

AWS Summits

2014



Dynamic Content Acceleration:
Lightning-Fast Web Apps with
Amazon CloudFront and
Amazon Route 53

Constantin Gonzalez, Solutions Architect
Amazon Web Services Germany GmbH



Any Web Application Must Have...

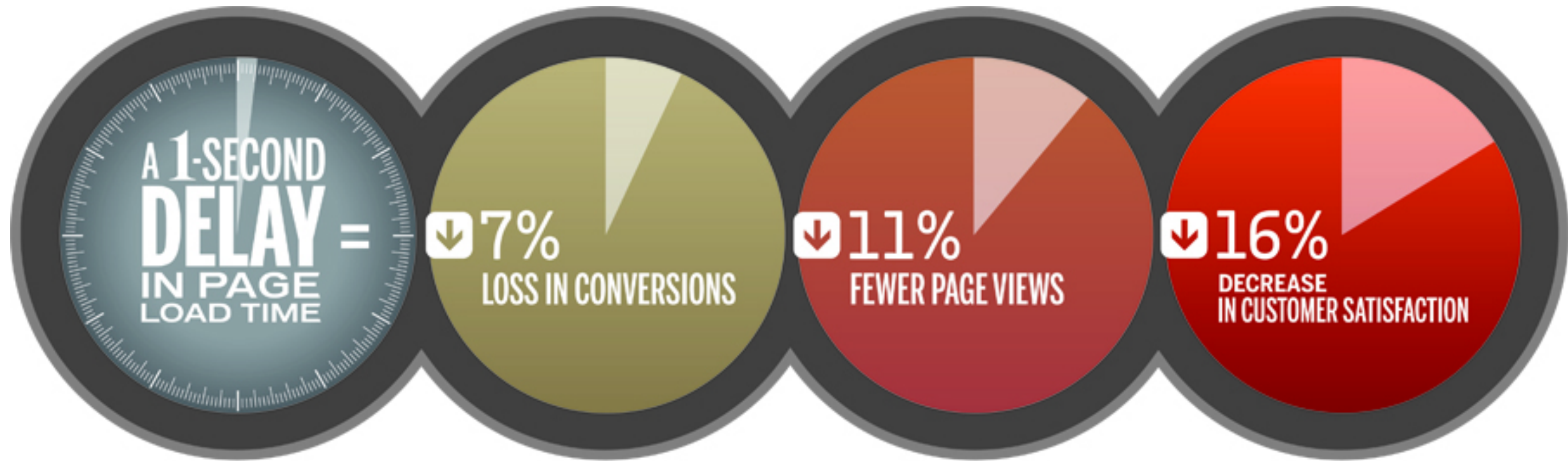
- Tight Security
- High Availability
- **High Performance**

Why Does Performance Matter?

- More Page Views
- Better Customer Experience
- Higher Conversion Rates



How Much Does Performance Matter?



IN DOLLAR TERMS,

this means that if your site typically earns \$100,000 a day, this year

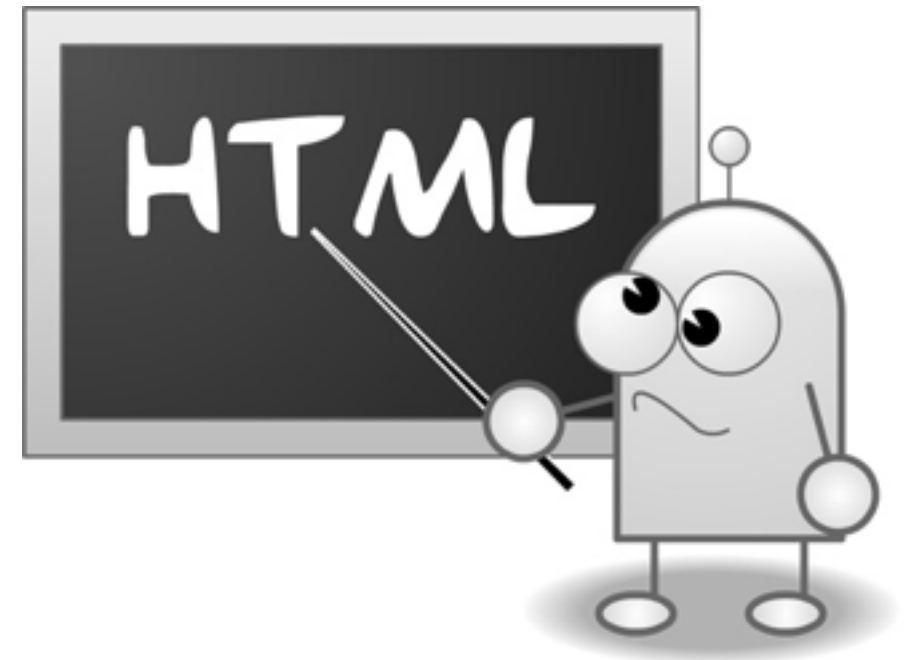
you could lose **\$2.5 MILLION** in sales.

SOURCE: Aberdeen Group

 **strangeloop** www.strangeloopnetworks.com

Where Does Performance Matter?

80%
of the end user
latency
comes from the
front-end



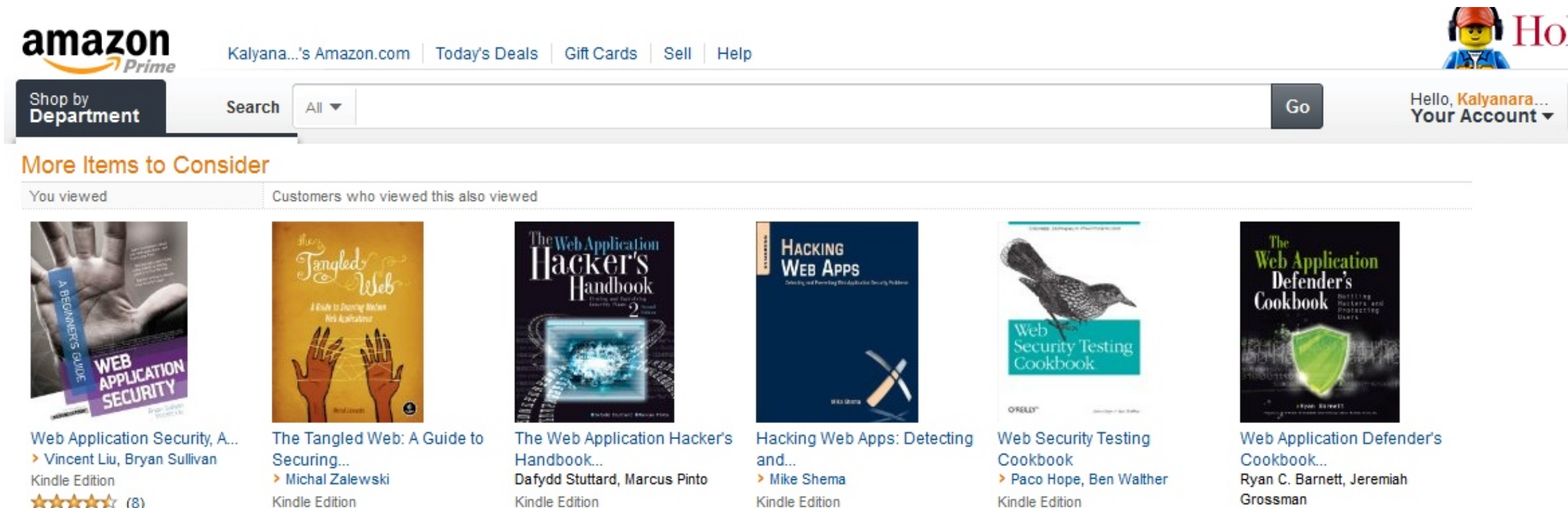
How to Improve Performance?

A Typical Web Application Has ...

- **Static or Re-Usable Content**
- **Dynamic or Unique Content**

Static or Re-Usable Content

Can be cached (high TTLs or low TTLs)



The screenshot shows the Amazon website interface. At the top, the Amazon Prime logo is on the left, and navigation links for 'Kalyana...s Amazon.com', 'Today's Deals', 'Gift Cards', 'Sell', and 'Help' are in the center. On the right, there's a user profile icon and the text 'Hello, Kalyanara... Your Account'. Below the navigation bar is a search bar with a 'Go' button. Underneath the search bar, there's a section titled 'More Items to Consider' with two tabs: 'You viewed' and 'Customers who viewed this also viewed'. The 'Customers who viewed this also viewed' tab is active, displaying six book covers related to web application security. Each book cover is accompanied by its title, author(s), and format (Kindle Edition).

amazon Prime

Kalyana...s Amazon.com | Today's Deals | Gift Cards | Sell | Help

Shop by Department Search All ▼ Go Hello, Kalyanara... Your Account ▼

More Items to Consider

You viewed Customers who viewed this also viewed

Web Application Security, A...
▶ Vincent Liu, Bryan Sullivan
Kindle Edition
★★★★★ (8)

The Tangled Web: A Guide to Securing...
▶ Michal Zalewski
Kindle Edition

The Web Application Hacker's Handbook...
Dafydd Stuttard, Marcus Pinto
Kindle Edition

Hacking Web Apps: Detecting and...
▶ Mike Shema
Kindle Edition

Web Security Testing Cookbook
▶ Paco Hope, Ben Walther
Kindle Edition

Web Application Defender's Cookbook...
Ryan C. Barnett, Jeremiah Grossman



CSS

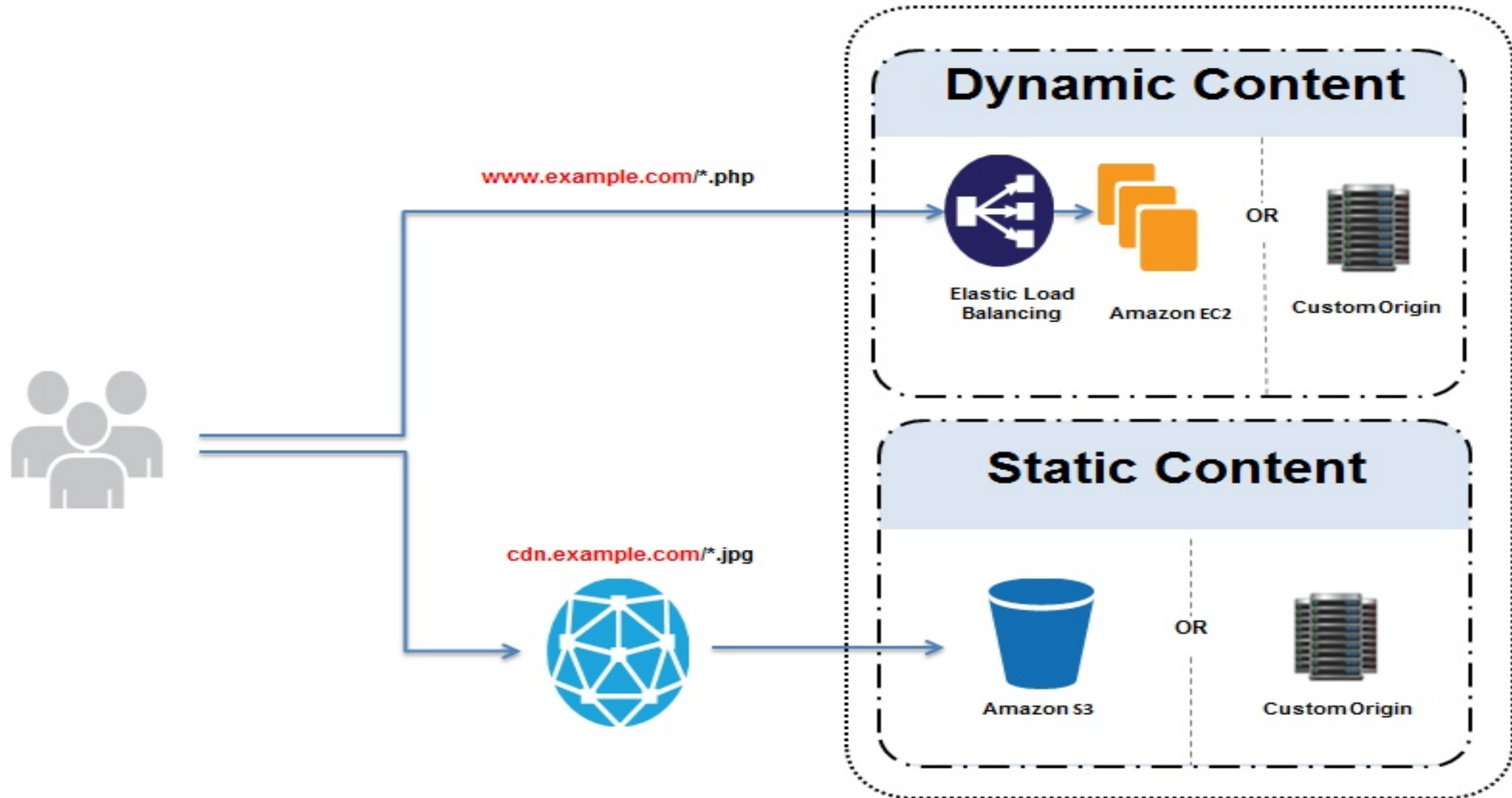


JavaScript



HTML

Typical Architecture

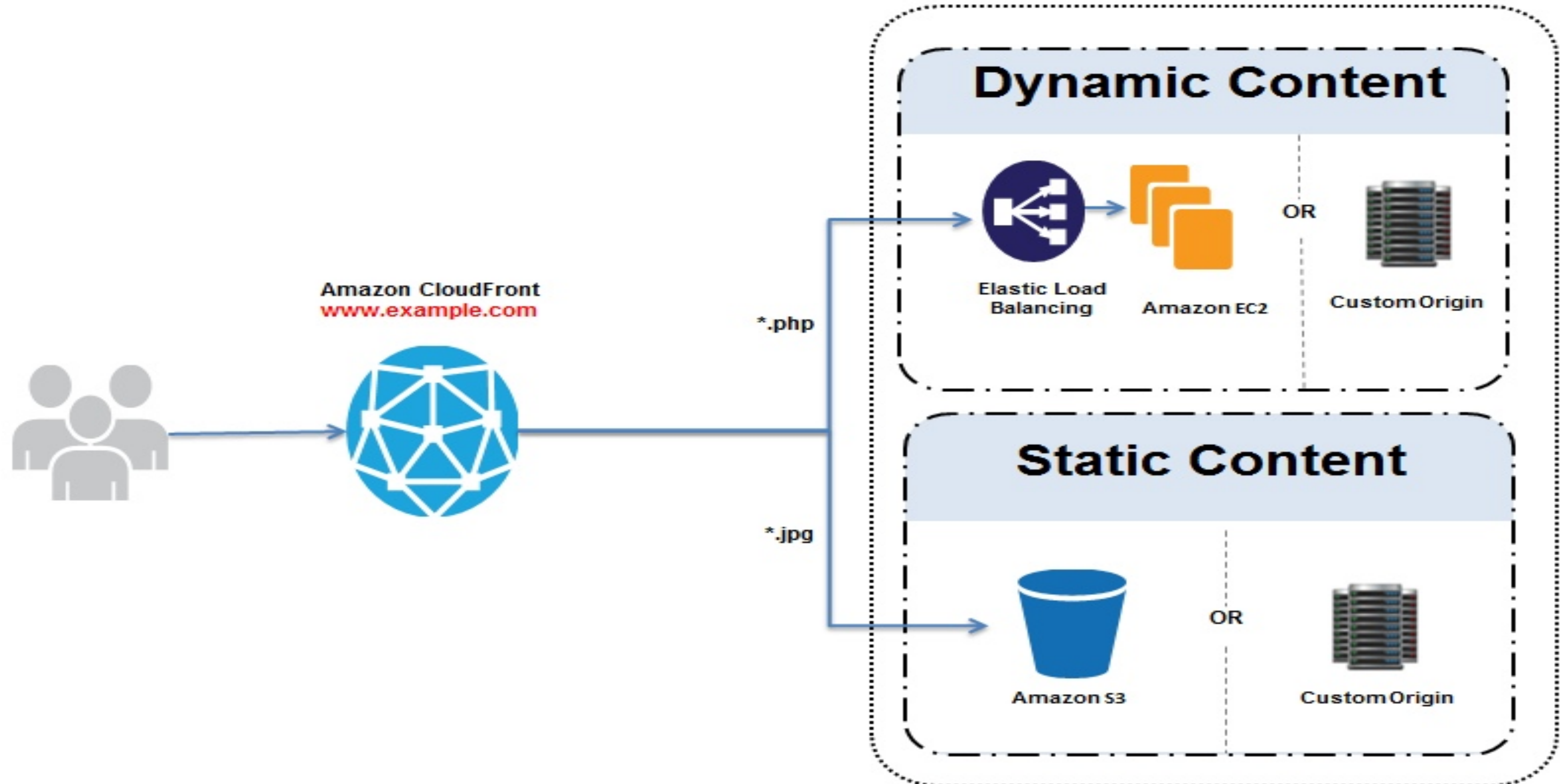


Dynamic or Unique Content

Cannot be cached – but affects 100% of your viewers!



