

# **Assessing IPv6 Adoption**

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NANOG 57

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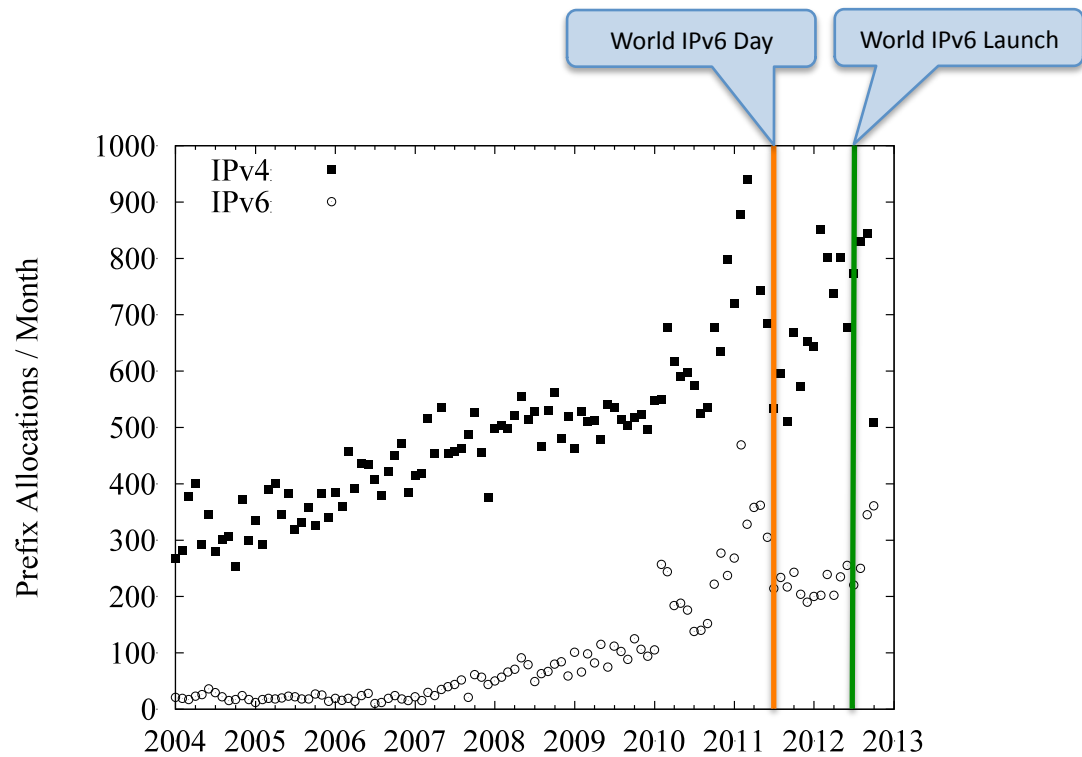
# Motivation

- A **comprehensive** view of IPv6 adoption from **multiple perspectives, at scale**, which includes data for **most of the important aspects** of adoption.

