Akamai CDN, IPv6 and DNS security

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Agenda

Akamai Introduction

- Who’s Akamai?
- Intelligent Platform & Traffic Snapshot

Basic Technology

- Akamai mapping
- Finding the IP address
- Downloading www.example.com

Akamai & IPv6 World Launch Anniversary

- Akamai IPv6 Deployment and Observations

Secure the Internet

- Open recursors and reflection attacks
- BCP-38 and DNS server maintenance

Akamai
FASTER FORWARD

Akamai Introduction

The Akamai Intelligent Platform

The world's largest on-demand, distributed computing platform delivers all forms of web content and applications

The Akamai Intelligent Platform:

110,000+	2,000+	1,100+	700+	83
Servers	Locations	Networks	Cities	Countries

Typical daily traffic:

- More than **2 trillion** requests served
- Delivering over **15 terabits/second**
- **15-30%** of all daily web traffic

Basic Technology

Akamai mapping

How CDNs Work

When content is requested from CDNs, the user is directed to the optimal server

- This is usually done through the DNS, especially for non-network CDNs, e.g. Akamai
- It can be done through anycasting for network owned CDNs

Users who query DNS-based CDNs be returned different A (and AAAA) records for the same hostname

This is called “mapping”

The better the mapping, the better the CDN

How Akamai CDN Work

Example of Akamai mapping

- Notice the different A records for different locations:

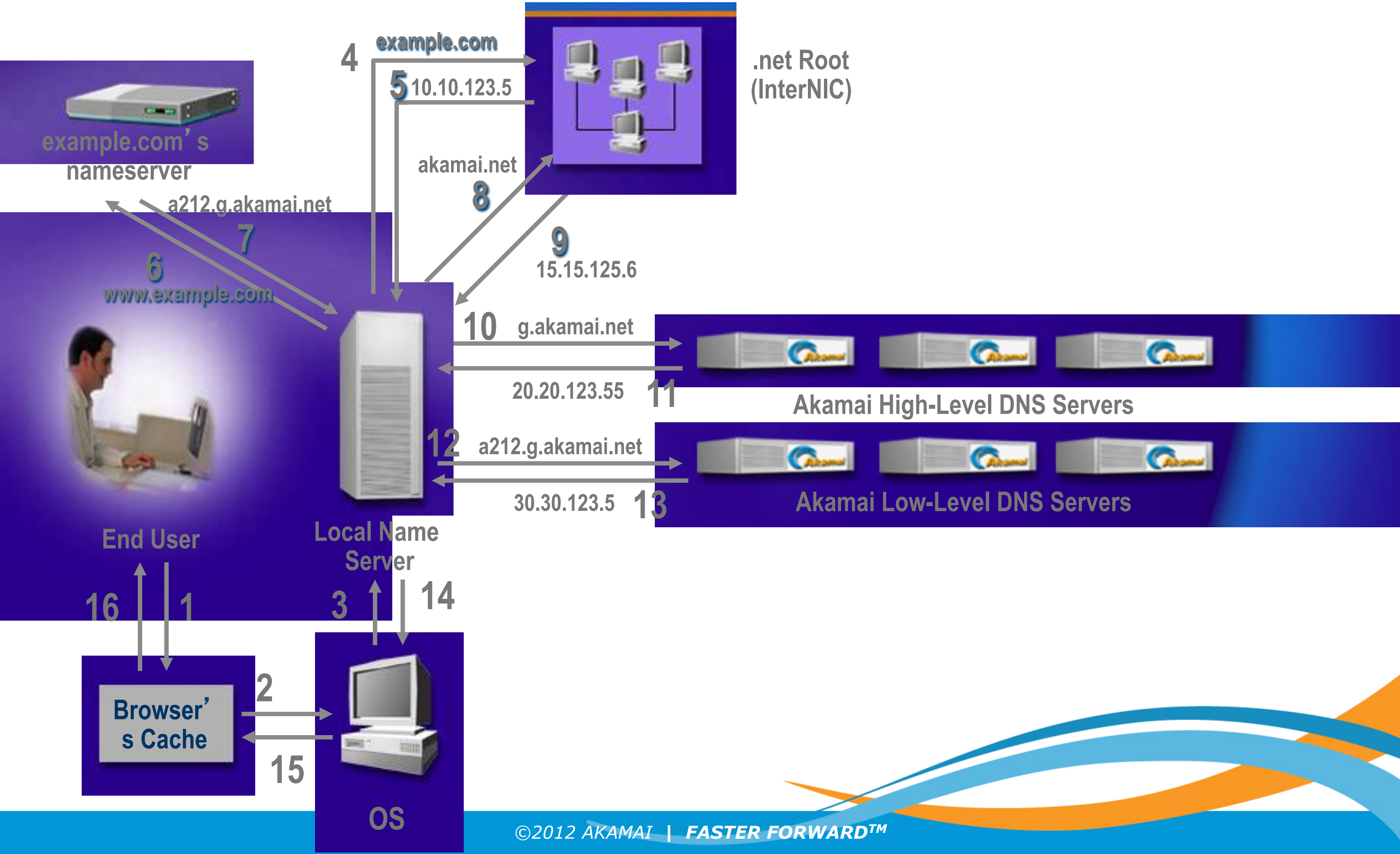
```
[NYC]% host www.symantec.com
www.symantec.com   CNAME  e5211.b.akamaiedge.net.
e5211.b.akamaiedge.net.  A      207.40.194.46
e5211.b.akamaiedge.net.  A      207.40.194.49

[Boston]% host www.symantec.com
www.symantec.com   CNAME  e5211.b.akamaiedge.net.
e5211.b.akamaiedge.net.  A      81.23.243.152
e5211.b.akamaiedge.net.  A      81.23.243.145
```