Why Not...?



How Can Amazon CloudFront Help?

- **TCP/IP optimizations** for the network path
- **Keep-Alive connections** to reduce RTT
- **SSL termination** close to viewers
- **POST/PUT upload optimizations**
- **Latency Based Routing**
- **Low prices**, same as static content delivery!



Unique or Reusable Content?



Static or Reusable

Content that does **not** change for a given period of time



Dynamic or Unique


Content that **changes** as soon as it is created



Example


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Example

Index.jsp (dynamic)

Images (static)


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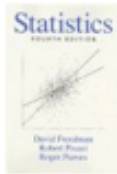

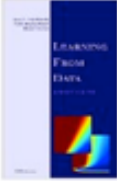
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Example

1.5 sec


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Pattern Recognition and Machine Learning
Christopher M. Bishop

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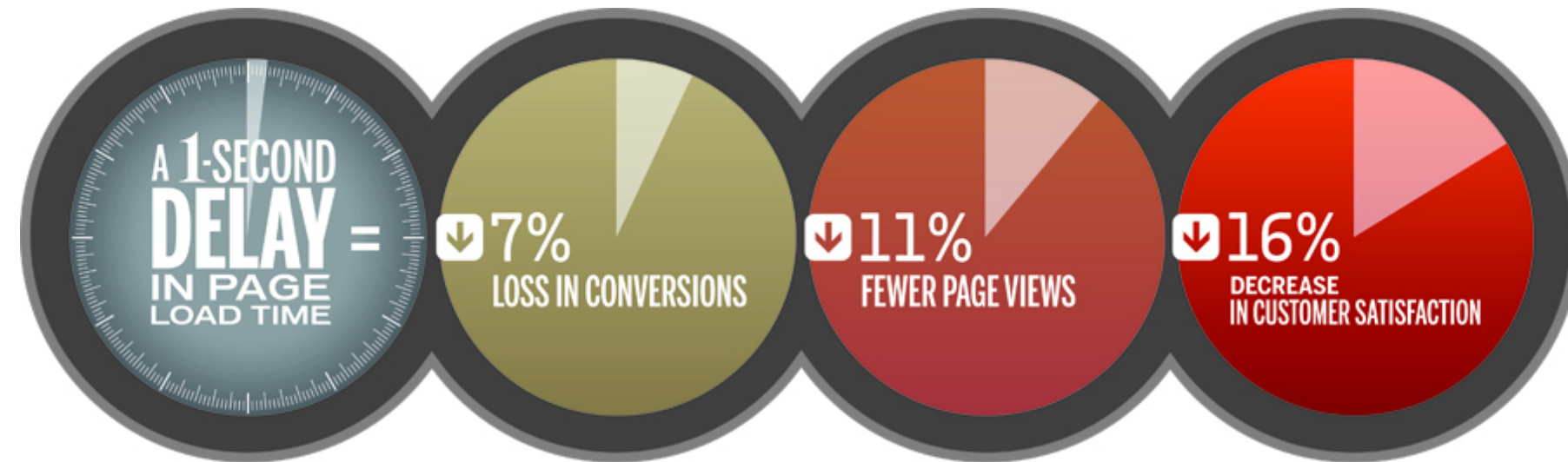
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Learning From Data
Elaine R. Steinberg

Page Load Time?

1.5 sec



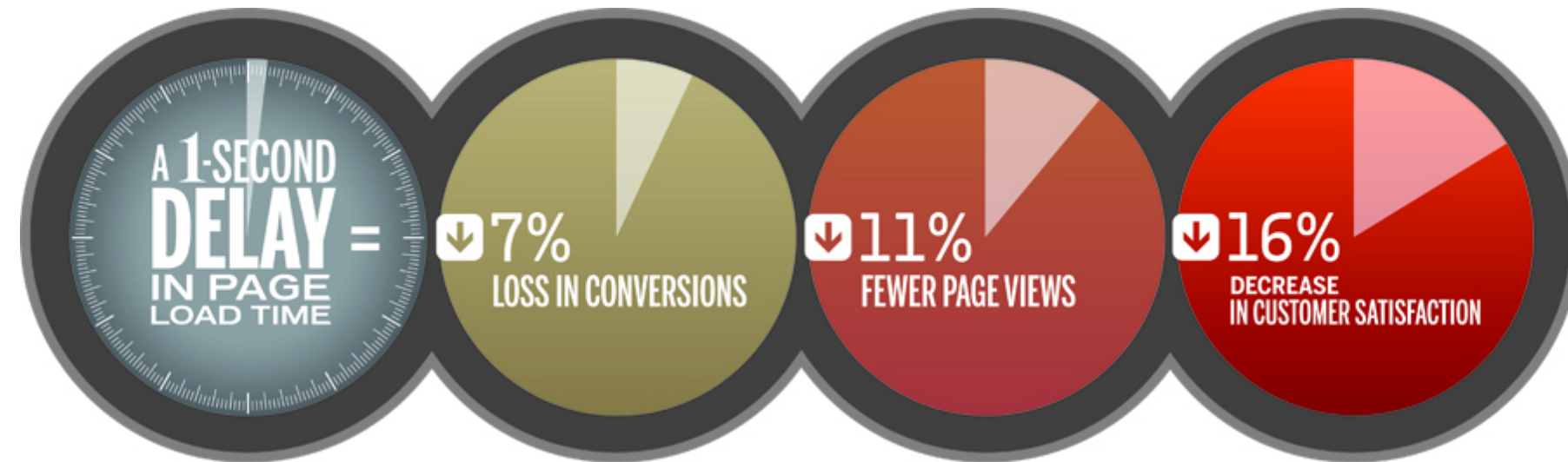
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SOURCE: Aberdeen Group

 **strangeloop** www.strangeloopnetworks.com

Goal:

0.5 sec



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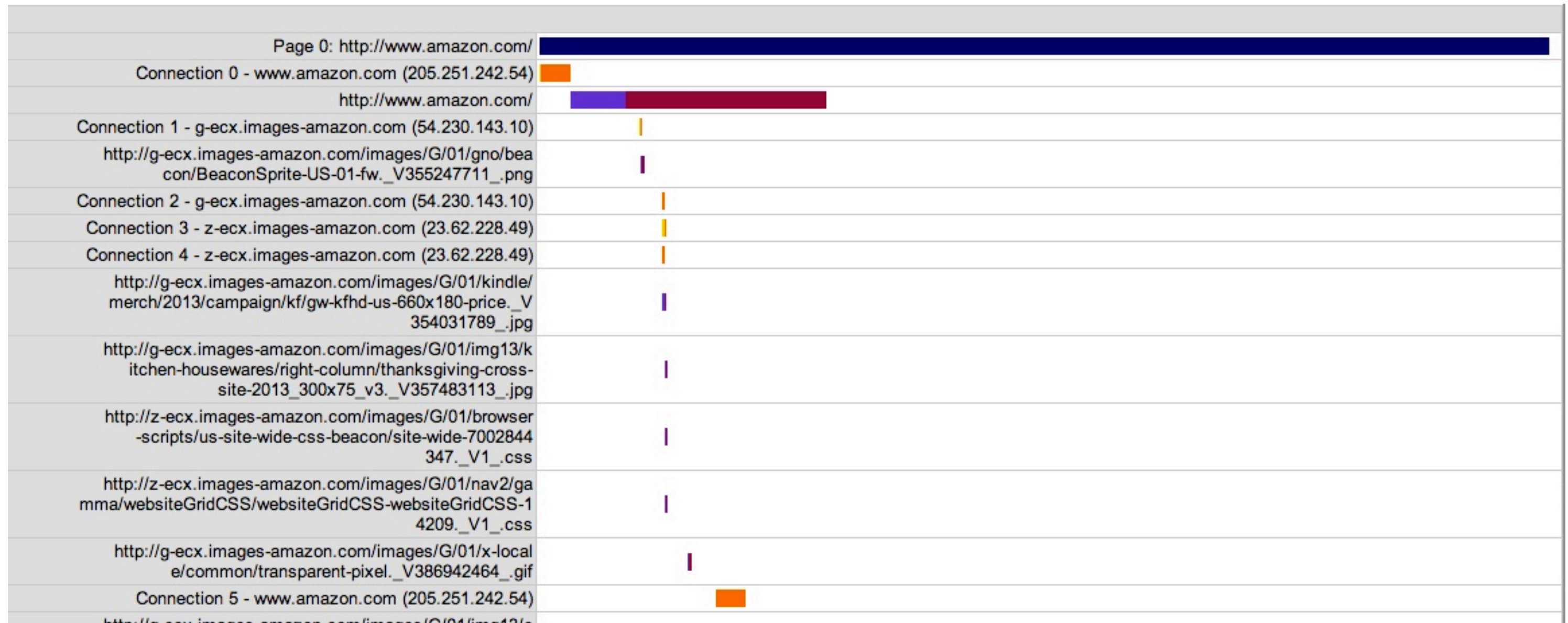
SOURCE: Aberdeen Group

 **strangeloop** www.strangeloopnetworks.com

Introduction to Waterfall Graphs

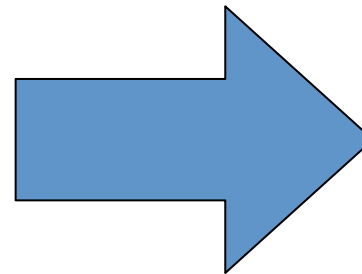
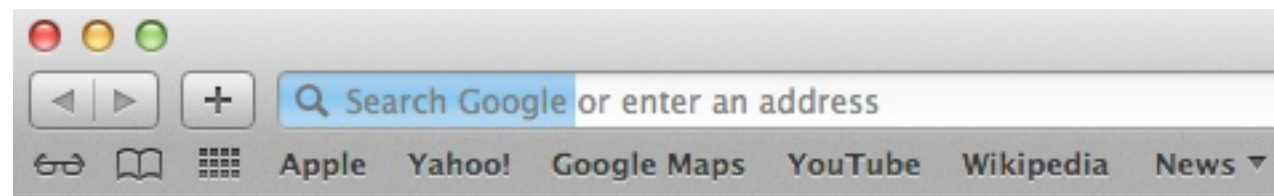


Waterfall Graphs

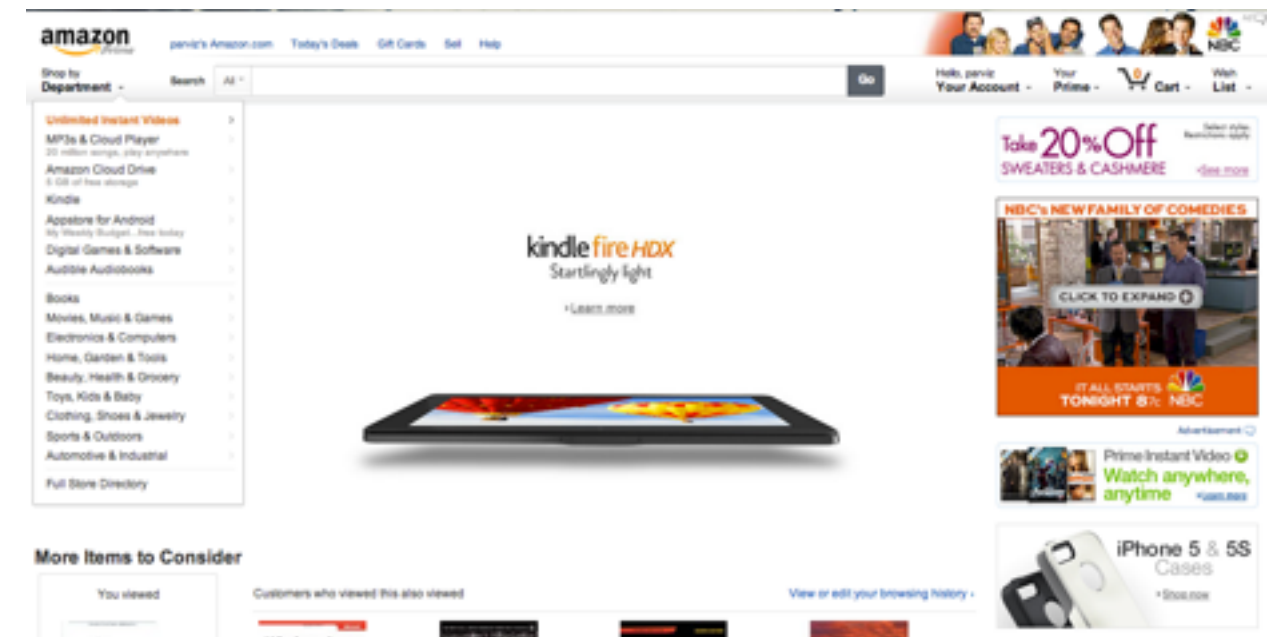


What Happens?