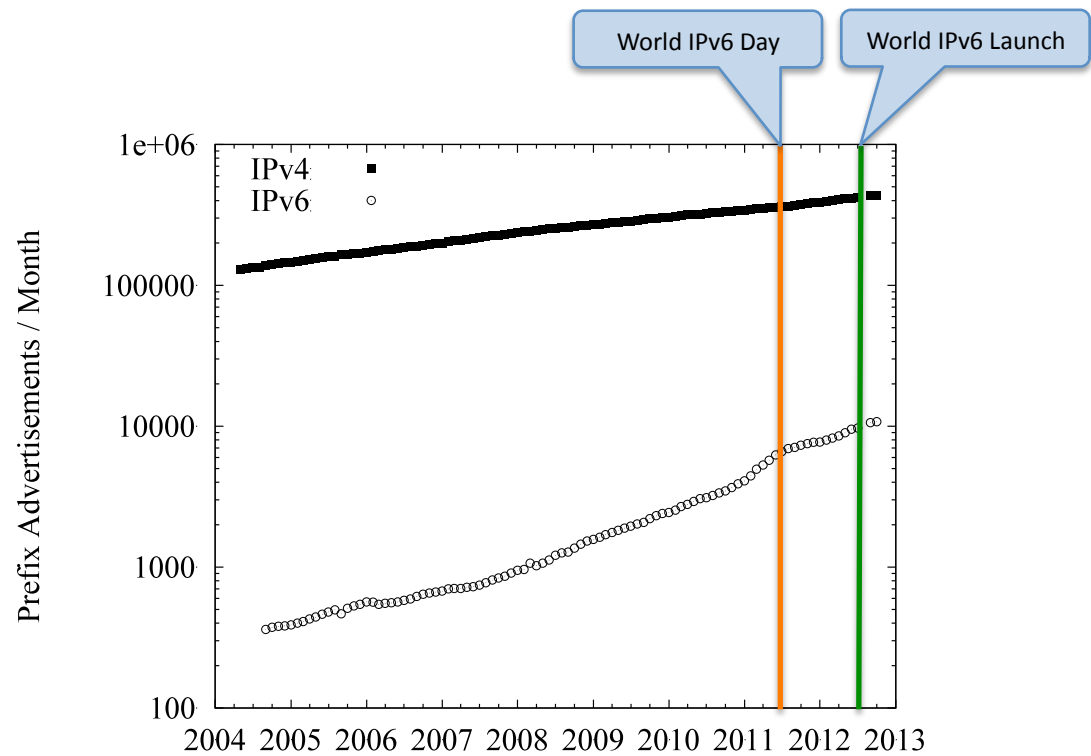
# Datasets

| Dataset                     | Time Period         | Scale  |
|-----------------------------|---------------------|--|
| RIR Address Allocations     | Jan 2004 - Oct 2012 | 9,126 allocation snapshots (5 daily)   |
| Route Views Routing Tables  | Sep 2004 - Oct 2012 | 36,945 BGP table dumps (12 daily)  |
| Google IPv6 Client Adoption | Sep 2008 - Oct 2012 | millions of daily global samples   |
| Arbor Netflow Traffic       | Mar 2010 - Oct 2012 | 12 customers, 400 routers, daily median: 3.9 terabits/sec (peak)                       |
| Verisign TLD Zone Files     | Apr 2007 - Oct 2012 | 24 daily snapshots of 2.5 million A+AAAA records (.com/.net)                           |
| Verisign TLD Packet Capture | 28 Aug 2012         | 4 global sites, 8 gTLD NS letters (.com/.net), 4.1Bn queries (~5% feasible gTLD sites) |
| Alexa Top Host Probing      | Apr 2011 - Oct 2012 | 10,000 servers probed daily  |