How Akamai CDN Work

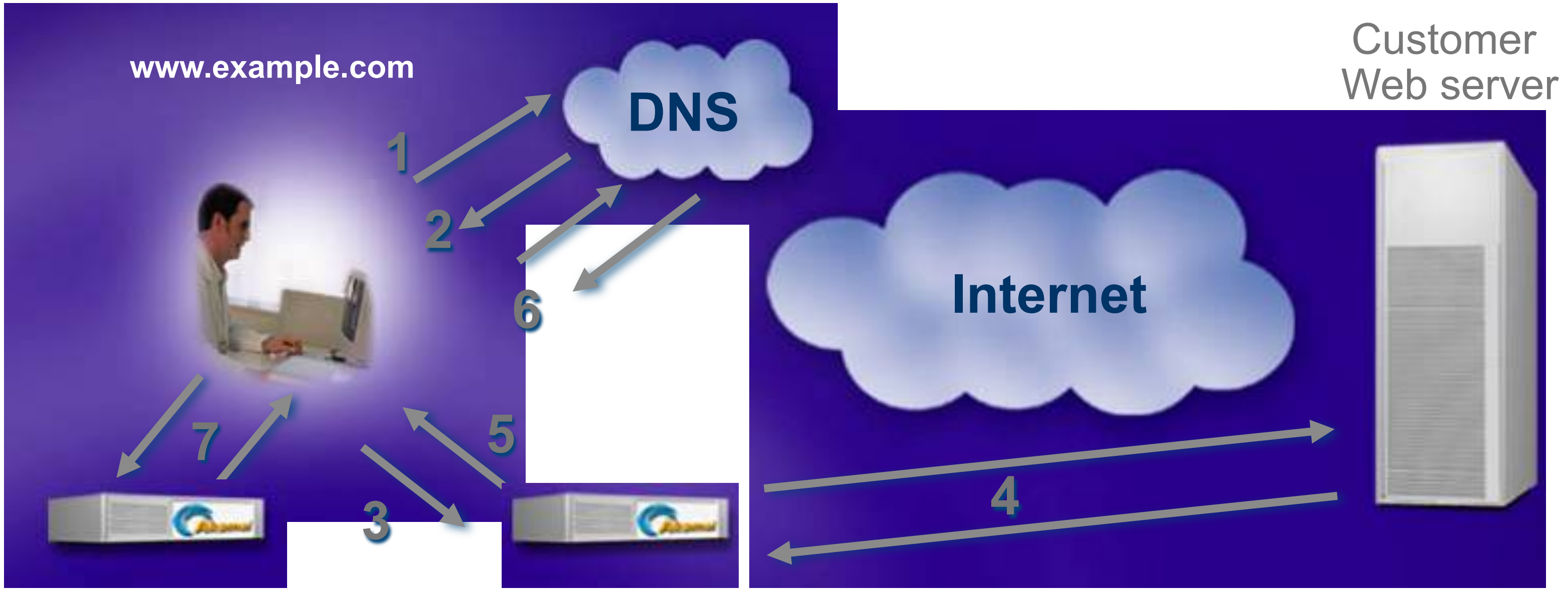
Akamai use multiple criteria to choose the optimal server

- These include standard network metrics:
  - Latency
  - Throughput
  - Packet loss
- These also include things like CPU load on the server, HD space, network utilization, etc.

Finding the IP Address: The Akamai Way



Downloading www.example.com with Akamai’s EdgeSuite



- User enters www.example.com
- 1. Browser requests IP address for www.example.com
- 2. DNS returns IP address of optimal Akamai server
- 3. Browser requests HTML
- 4. Akamai server assembles page, contacting customer Web server if necessary
- 5. Optimal Akamai server returns Akamaized HTML
- 6. Browser obtains IP address of optimal Akamai servers for embedded objects
- 7. Browser obtains objects from optimal Akamai servers