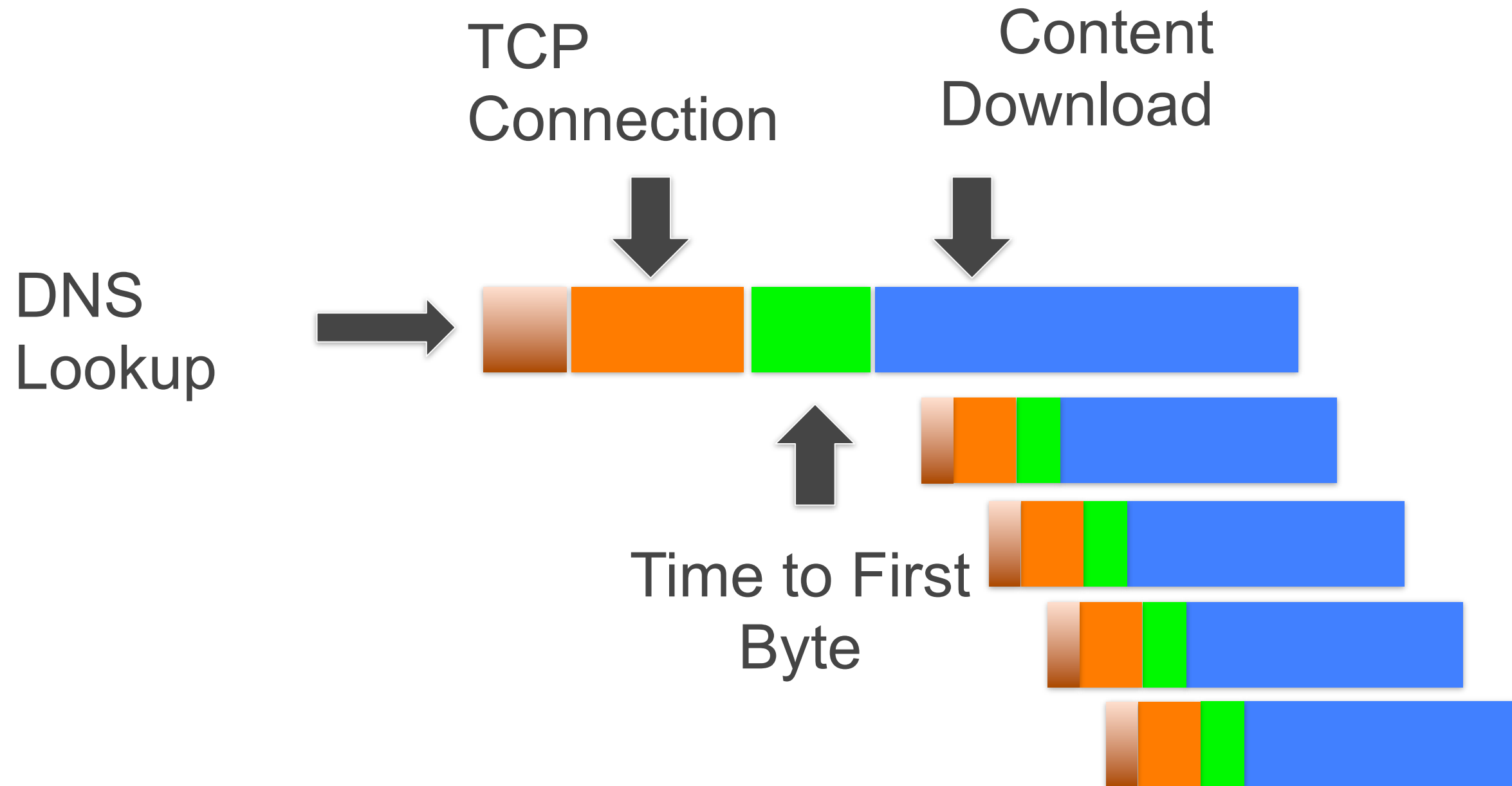
Typing the address



Browser renders



Understanding Waterfall Graphs



Understanding Waterfall Graphs


Index.jsp

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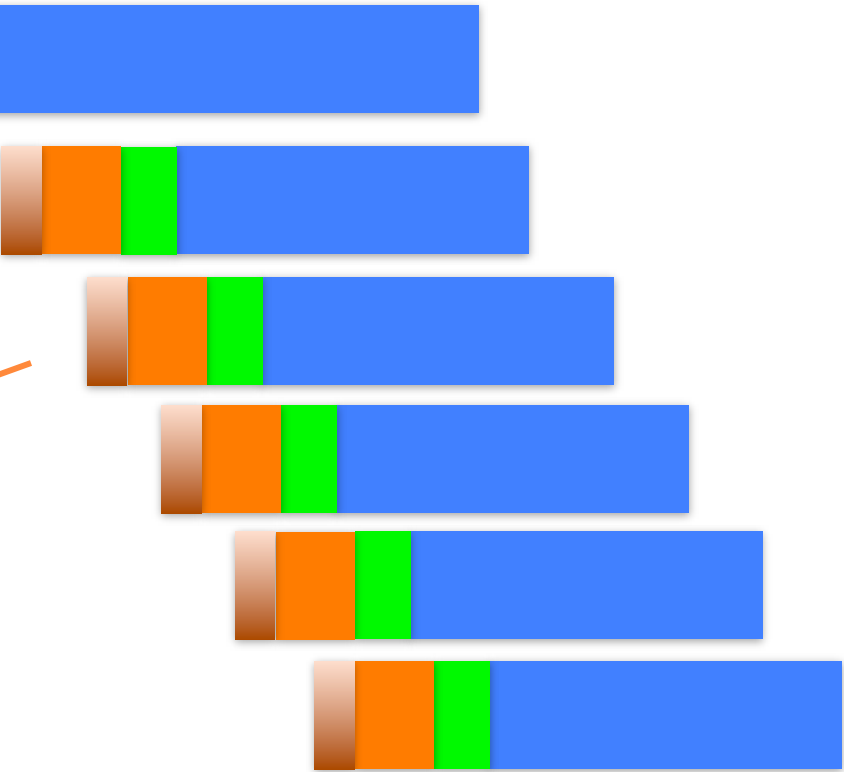
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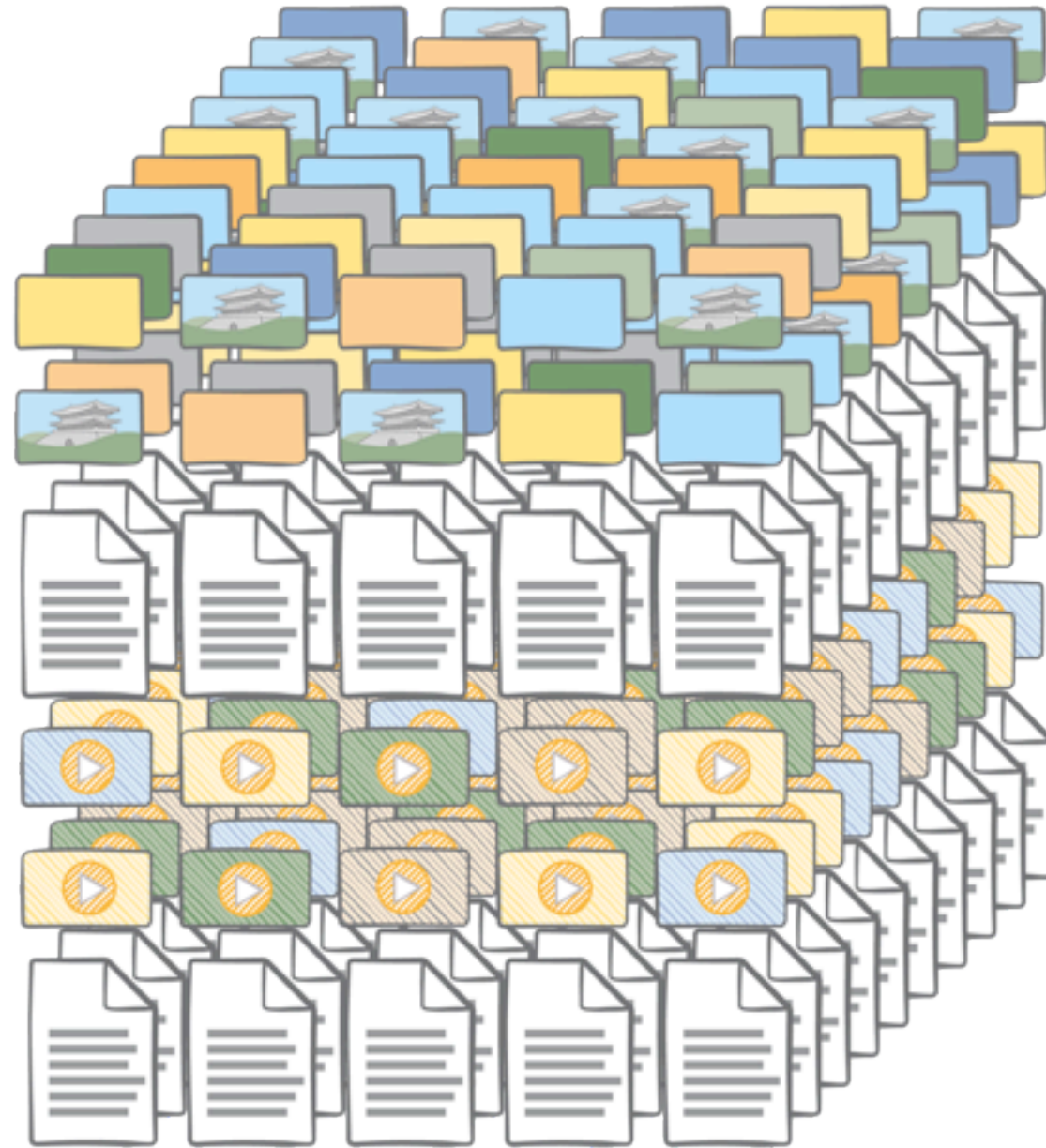
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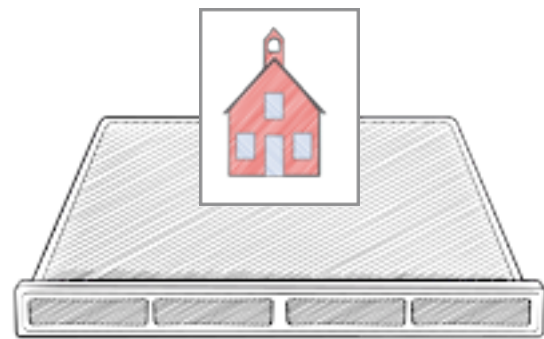




