.p43.dynect.net.
linkedin.com.           58808   IN      NS      ns2.p43.dynect.net.
linkedin.com.           58808   IN      NS      ns3.p43.dynect.net.
linkedin.com.           58808   IN      NS      ns4.p43.dynect.net.
$
```

NSOne

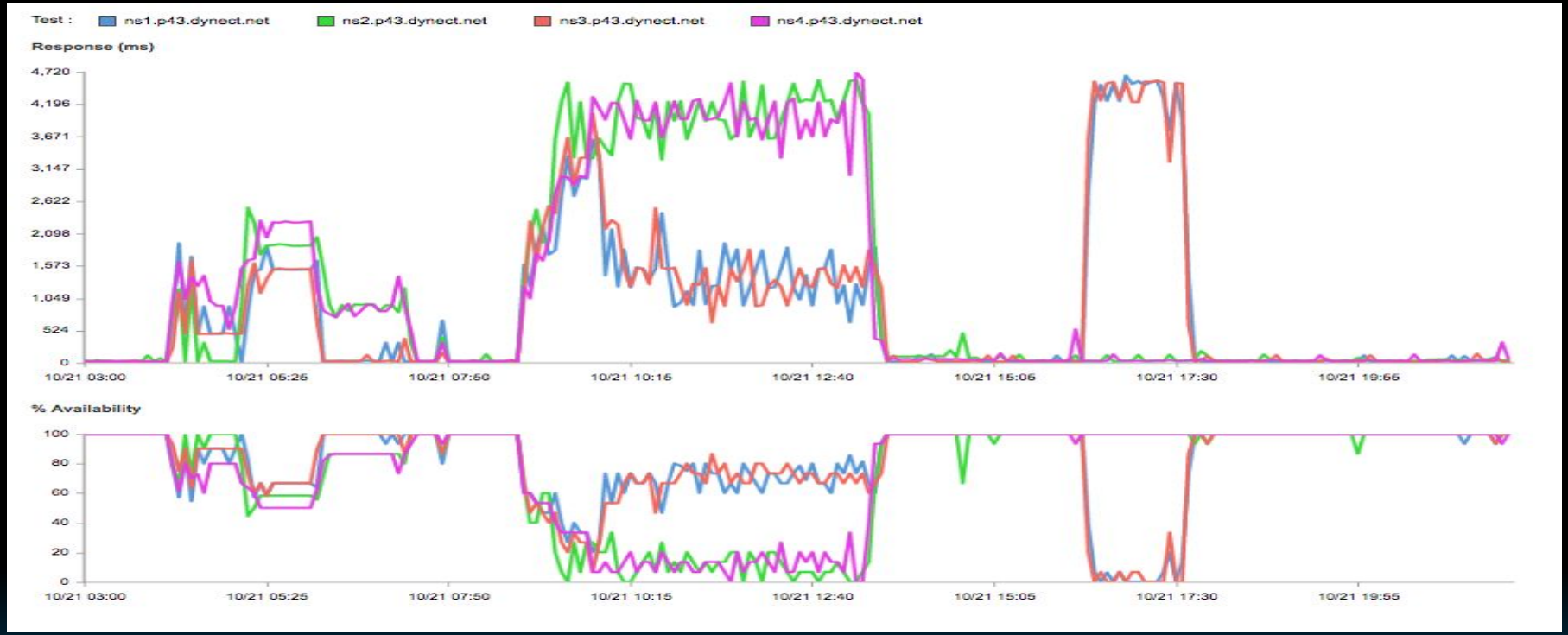
DynDNS

Multi DNS

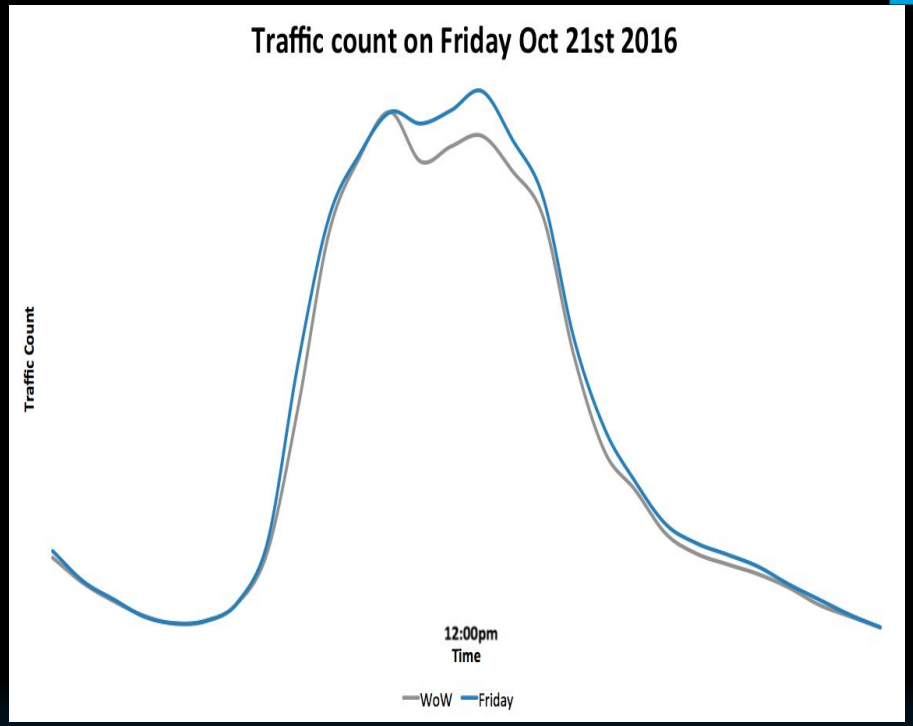
Benefits

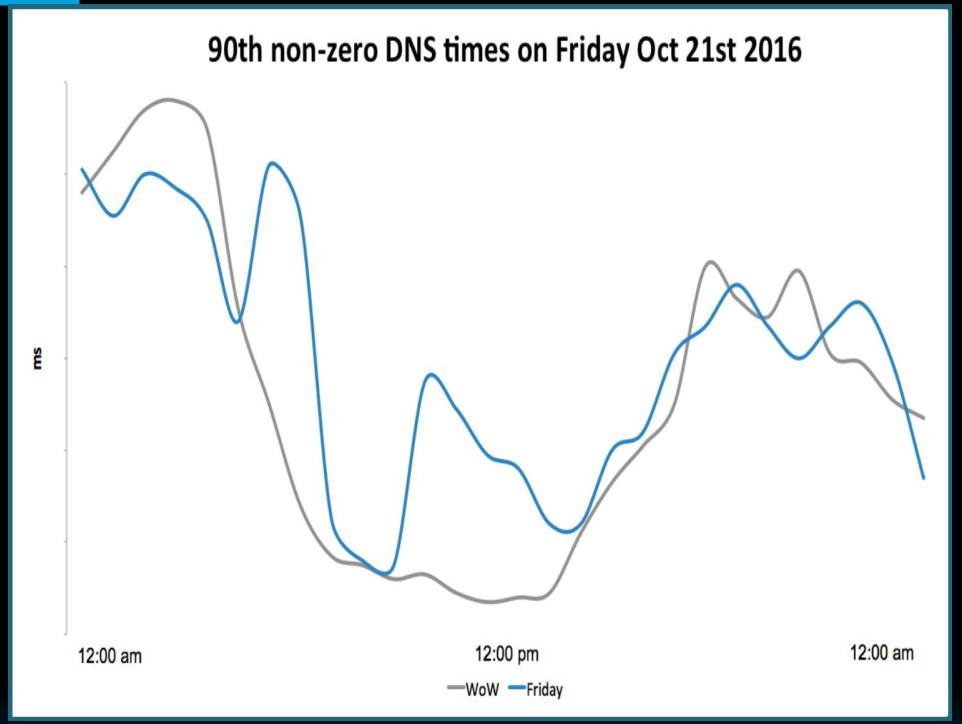
- Performance
- Availability

Multi DNS
Dyn DDOS



Multi DNS
Dyn DDOS



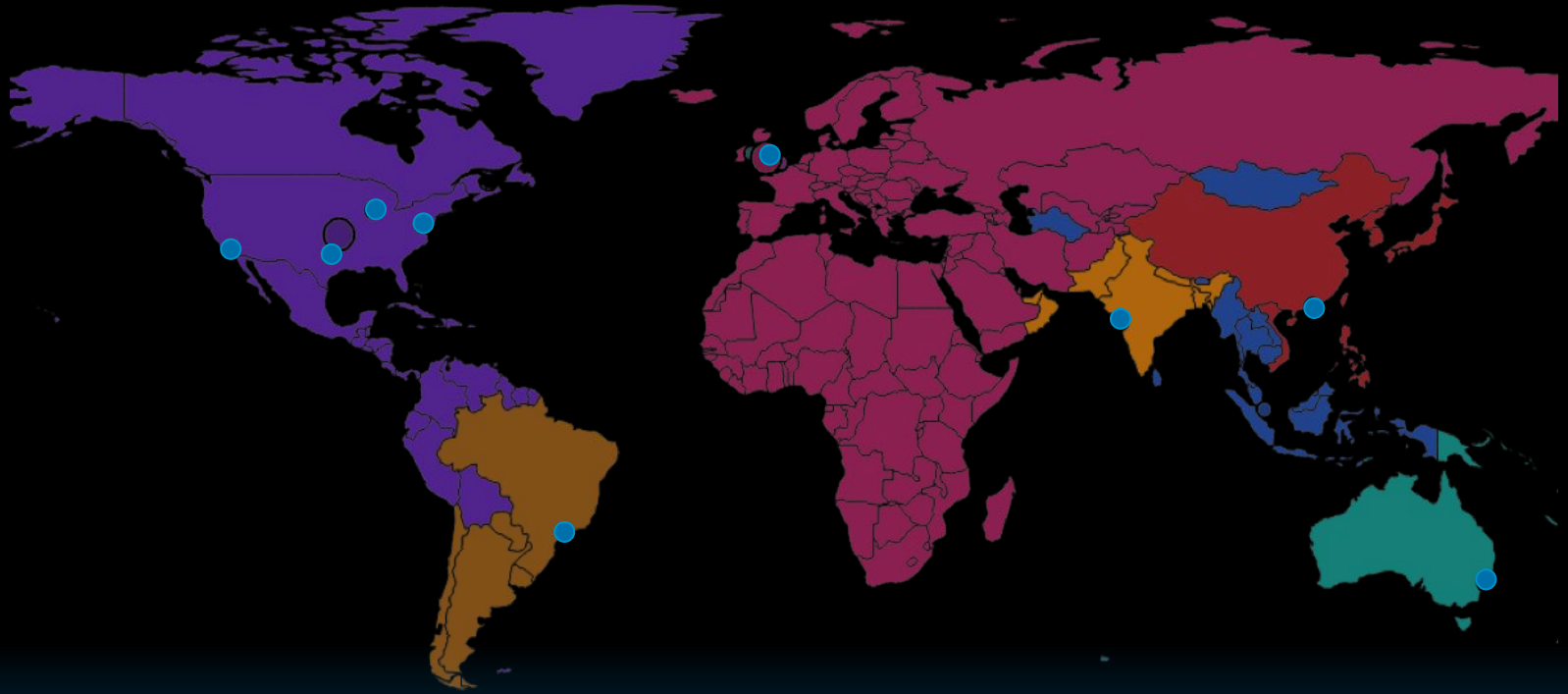


Traffic Steering

How to select the best POP and CDN ?