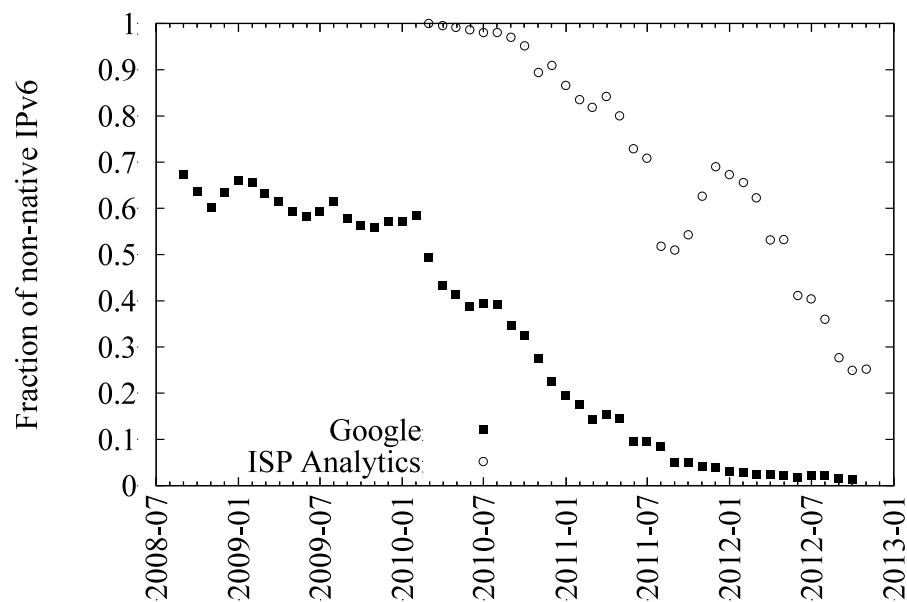
# IPv4 and IPv6 Prefixes Allocated



# IPv4 and IPv6 Prefixes Advertised

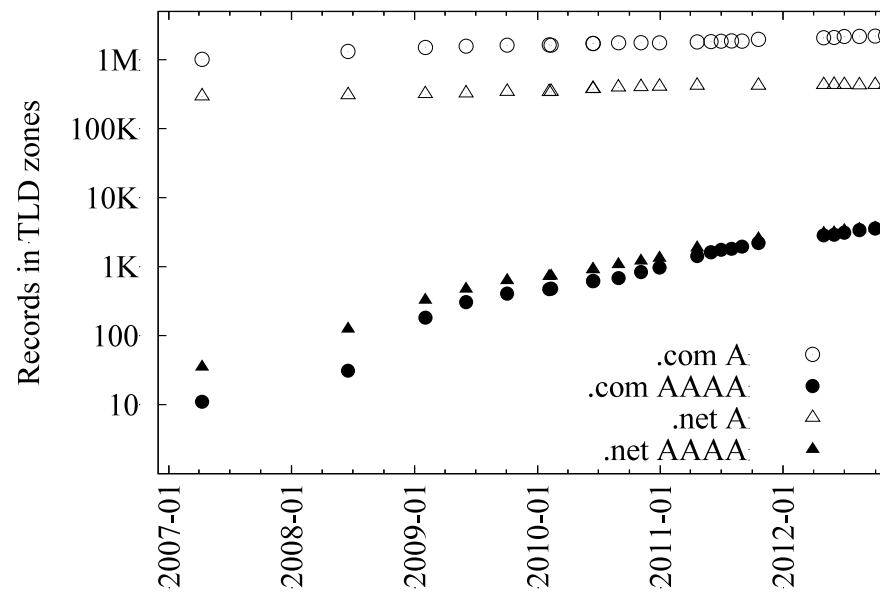


# Fraction of non-native IPv6 Traffic Seen by Google.com and in Arbor Samples



Where “non-native” = Teredo + Protocol 41

# Number of A and AAAA Glue Records in the .com and .net zones





# Resolver Population AAAA Demand

(Verisign .com/.net TLD Query Sample)

|               |                          |                         |
|---------------|--------------------------|-------------------------|
| <b>All</b>    | <b>All resolvers</b>     | <b>8,801,133 (100%)</b> |
|               | <b>with A queries</b>    | <b>8,603,372 (98%)</b>  |
|               | <b>with AAAA queries</b> | <b>2,967,950 (34%)</b>  |
| Active (>10k) | All active resolvers     | 78,249 (0.9% of all)    |
|               | with A queries           | 77,983 (100%)           |
|               | with AAAA queries        | 69,729 (89%)            |

# Top AAAA Lookups by Domain

(Verisign .com/.net TLD Query Sample)