Optimizing Static Content



Caching



Origin

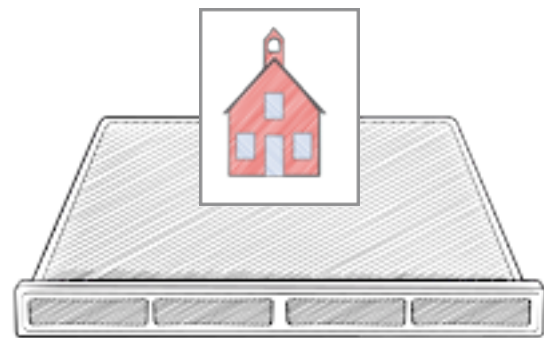


Edge Location



User Request A

Caching



Origin

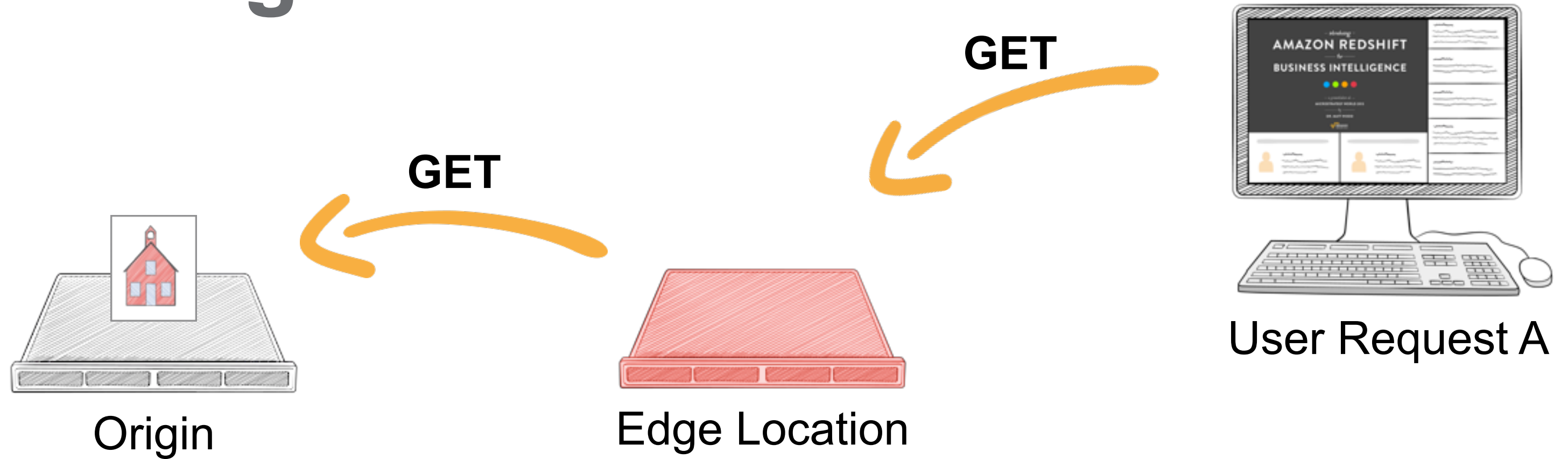


Edge Location

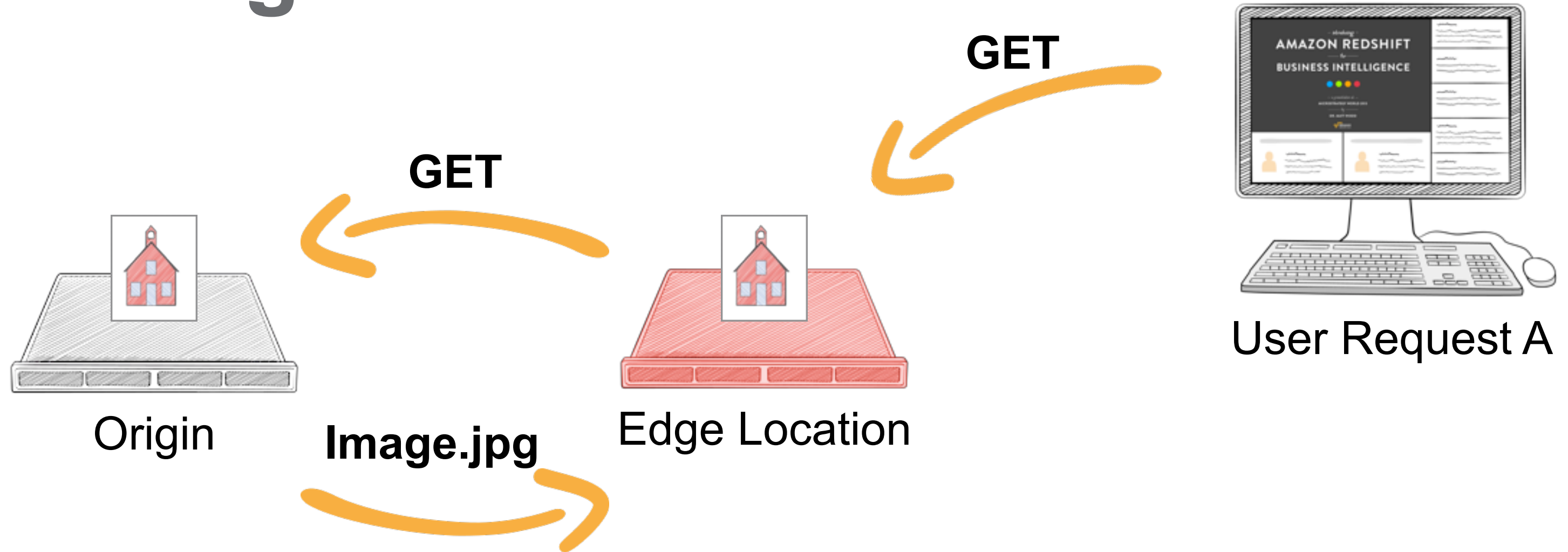


User Request A

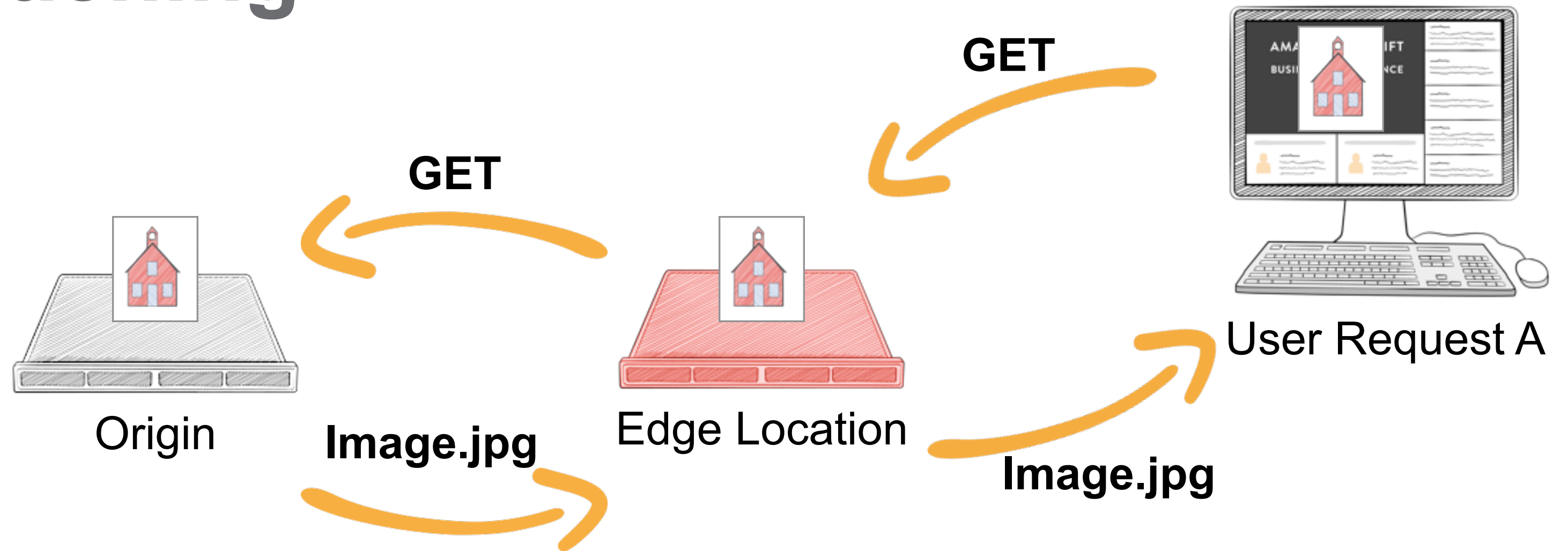
Caching



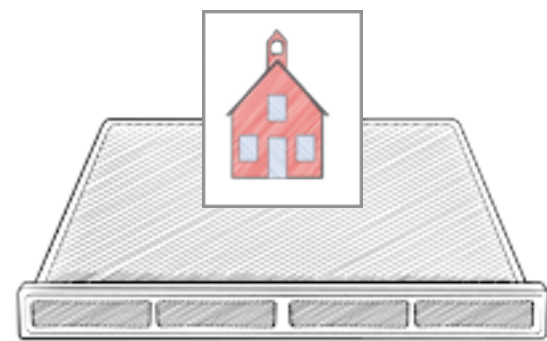
Caching



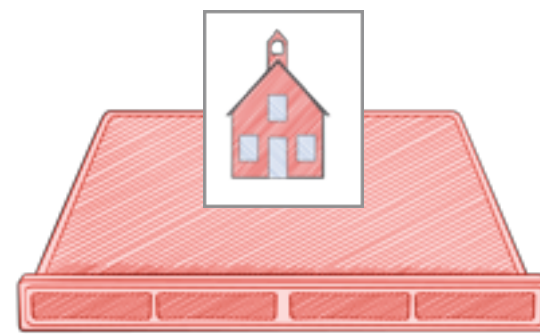
Caching



Caching



Origin



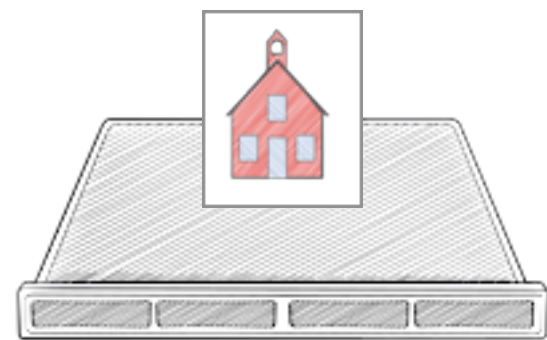
Edge Location

GET

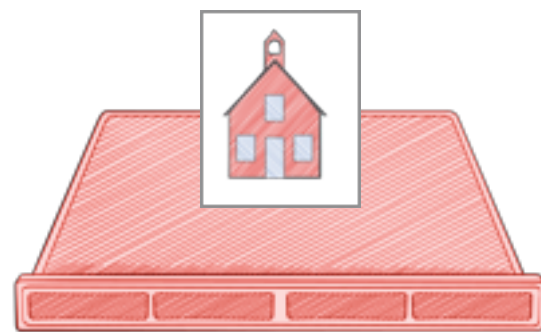


User Request B

Caching



Origin



Edge Location

GET

Image.jpg



User Request B

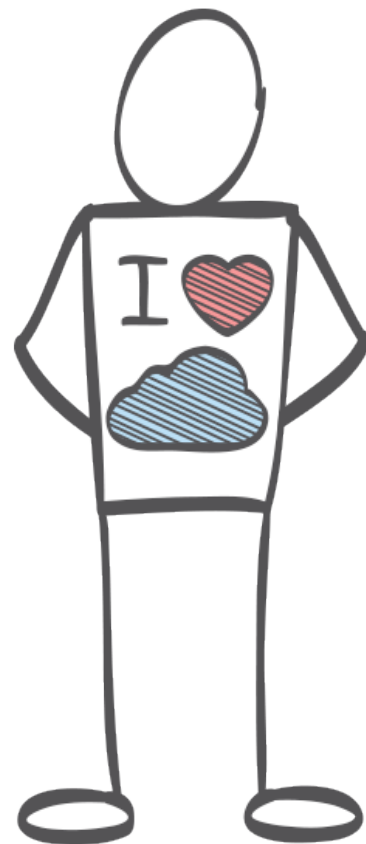
Optimizing Static Content with Caching

- **Brings Content Closer to Your Users**



Optimizing Static Content with Caching

- Brings Content Closer to Your Users
- **Improves Experience and Performance**



Optimizing Static Content with Caching

- Brings Content Closer to Your Users
- Improves Experience and Performance
- **Offloads Your Infrastructure**



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Alexander D. McWilliam
Director Software Development
Berlin Phil Media GmbH

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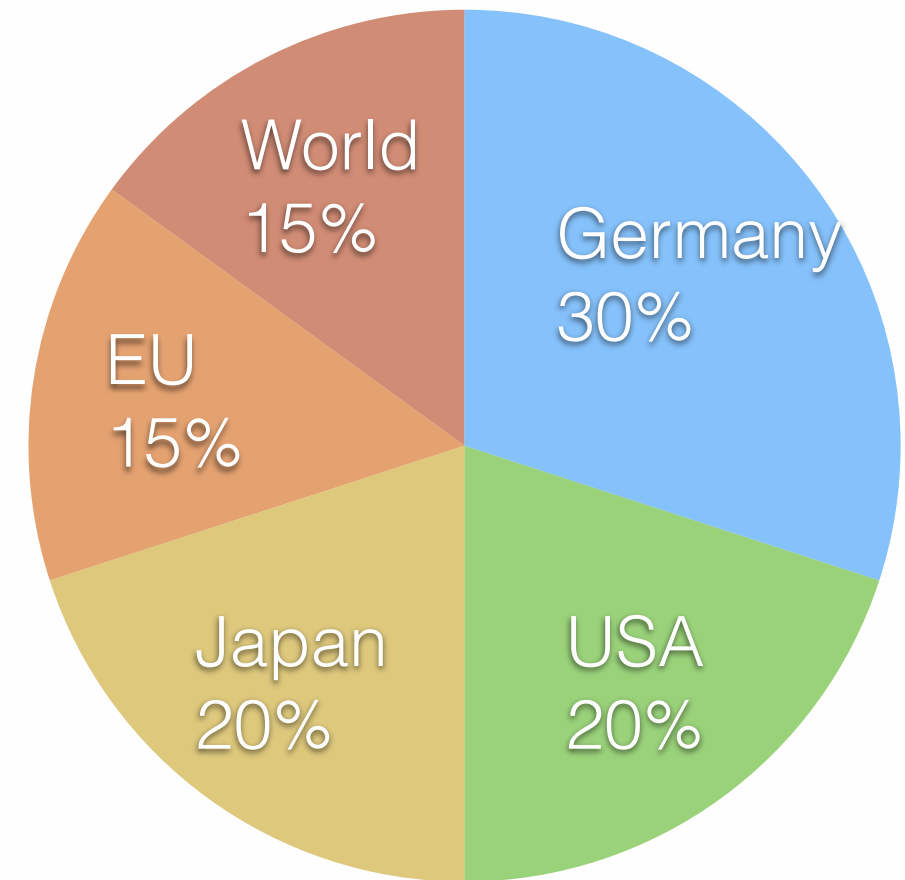






Our Audience

- 400,000 registered users
- from 100 different countries
- aged 18 to 88



Our Content

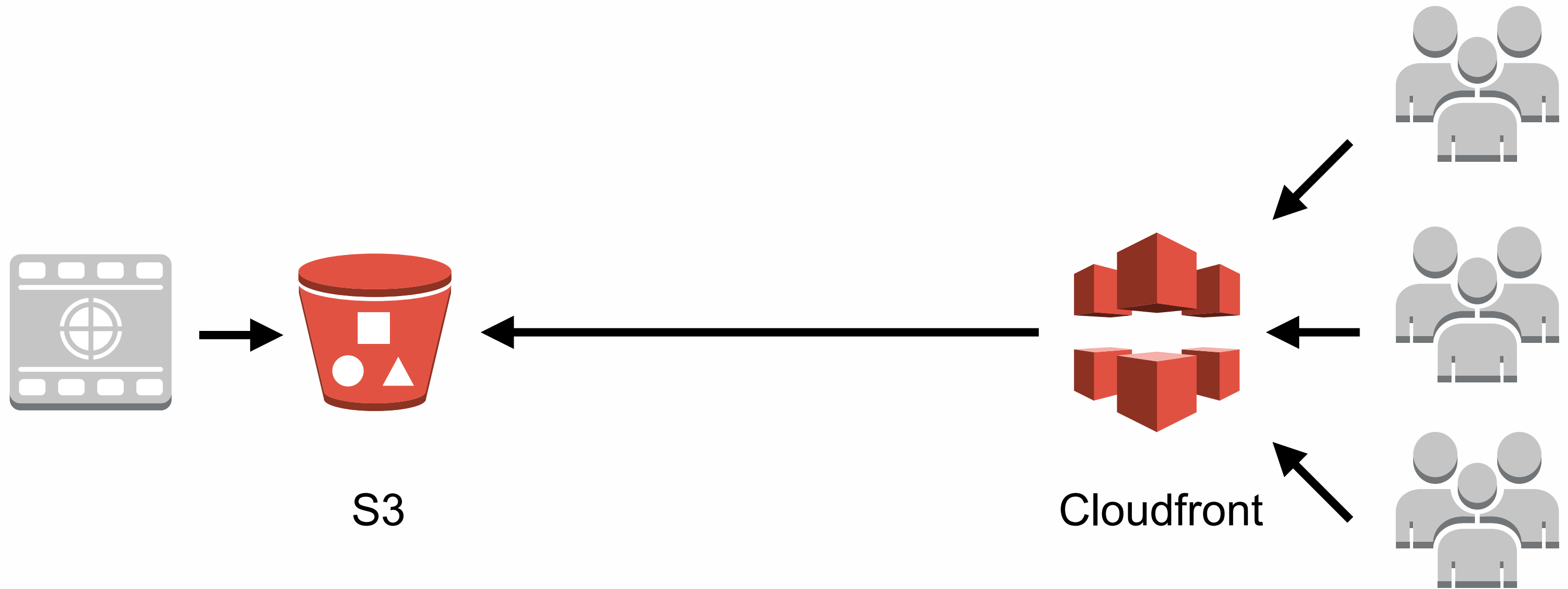
- 8 bit rates up to 2,500 kbps
- 100 terabytes of video traffic per month
- 2.5 terabytes of video library storage
- Delivery via HLS and progressive download

Other CDNs vs. Cloudfront

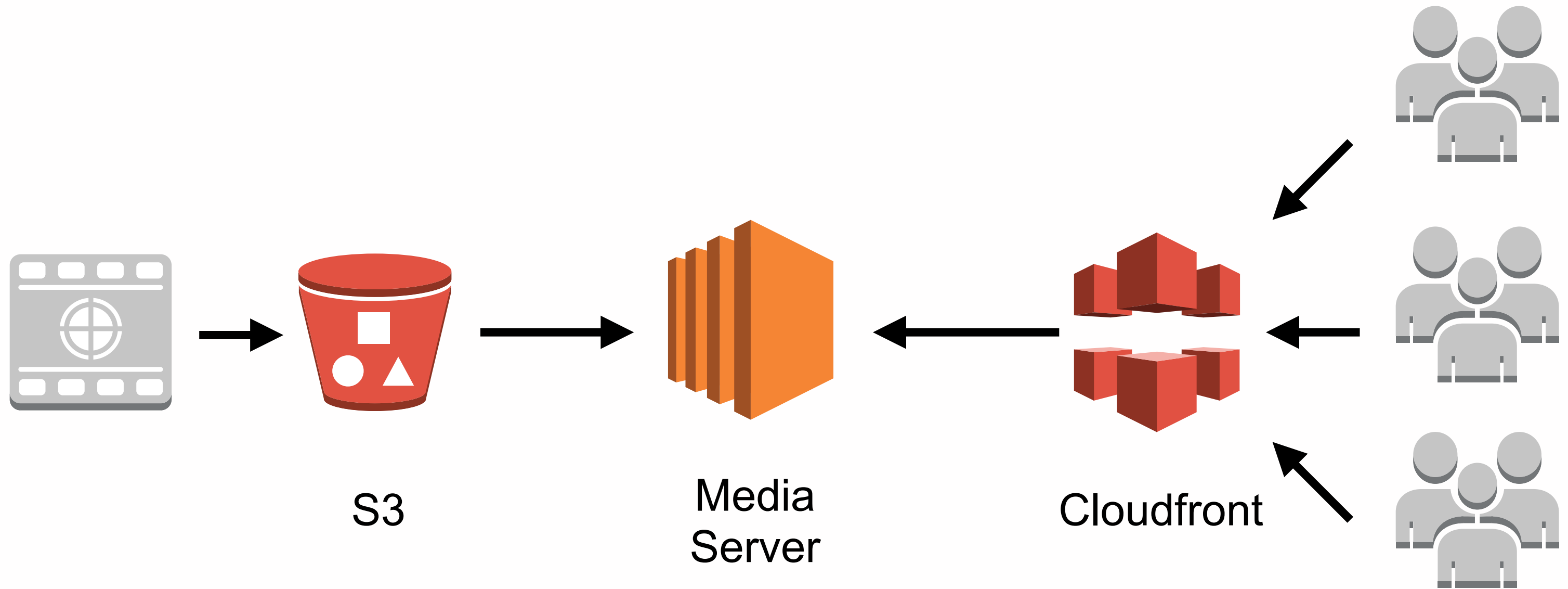
- Always 12-month up front commitments
 - Insufficient caching performance
 - Black box between us and our customers
-
- No commitments
 - *Hopefully* better caching performance
 - Extensive documentation



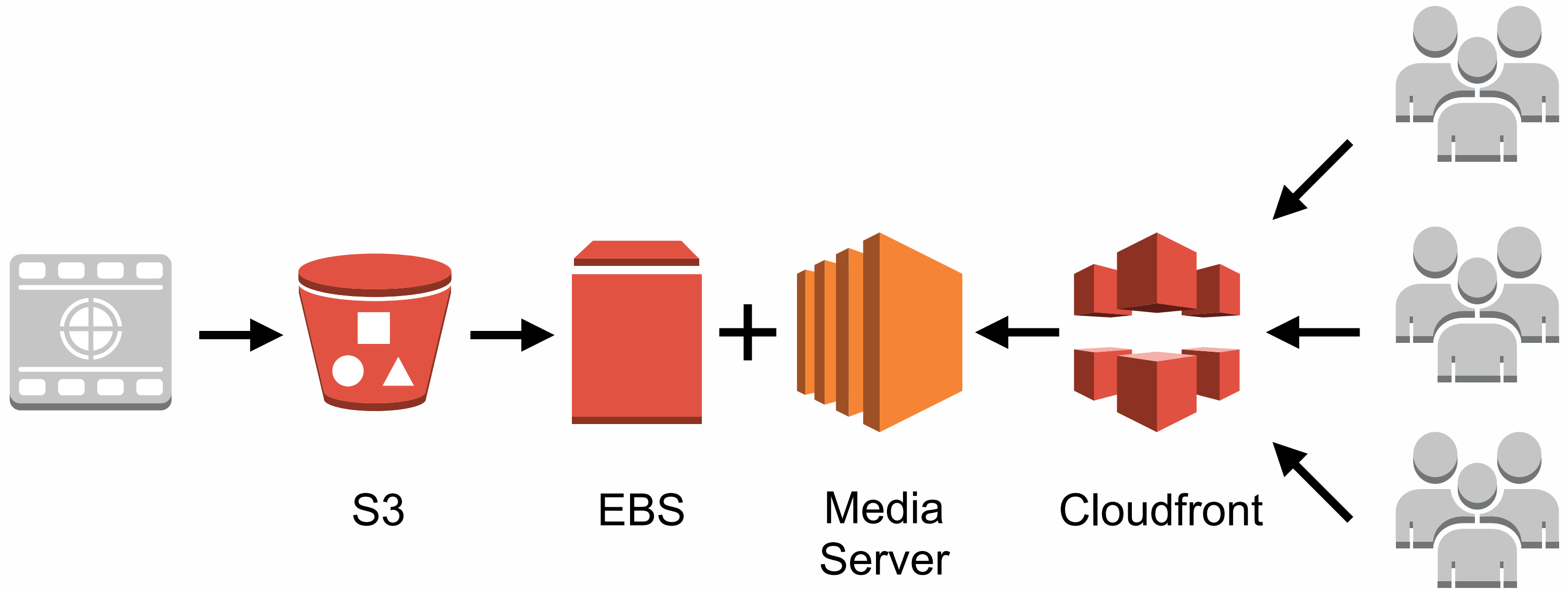
Our First Cloud (progressive download only)



Our Second Cloud (progressive download + streaming)



Our Second Cloud (progressive download + streaming)



Verdict

- Cheaper
- More fun implementing
- **Slightly** better performance

FAIL

Why did it not work?

