Rendezvous-based Traffic Classification, Measurement, and Analysis

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Outline

- Rendezvous-based Traffic Analysis
  - What is it? Why use it?
- Implementation: TreeTop
  - a DNS rendezvous-based analysis tool

    [Plonka & Barford, IMC 2009, SATIN 2011, work in progress]
  - flow export with rendezvous annotations
- Sample Applications:
  - Aggregate traffic measurement by service
  - Passive performance measurement of services on IPv6 versus IPv4

Rendezvous-based Traffic Analysis?

- Traffic classification and analysis has focussed on target traffic features (IP headers, DPI, etc.)

- However, Internet hosts learn IP addresses by some *rendezvous* mechanism, e.g.:
  - By static configuration (IP addrs in config files)
  - The Doman Name System (DNS)
  - Application-specific mechanisms (URLs, p2p)

- Inform traffic analysis by considering,
  "How does this host know this IP address?"
  rather than simply,
  "With what IP address did this host interact?"

Why Focus on Rendezvous?

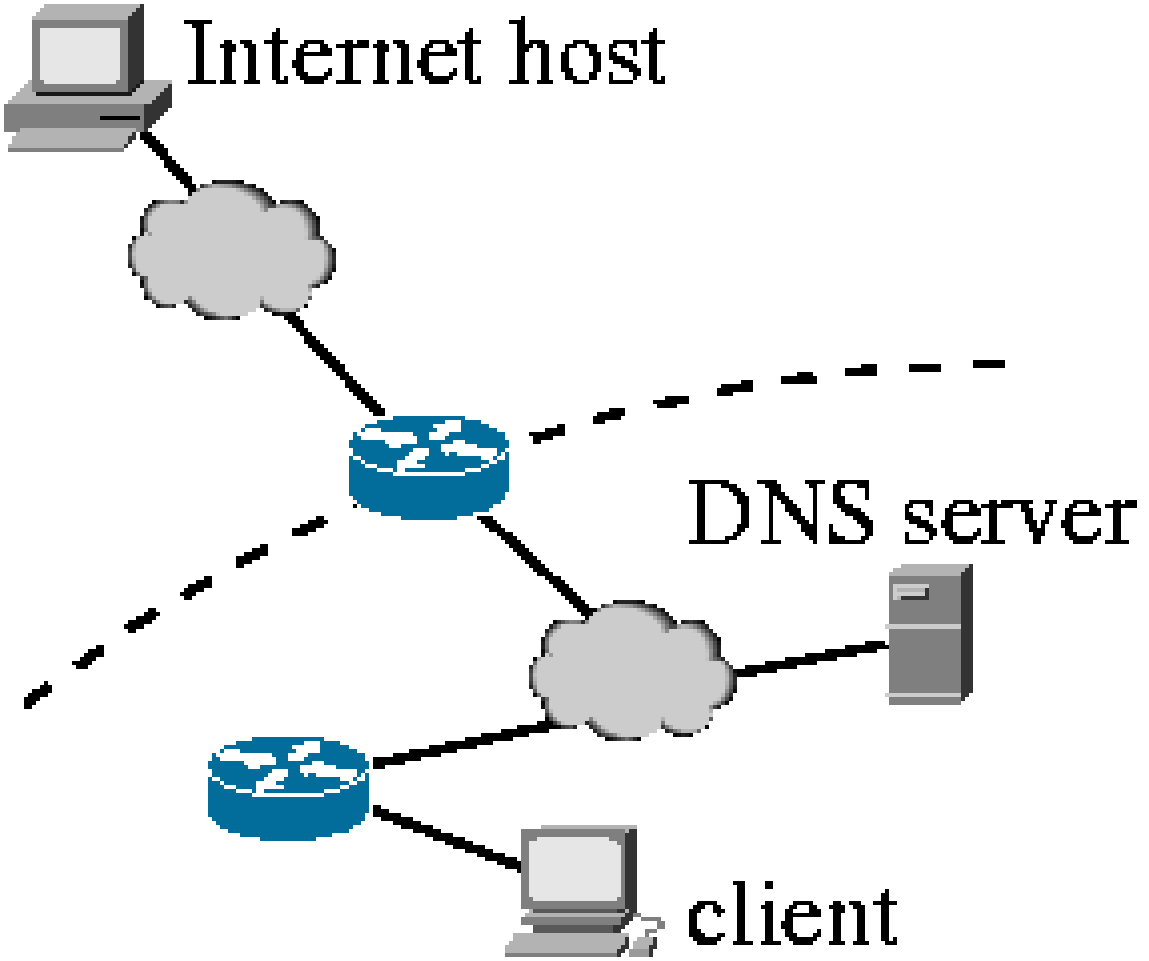
Rendezvous: how hosts “present themselves”

- For standard protocols, rendezvous information is not private and is of low-volume
  - Separate and separable from private payloads
  - Can be monitored in situations where target traffic is *high-volume, sampled, or encrypted*

