How Akamai Handles Large Events

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Traffic Statistics

- 30,000+ domains
- 1.1 Tbps daily peak traffic
- 6,419 terabytes / day
- 274 billion hits / day
- 274 million unique client IP addresses / day
- In 2009 expect to deliver more bits than in 1998-2008 combined

Assigning Clients to Servers

- "High level": Map client to a cluster based on client's nameserver's IP address. Algorithm: stable marriage with multi-dimensional hierarchical capacity constraints.
- "Low level": Assign client to specific server or servers within cluster based on content requested. Algorithm: consistent hashing.

Network Deployment

4000+ 1450+ 950+ 67+
Servers POPs Networks Countries
Embedded Image Delivery (e.g., Amazon)

Embedded URLs are converted to ARLs.

```html
<html>
<head>
<title>Welcome to xyz.com!</title>
</head>
<body>
<img src="http://www.xyz.com/logos/logo.gif">
<img src="http://www.xyz.com/jpgs/navbar1.jpg">
<a href="page2.html">Click here to enter</a>
</body>
</html>
```

Akamai DNS Resolution

```
```

Mapping

- Maps IP address of client’s name server and type of content being requested to an Akamai cluster.
- Note: Doesn’t depend on content provider (although indicated by ak.xyz.com).
- Special cases: Akamai Accelerated Network Partners (AANPs)
- General case: “Core Point” analysis

Core Points

- Core point X is the first router at which all paths to nameservers 1, 2, 3, and 4 intersect.
- Traceroute once per day from 300 clusters to 280,000 nameservers.
Core Points

280,000 nameservers (98.8% of requests)
  reduced to
  30,000 core points

ping core points every 6 minutes

Akamai Cluster

Servers pool resources
• RAM
• Disk
• Throughput

Hashing

Universe $U$ of all possible objects, set $B$ of buckets.

object: set of web objects with same serial number
bucket: web server

Hash function $h: U \rightarrow B$
  Assigns objects to buckets

E.g., $h(x) = (((a \times x + b) \mod P) \mod |B|)$, where
  $P$ is prime, $P > |U|
  $a, b$ chosen uniformly at random from $Z$
  $x$ is a serial number (designates content provider)

Difficulty changing number of buckets

$f(d) = d + 1 \mod 5$
$f(d) = d + 1 \mod 4$
Consistent Hashing

Idea: Map both objects and buckets to unit circle.

Assign object to next bucket on circle in clockwise order.

How it’s really done

new bucket

random permutations of servers

Why? To spread load for one serial number.

Strategies for Handling Large Events

- Flash crowds (no advance notice): Rely on rapid load balancing. Cross fingers.
- Planned events: “pre-warm” caches with objects to be served.

Content Delivery on 9/11 (2001)

- Akamai’s network had capacity for all content providers requesting service
- Total bits served on September 11 was approximately 3.5 times normal
- Traffic was higher on September 12
- (But not as high as January 7, 2002)
9713 Akamai Template

News Site A – Image Traffic

News Site A – Streaming

News Site B – HTML Traffic

News Site B – Image Traffic
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News Site B – Streaming

Portal A – Image Traffic

Sports Site A – Image Traffic

Steve Jobs Keynote (2002)
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Akamai live streaming infrastructure

Source

Reflectors

Edge servers

Trace format
[Client IP, Player ID, Stream URL, Session start time, Session duration, Mean receiving bandwidth]

Extensive traces (2004)

~ 1,000,000 daily requests
~ 200,000 daily client IP addresses from over 200 countries
~ 1,000 daily streams
~ 1,000 edge servers
~ Everyday, over a 3-month period

Audio vs. video

Most streams are audio.

Audio 71%

Unknown 22%

Stream types

• Non-stop (76%) vs. short duration (24%)
  – All video streams have short duration
• Smooth arrivals (50%) vs. sudden onset (50%)
  – Flash crowds are common
Obama Inauguration (2009)
- 7 million simultaneous data streams, most carrying live video
- total traffic peaking at 2 terabits per second
- requests per minute fifth place historically, behind election night in November and three sports events (a World Cup soccer playoff and two NCAA basketball playoff games)