- We have too **many objects** and too **large objects***
- We have too **few users**
- **dispersed** too far around the planet

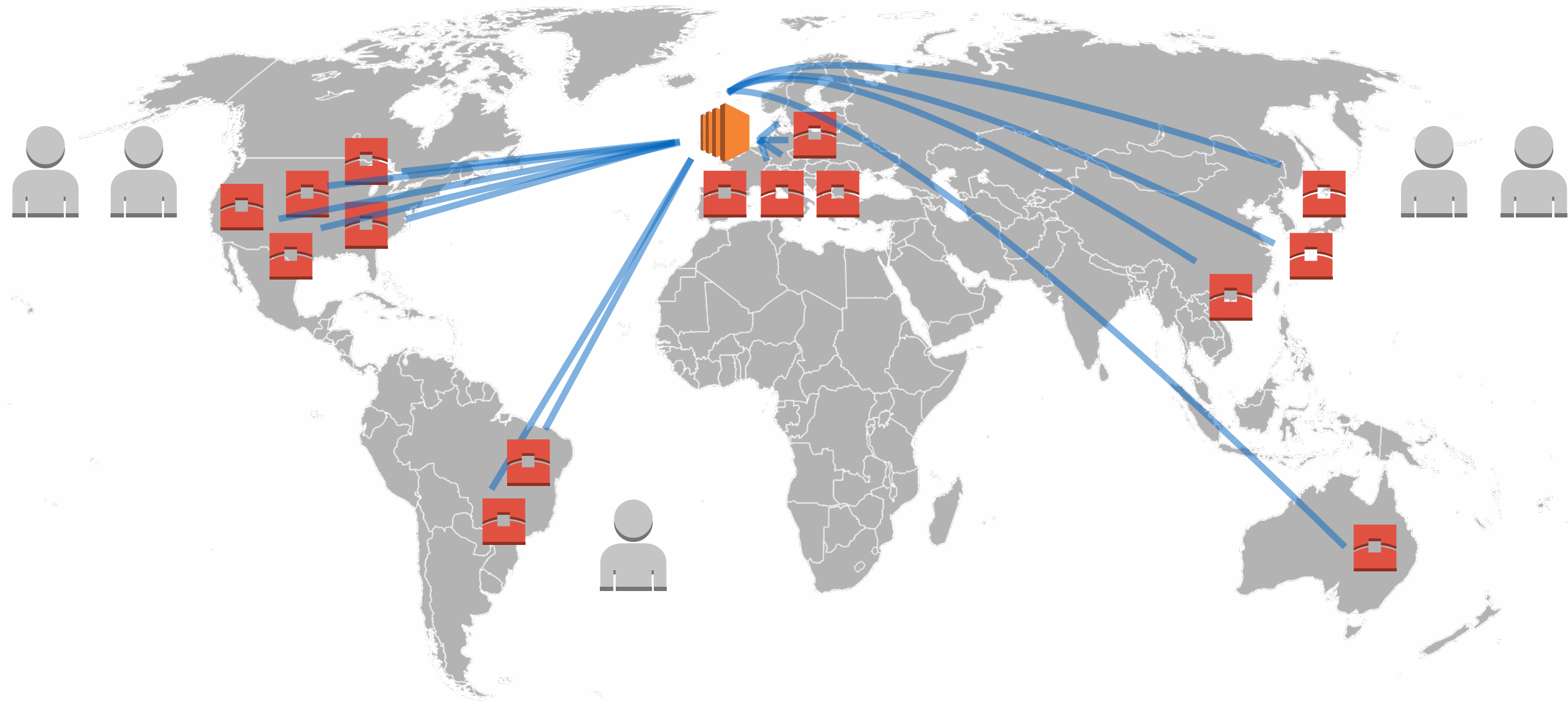
...resulting in too many **CACHE MISSES**.

*HLS: 200,000 different objects / progressive download: objects over 1GB

All CDNs assume that a sufficiently **large number of users** are requesting a sufficiently **small number of objects**.

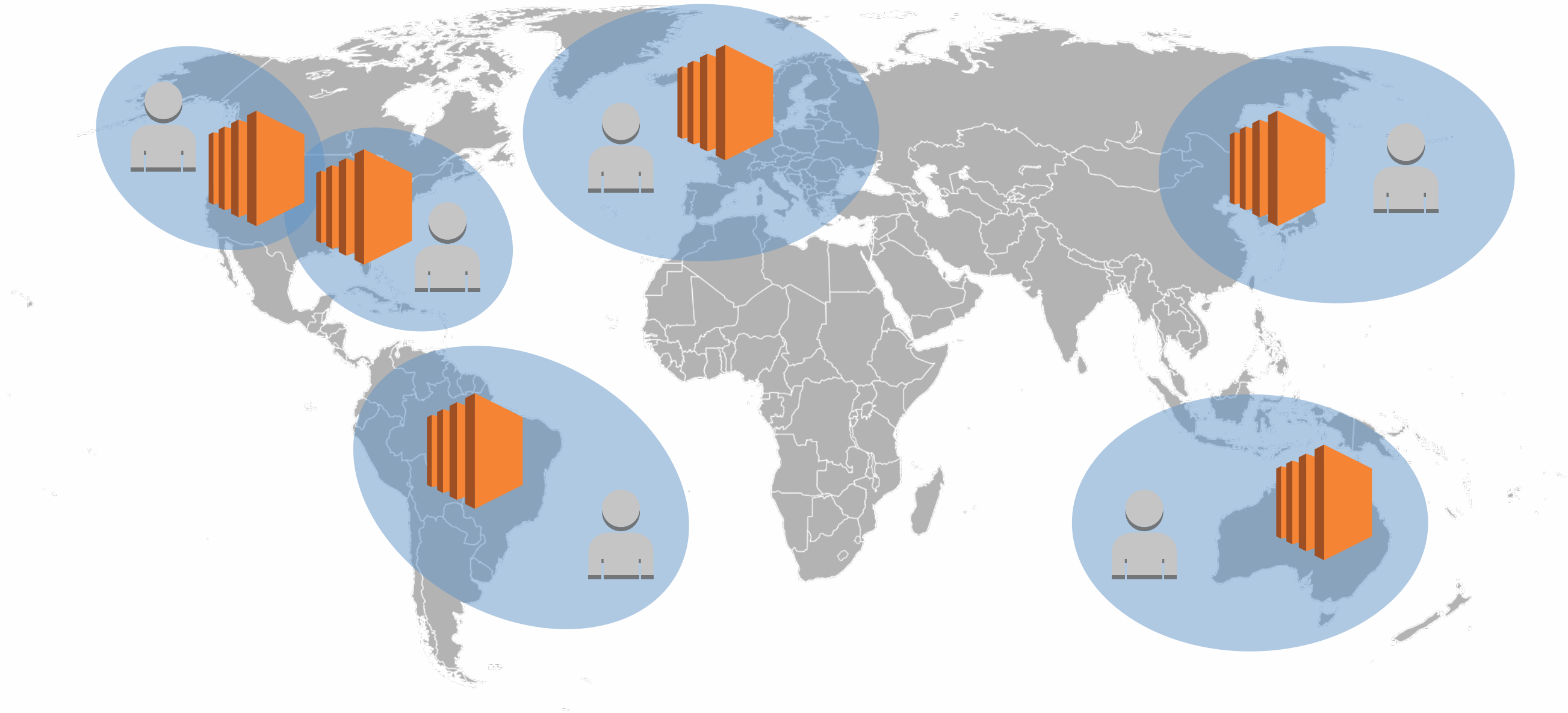
The first user is the pawn.

One origin is not enough



If the user can't come to us
we must go to the user.

Our Third Cloud – with Route53



Challenges

- We had to do our own URL signing with `mod_auth_token`
- We had to copy our library across the world 6x
- We have to keep all regions in sync with S3/Ireland

New verdict



- Not cheaper
- Maximum control
- **Awesome** performance

What about live streaming?



Live streaming with Cloudfront

- We have very **few** and very **small objects***
- We have **a lot of users**
- (still dispersed around the planet)

...resulting in many **CACHE HITS**.



*40 different objects, each under 2 MB

Further employments of Cloudfront

- DONE: static website assets (GFX/CSS/JS)
- DONE: static app content via JSON API
- NEXT: full site acceleration incl. dynamic content



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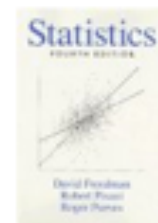
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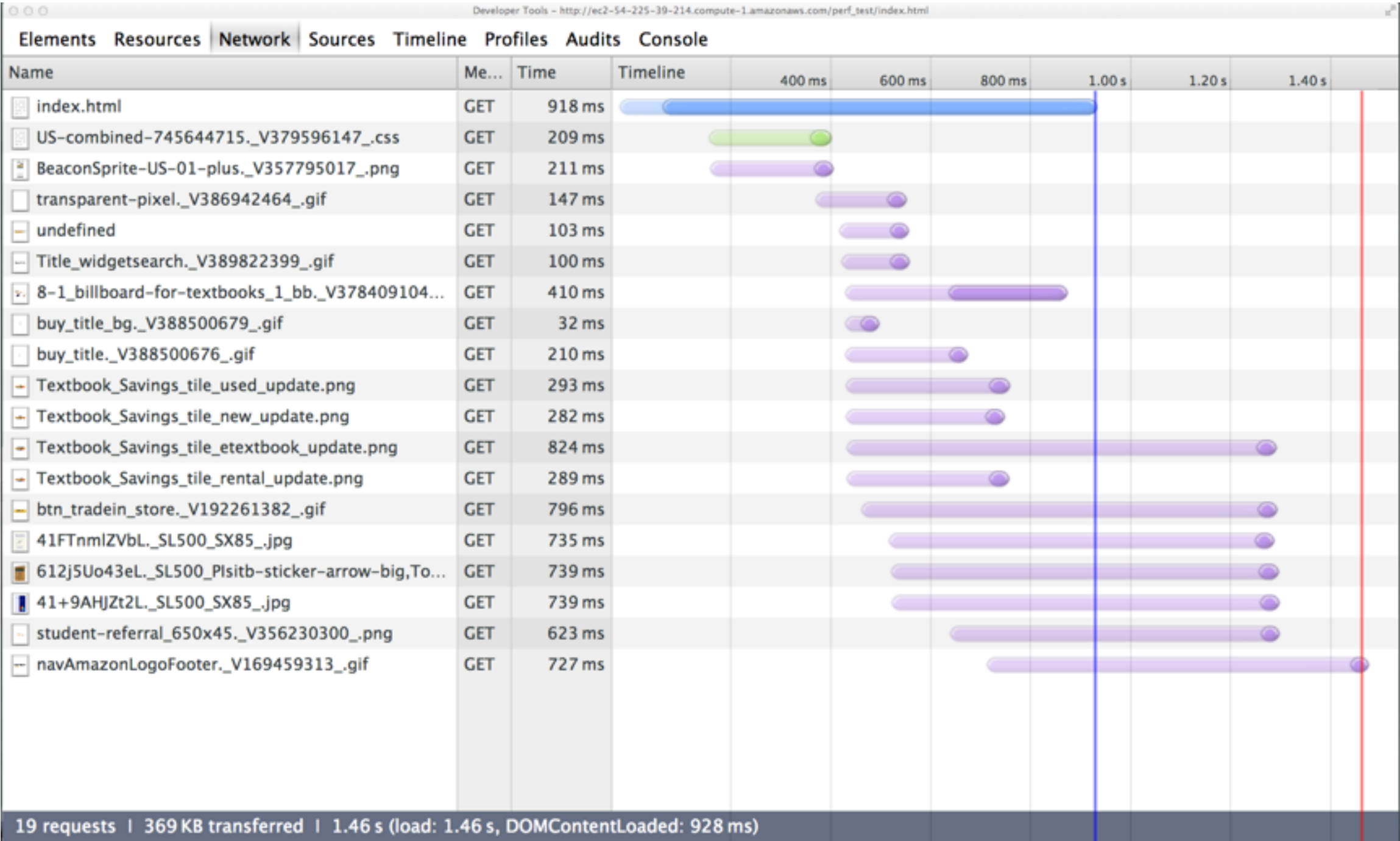
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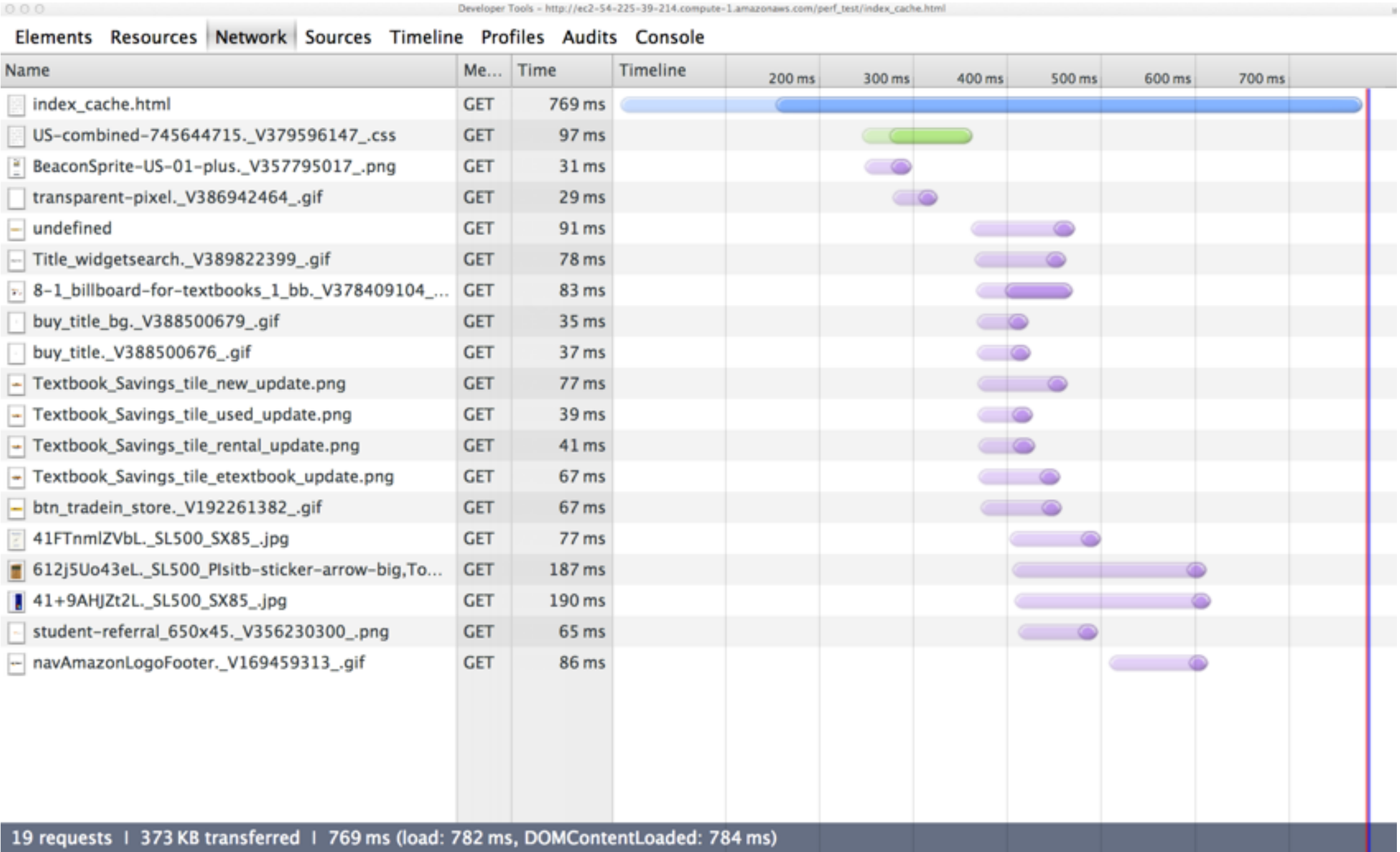
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Before Caching: 1460 ms



After Caching: 770 ms



Goal:



0.5 sec

Cache as Much as You Can!