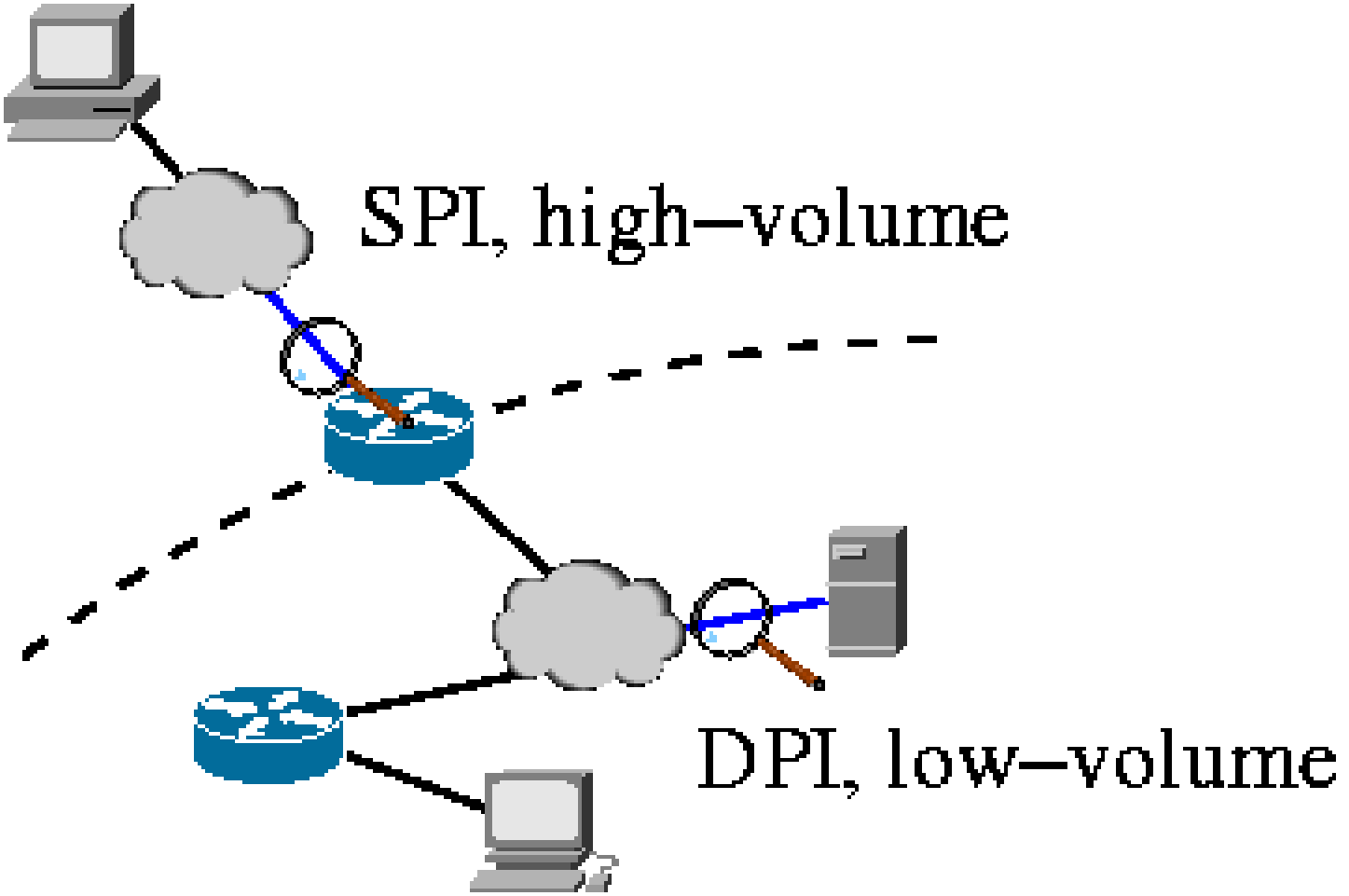
- Rendezvous info can indicate when other analysis or classification techniques are effective and when they're not
  - e.g., bolstered *port-based classification*

    [Kim, et al., 2008] [Plonka & Barford, 2011]