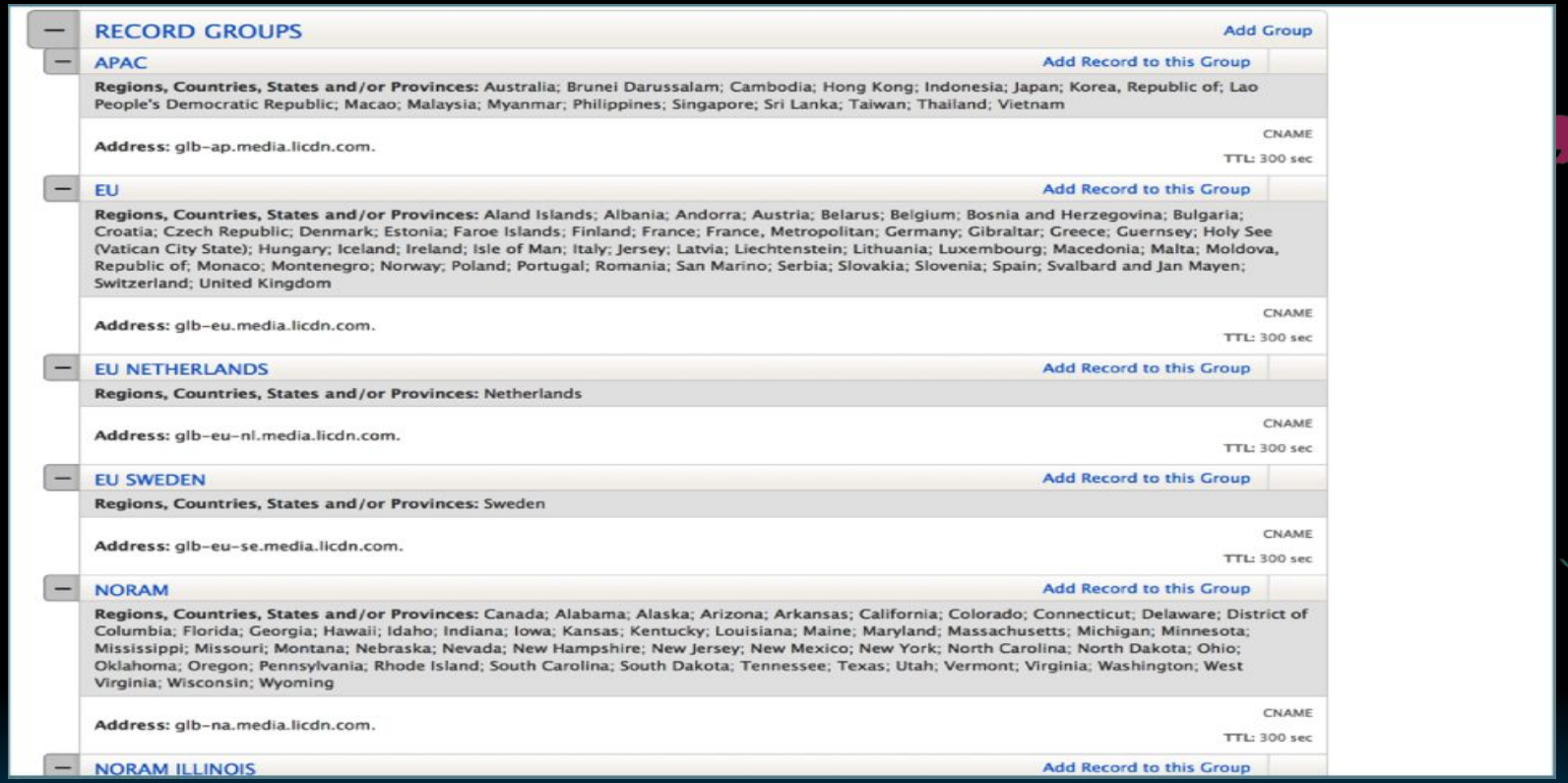
Traffic Steering

GeoDNS



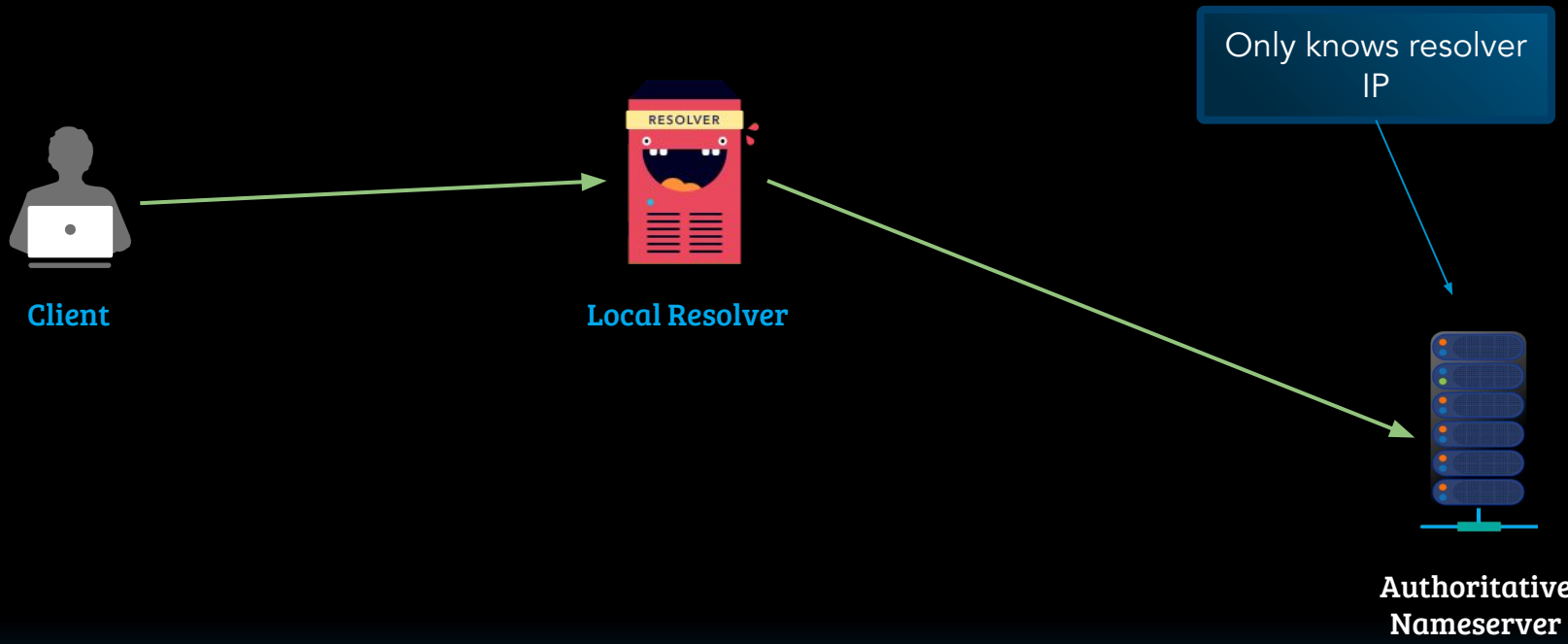
Traffic Steering

GeoDNS



Traffic Steering

GeoDNS



Traffic Steering

GeoDNS

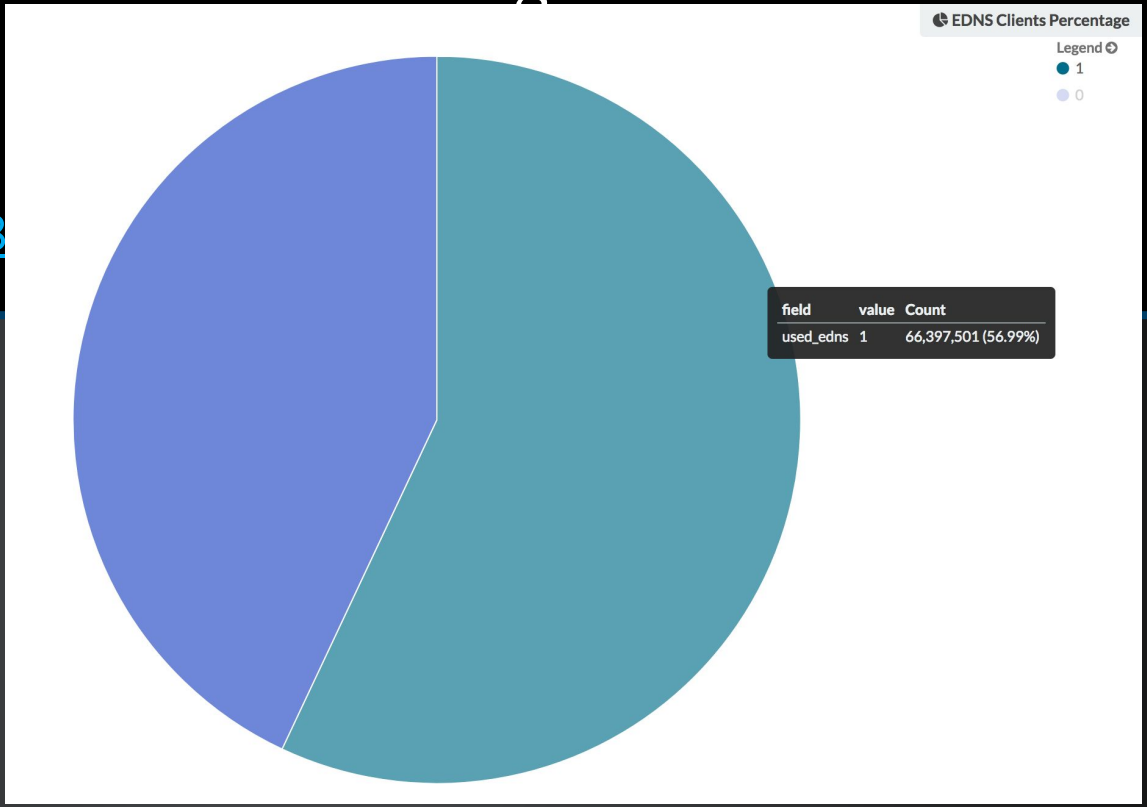
EDNS Client Subnet (rfc7871)

```
# Ireland IP subnet
➤ dig +short +noshort  @dns1.p09.nsone.net. +client=50.7.155.0/24 media-lcdn.licdn.com
media-lcdn.licdn.com.    300  IN   CNAME     pop-tln1.media-src.linkedin.com.

# India IP Subnet
➤ dig +short +noshort  @dns1.p09.nsone.net. +client=183.82.18.0/24 media-lcdn.licdn.com
media-lcdn.licdn.com.    300  IN   CNAME     pop-tmu1.media-src.linkedin.com.
```

Traffic Steering

EDNS Client Subnet (rfc78

```
# Ireland IP subnet
➤ dig +short +noshort  @dns1
media-lcdn.licdn.com.    300

# India IP Subnet
➤ dig +short +noshort  @dns1
media-lcdn.licdn.com.    300
```



Traffic Steering

Anycast

Traffic Steering

Anycast

Region/Country	Performance
Illinois	+20%
Florida	+22%
Georgia	+18%
Pennsylvania	+10%

Traffic Steering

Anycast

Region/Country	Performance
Illinois	+20%
Florida	+22%
Georgia	+18%
Pennsylvania	+10%
Arizona	-21%
Brazil	-55%
New York	-3%

Traffic Steering

Anycast

Least # of hops != Least latency

Region/Country	Performance
Illinois	+20%
Florida	+22%
Georgia	+18%
Pennsylvania	+10%
Arizona	-21%
Brazil	-55%
New York	-3%

Traffic Steering

RUM (Real User Measurements) DNS

Public DNS with RUM

Traffic Steering

RUM DNS

RUM Steering

2 Phases

Measure

Steer

RUM Steering

Measurement Phase

0. Visitor

RUM Steering

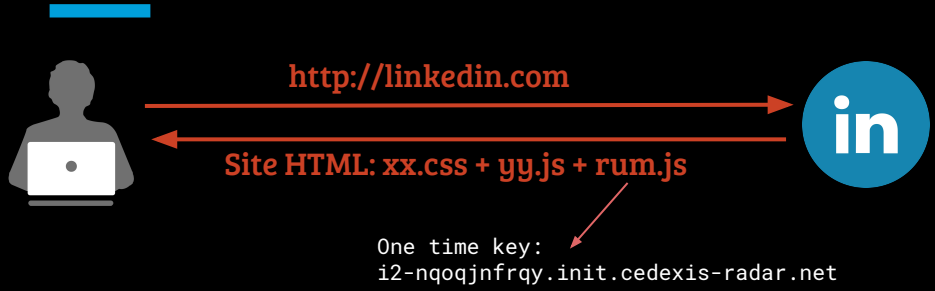
Measurement Phase

0. Visitor

RUM Steering

Measurement Phase

0. Visitor
1. Identify



RUM Steering

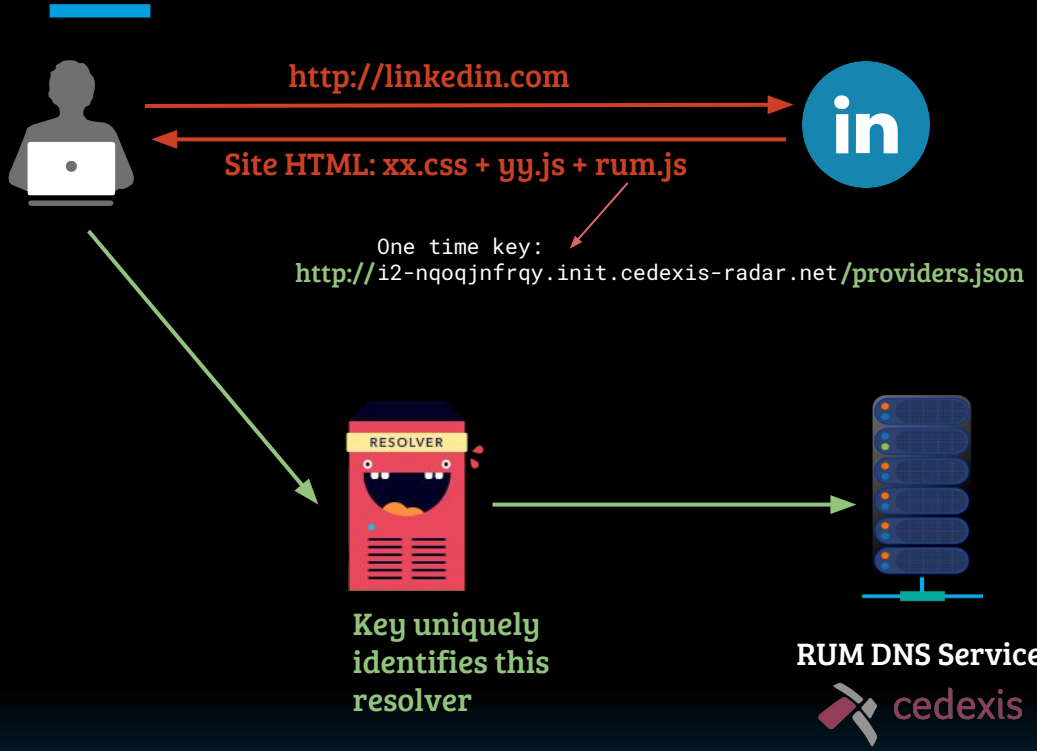
Measurement Phase

0. Visitor
1. Identify

RUM Steering

Measurement Phase

0. Visitor
1. Identify



RUM Steering

Measurement Phase

0. Visitor