Akamai & IPv6

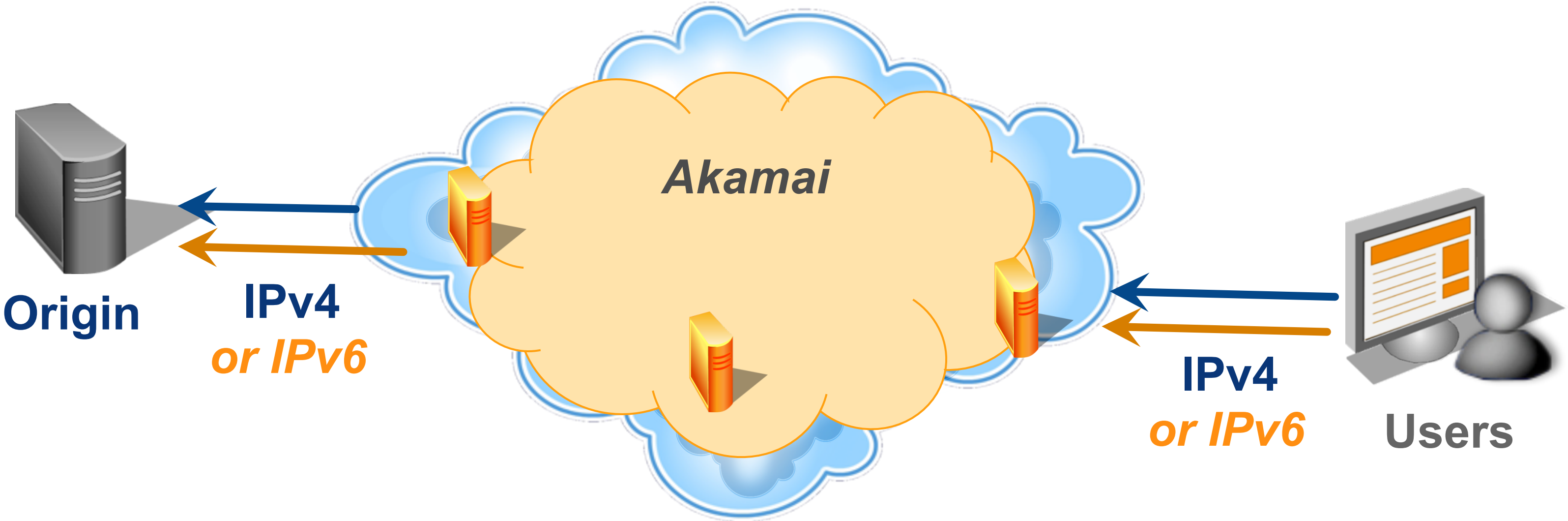
World IPv6 Launch Anniversary

How we enable IPv6

Dual-stacking edge servers

Customer properties can be dual-stacked

- Terminate IPv4 and IPv6 connections in server software
- Can go forward to customer origin via IPv4 *(or IPv6)*



World IPv6 Launch Day: deployment status

In-production serving HTTP over IPv6 to users, tried to dual-stack every server everywhere

As of 2012-06-06, IPv6 now live in…
… over 53 countries
… over 175 cities (in all continents except Antarctica)
… over 225 networks
… over 600 Akamai server locations
… over 37,000 Akamai servers

Compare to a total of 1070 networks in 83 countries

(many network providers don’t have working IPv6 yet, not all networks have full IPv6 routing table)

Current deployment status

In-production serving HTTP over IPv6 to users, tried to dual-stack every server everywhere

As of Jun 2013, IPv6 now live in…

… over 64 countries

… over 240 cities (in all continents except Antarctica)

… over 300 networks

… over 800 Akamai server locations

… over 70,000 Akamai servers

Compare to a total of 1100+ networks in 83 countries

(many network providers don't have working IPv6 yet, not all networks have full IPv6 routing table)

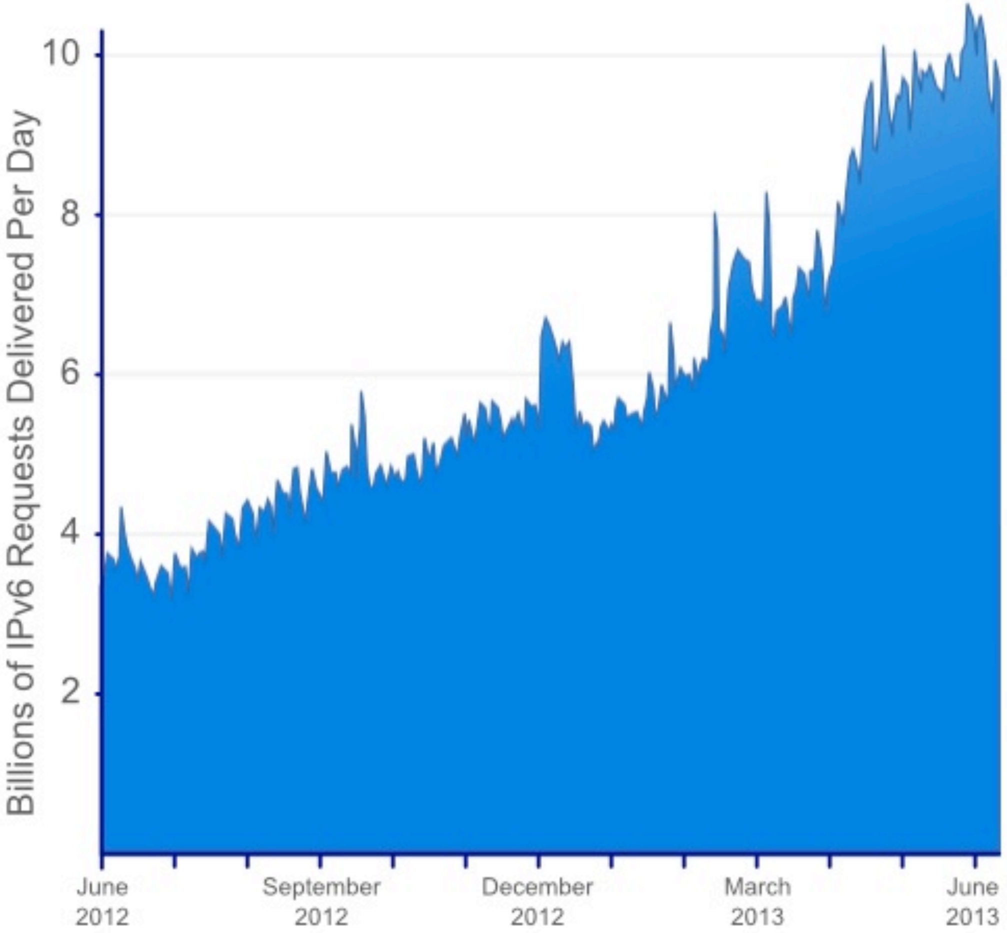
World IPv6 Launch Anniversary: A closer look from Akamai