Traffic Observation Points



Traffic Observation Points



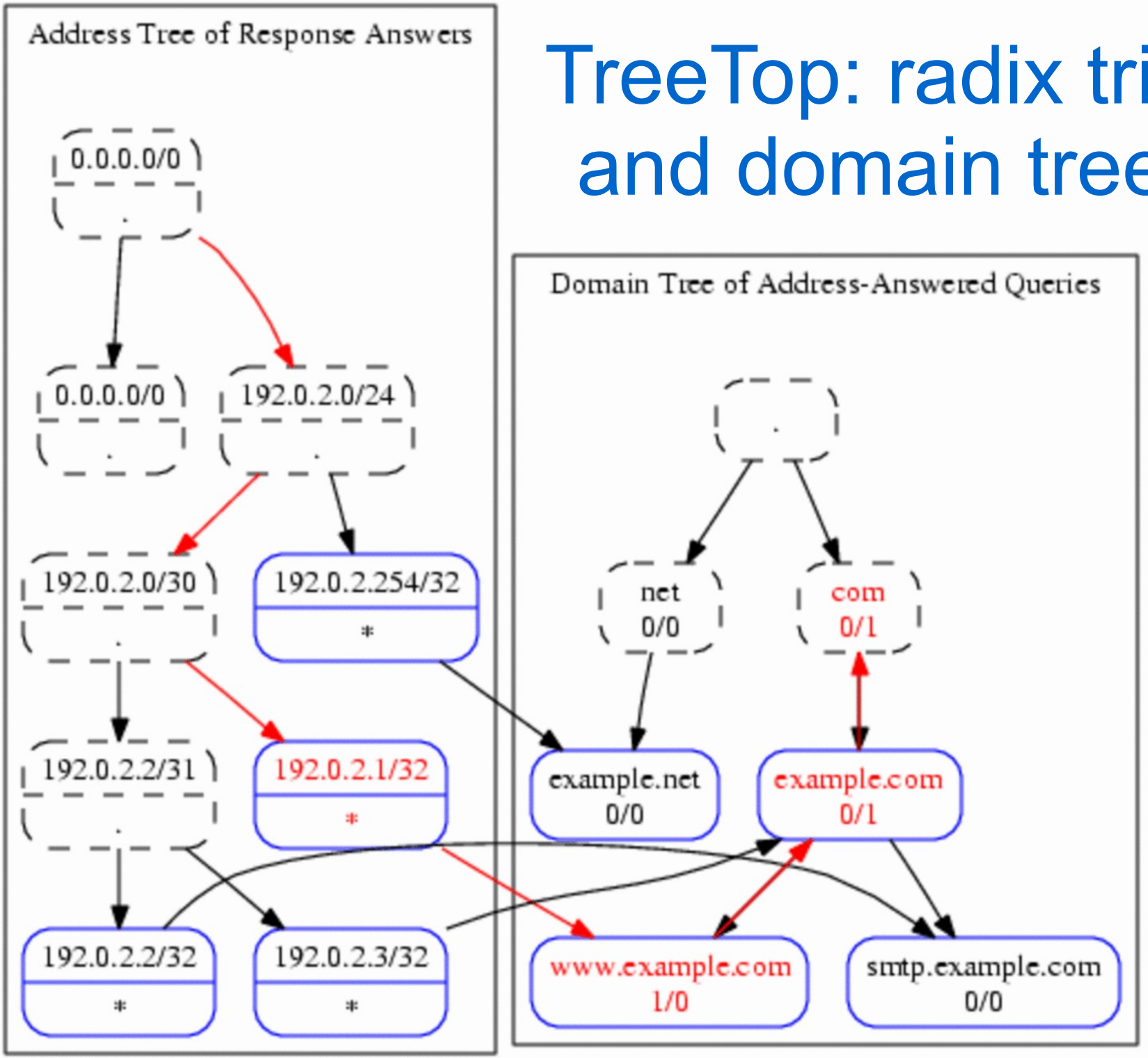
Rendezvous-annotated Flow Export

TreeTop uses two annotation approaches for flow source and destination addresses:

- ***Direct:*** TreeTop discovers that the given client end-host knows a remote IP address by a domain name from a prior DNS A or AAAA query

- ***Consensus***: we *infer*, by *shared* consensus of other client end-hosts, that the hosts could have used the DNS to similarly resolve the peer's name. Name *sampling* is performed to clarify otherwise ambiguous names.

TreeTop: radix tries and domain trees

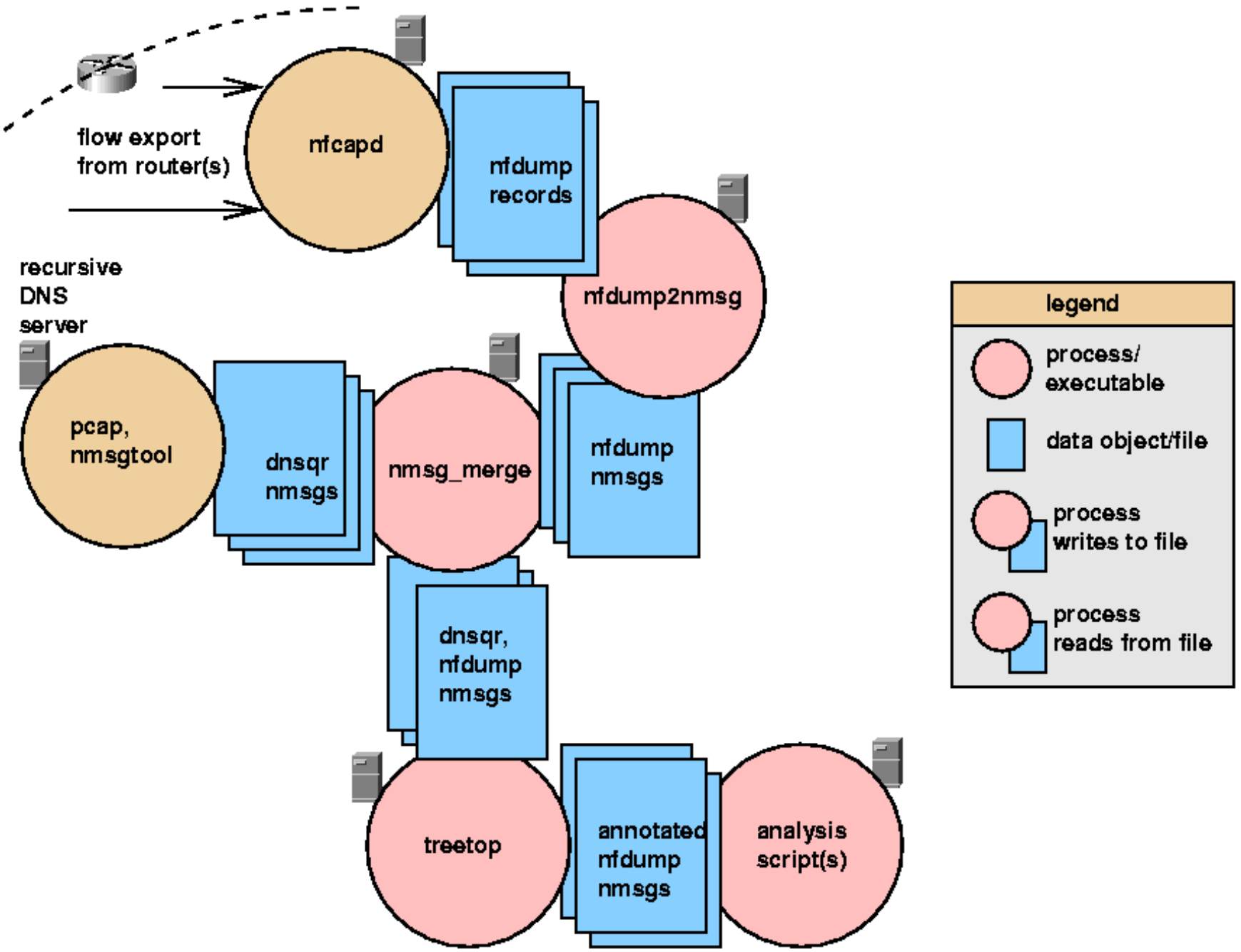


TreeTop enhanced with nmsg support

We select **nmsg** because it provides:

- an extensible mechanism for encapsualting rendezvous and IP traffic trace (flow) data
- a means of transmitting streams to distributed encapsulation and online analysis elements
- a serialized file format for offline analyses
- a scripting interface to build prototype components and perform ad hoc analyses

Rendezvous-annotated Flow Export



Rendezvous-annotated Flow Export (1)

```
[2011-06-08 21:52:26.000000000] [7:1 WISC nfdump]
ts: 1307569945
te: 1307569945
td: 0.064000
sa: 203.0.113.71
da: 192.0.2.32
sp: 80
dp: 55983
pr: 6
ibyt: 396630
snamed: CLIENT_DNS_NAMED
sn: static.ak.facebook.com
ip_version: IPV4
```