1. Identify

POP-X

CDN1

CDN2

Key uniquely identifies this resolver

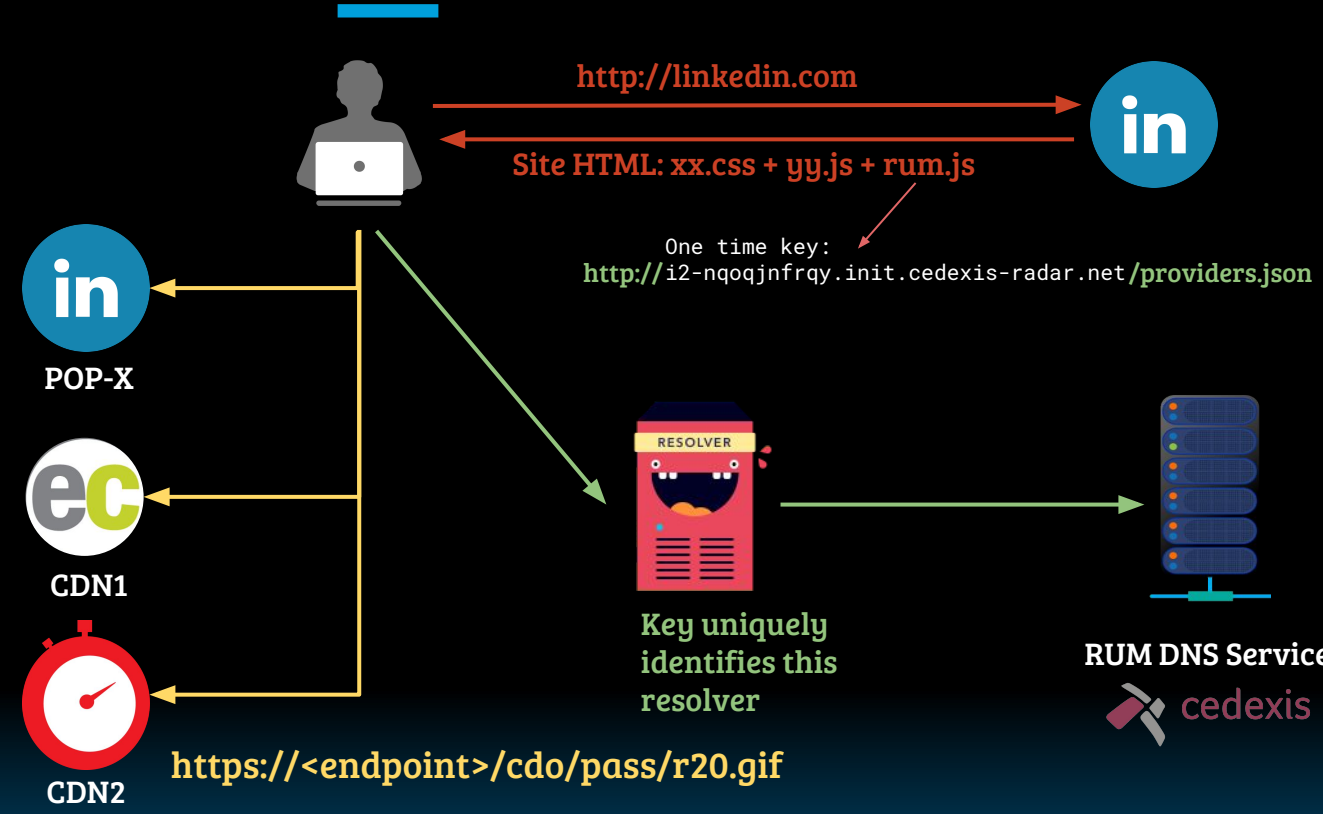
RUM DNS Service

cedexis

RUM Steering

Measurement Phase

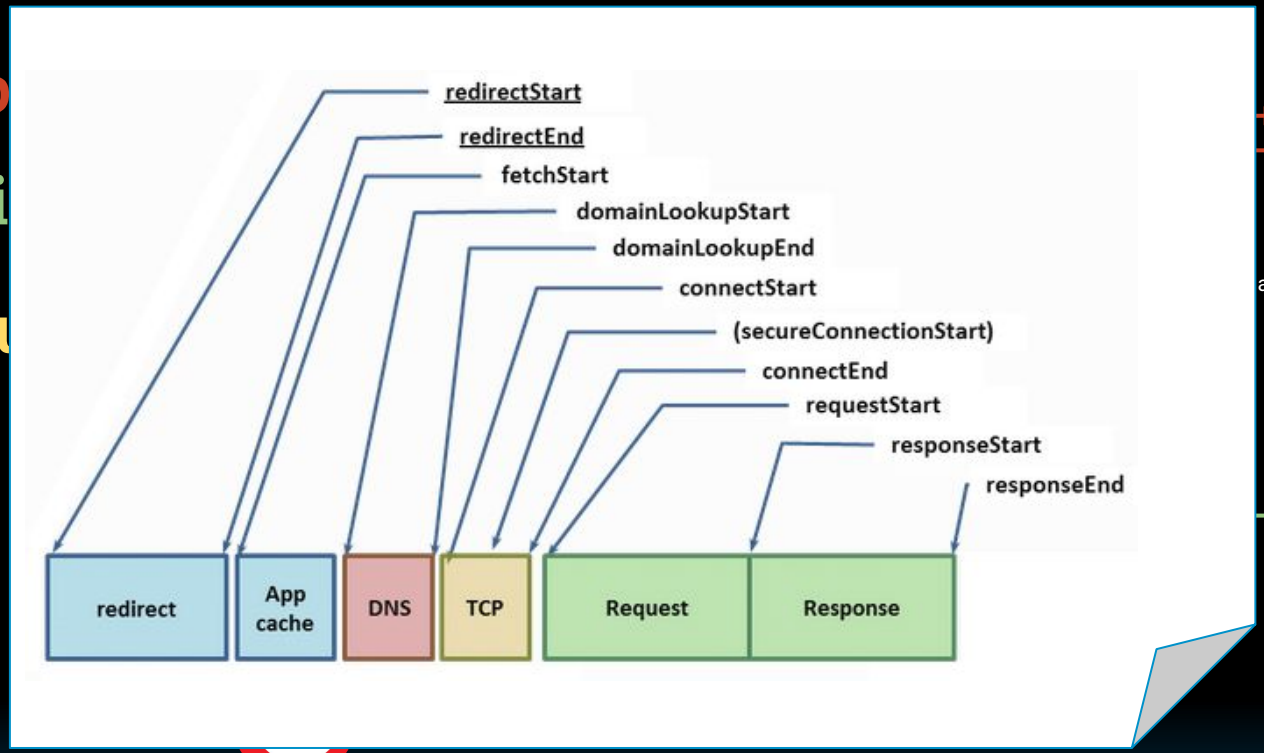
0. Visitor
1. Identify
2. Measure



RUM Steering

Measurement Phase

0. Visito
1. Identi
2. Measu



ar.net/providers.json

RUM DNS Service

cedexis

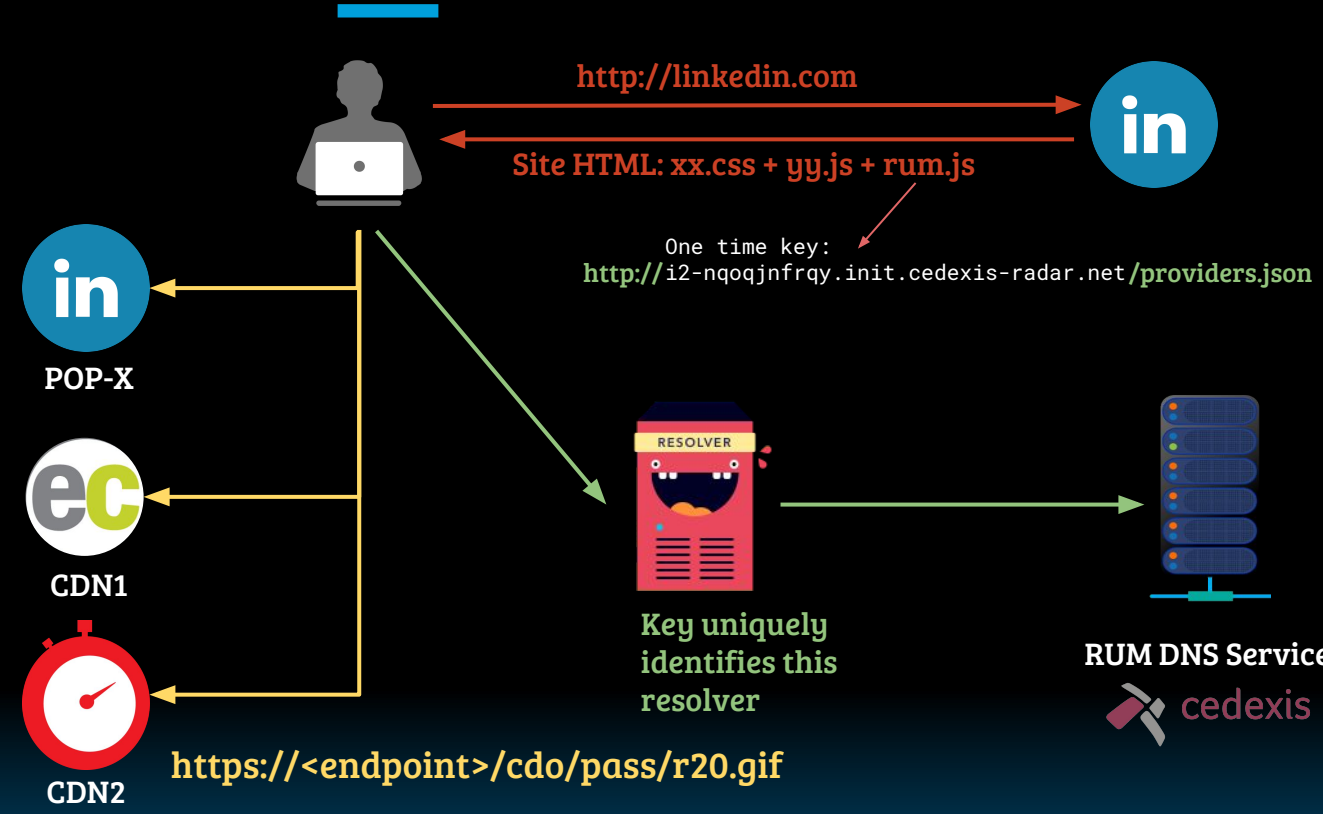
CDN2

https://<endpoint>/cdo/pass/r20.gif

RUM Steering

Measurement Phase

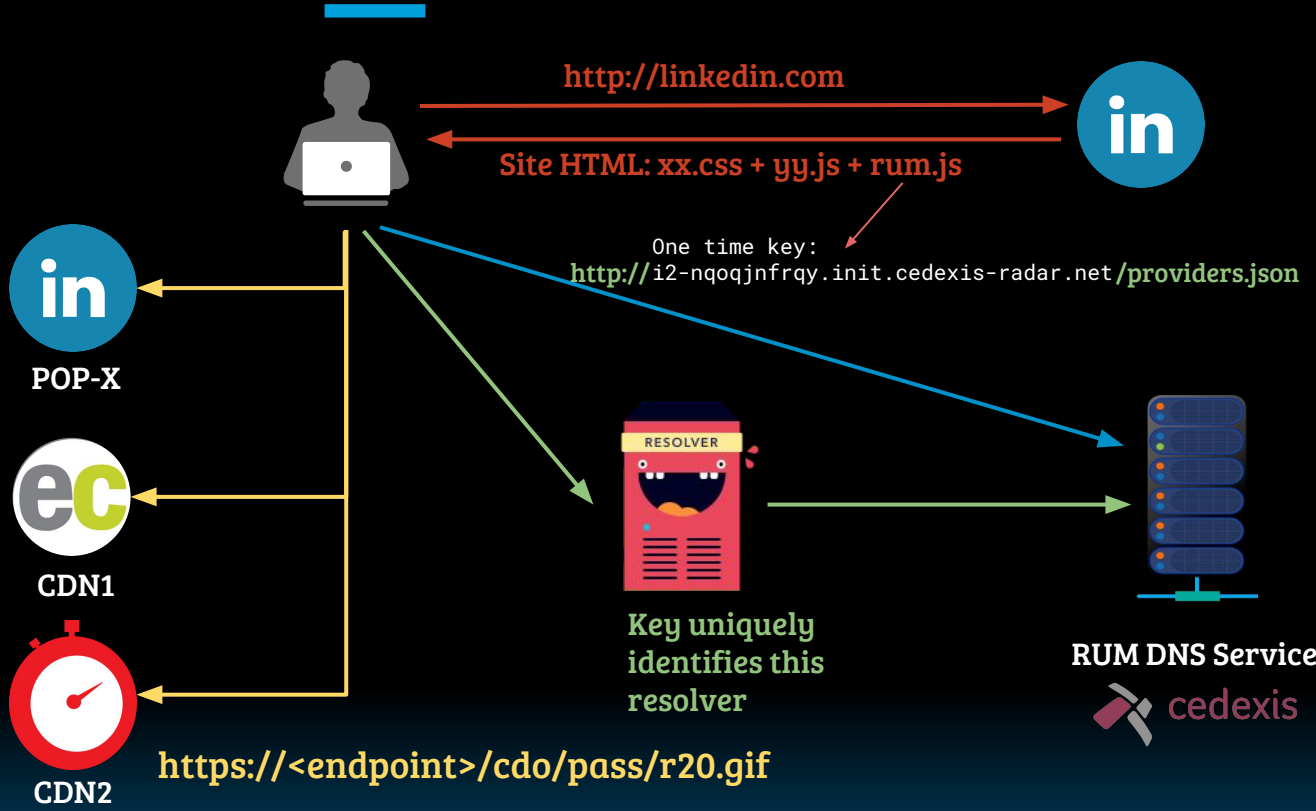
0. Visitor
1. Identify
2. Measure



RUM Steering

Measurement Phase

0. Visitor
1. Identify
2. Measure
3. Report



RUM Steering

Measurement Phase

0. http://linkedin.com
1. Site HTML: xx.css + yy.js + rum.js
2. One time key: http://i2-nqoqjnfrqy.init.cedexis-radar.net/providers.json
3. https://<endpoint>/cdo/pass/r20.gif

- Client's IP address
  - ASN
  - Geolocation (reporting/aggregation)
  - Performance data for client
- Client's resolver IP address
  - Various clients/ASNs behind this resolver
  - Performance data for various clients behind this resolver

Key uniquely identifies this resolver

RUM DNS Service

cedexis

CDN2

RUM Steering

Measurement Phase

Name	Status	Protocol	Domain	Type	Initiator	Size
radar.html	302	http/1.1	radar.cedexis.com		c14k9d6r773pni5e61nlqxojf…	396B
radar.html?customer-id=11326	200	http/1.1	radar.cedexis.com	document	radar.cedexis.com/1/11326/…	17.3KB
providers.json?imagesok=1&n=1&p=1&r=1&t=1	200	http/1.1	i2-nqoqjnfrqyqtvbtmsxsrziocya…	xhr	radar.html?customer-id=113…	1017B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B

RUM Steering

Measurement Phase

Name	Status	Protocol	Domain	Type	Initiator	Size
radar.html	302	http/1.1	radar.cedexis.com		c14k9d6r773pni5e61nlqxojf…	396B
radar.html?customer-id=11326	200	http/1.1	radar.cedexis.com	document	radar.cedexis.com/1/11326/…	17.3KB