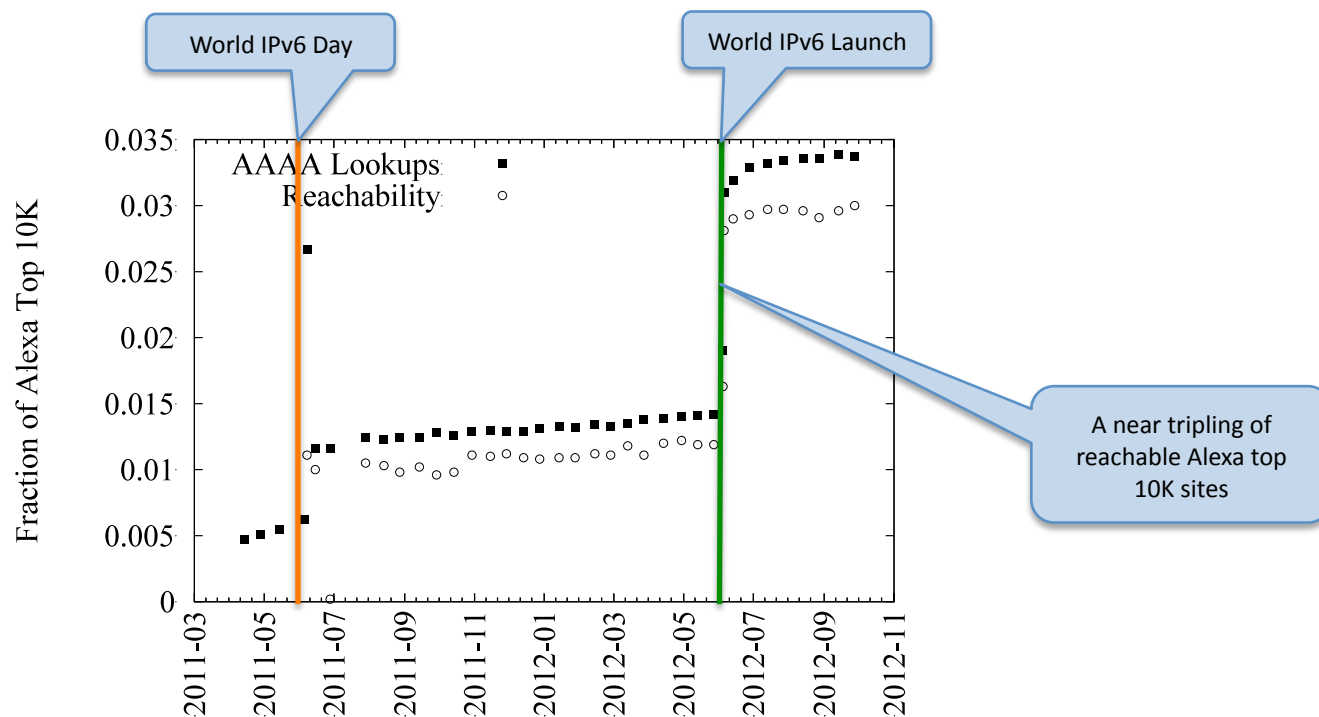
| Domain by 2LD     | AAAA<br>K Queries | A<br>Rank | A<br>K Queries | Alexa<br>Rank |
|-------------------|-------------------|-----------|----------------|---------------|
| gslb.com          | 3,421             | 6         | 5,776          |               |
| manitu.net        | 2,010             | 9         | 3,654          | 232K          |
| msft.net          | 2,005             | 7         | 4,225          |               |
| gtld-servers.net  | 1,327             | 16        | 2,903          |               |
| register.com      | 1,291             | 17        | 2,879          | 4K            |
| coremetrics.com   | 1,220             | 26        | 2,189          | 40K           |
| facebook.com      | 1,158             | 22        | 2,558          | 1             |
| savvis.net        | 1,144             | 12        | 3,507          | 211K          |
| weather.com       | 1,013             | 25        | 2,200          | 132           |
| cedexis-radar.net | 1,013             | 193       | 584            |               |
| qq.com            | 901               | 109       | 860            | 9             |
| iana-servers.net  | 891               | 36        | 1,775          |               |
| akam.net          | 875               | 31        | 2,011          | 998K          |
| name-services.com | 853               | 23        | 2,325          | 33K           |
| wearehair.net     | 788               | 99        | 915            |               |
| ib-ibi.com        | 772               | 46        | 1,563          | 962K          |
| apnic.net         | 765               | 54        | 1,456          | 48K           |
| amazonaws.com     | 744               | 48        | 1,532          | 156           |
| amazon.com        | 731               | 23        | 2,284          | 10            |
| ultradns.net      | 696               | 35        | 1,792          | 326K          |
| demonoid.com      | 686               | 90        | 966            | 53K           |
| comcast.net       | 628               | 60        | 1,265          | 168           |
| twtelecom.net     | 627               | 40        | 1,652          |               |
| shifen.com        | 623               | 103       | 889            |               |
| mediateple.net    | 617               | 69        | 1,163          | 104K          |