Cache as Much as You Can!

- Collect Logs From Your Web Tier



Cache as Much as You Can!

- Collect Logs From Your Web Tier
- Run a Report on Your Logs (EMR, RDS, Redshift)
- Identify Top N URLs



220 /index.jsp
✓ 200 /images/book1.gif
✓ 120 /css/style.css
✓ 119 /js/script1.js
110 /factory/create_image?name=book1&size=10x10
100 /api/GetBooks?category=math
90 /api/GetBooks?category=math&lang=spanish
80 /api/GetBooks?top=10

Static or Reusable

Content that does **not** change for a **given period of time**



Static or Reusable

Content that does **not** change for a **given period of time**

CloudFront caches content for **any period of time**:

Hours, Minutes, Seconds



Content with Query Strings

110 /factor/create_image?name=book1&size=10x10

Reusable?

Content with Query Strings

110 /factor/create_image?name=book1&size=10x10

Yes!

- CloudFront can cache content with query strings
- Every unique query string combination is a new object in CloudFront's cache

- 220 /index.jsp
- ✓ 200 /images/book1.gif
- ✓ 120 /css/style.css
- ✓ 119 /js/script1.js
- ✓ 110 /factory/create_image?name=book1&size=10x10
- ✓ 100 /api/GetBooks?category=math
- ✓ 90 /api/GetBooks?category=math&lang=spanish
- ✓ 80 /api/GetBooks?top=10

Why Caching for Smaller Time Units?

1000 /api/GetBooks?top=10

- Example: Read heavy API with 1000 requests per second
- Offload your web-tier from handling 1000 RPS
- Offload your load balancer
- Provision less capacity and reduce cost

How About the Base Page?

220 /index.jsp

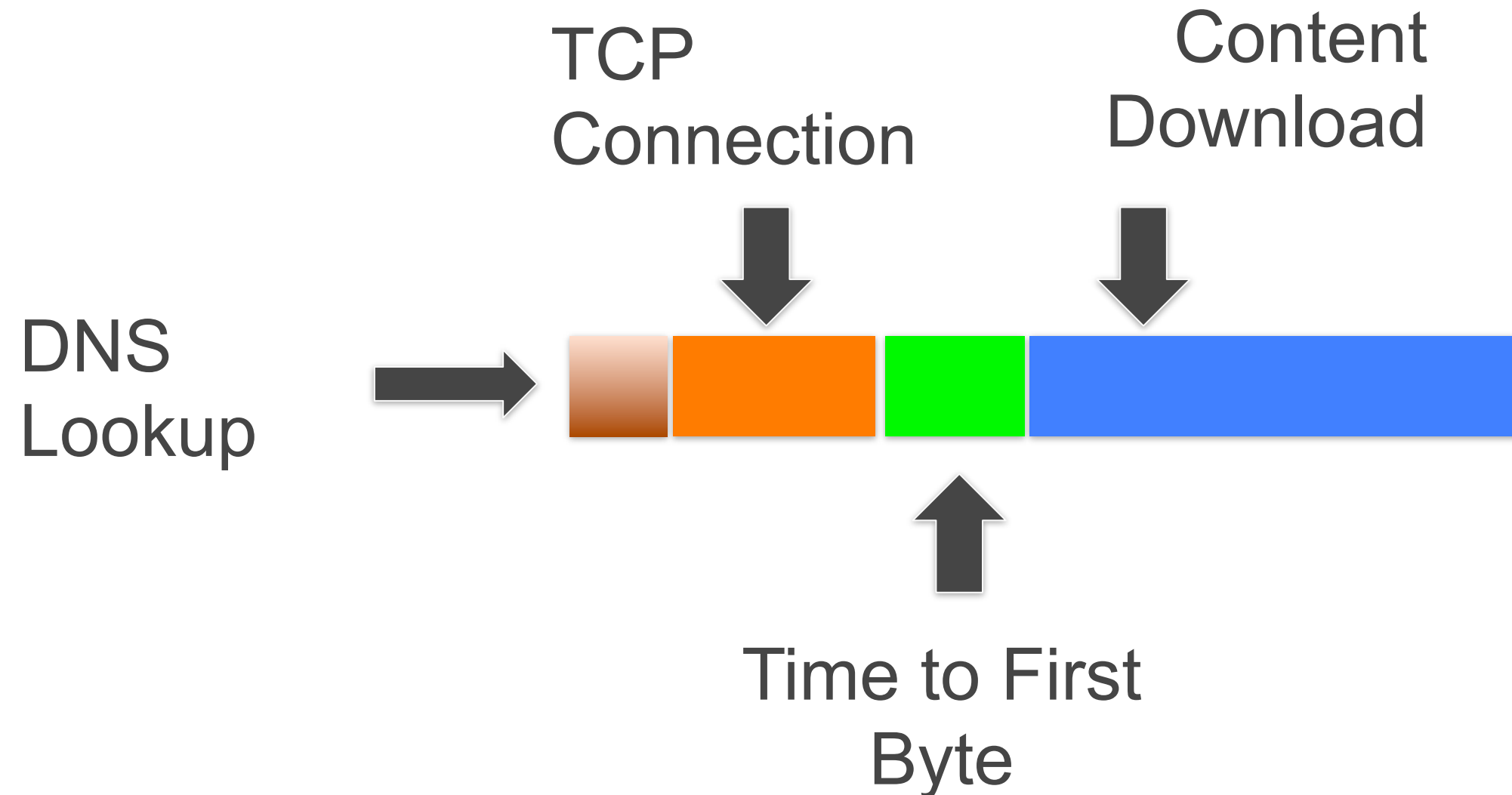
Reusable?

Optimizing Dynamic Content



Response Time

DNS + Connection + First Byte + Content Download



Optimizing Response Time

DNS

Optimizing Response Time

DNS



Amazon Route 53

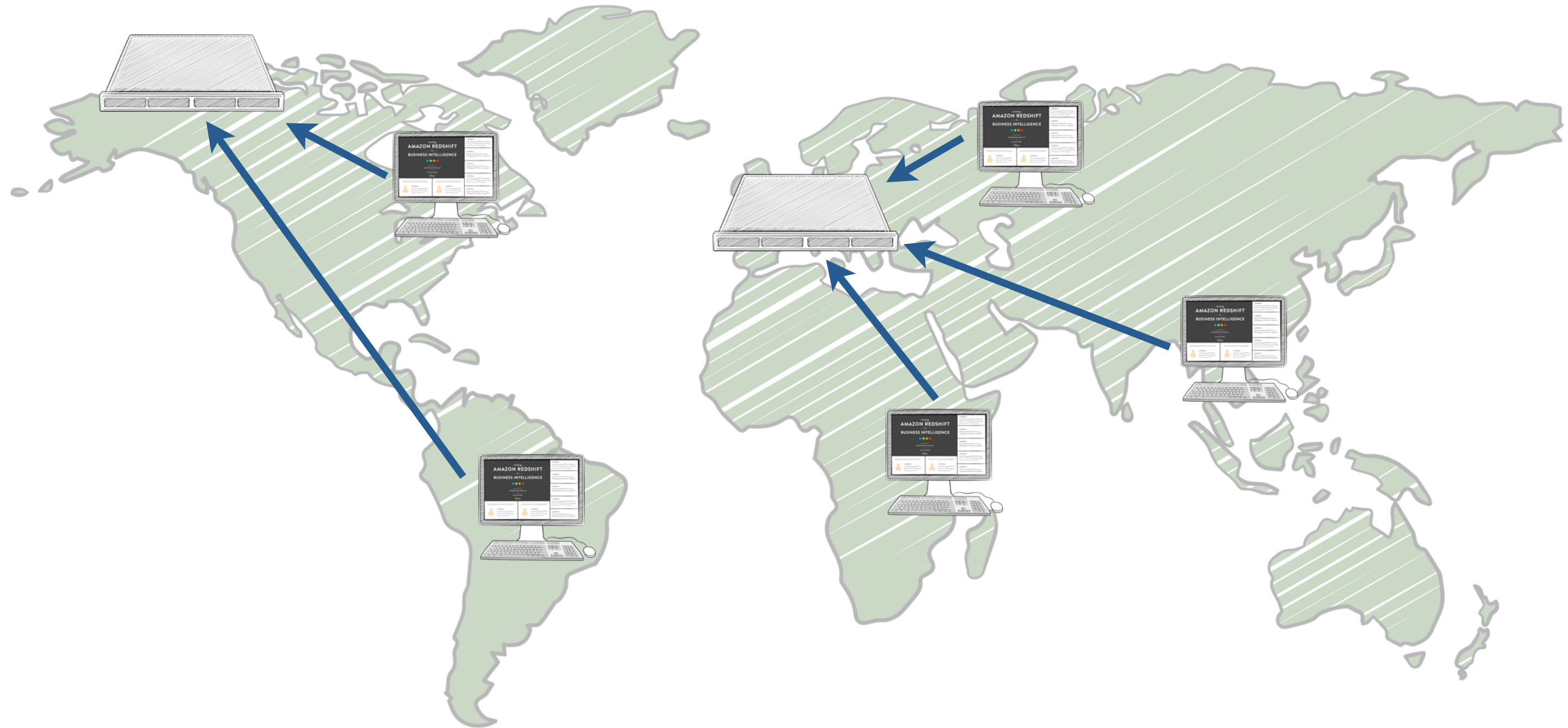
Optimizing DNS Response Time

- Managed DNS
- Fast
- Low latency
- Global network
- Queries routed to the nearest DNS server



Amazon Route 53

Without Route 53



With Route 53



Optimizing Response Time

DNS



Amazon Route 53

Optimizing Response Time

DNS



Amazon Route 53

Connection

First Byte

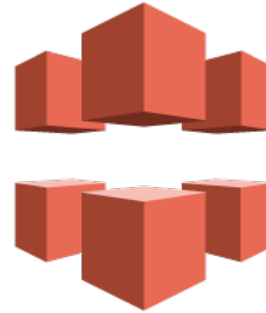
Optimizing Response Time

DNS



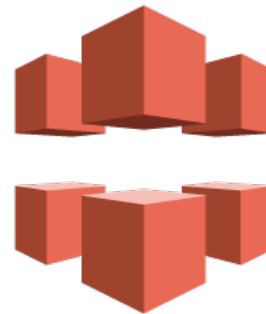
Amazon Route 53

Connection



Amazon CloudFront
Keep Alive

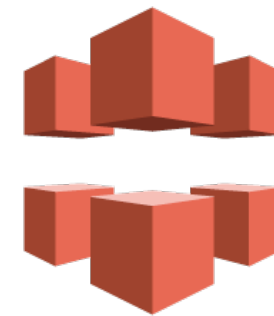
First Byte



Amazon CloudFront
Keep Alive

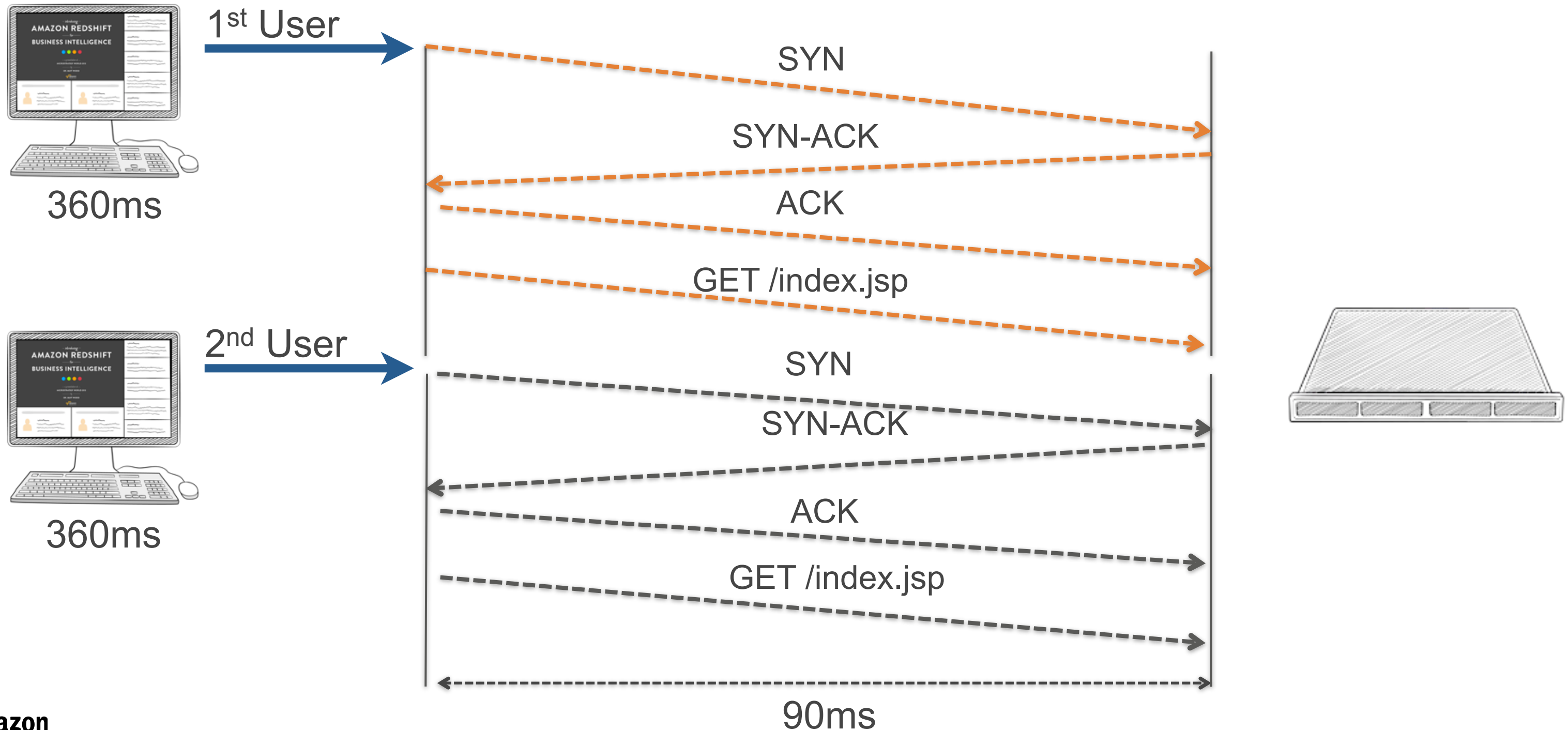
TCP/IP Hand Shake

- HTTP Runs on TCP/IP
- TCP uses TCP handshake
- TCP handshake costs time
- Every HTTP Connection needs to complete TCP Handshake