providers.json?imagesok=1&n=1&p=1&r=1&t=1	200	http/1.1	i2-nqoqjnfrqyqtvbtmsxsrziocya…	xhr	radar.html?customer-id=113…	1017B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B

RUM Steering

Measurement Phase

Name	Status	Protocol	Domain	Type	Initiator	Size
radar.html	302	http/1.1	radar.cedexis.com		c14k9d6r773pni5e61nlqxojf…	396B
radar.html?customer-id=11326	200	http/1.1	radar.cedexis.com	document	radar.cedexis.com/1/11326/…	17.3KB
providers.json?imagesok=1&n=1&p=1&r=1&t=1	200	http/1.1	i2-nqoqjnfrqyqtvbtmsxsrziocya…	xhr	radar.html?customer-id=113…	1017B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B

RUM Steering

Measurement Phase

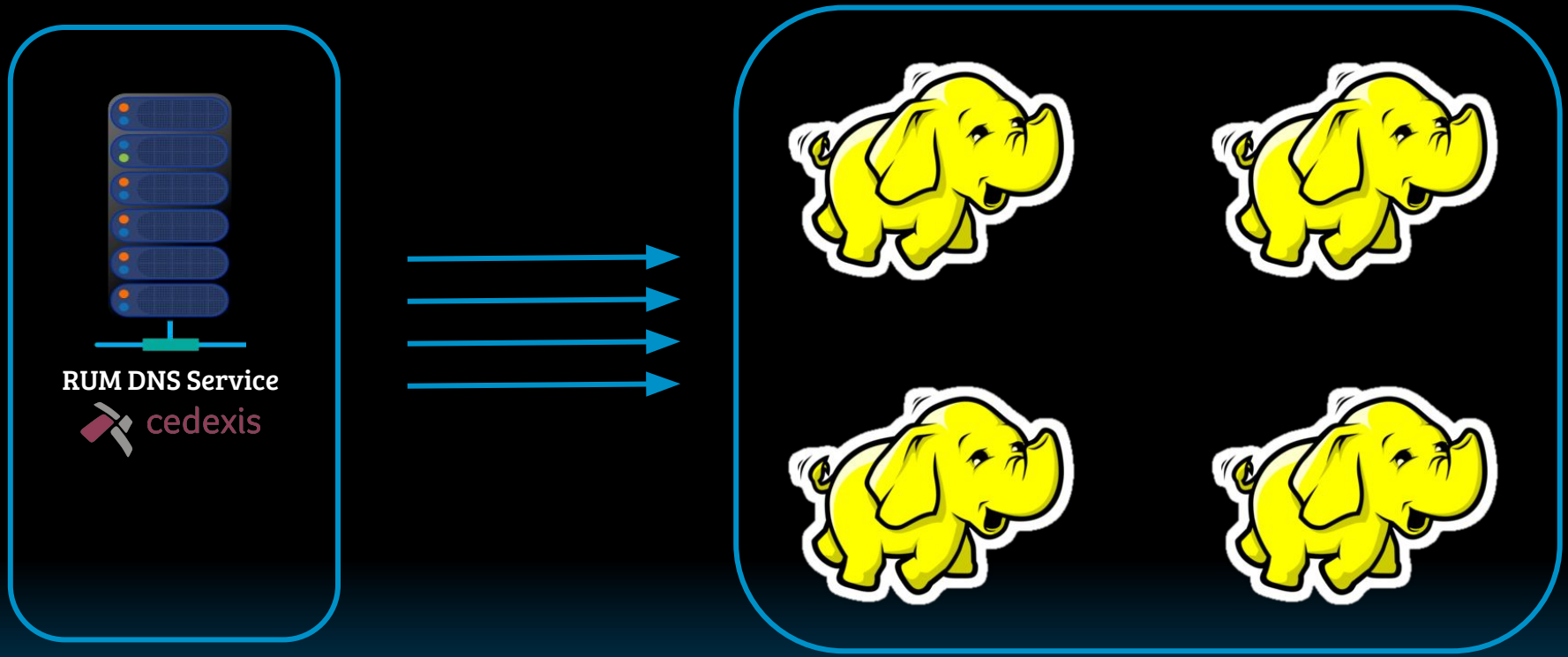
Name	Status	Protocol	Domain	Type	Initiator	Size
radar.html	302	http/1.1	radar.cedexis.com		c14k9d6r773pni5e61nlqxojf…	396B
radar.html?customer-id=11326	200	http/1.1	radar.cedexis.com	document	radar.cedexis.com/1/11326/…	17.3KB
providers.json?imagesok=1&n=1&p=1&r=1&t=1	200	http/1.1	i2-nqoqjnfrqyqtvbtmsxsrziocya…	xhr	radar.html?customer-id=113…	1017B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B
0	200	http/1.1	rpt.cedexis.com	xhr	radar.html?customer-id=113…	318B

RUM Steering

Measurement Phase

RUM Steering

Measurement Phase



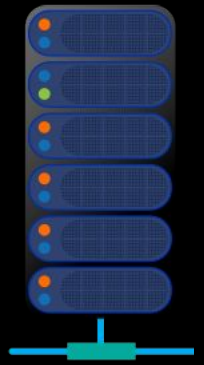
RUM Steering

Steering Phase

RUM Steering

Steering Phase

1. DNS Request



RUM DNS Service

cedexis

RUM Steering

Steering Phase

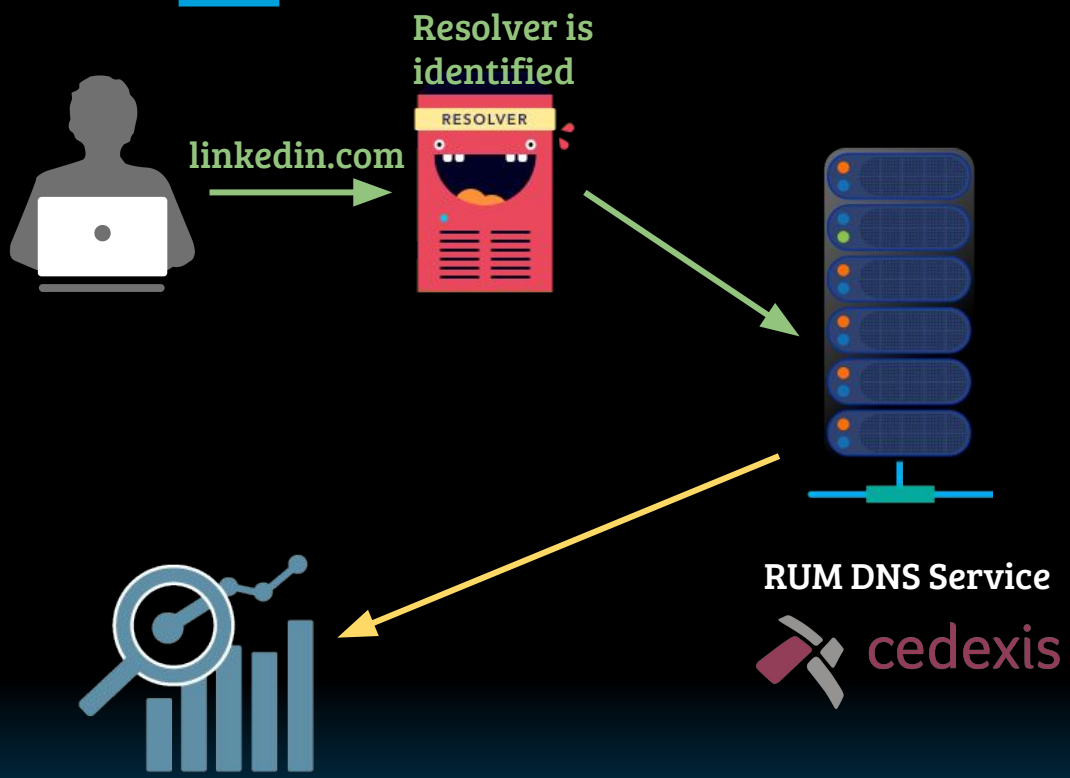
1. DNS Request

RUM DNS Service

cedexis

RUM Steering

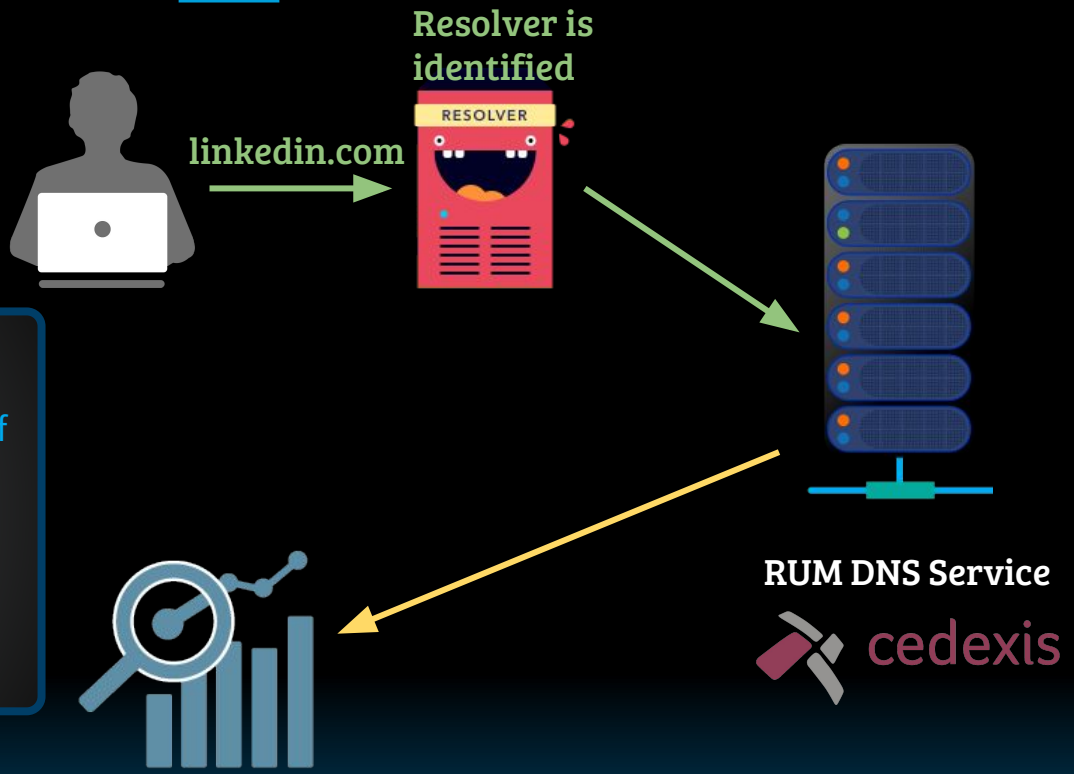
1. DNS Request
2. Inspect RUM



RUM Steering

Steering Phase

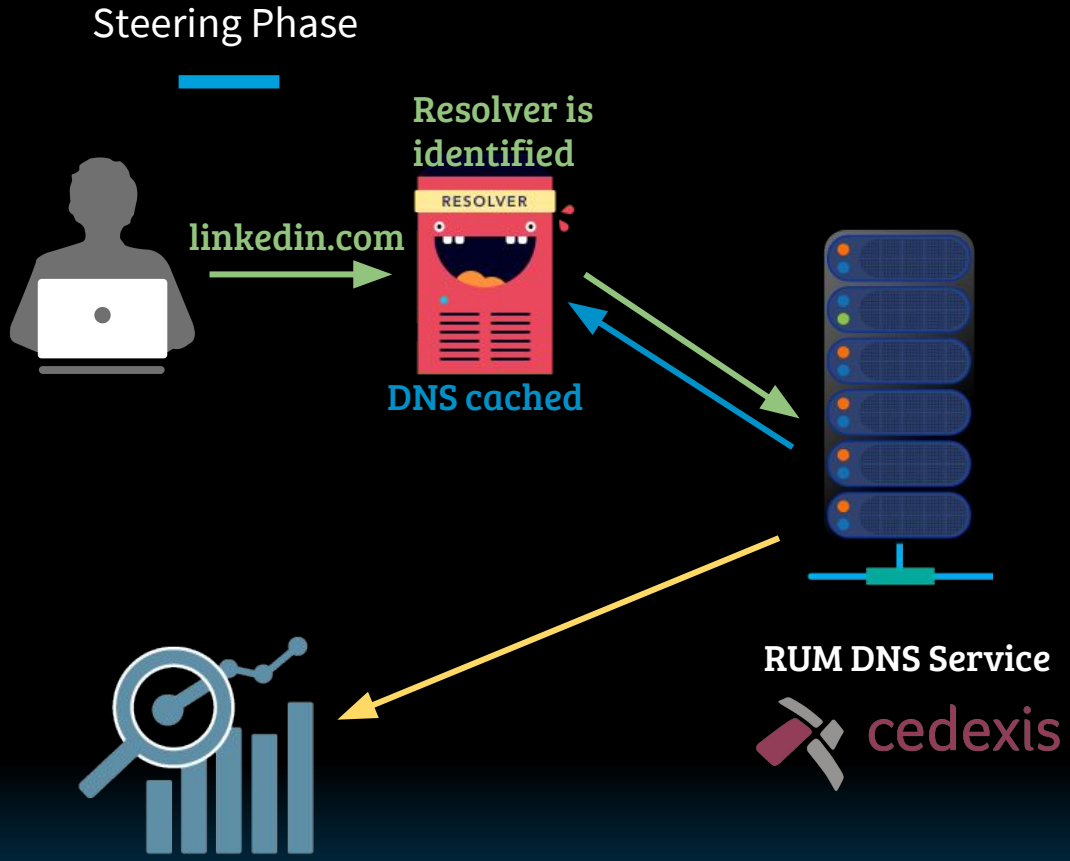
1. **DNS Request**
2. **Inspect RUM**



- If no ECS
  - DNS resolver IP
  - Aggregate performance data of ASNs behind that resolver
- If ECS
  - Subnet of client to return the right DNS response with high confidence score.