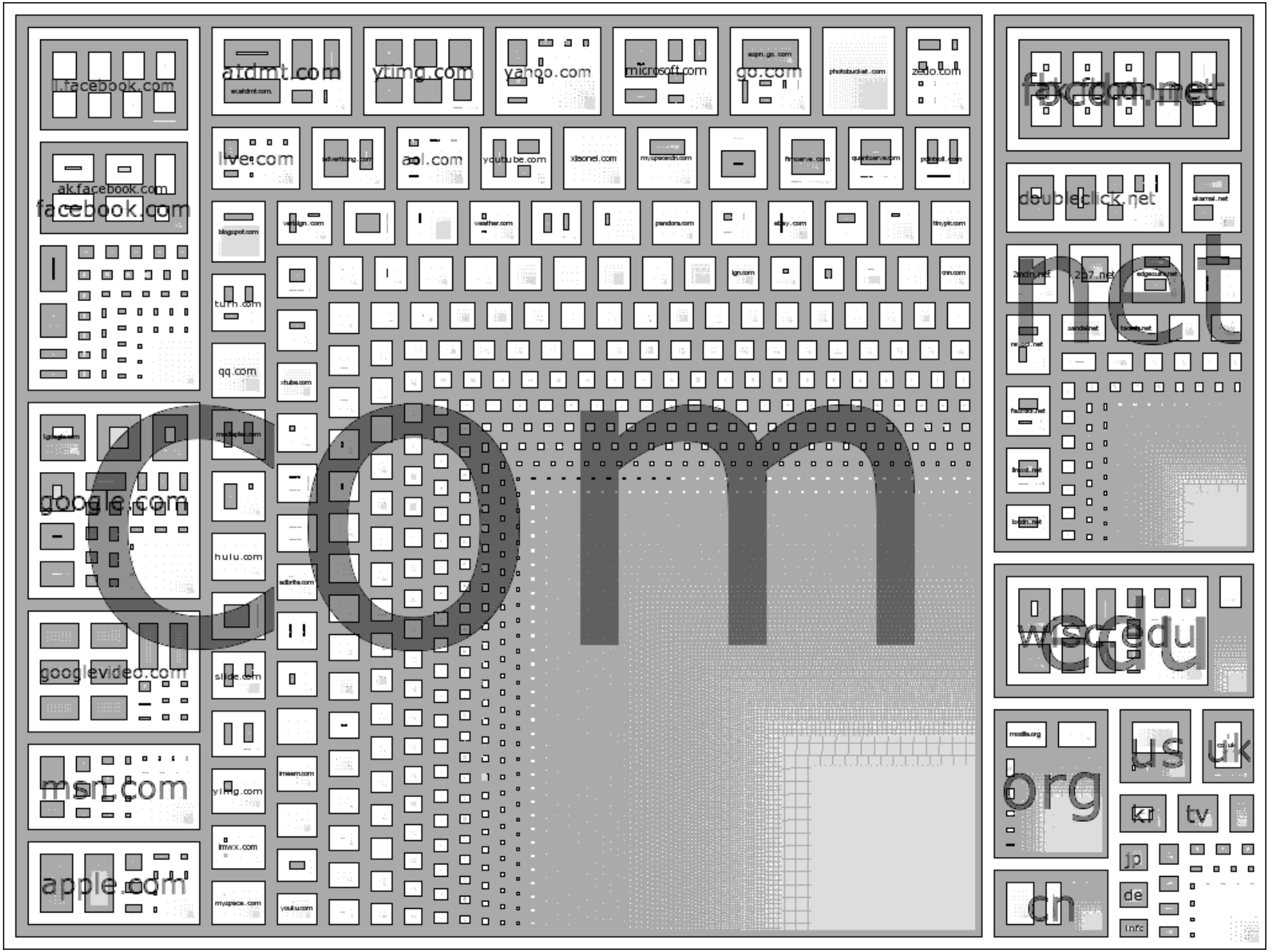
Rendezvous-annotated Flow Export (2)

```
[2011-06-08 20:14:11.000000000] [7:1 WISC nfdump]
ts: 1307564050
te: 1307564050
td: 0.064000
sa: 2001:0db8::face:b00c:0:3
da: 2001:0db8::2:1
sp: 443
dp: 53646
pr: 6
ibyt: 34297
snamed: INFERRED_DNS_NAMED
sn: *.facebook.com.
sn_sample: de-de.facebook.com.
sn_sample: check6.facebook.com.
sn_sample: ar-ar.facebook.com.
ip_version: IPV6
```