IPv6 Addresses

- 2011: 280,229
- 2012: 18,899,253
- ***67x***
- 2013: 200m – 300m
- ***10x***

IPv6 Requests/Day

- 2011: 8,343,590
- 2012: 3,394,971,156
- ***460x***
- 2013: >10 billions
- ***2.5x***



IPv6 Requests/Day on Akamai from June 2012 to June 2013

World IPv6 Launch Anniversary: Observations

Top 10 IPv6 by Geo

Country	IPv6 as % of Requests
Switzerland	10.4%
Romania	7.7%
France	4.6%
Luxembourg	3.6%
Belgium	3.3%
United States of America	3.2%
Germany	2.9%
Japan	2.1%
Peru	2.1%
Norway	1.4%

World IPv6 Launch Anniversary: Observations

Top 10 IPv6 by Network Provider

Network Operator	IPv6 as % of Requests	Primary Country
Verizon Wireless	34.9%	U.S.A.
Brutele (VOO)	29.7%	Belgium
Free/Proxad	18.9%	France
RCS & RDS	18.5%	Romania
Swisscom	15.8%	Switzerland
KDDI	9.9%	Japan
AT&T	8.4%	U.S.A.
Comcast	3.2%	U.S.A.
Deutsche Telekom AG	3.4%	Germany
Telefonica del Peru	2.6%	Peru

World IPv6 Launch Anniversary: IPv6 and Mobile

Mobile Operating System	IPv6 as % of Requests
Windows Phone OS 8	12%
BlackBerry OS 10	5.9%
Android 4.1/4.2 ("JellyBean”)	10.8%
Android 4.0 ("Ice Cream Sandwich”)	3.2%
Android 2.3 ("Gingerbread”)	1.6%
Apple iOS 6	1.8%
Apple iOS 5	**1.4%**
Apple iOS 3/4	1.1%

- using Akamai's Mobile Browser Detection for categorization
- Within Android, there are individual device types where well over 50% of the traffic to dual-stacked websites arrived over IPv6.

World IPv6 Launch Anniversary: IPv6 and Desktop/Laptop Operating Systems

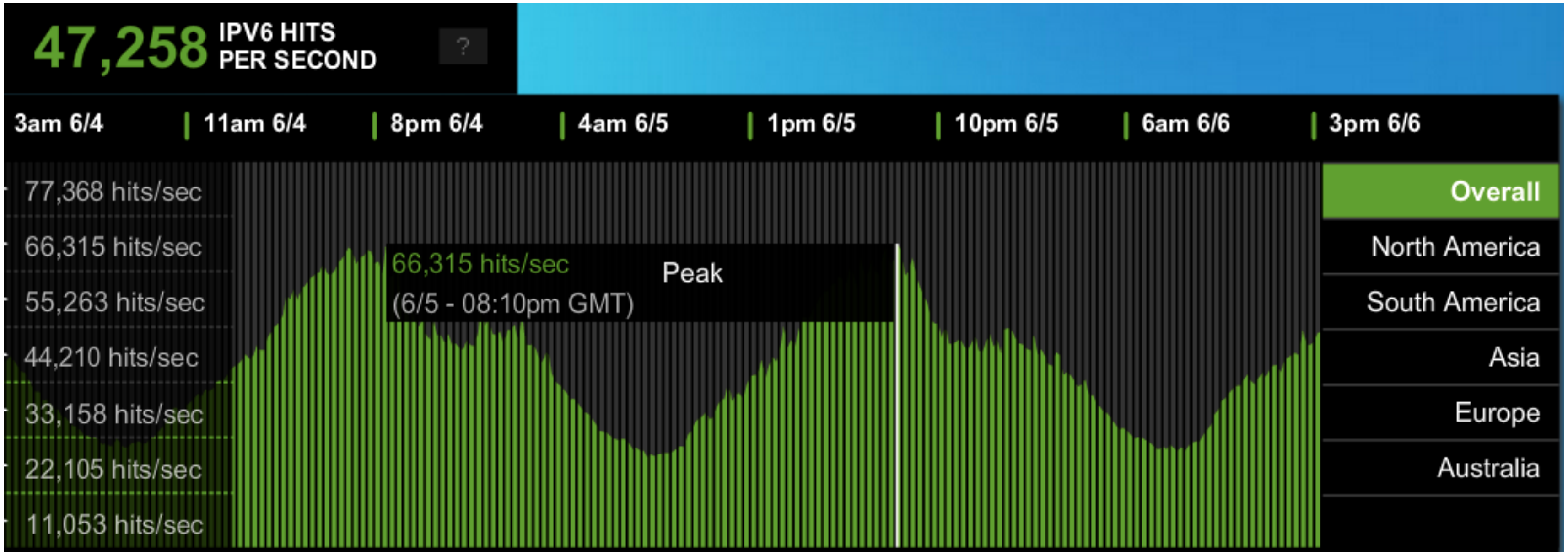
Operating System	Browser	IPv6 as % of Requests
Microsoft Windows 8		4.1%
Microsoft Windows Vista		3.3%
Microsoft Windows 7		2.5%
Microsoft Windows XP		0.5%
Mac OS X 10.5 & 10.6	Chrome & Firefox	3.4%
Mac OS X 10.5 & 10.6	Safari	3.3%
Mac OS X 10.7 & 10.8	Chrome & Firefox	3.3%
Mac OS X 10.7 & 10.8	Safari	2.1%