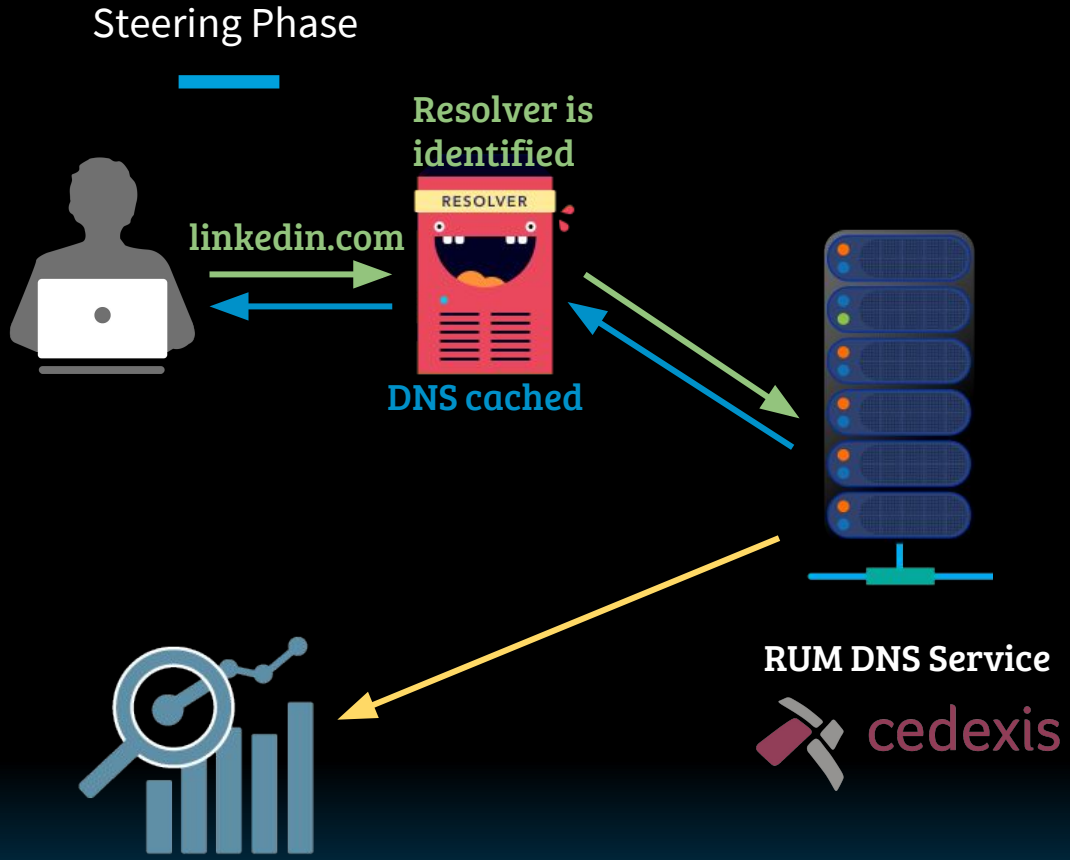
RUM Steering

1. DNS Request
2. Inspect RUM
3. DNS Response



RUM Steering

1. DNS Request
2. Inspect RUM
3. DNS Response



RUM Steering

RUM DNS at LinkedIn

```
$ dig +short +noshort static.licdn.com
```

What happens when a client resolves our LICDN domain

RUM Steering

RUM DNS at LinkedIn

```
$ dig +short +noshort static.licdn.com
static.licdn.com.                300    IN   CNAME   2-01-2c3e-003d.cdx.cedexis.net.
```

Cedexis owned CNAME belonging to our account

RUM Steering

RUM DNS at LinkedIn

```
$ dig +short +noshort static.licdn.com
static.licdn.com.                300   IN   CNAME   2-01-2c3e-003d.cdx.cedexis.net.
2-01-2c3e-003d.cdx.cedexis.net.  300   IN   CNAME   cs627.wac.epsiloncdn.net.
```

Cedexis looks at RUM measurements and hands out the best from our CDNs

RUM Steering

RUM DNS at LinkedIn

```
$ dig +short +noshort static.licdn.com
static.licdn.com.                300   IN   CNAME   2-01-2c3e-003d.cdx.cedexis.net.
2-01-2c3e-003d.cdx.cedexis.net.  300   IN   CNAME   cs627.wac.epsiloncdn.net.
```

Low TTL so that clients pick up response changes faster

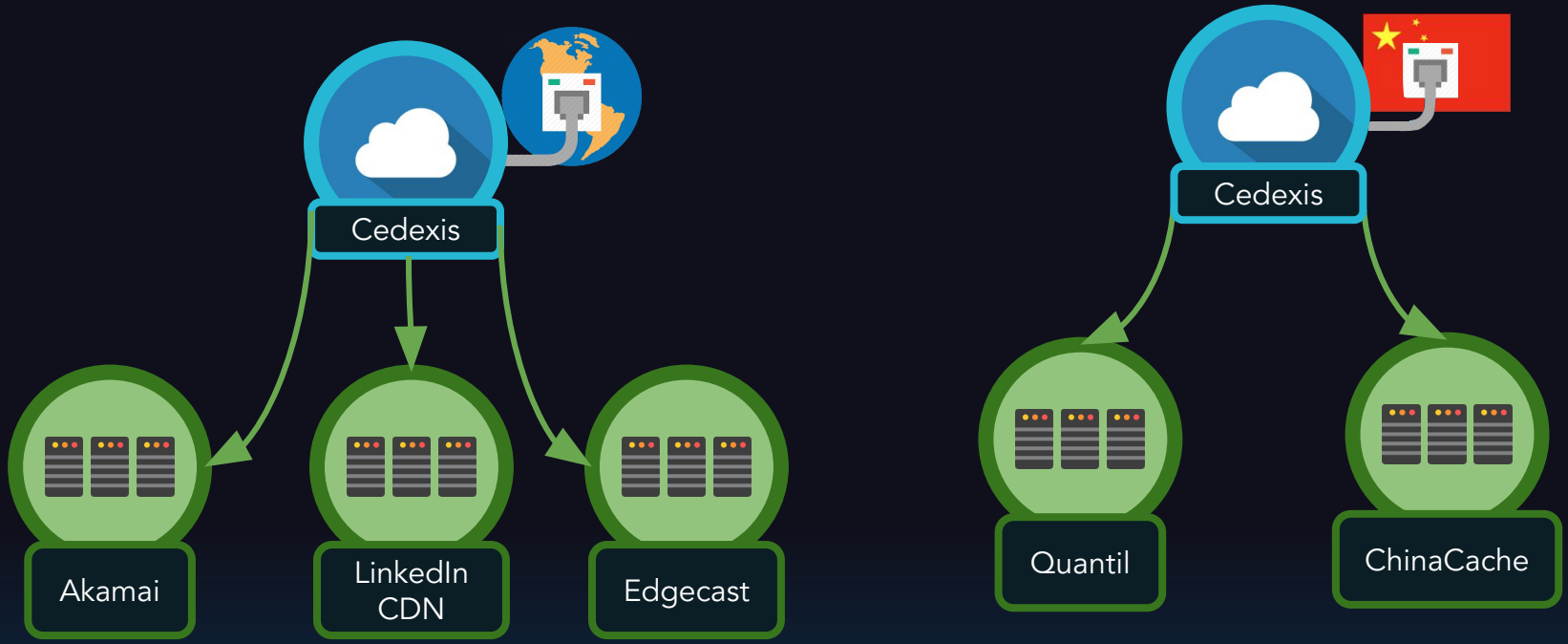
RUM Steering

RUM DNS at LinkedIn

```
$ dig +short +noshort static.licdn.com
static.licdn.com.                300   IN   CNAME   2-01-2c3e-003d.cdx.cedexis.net.