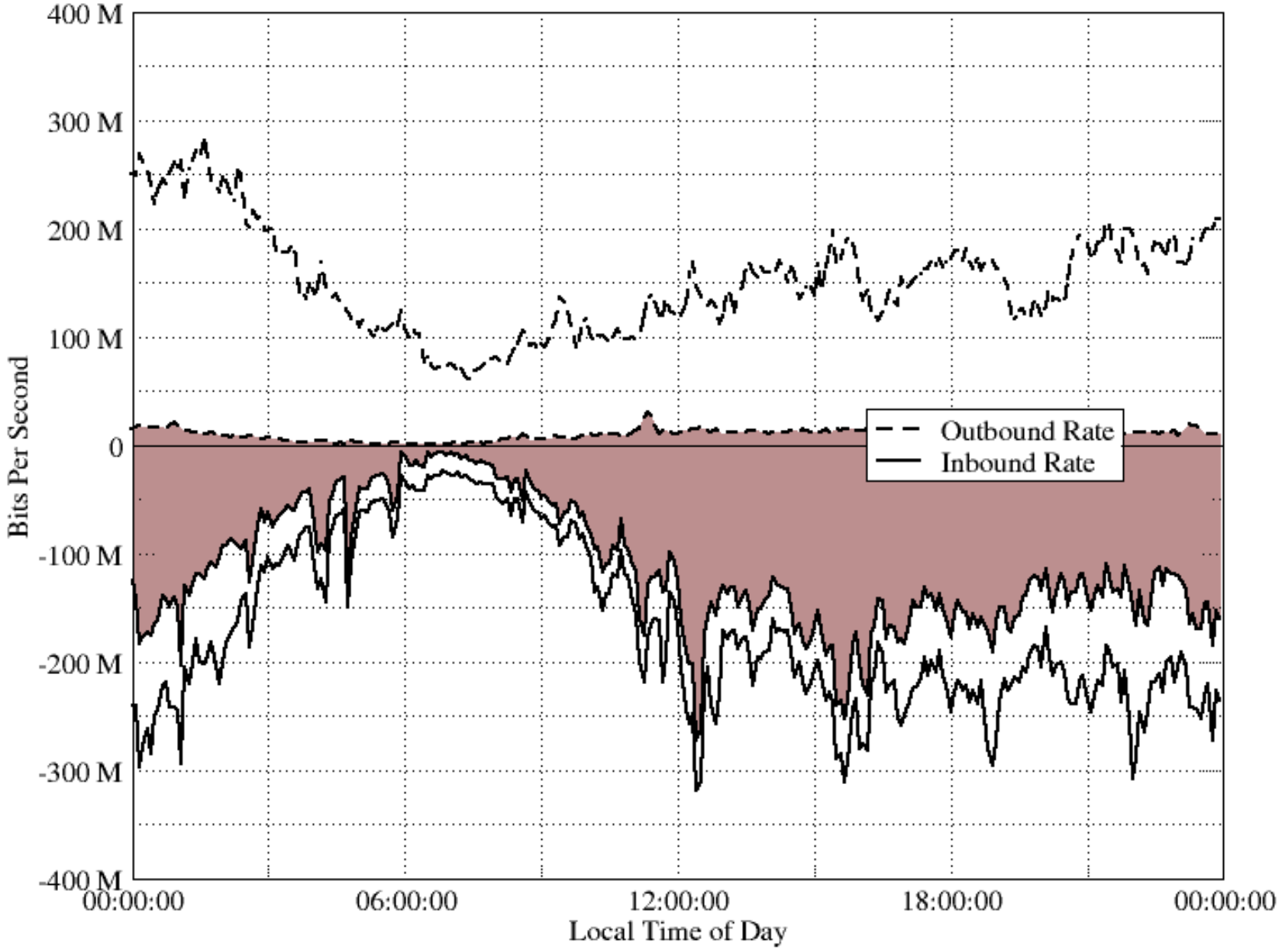
Rendezvous-annotated Flow Export (3)

```
[219] [2011-06-08 00:11:10.000000000] [7:1 WISC nfdump]
ts: 1307491869
te: 1307491869
td: 0.128000
sa: 2001:0db8::2:1
da: 2001:0db8:fff4::79
sp: 56451
dp: 80
pr: 6
ibyt: 849
dnamed: INFERRED_DNS_NAMED
dn: *.
dn_sample: rss.slashdot.org.
dn_sample: www.beantownbloggery.com.
ip_version: IPV6
```