# Top 10 Resource Records Queried For

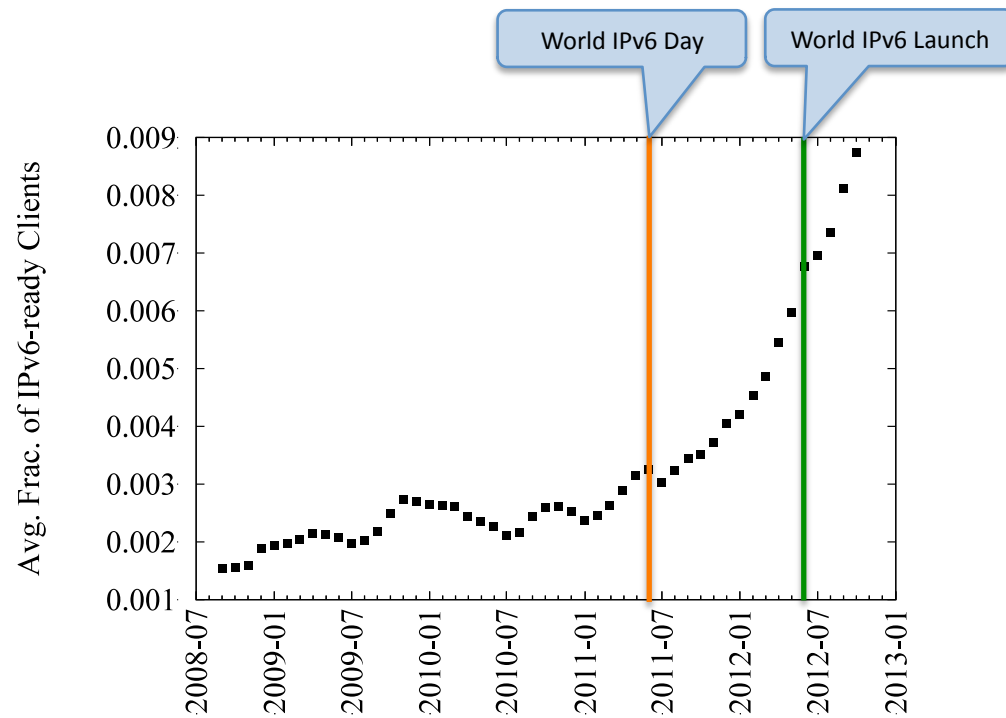
(Verisign .com/.net TLD Query Sample)

| Record Type | Million Queries | Percentage |
|-------------|-----------------|------------|
| A           | 2,741           | 66.60%     |
| MX          | 551             | 13.40%     |
| AAAA        | 430             | 10.50%     |
| DS          | 171             | 4.20%      |
| NS          | 64              | 1.60%      |
| TXT         | 61              | 1.50%      |
| ANY         | 43              | 1.00%      |
| SPF         | 12              | 0.30%      |
| SRV         | 12              | 0.30%      |
| A6          | 8               | 0.20%      |
| Other       | 20              | 0.50%      |
| Total       | 4,116           |            |

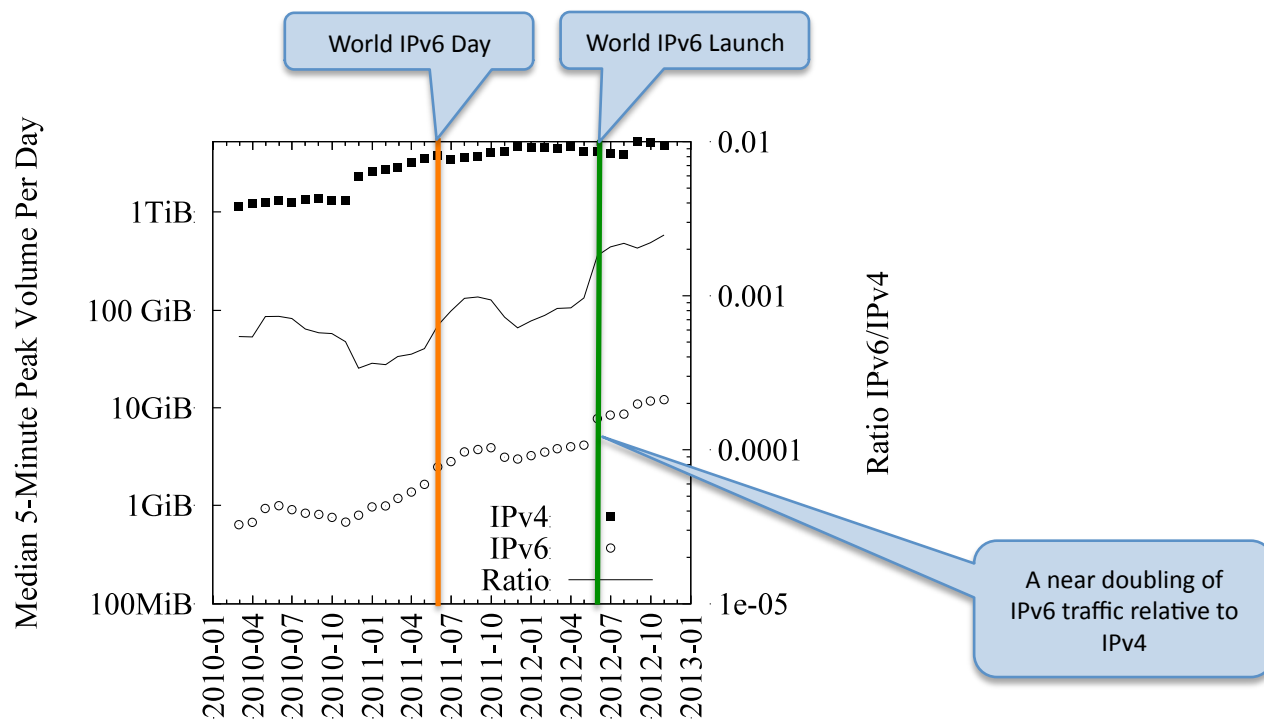
# AAAA Lookups and IPv6 Pings for Alexa top 10K domains