2-01-2c3e-003d.cdx.cedexis.net.  300   IN   CNAME   cs627.wac.epsiloncdn.net.
cs627.wac.epsiloncdn.net.        3600  IN   A       192.229.237.53
$
```

CDN owned CNAME then resolves to an IP

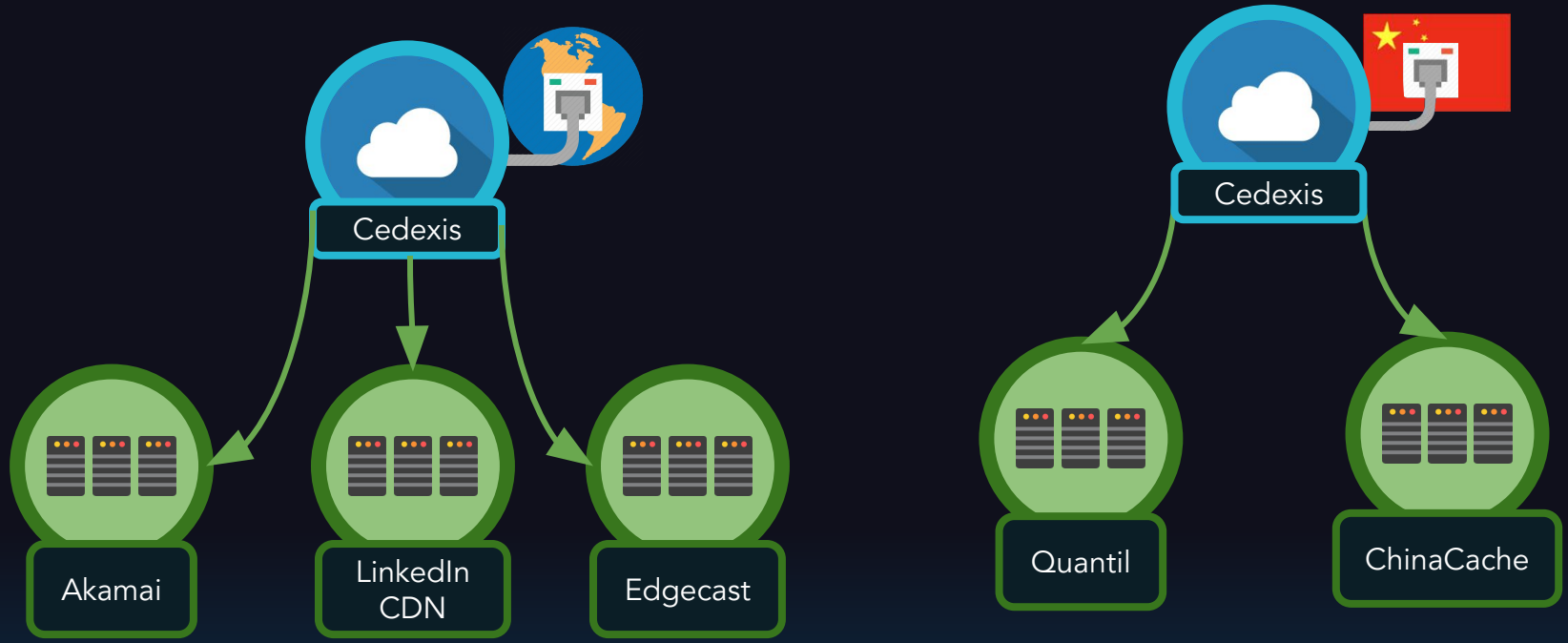
CDN RUM Steering



CDN RUM Steering

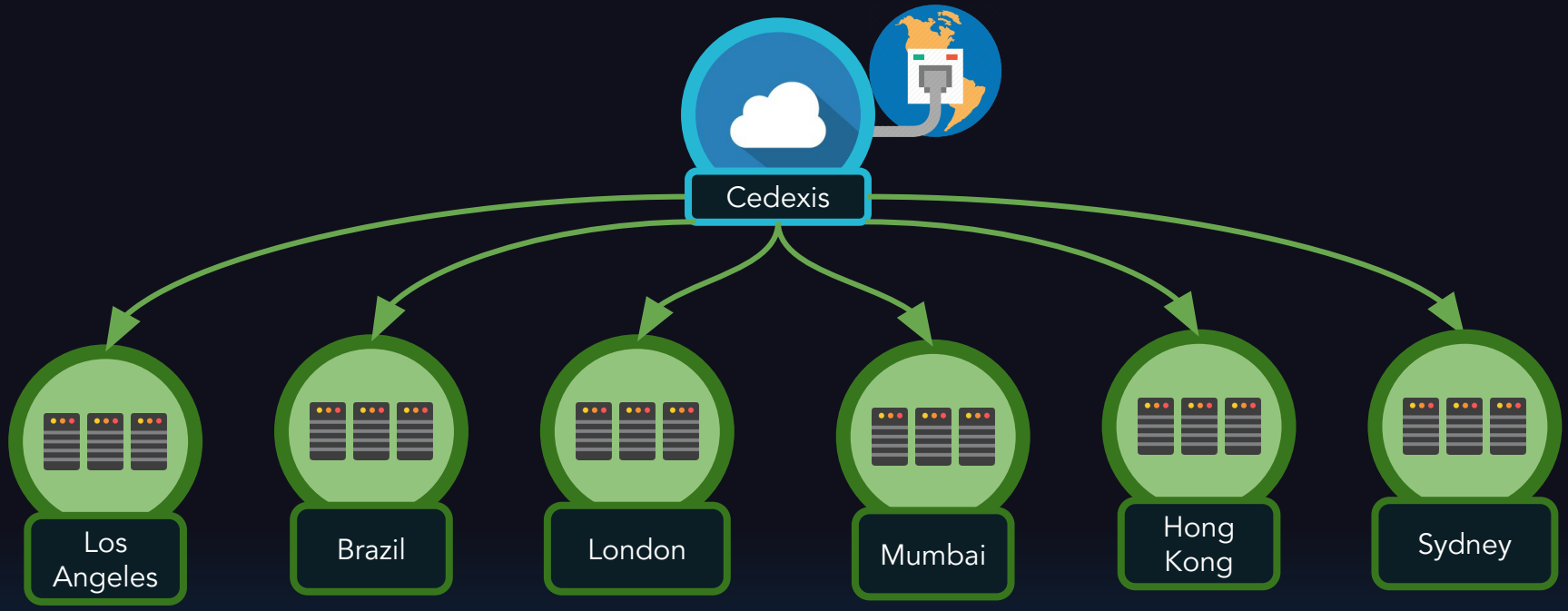
static.licdn.com. 300 IN CNAME 2-01-2c3e-003d.cdx.cedexis.net

static.licdn.com. 300 IN CNAME 2-01-2c3e-0040.cdx.cdxcn.cn



POP RUM Steering

www.linkedin.com. 300 IN CNAME 2-01-2c3e-003c.cdx.cedexis.net

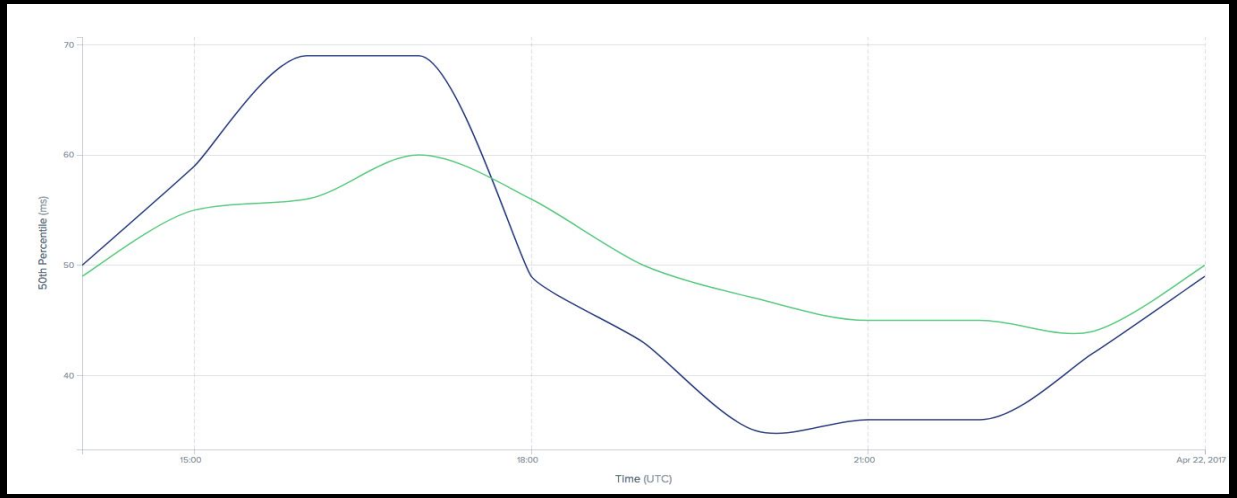


RUM Steering

Benefits of RUM DNS

RUM Steering

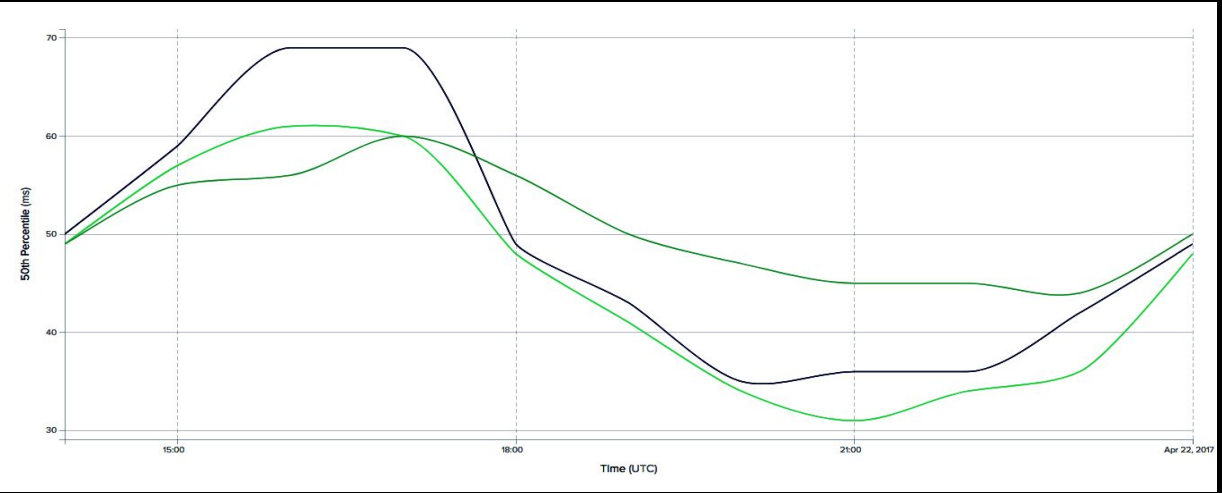
Benefits of RUM DNS



Two CDNs having opposite performance throughout the day

RUM Steering

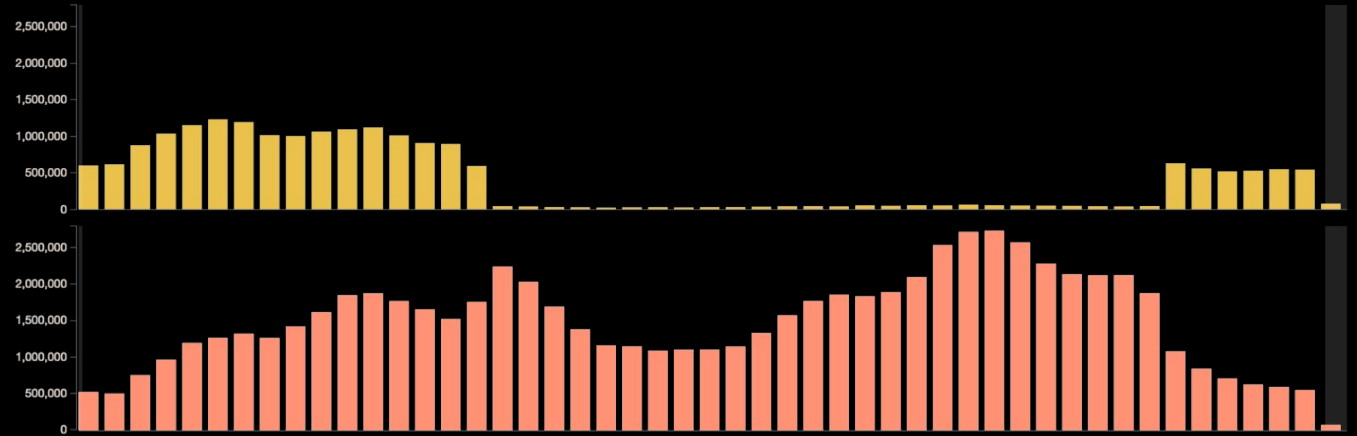
Benefits of RUM DNS



RUM DNS always picks the best of the two CDNs

RUM Steering

Benefits of RUM DNS



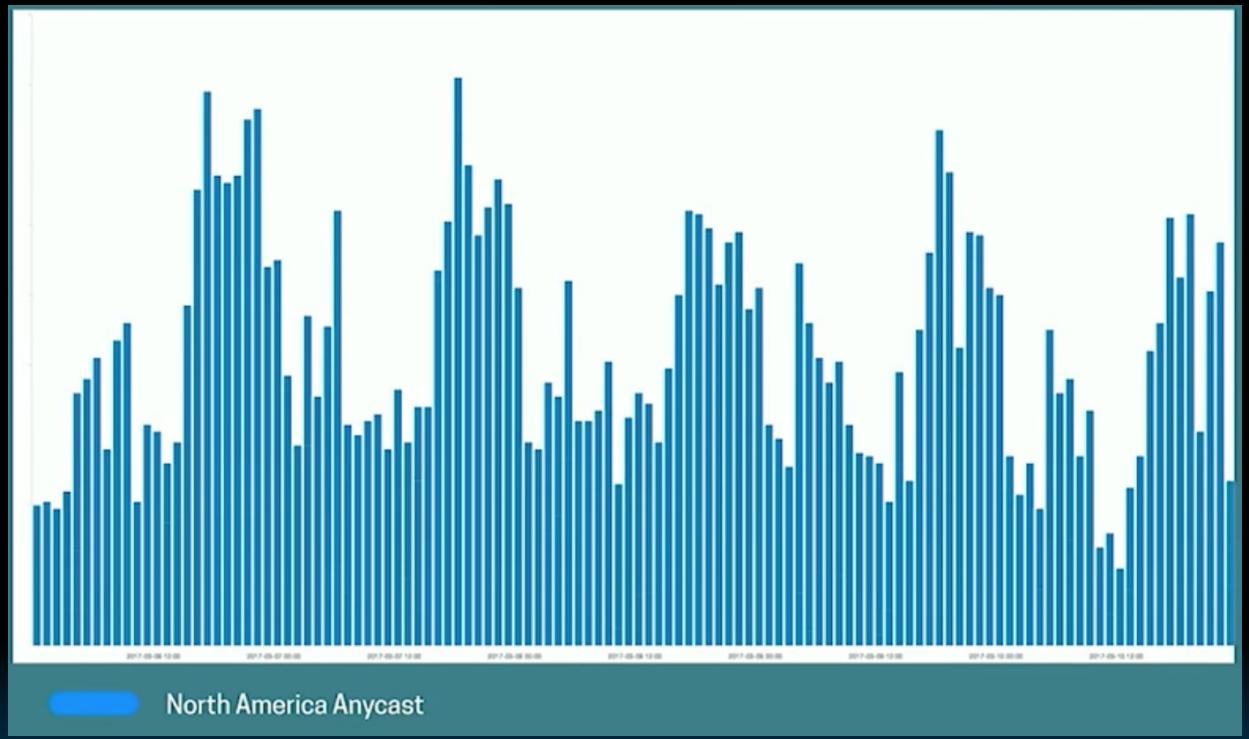
RUM DNS failing out a CDN automatically and shifting to others

RUM Steering

RUM DNS vs GeoDNS

RUM Steering

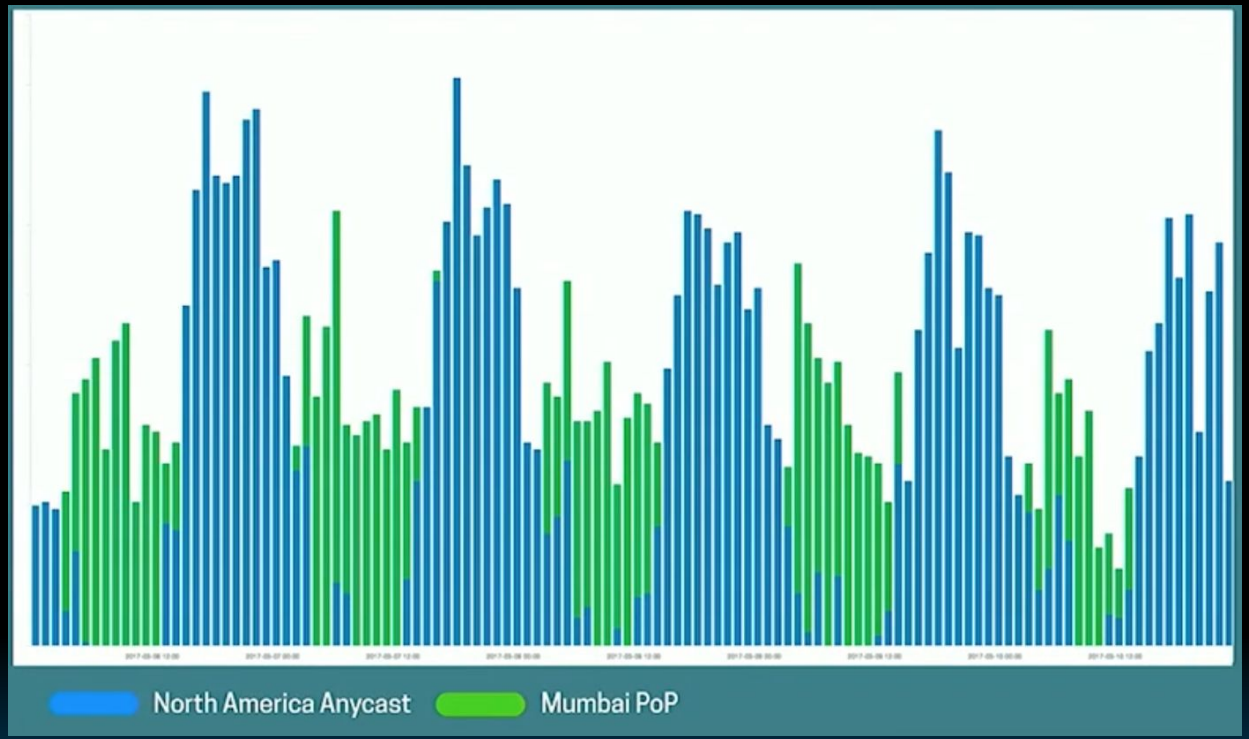
RUM DNS vs GeoDNS (DNS Resolver in US)



DNS Resolver of a large chip manufacturing company.

RUM Steering

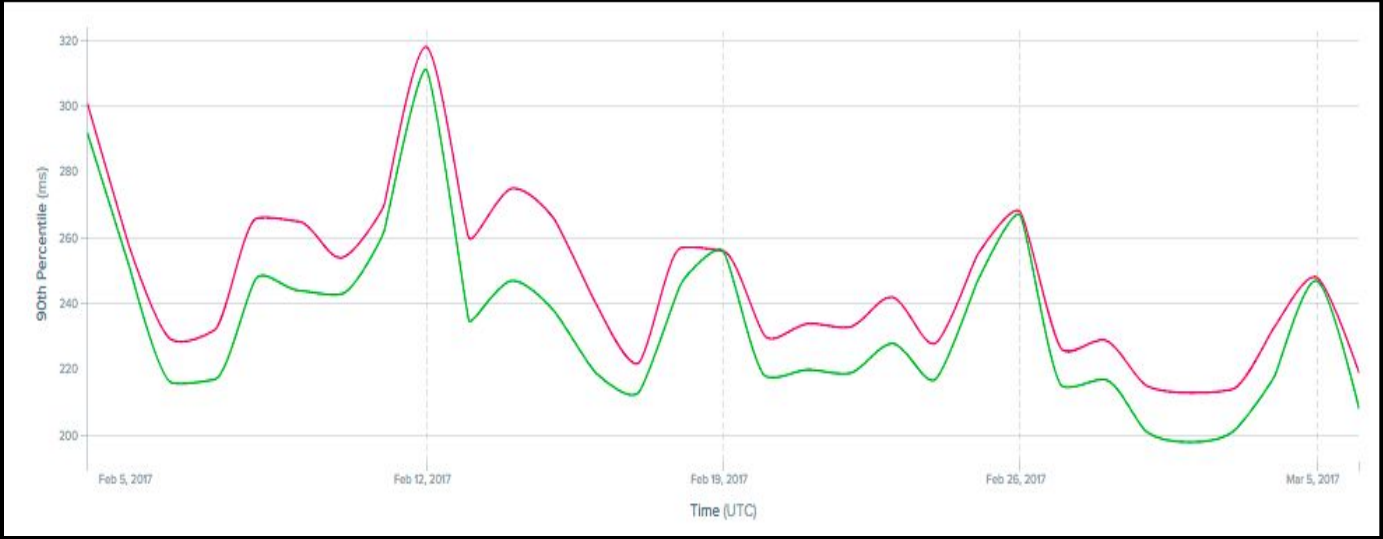
RUM DNS vs GeoDNS (DNS Resolver in US)



RUM Steering correctly to specific PoPs at different times.