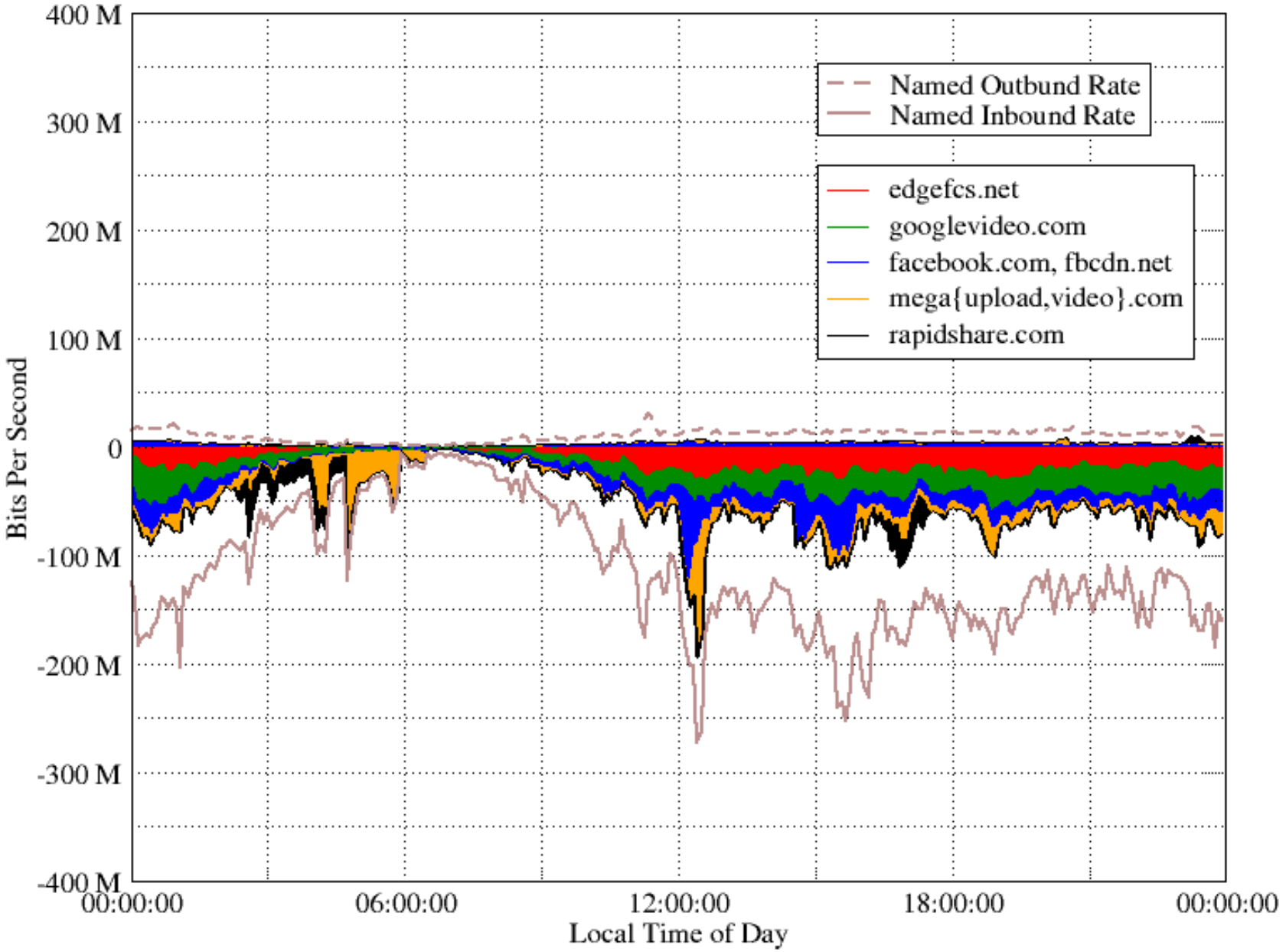
Residential: Domain Popularity



Aggregate Traffic: named & unnamed



Aggregate Traffic by Domain Name



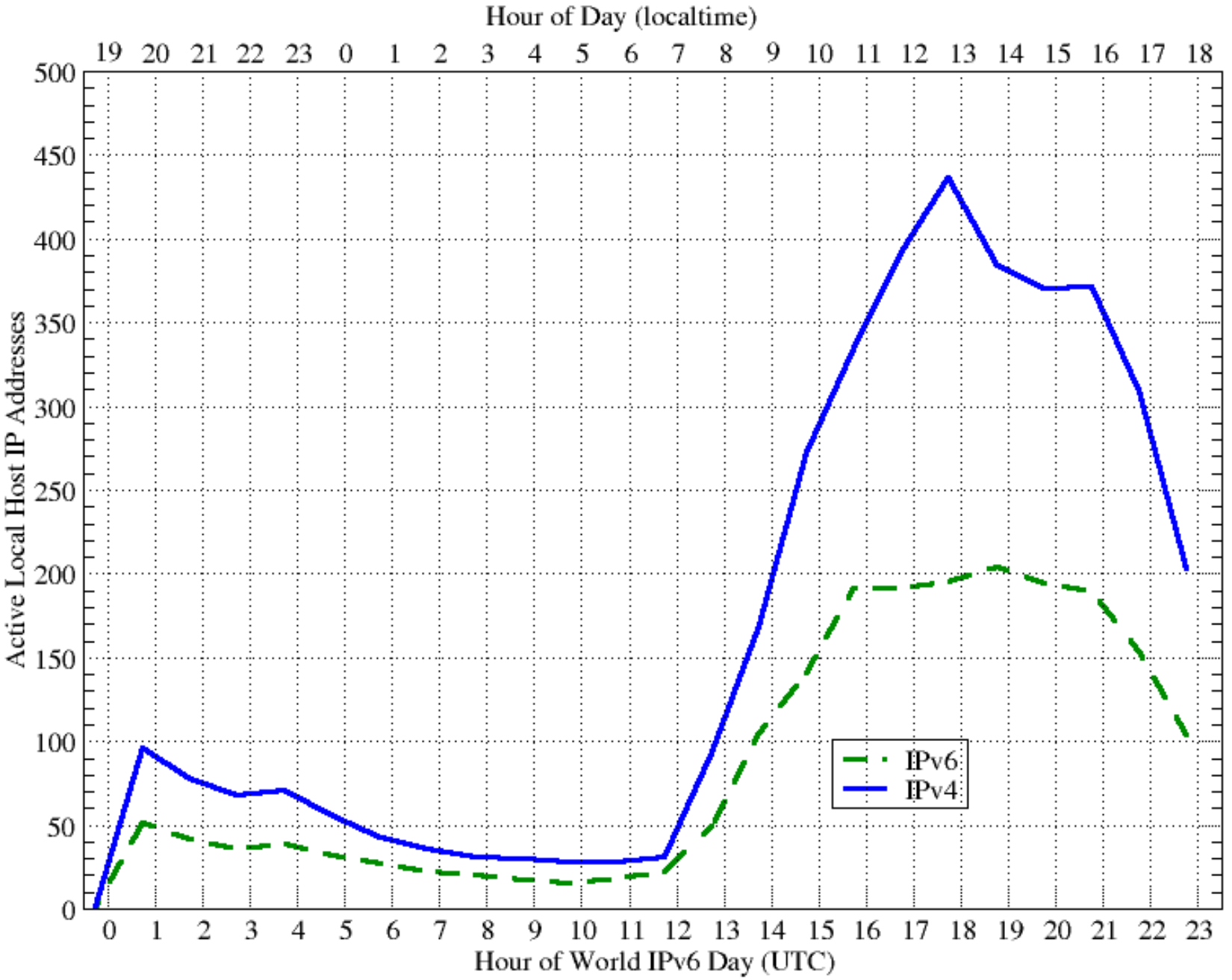
World IPv6 Day Performance Study: Trace Data Characteristics

Characteristic	Count
Trace duration	24 hours
DNS query responses	~14.2M
DNS IPv4 client addresses	2028
DNS IPv6 client addresses	23
DNS AAAA queries	~114.3K
DNS AAAA NOERROR responses	~6.2K
Flows - IPv4	~58.8M
Flows - IPv6	~2.4M