- Happy Eyeballs

World IPv6 Launch Anniversary: Three drivers of IPv6 growth

1. Content availability
   - Customers opting in to have their sites, content, and applications permanently available dual-stacked.
2. Availability of IPv6 from access network providers
   - IPv6 in production networks, e.g. Verizon Wireless, AT&T, and Comcast.
   - Some ISPs, Universities and Research Labs in Europe and Asia that have had IPv6 deployed
3. End-user device support
   - Recent desktop and laptop OS and client software supports IPv6
   - Many home routers / gateways start to support IPv6 recently.
   - 4G LTE smart phones.

Observations from World IPv6 Launch

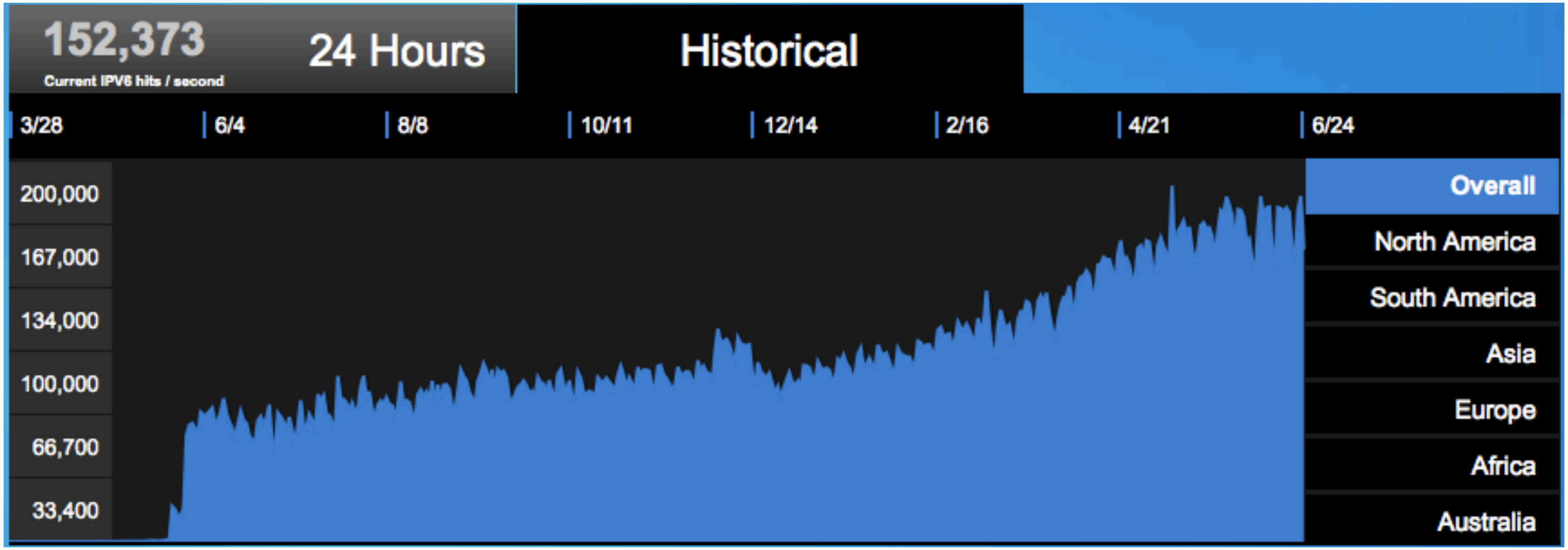


Akamai has a lot of customers on IPv6

- Over 700 US government hostnames
- Over 20 US government agencies
- 1/3 of top-30 World IPv6 Launch Day participants (by Alexa rank), etc.