RUM Steering

RUM DNS vs GeoDNS (India)

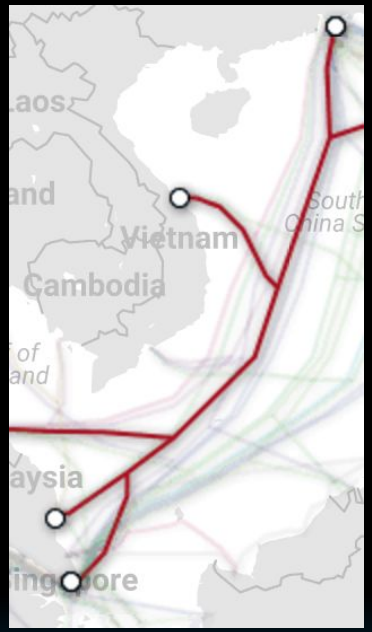


GeoDNS **RUM DNS**

RUM DNS circumvents GeoIP inaccuracies in India

RUM Steering

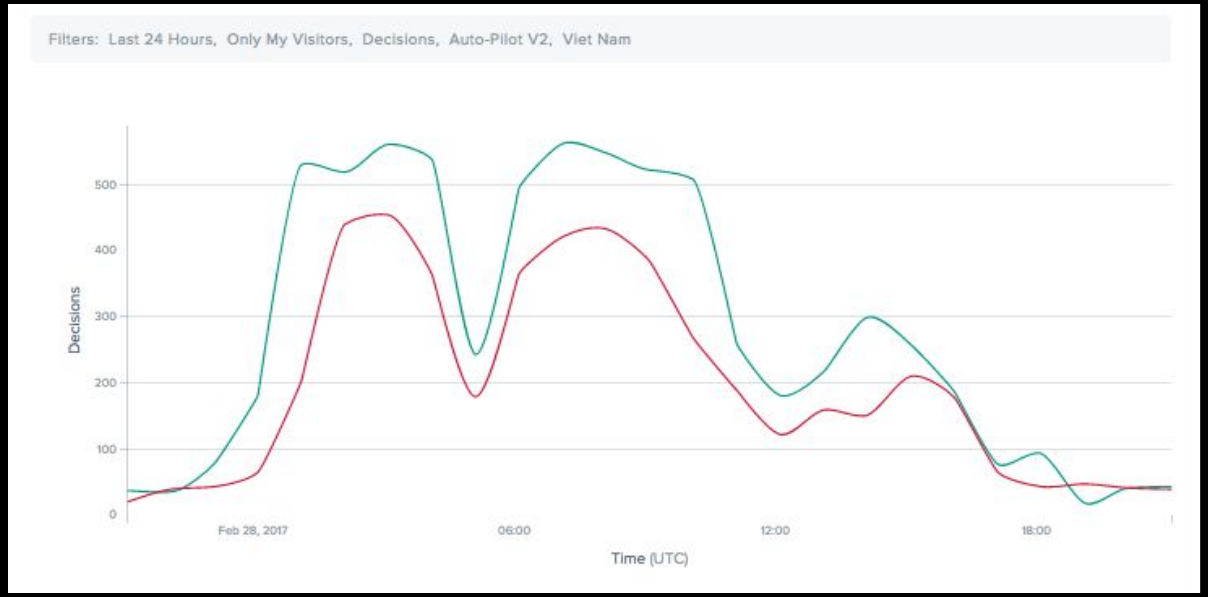
RUM DNS vs GeoDNS (Vietnam)



Vietnam equidistant from **Hong Kong** and **Singapore**

RUM Steering

RUM DNS vs GeoDNS (Vietnam)



Singapore POP

Hong Kong POP

Vietnam correctly routed to a blend of POPs

RUM Steering

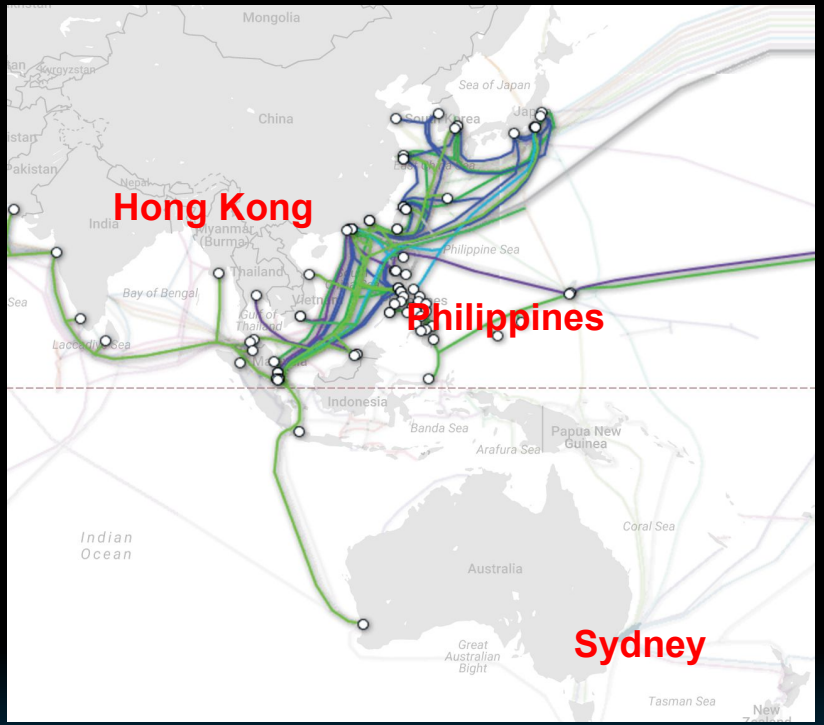
RUM DNS vs GeoDNS (Vietnam)

RUM DNS **GeoDNS**

Viettel sees 50% latency improvement

RUM Steering

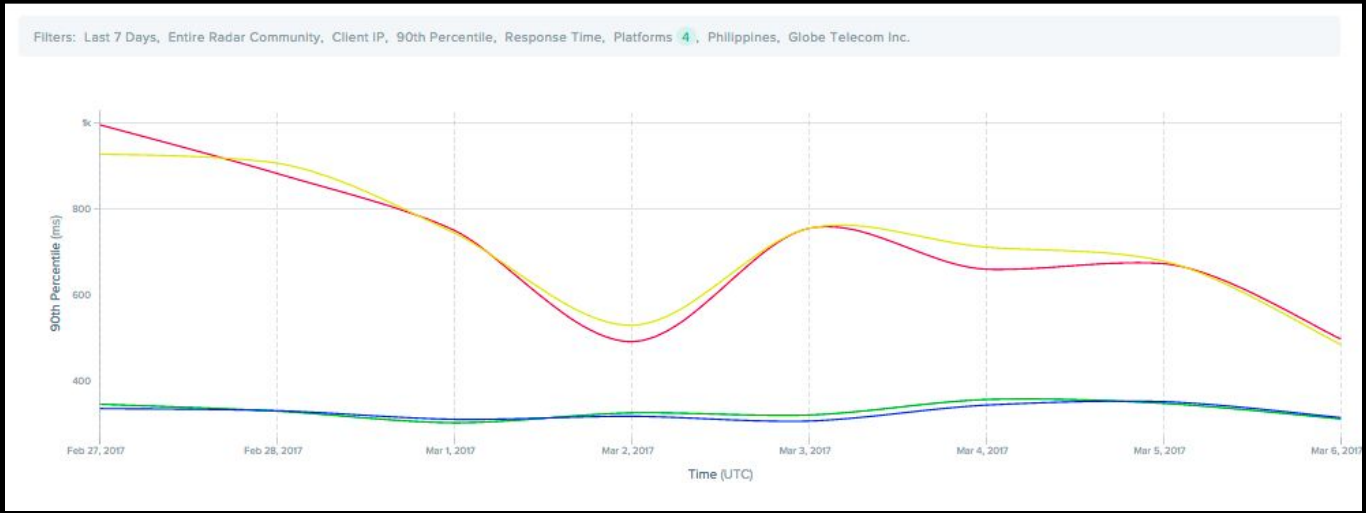
RUM DNS vs GeoDNS (Philippines)



Philippines closer to Hong Kong than Sydney.

RUM Steering

RUM DNS vs GeoDNS (Philippines)



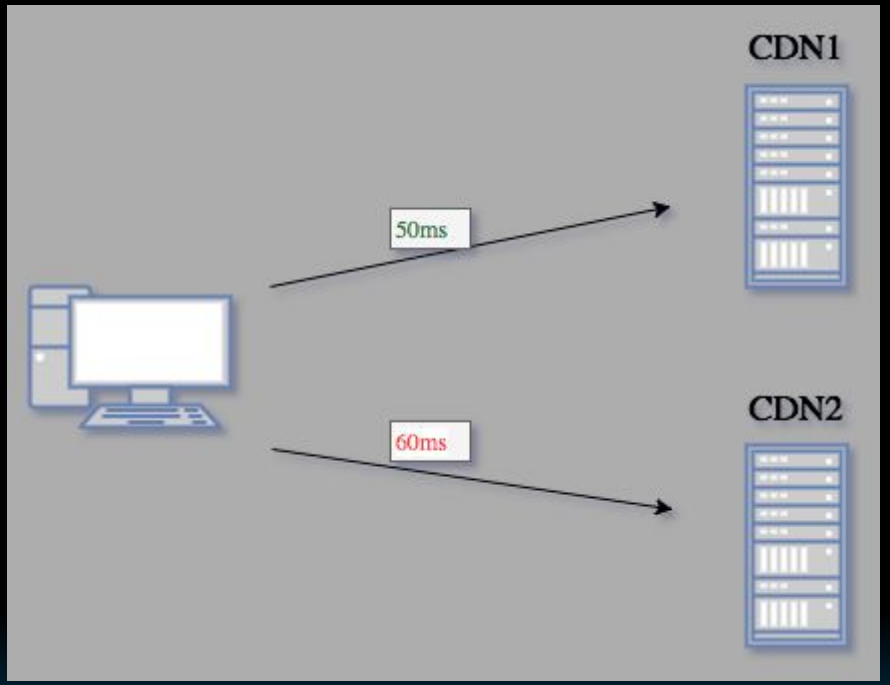
Philippines Globe Telecom routed to the correct POP

GeoDNS Hong Kong POP RUM DNS Sydney POP

RUM Steering

Closing thoughts: FLAWS

Cache hit ratio



RUM Steering

Closing thoughts: FLAWS

WORKAROUNDS

Cache hit ratio

CDN stickiness

RUM Steering

Closing thoughts: FLAWS

WORKAROUNDS

Cache hit ratio

CDN stickiness

Cache miss latency

RUM Steering

Closing thoughts: FLAWS

Workarounds

Cache hit ratio

CDN stickiness

Cache miss latency

Measure miss latency with 2nd object

RUM Steering

Closing thoughts: FLAWS

Workarounds

Cache hit ratio

CDN stickiness

Cache miss latency

Measure miss latency with 2nd object

POP load shedding

RUM Steering

Closing thoughts

Workarounds

Cache hit ratio

CDN stickiness

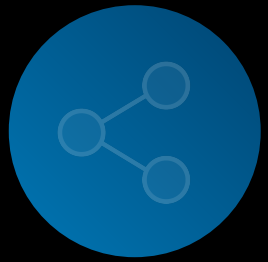
Cache miss latency

Measure miss latency with 2nd object

POP load shedding

Latency padding

Agenda



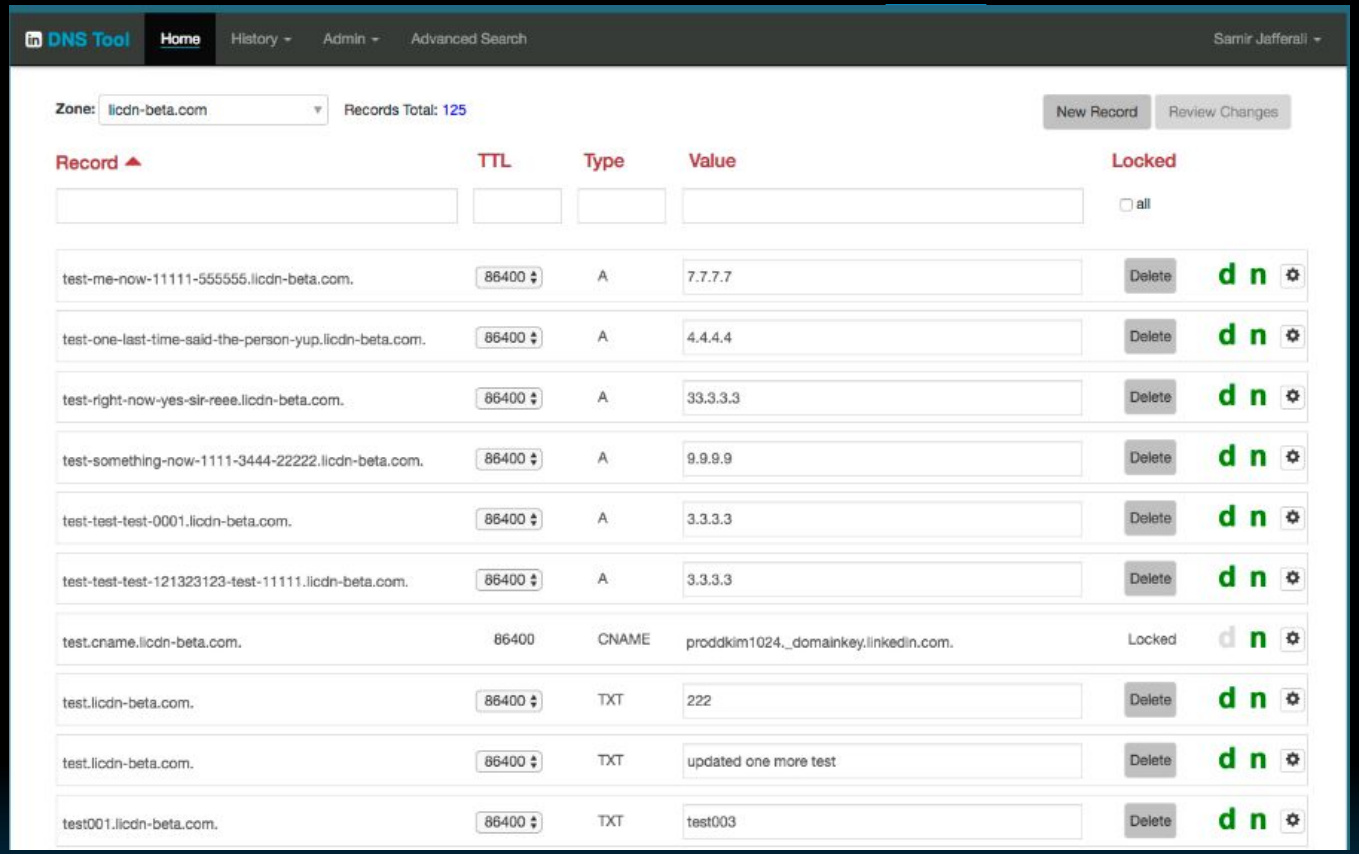
CDN strategy

POP Strategy

RUM Steering

Tooling

DNS Tool



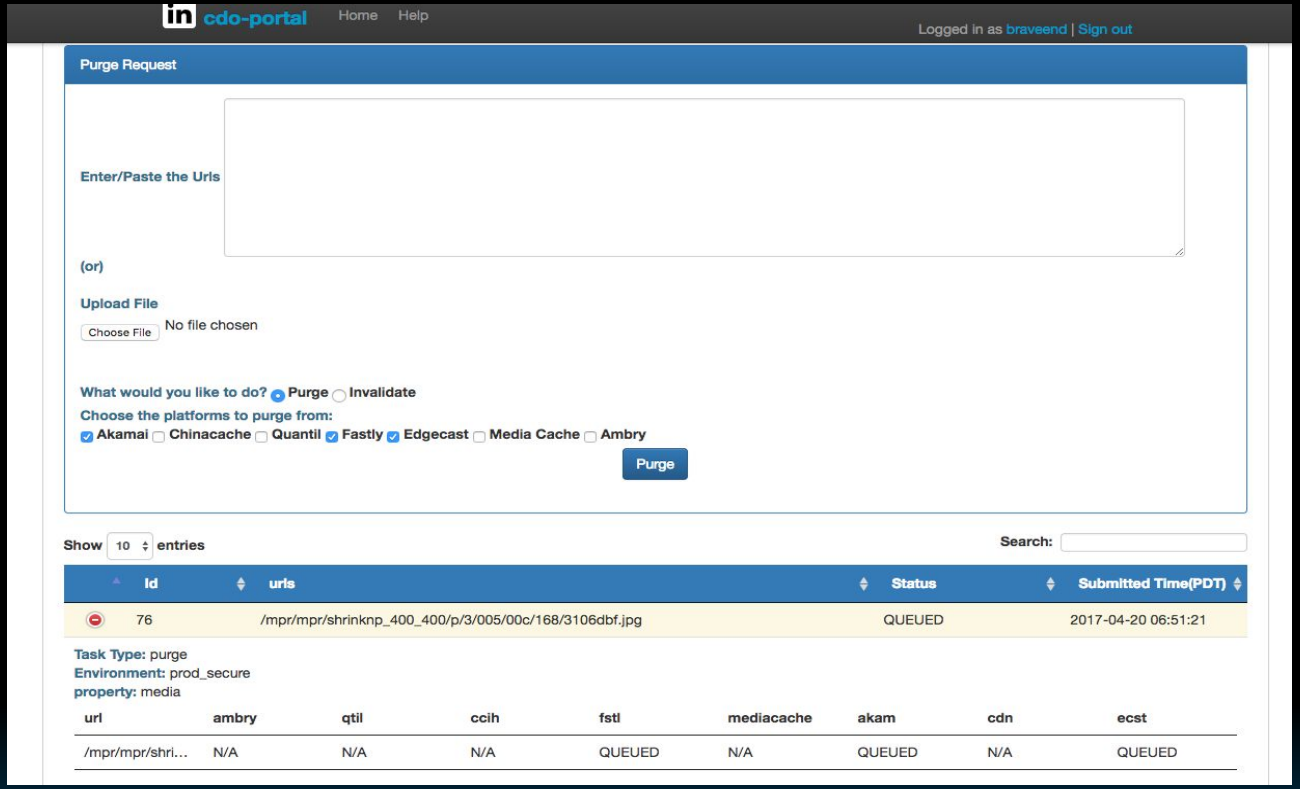
- Single interface
- Auditing and logging
- Search records across zones
- Exposes API

CDN Regression tool

```
$ python regressor.py --cdn fstl --property static --protocol https
 -=TEST=- Certificate Validation Regression Suite
   [PASS] - Both hostnames listed in deployed cert: (static.licdn.com,
 -=TEST=- sc Regression Suite
   [PASS] - Verify Caching enabled: True
   [PASS] - Custom header X-CDN: FSTL matches expected values
   [PASS] - Cache-Key includes query-string, expected True
   [PASS] - Cache-key is case sensitive, assert True
   [PASS] - Cache-Key spans hostnames, assert True