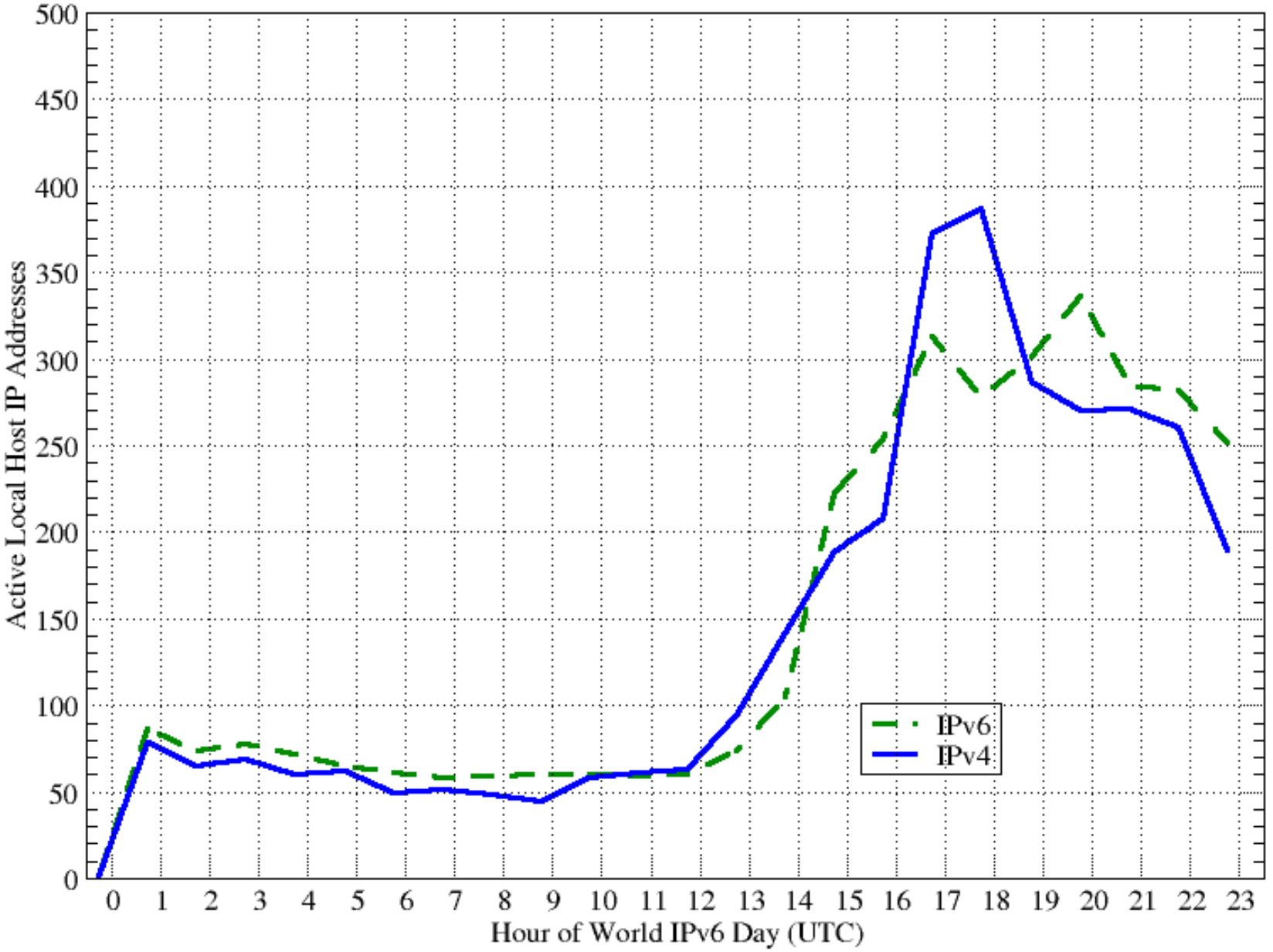
World IPv6 Day: Popular IPv6 FQDNs

Rank	FQDN
1	www.google.com.
2	www.google-analytics.com.
3	www.facebook.com.
4	ssl.gstatic.com.
5	safebrowsing.clients.google.com.
6	mail.google.com.
7	safebrowsing-cache.google.com.
8	clients1.google.com.
9	www.youtube.com.
10	view.atdmt.com.
11	ajax.googleapis.com.
12	news.google.com.
13	maps.google.com.
14	ssl.google-analytics.com.
15	addons.mozilla.org.
16	docs.google.com.
17	chatenabled.mail.google.com.
18	translate.google.com.
19	mail-attachment.googleusercontent.com.
20	sites.google.com.