Amazon CloudFront

Two Users Without CloudFront



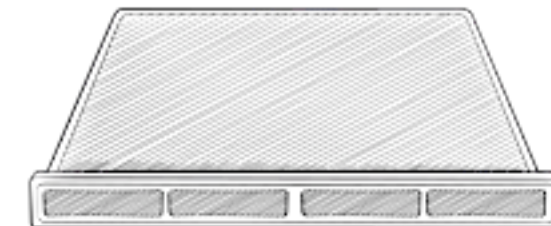
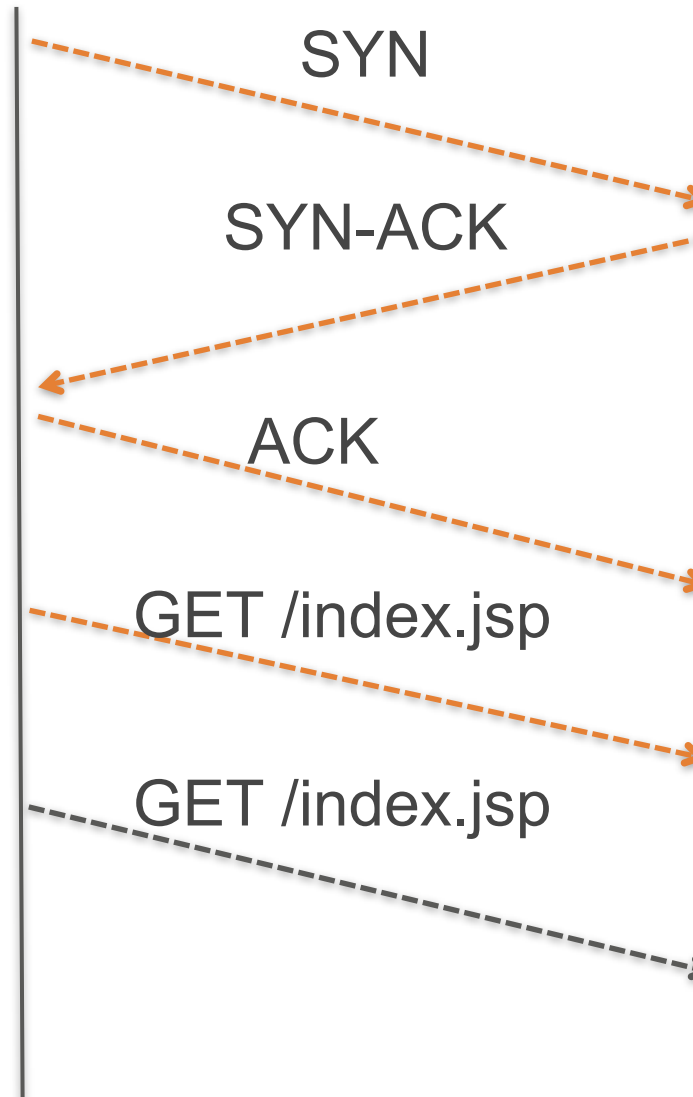
Keep Alive



1st Request



2nd Request



CloudFront Keep Alive

1st User

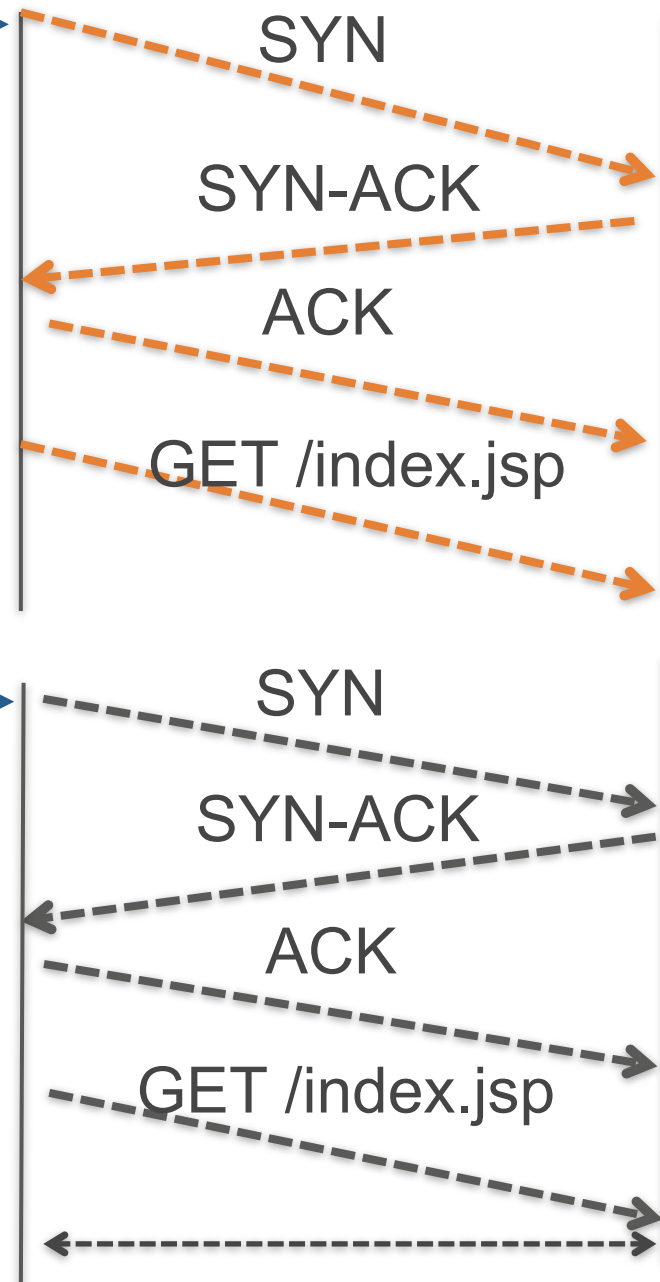


360ms

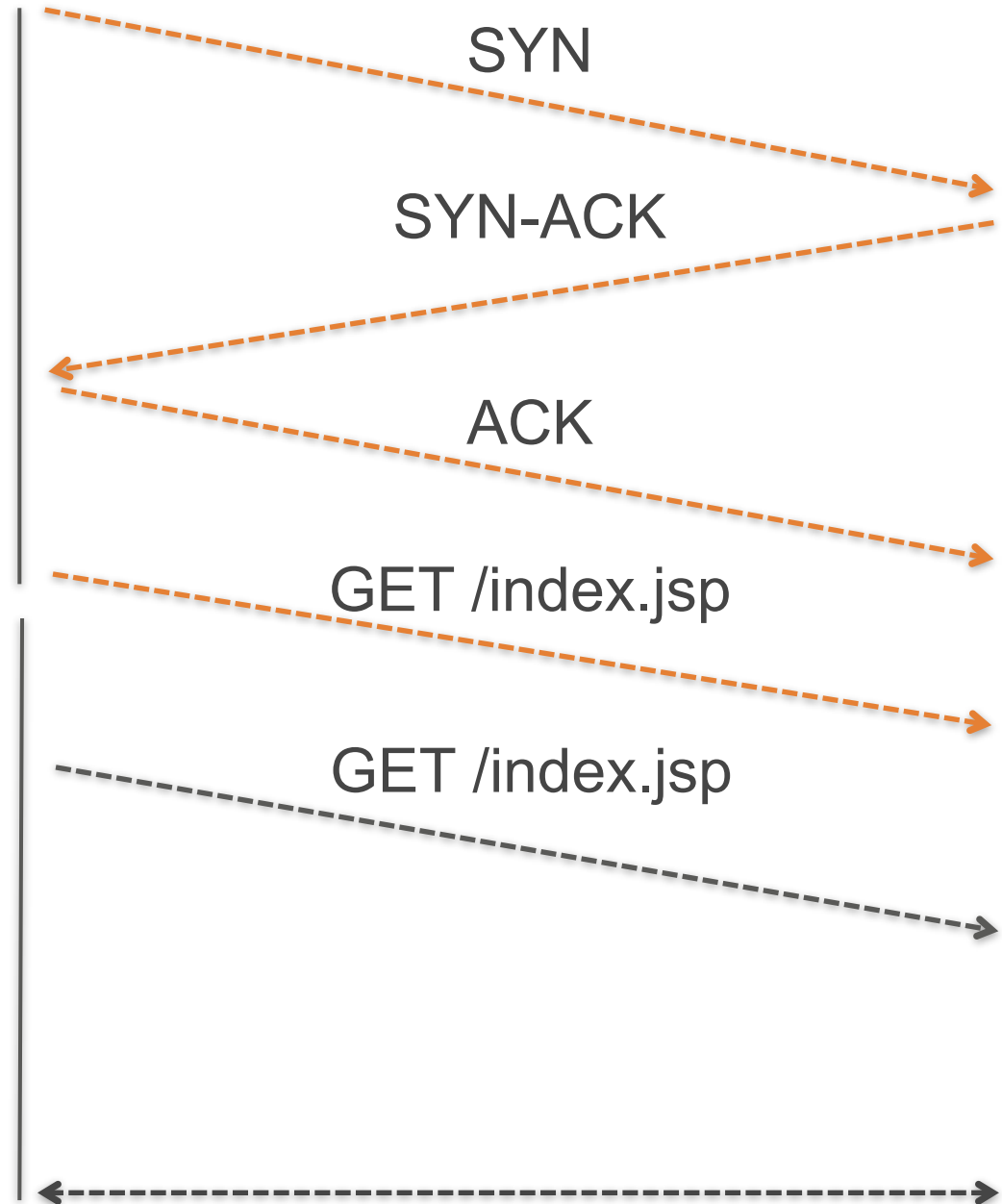
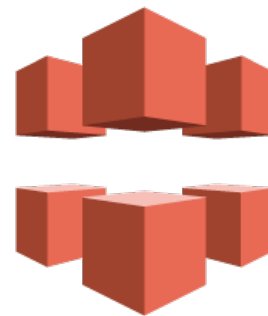
2nd User



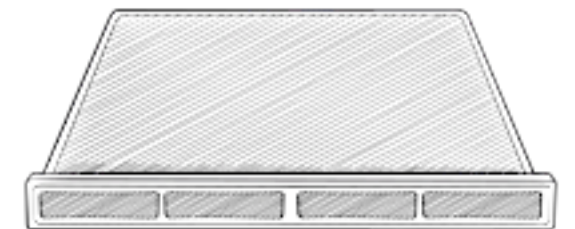
180ms



30ms

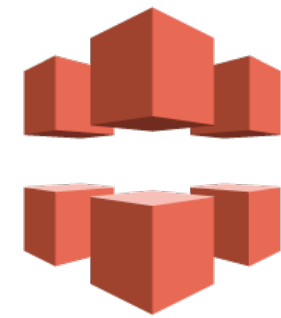


60ms



CloudFront Keep Alive

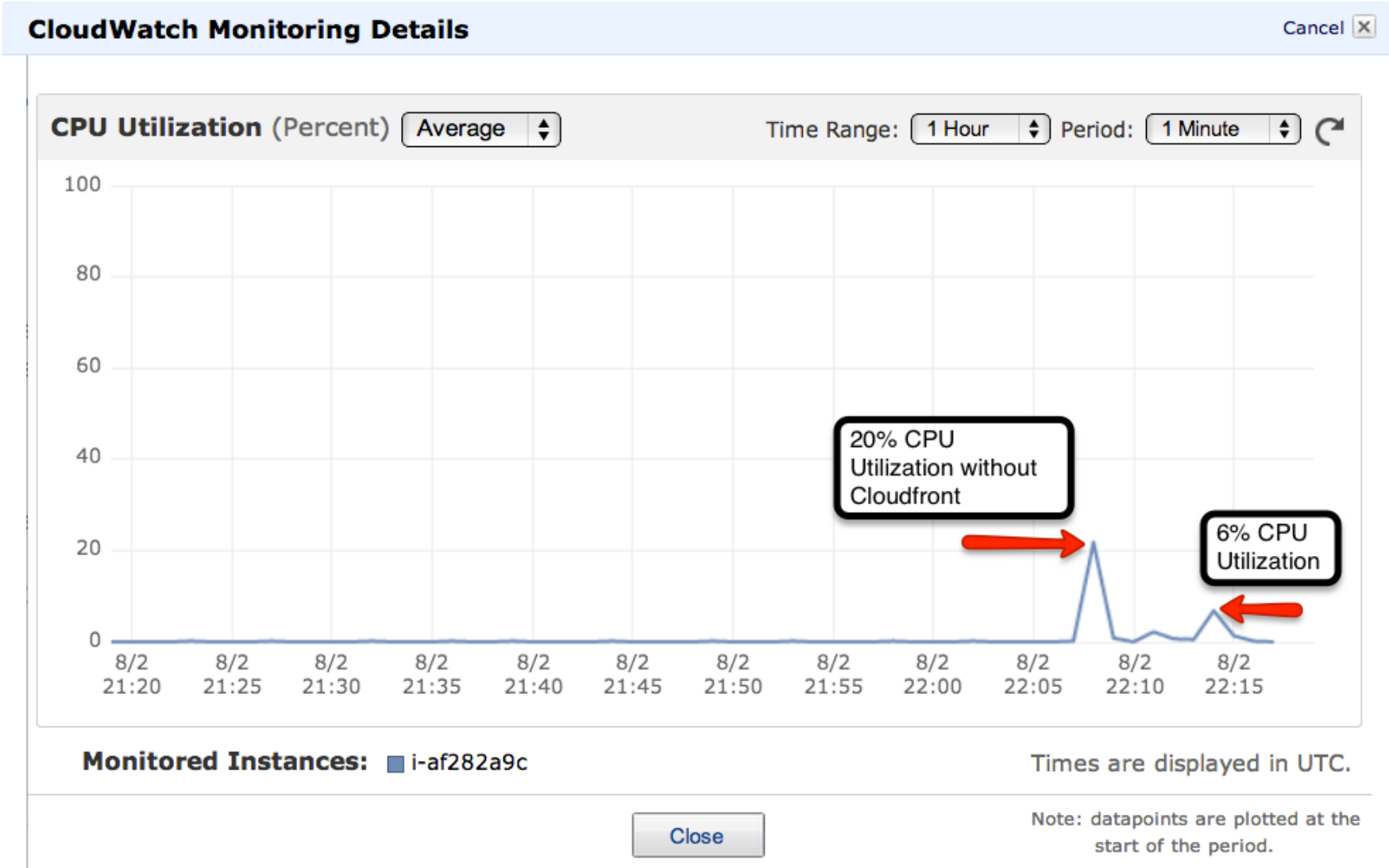
- More Users \neq More Connections
- Offloads Origin's CPU/Memory
- Improves Response Time



Amazon CloudFront

CloudFront Keep Alive Test

Test	CPU %
Without CloudFront	20 %
With CloudFront	6 %



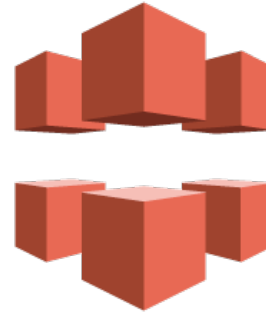
Optimizing Response Time

DNS



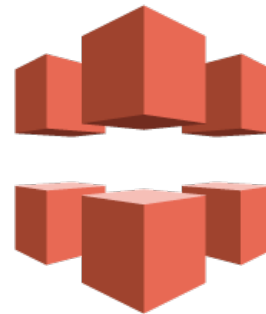
Amazon Route 53

Connection



Amazon CloudFront
Keep Alive

First Byte



Amazon CloudFront
Keep Alive

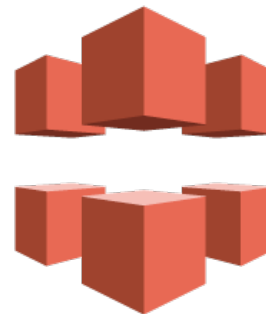
Optimizing Response Time

DNS



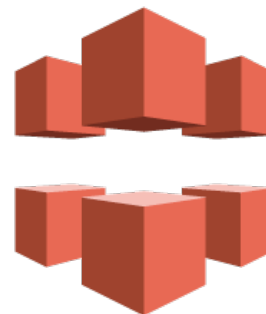
Amazon Route 53

Connection



Amazon CloudFront
Keep Alive & SSL Termination

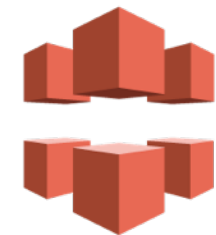
First Byte



Amazon CloudFront
Keep Alive

CloudFront SSL Termination

- CloudFront Supports SSL
- Terminate SSL at the Edge (Half-Bridge)
- Or Terminate SSL at the Edge and Use SSL to the Origin as Well (Full-Bridge)
- Use CloudFront SSL Certificate
- Or Bring Your Own