   [PASS] - Compression Check: requested identity, received identity
   [PASS] - Compression Check: requested gzip, received gzip
   [PASS] - Compression Check: requested gzip,deflate, received gzip
   [PASS] - Compression Check: requested deflate, received identity
   [PASS] - Access-Control-Allow-Origin: * matched expected
   [PASS] - Context specific header Timing-Allow-Origin: * matches expe
   [PASS] - Context specific header Access-Control-Expose-Headers: X-CD
   [PASS] - Edge Cache-Control honors Origin Cache-Control, asserted Tr
   [PASS] - If-Modified-Since after Last-Modified, asserted True
   [PASS] - If-Modified-Since equals Last-Modified, asserted True
   [PASS] - If-Modified-Since before Last-Modified, asserted True
```

- SSL certificate
- Caching headers
- Compression
- honors origin cache headers

Purge Tool



- Self service
- Purge status tracking
- 5 minute SLA for site-wide purge

Synthetic Monitoring | Catchpoint @ LinkedIn

- Mo

ser

- Cre

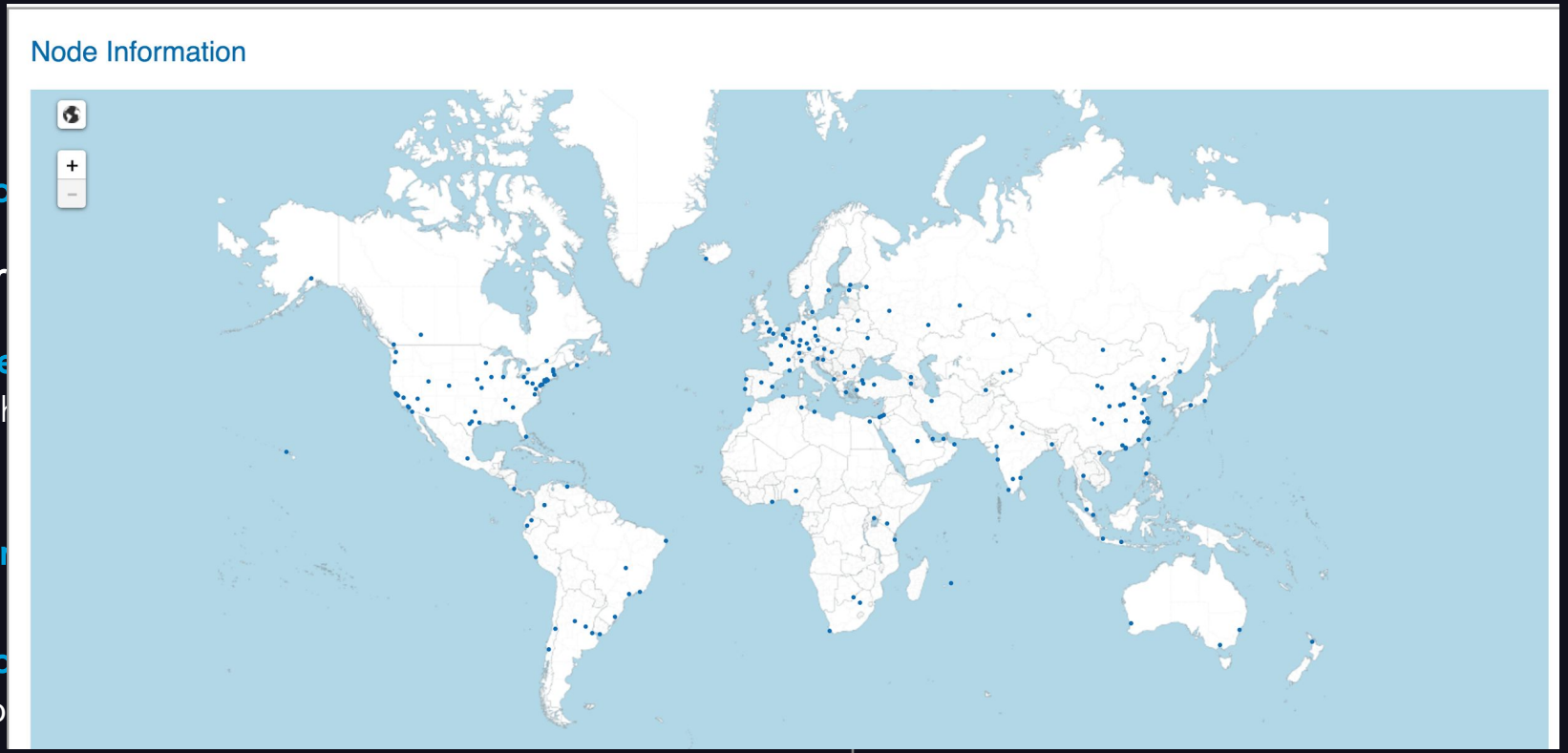
beh

an

- Per

. Tro

plo

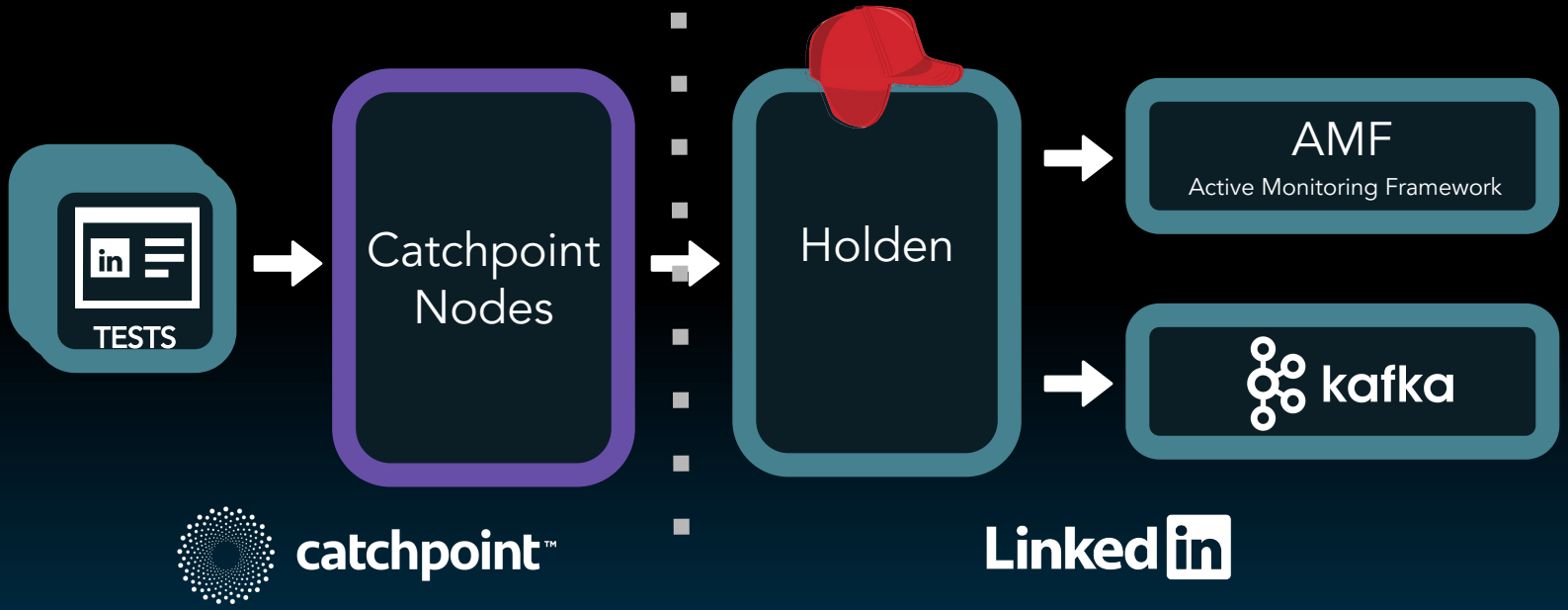


Synthetic Monitoring
Akamai vs Edgecast

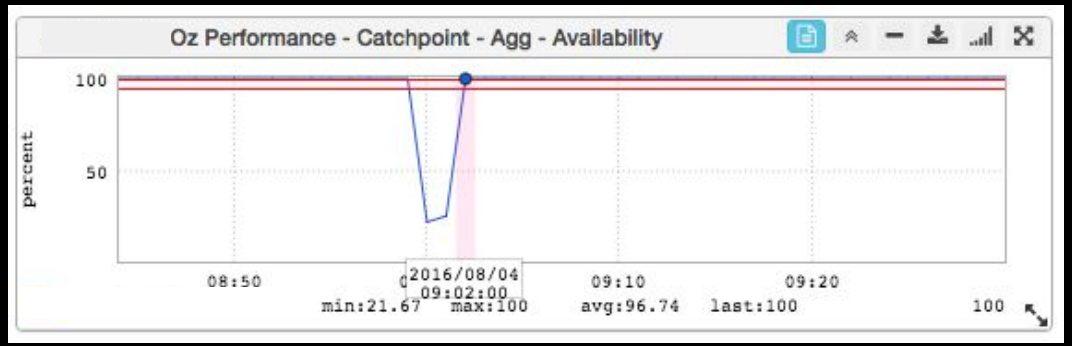
Chart Summary | Chart Data

Breakdown 1	95 Percentile	Median	Geometrical Mean	# Runs
Akamai - HTTPS - IPv4 - APAC	9,993.00	7,268.00	7,380.04	65
Edgecast - HTTPS - IPv4 - APAC	10,223.00	7,033.00	7,332.73	64

Catchpoint ➡ LinkedIn



Synthetic Monitoring
Holden - CDN Availability



- Catchpoint Push API scales better
- Reduced time to detect issues
- Reduced time to recover from issues

Closing thoughts

Closing thoughts

- Build even more POPs

Closing thoughts

- Build even more POPs
- Don't depend on one provider

Closing thoughts

- Build even more POPs
- Don't depend on one provider
- Regionalize & reevaluate your vendors

Closing thoughts

- Build even more POPs
- Don't depend on one provider
- Regionalize & reevaluate your vendors
- Clients are your measurement agents

Closing thoughts

- Build even more POPs
- Don't depend on one provider
- Regionalize & reevaluate your vendors
- Clients are your measurement agents
- Don’t stop your analysis

Closing thoughts

- Build even more POPs
- Don't depend on one provider
- Regionalize & reevaluate your vendors
- Clients are your measurement agents
- Don’t stop your analysis
- Automate when you onboard itself

ANY
QUESTIONS
?