Those customers who were dual-stacked before World IPv6 Launch show 0.3% to 1.5% of their traffic on IPv6

Observations from World IPv6 Launch Anniversary



IPv6 traffic continue to growth steadily after World IPv6 Launch

- 2x customers
- 2.5x daily IPv6 requests
- 2.5x dual-stack hostnames (over 1,600 US government hostnames)
- Users upgrade their devices over the next few years
- **We really running out of IPv4!**

Secure the Internet

Open recursors and DNS reflection attack

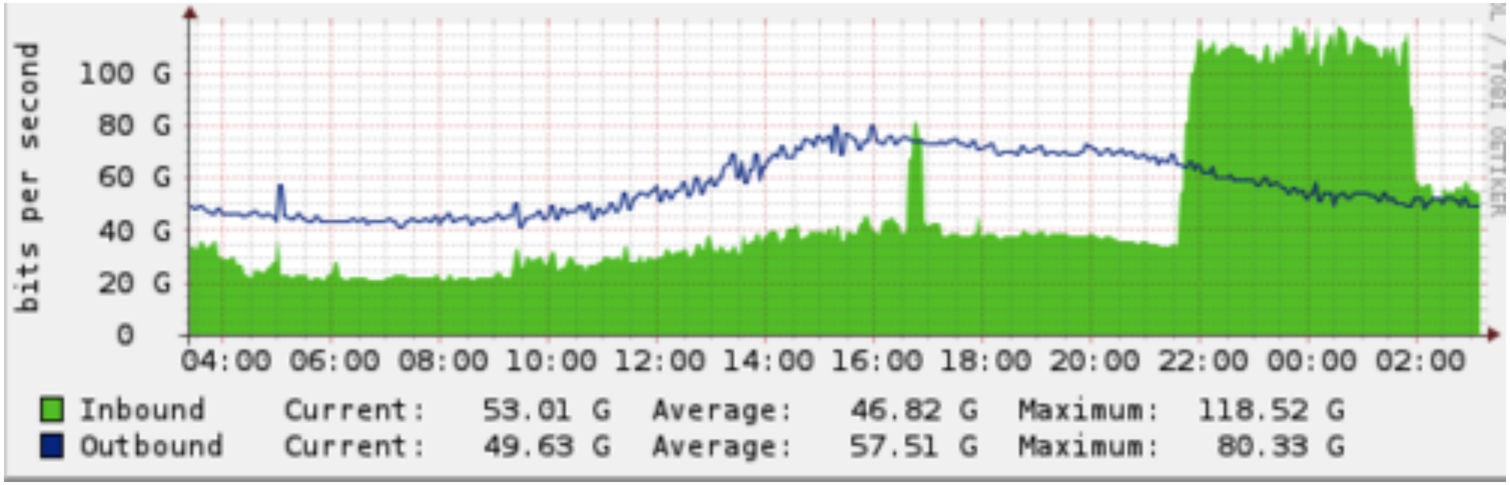
Recursors

Why?

- Exist to aggregate and cache queries
    - Not every computer run its own recursive resolver.
- ISPs, Large Enterprises run these
- Query through the root servers and DNS tree to resolve domains
- Cache results
- Deliver cached results to clients.

Recursors

The Problem!



- Example of DNS Based reflection attack exceeding 70Gbit.

www.cloudflare.com

Recursors

Open / Unsecured Recursors ?

- DNS server set up for recursion
  - i.e. non-authoritative
  - Will answer for zones it is not authoritative for
  - Recursive lookups
  - Will answer queries for anyone
- Some Public Services:
  Google, OpenDNS, Level 3, etc.
  - These are “special” set-ups and secured.

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Recursors

Say Again?

- There are hundreds of thousands of DNS Recursors.
- Many of these are not secured.
- Non secured DNS Recursors can and will be abused
- CloudFlare has seen DNS reflection attacks hit 300Gbit traffic globally.

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Reflection Attack

- UDP Query
- Spoofed source
  - Using the address of the person you want to attack
  - DNS Server used to attack the victim (sourced address)

- Amplification used
  - Querying domains like ripe.net or isc.org
  - ~64 byte query (from attacker)
  - ~3233 byte reply (from unsecured DNS Server)
  - 50x amplification!

- Running an unsecured DNS server helps attackers!