Amazon CloudFront

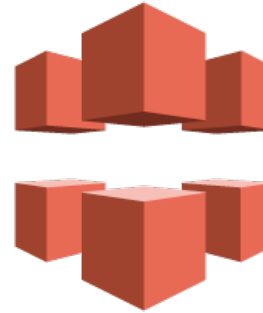
Optimizing Response Time

DNS



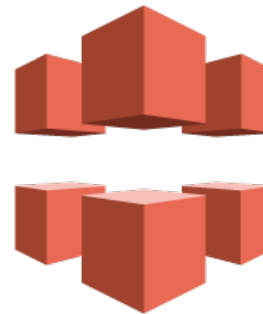
Amazon Route 53

Connection



Amazon CloudFront
Keep Alive & SSL Termination

First Byte



Amazon CloudFront
Keep Alive

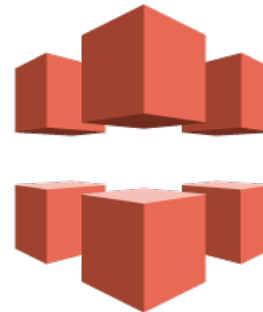
Optimizing Response Time

DNS



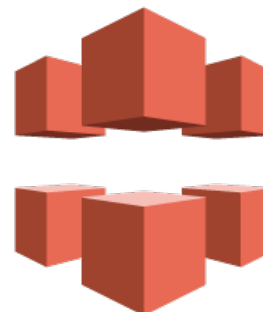
Amazon Route 53

Connection



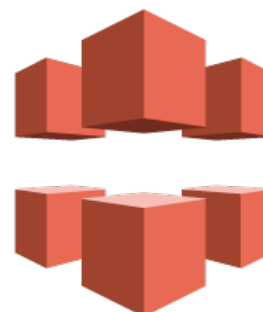
Amazon CloudFront
Keep Alive & SSL Termination

First Byte



Amazon CloudFront
Keep Alive

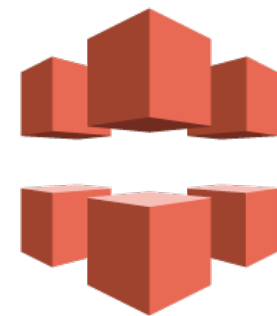
Content Download



Amazon CloudFront
TCP/IP Optimizations

CloudFront TCP/IP Optimizations

- TCP Slow Start Optimizations



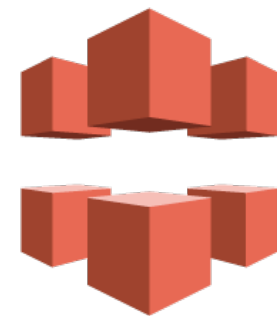
Amazon CloudFront

TCP Slow Start Optimization Performance Results

Test	# Of Packets	Response Time Per Request	Response Time For 200 Requests
Without CloudFront	2605	170 ms	33.876 ms
With CloudFront	896	96 ms	19.24 ms

CloudFront TCP/IP Optimizations

- TCP Slow Start Optimizations
- HTTP PUT/POST Optimizations



Amazon CloudFront

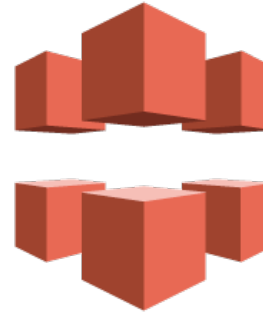
Optimizing Response Time

DNS



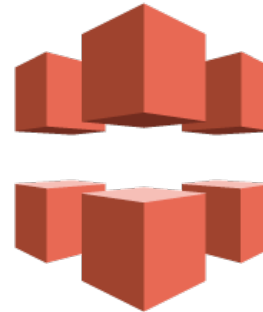
Amazon Route 53

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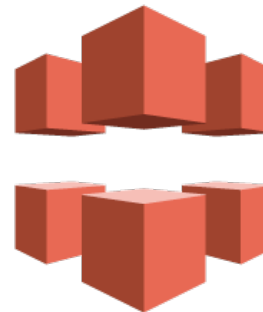
Amazon CloudFront
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Amazon CloudFront
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Content Download



Amazon CloudFront
TCP/IP Optimizations

But You Can Do More



Route 53 Latency Based Routing



Route 53

Route 53 Latency Based Routing

- Create multiple stacks in different EC2 regions
- Create LBR records with geo information tags
- Route 53 routes users to the lowest latency endpoint
- Better performance and availability
- Easy to use, low cost
- With or without CloudFront



Route53

Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



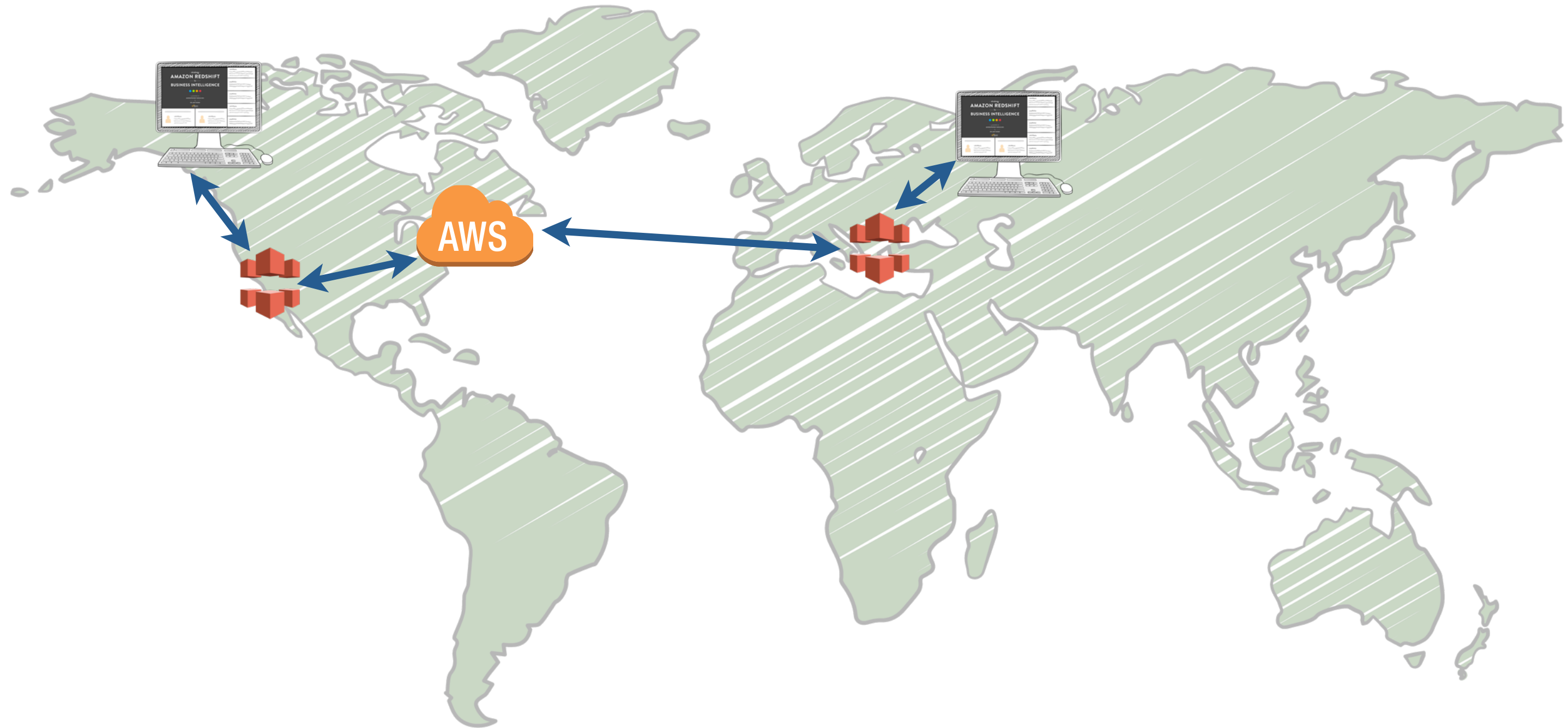
Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



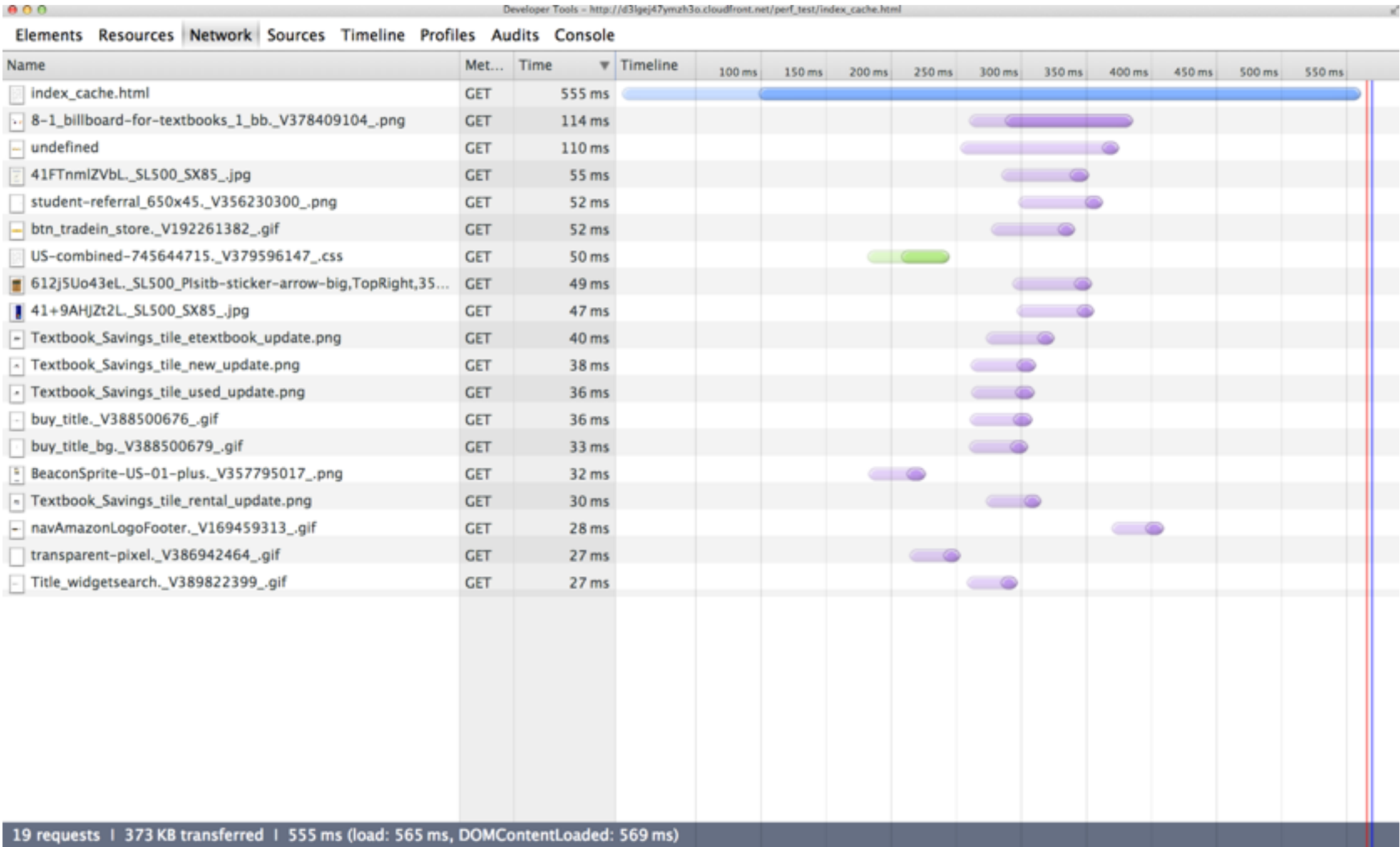
Lower Latency with CloudFront and Route 53



Lower Latency with CloudFront and Route 53



After CloudFront Dynamic Content Optimization: 555 ms



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0.5 sec

A 1-SECOND DELAY =

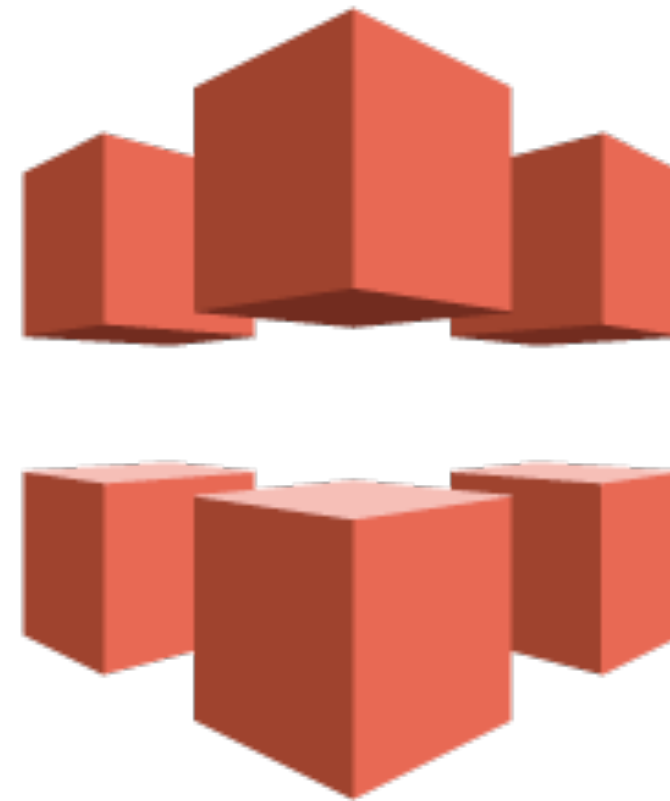
- 7% LOSS IN CONVERSIONS
- 11% FEWER PAGE VIEWS
- 16% DECREASE IN CUSTOMER SATISFACTION

IN DOLLAR TERMS, this means that if your site typically earns \$100,000 a day, this year you could lose **\$2.5 MILLION** in sales. SOURCE: Aberdeen Group

strangeloop www.strangeloopnetworks.com

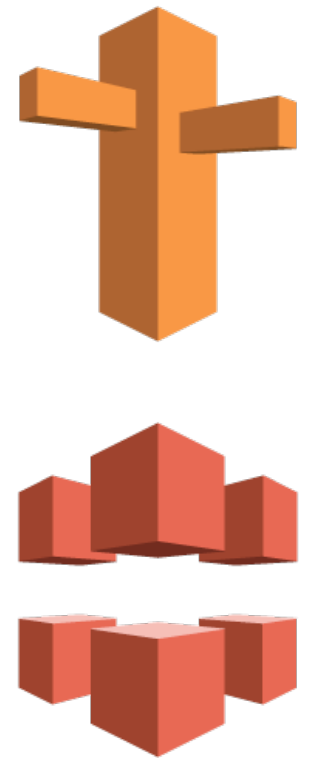
amazon
web services

Bonus: Fault Tolerance



Bonus: Fault Tolerance

- Route 53 Health Checks
- CloudFront Reduces Load on Your Origins
- CloudFront Works Together With Route 53 Latency Based Routing
- CloudFront Fails Over to Cached Content
- CloudFront Customized Error Pages



Summary

- Accelerate **all** your content with **CloudFront**
- Use **CloudFront with Route 53** latency-based routing to improve your performance
- **Design for failure** with CloudFront and Amazon Route 53

AWS Summits

2014

Thank You!

Constantin Gonzalez

Alexander D. MacWilliam