# Google.com IPv6-Ready Clients



# IPv4 and IPv6 Traffic Volume from Arbor's 12-provider Sample



# Application Mix

(Arbor data for April & May 2012)

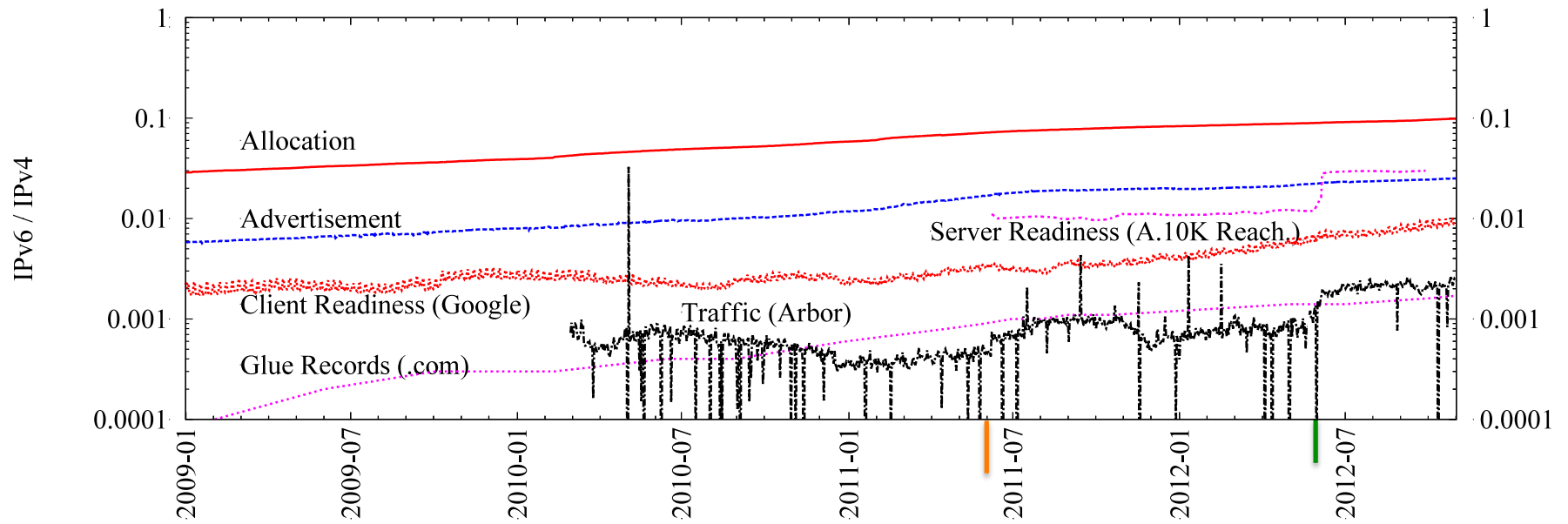
| App.      | IPv6 (%) | IPv4 (%) |
|-----------|----------|----------|
| http      | 63.04    | 62.4     |
| dns       | 4.09     | 0.14     |
| ssh       | 2.65     | 0.11     |
| rsync     | 2.65     | n/a      |
| nntp      | 1.03     | 0.13     |
| https     | 0.39     | 3.91     |
| flash     | 0.11     | 2.39     |
| other TCP | 18.72    | 3.2      |
| other UDP | 1.73     | 11.9     |
| other     | 4.94     | 14.1     |