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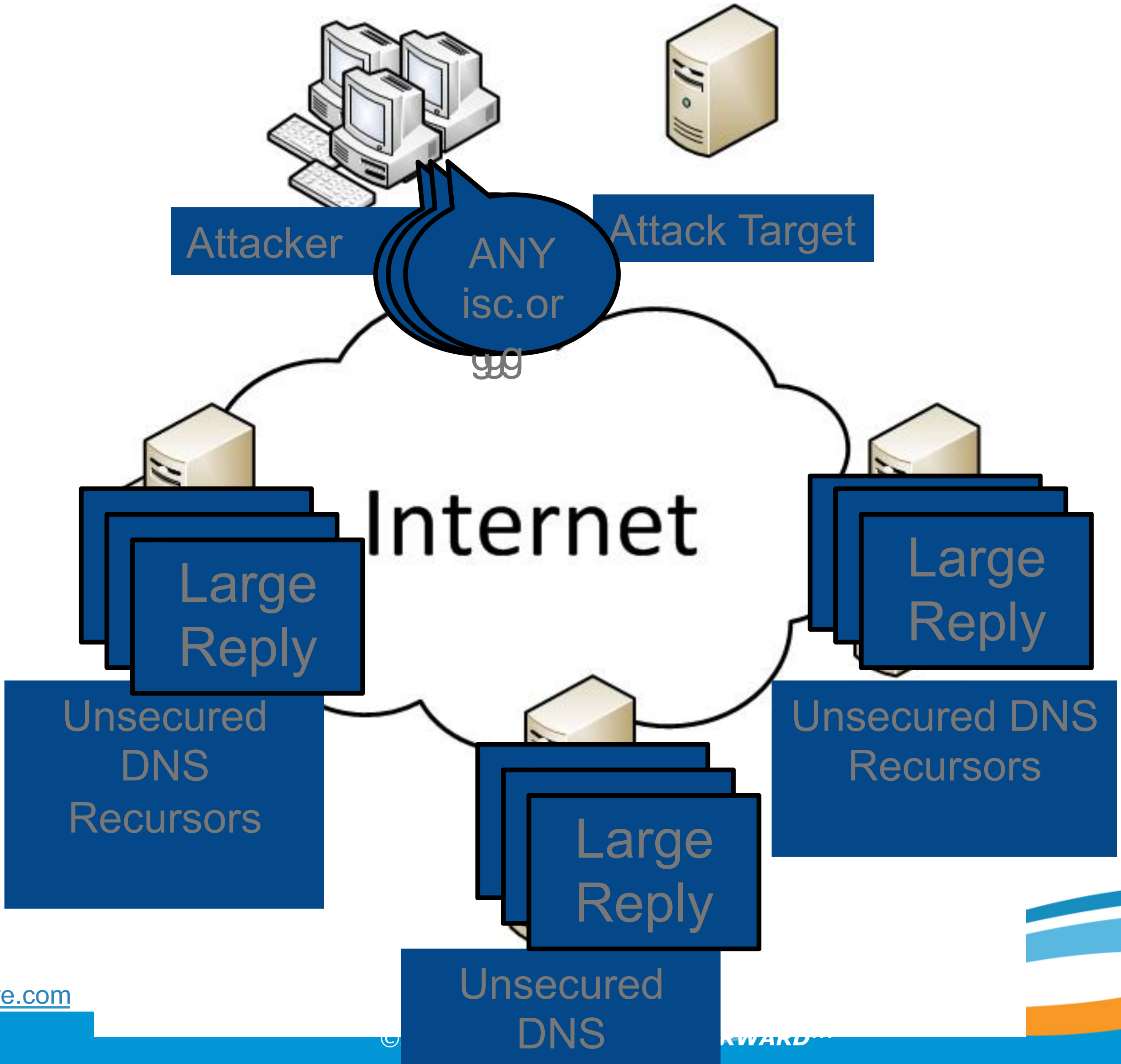
Reflection Attack



Attacker

ANY isc.or
g

Attack Target

Internet

Large Reply

Unsecured DNS Recursors

Large Reply

Unsecured DNS Recursors

Large Reply

Unsecured DNS

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Reflection Attack

- With 50x amplification:
    - 1Gbit uplink from attacker (eg: Dedicated Servers)
    - 50Gbit attack
    - Enough to bring most services offline!

- Prevention is the best remedy.

- In recent attacks, we've seen around 80,000 open/ unsecured DNS Resolvers being used.
- At just 1Mbit each, that's 80Gbit!
    - 1mbit of traffic may not be noticed by most operators.
    - 80Gbit at target is easily noticed!

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Where are the open Recursors?

- Nearly Everywhere!

- CloudFlare has seen DNS Reflection attack traffic from:
  - 27 out of 56 Economies in APNIC Region
  - More attacks from higher populated economies.

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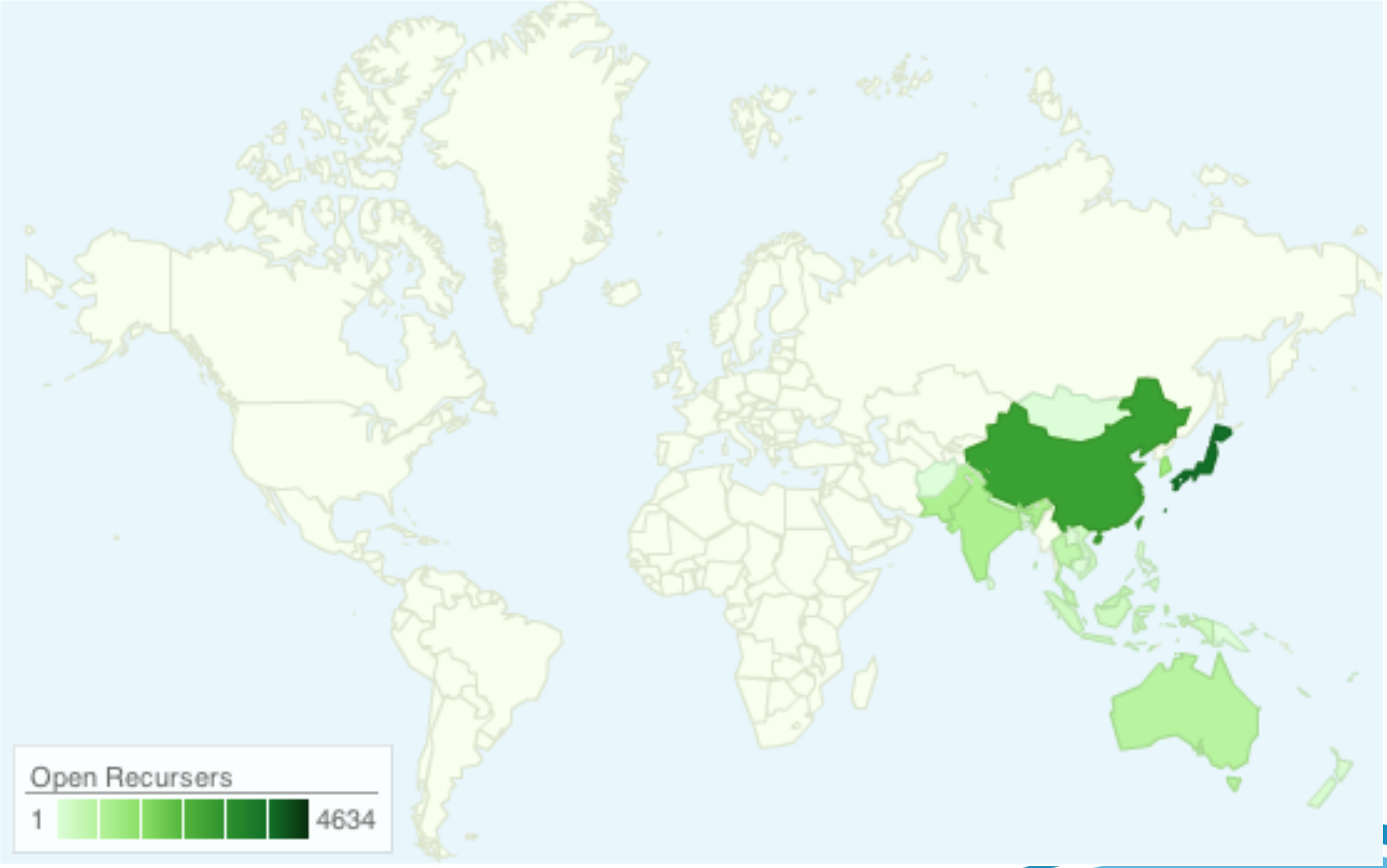
Where are the open Recursors?



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Where are the open Recursors?

Country	Open Recursors		Country	Open Recursors
Japan	4625		Bangladesh	103
China	3123		New Zealand	98
Taiwan	3074		Cambodia	13
South Korea	1410		Sri Lanka	7
India	1119		Nepal	7
Pakistan	1099		Mongolia	5
Australia	761		Laos	4
Thailand	656		Bhutan	2
Malaysia	529		New Caledonia	2
Hong Kong	435		Fiji	2
Indonesia	349		Maldives	2
Vietnam	342		Papua New Guinea	1
Philippines	151		Afghanistan	1
Singapore	118			

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Where are the open Recursors?

- Where are they running?

Mostly on Servers.

~11,000	Servers profiled.
~7,500	BIND
~1600	unknown / undetermined
~900	Microsoft DNS Server
~500	dnsmasq
~200	ZyWALL DNS (a consumer internet router)

Fixing this?

Preventative Measures!

- BCP-38
  - Source Filtering.
  - You shouldn’t be able to spoof addresses.
  - Needs to be done in hosting and ISP environments.
  - If the victim’s IP can’t be spoofed the attack will stop
  - Will also help stop other attack types
    - (eg: Spoofed Syn Flood).

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Fixing this?

Preventative Measures!

•DNS Server Maintenance

- Secure the servers!
  - Lock down recursion to your own IP addresses
- Disable recursion
  - If the servers only purpose is authoritative DNS, disable recursion
- Turn them off!
  - Some Packages (eg, Plesk, cPanel) have included a recursive DNS server on by default.

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Fixing this?

Consumer Internet Routers / Modems

- Update firmware.
  - Some older firmware has security bugs
    - Allows administration from WAN (including DNS, SNMP)

- Does the feature need to be on?
    - Make sure its set up properly

Fixing this?

Information

•BCP-38:

http://tools.ietf.org/html/bcp38

•BIND:

http://www.team-cymru.org/Services/Resolvers/instructions.html

•Microsoft:

http://technet.microsoft.com/en-us/library/cc770432.aspx

•The Open Resolver Project:

http://openresolverproject.org/

Summary

- **Akamai Intelligent Platform**
  - Highly distributed edge servers
  - Akamai mapping is different than BGP routing

- **IPv6 traffic is still small today, but catching up**
  - Dual-stack approach
  - IPv4 is really running out!

- **Secure the Internet**
  - Open recursors and DNS reflection attacks
  - BCP-38 and DNS servers maintenance

Questions?

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More information:

Peering: http://as20940.peeringdb.com

IPv6: http://www.akamai.com/ipv6

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