# IPv6 Adoption Current State

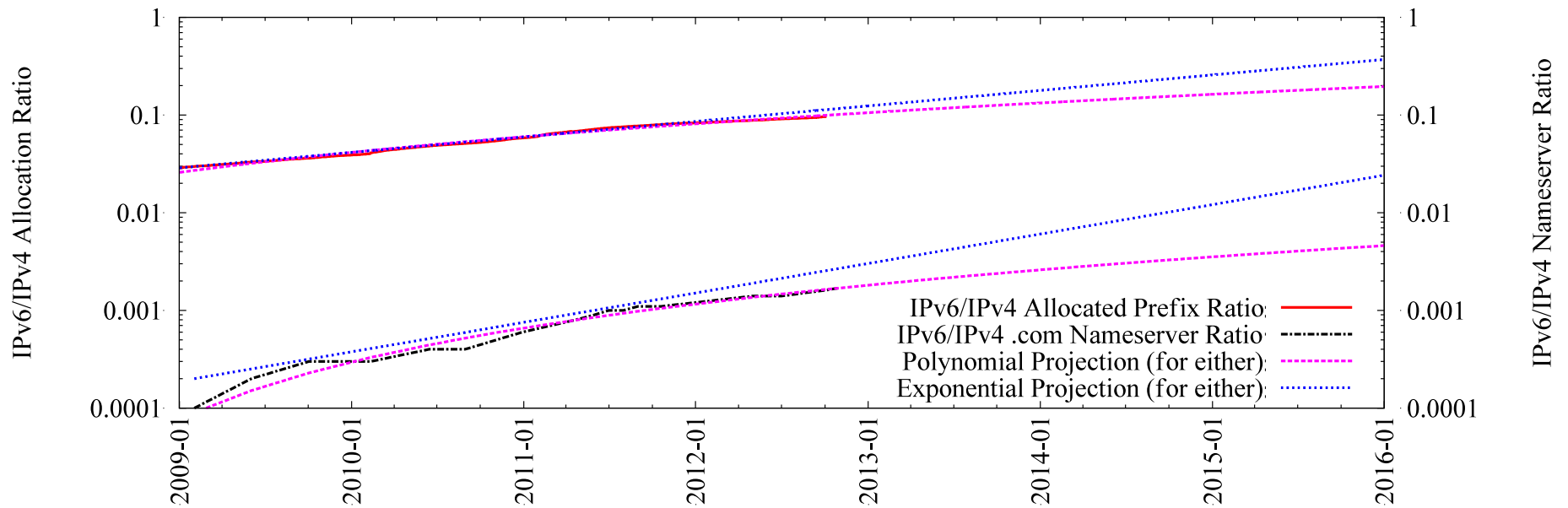
| Name                    | Current Status  |
|-------------------------|---|
| Address allocation      | 200+ IPv6 prefixes allocated per month (over 20% of total new allocations; nearly 10% of all prefixes allocated to date)      |
| Address advertisement   | 10500+ IPv6 prefixes advertised per month (nearly 3% of all prefixes advertised to date)                                      |
| Transition Technologies | Native IPv6 makes up about 75% of traffic   |
| DNS Nameservers         | 0.16% of .com and 0.84% of .net servers with A also have AAAA glue records  |
| DNS Resolvers           | 34% of all and 89% of active resolvers query for AAAA records   |
| DNS Queries             | AAAA records are the 3rd most popular RR query type and AAAA lookups tend towards under-the-hood services rather than content |
| Server readiness        | 3% of the Alexa top 10K web sites are reachable via IPv6  |
| Client readiness        | 0.8% of clients could access Google via IPv6  |
| Traffic Volume          | Peak IPv6 traffic is 0.2% of observed peak IPv4 ISP traffic volume  |
| Application Mix         | Aside from HTTP, IPv6 is used for a different set of applications than IPv4   |



# Longitudinal Measures



# Trends and Projections



# Conclusions

- Traffic data shows peak usage exceeding 0.2% -- a doubling in the last year
- Different metrics show different adoption levels, demanding comprehensive studies
- Prerequisite adoption follows logical order
- single-day events (e.g. World IPv6 day & esp. World IPv6 Launch) can have marked impact
- Over last four years adoption relative to v4 has increased by order of magnitude, with significant increase in the last six months