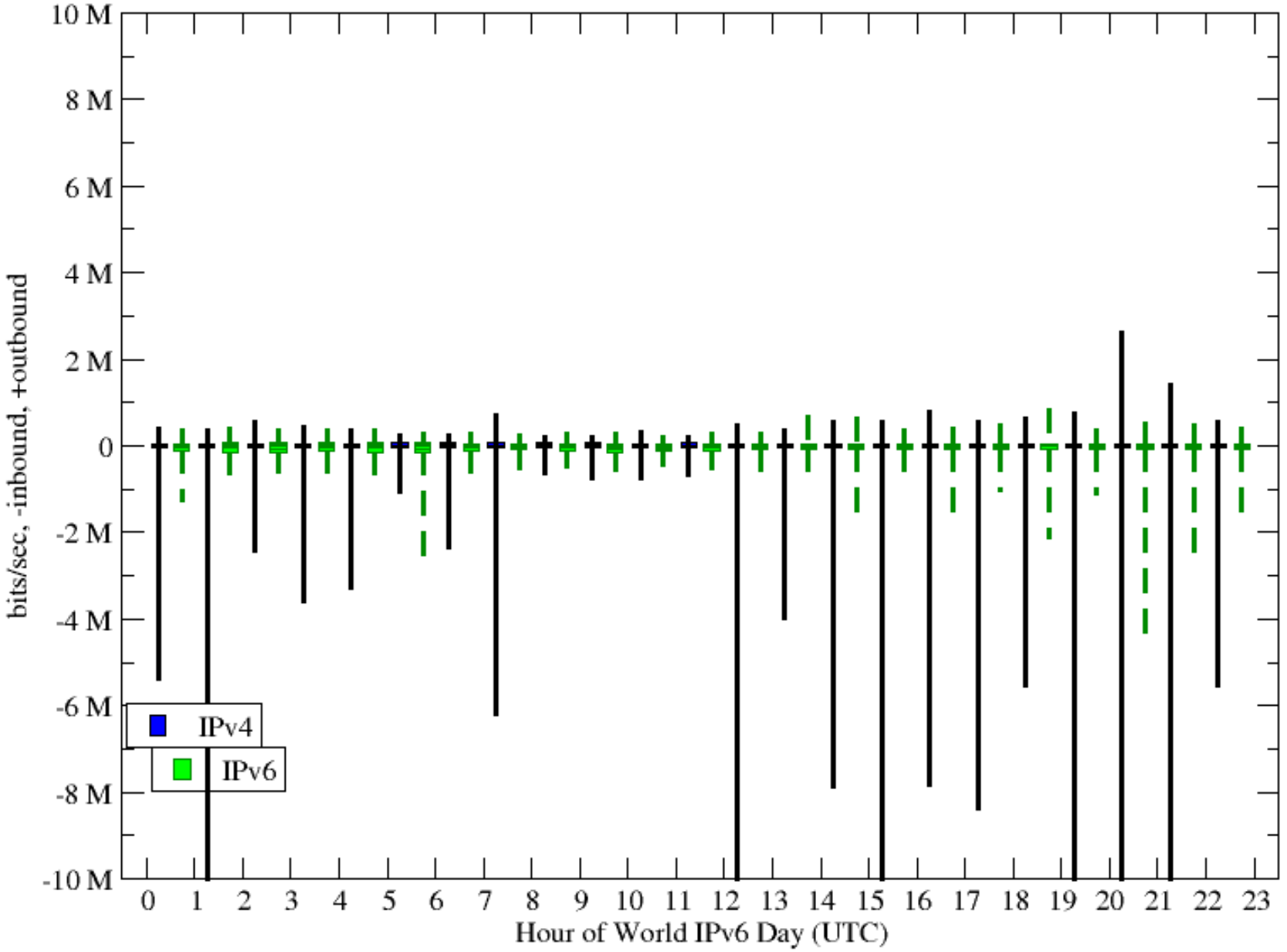
Facebook Active Client IP Addresses



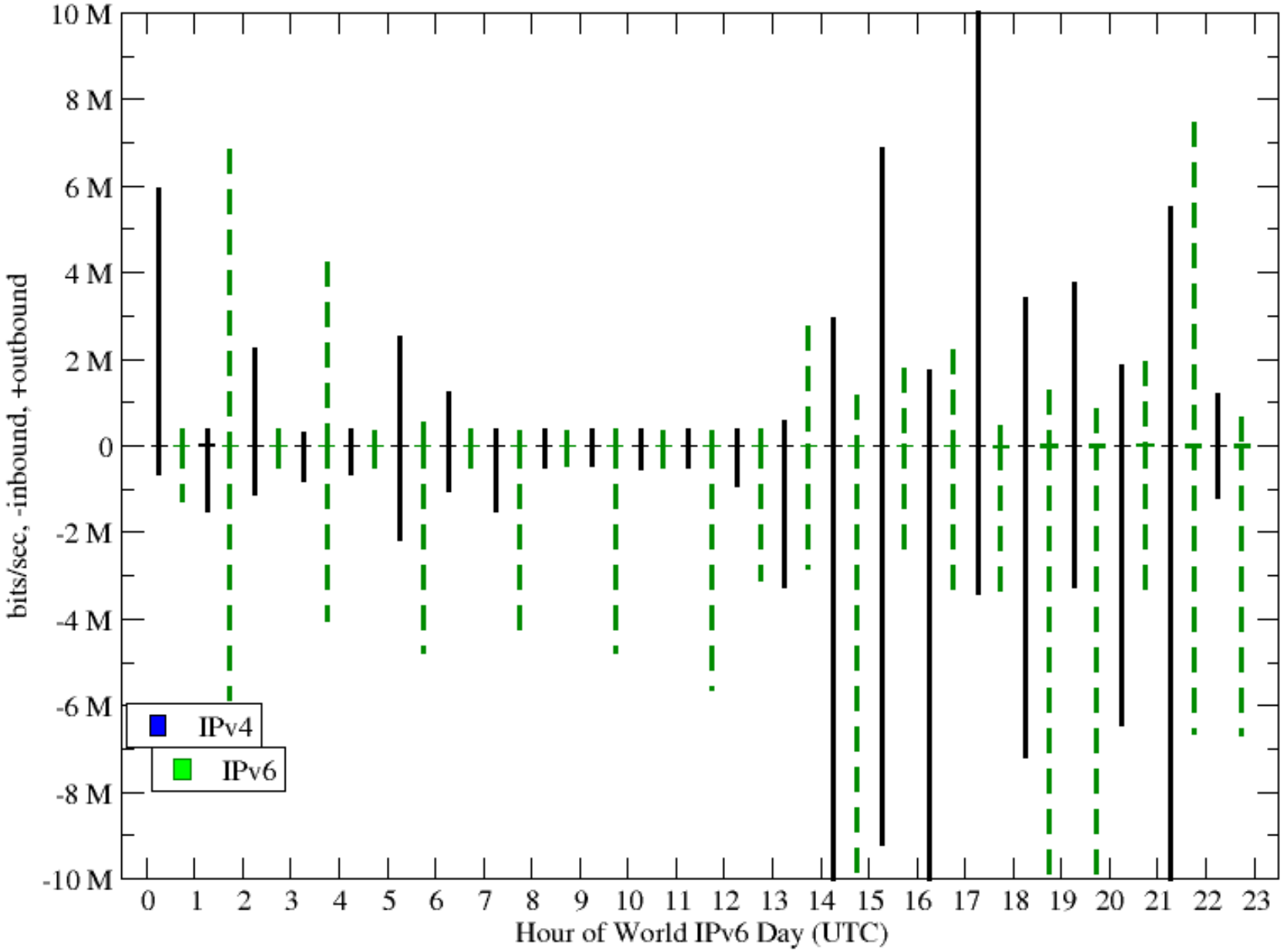
Gmail Active Client IP Addresses



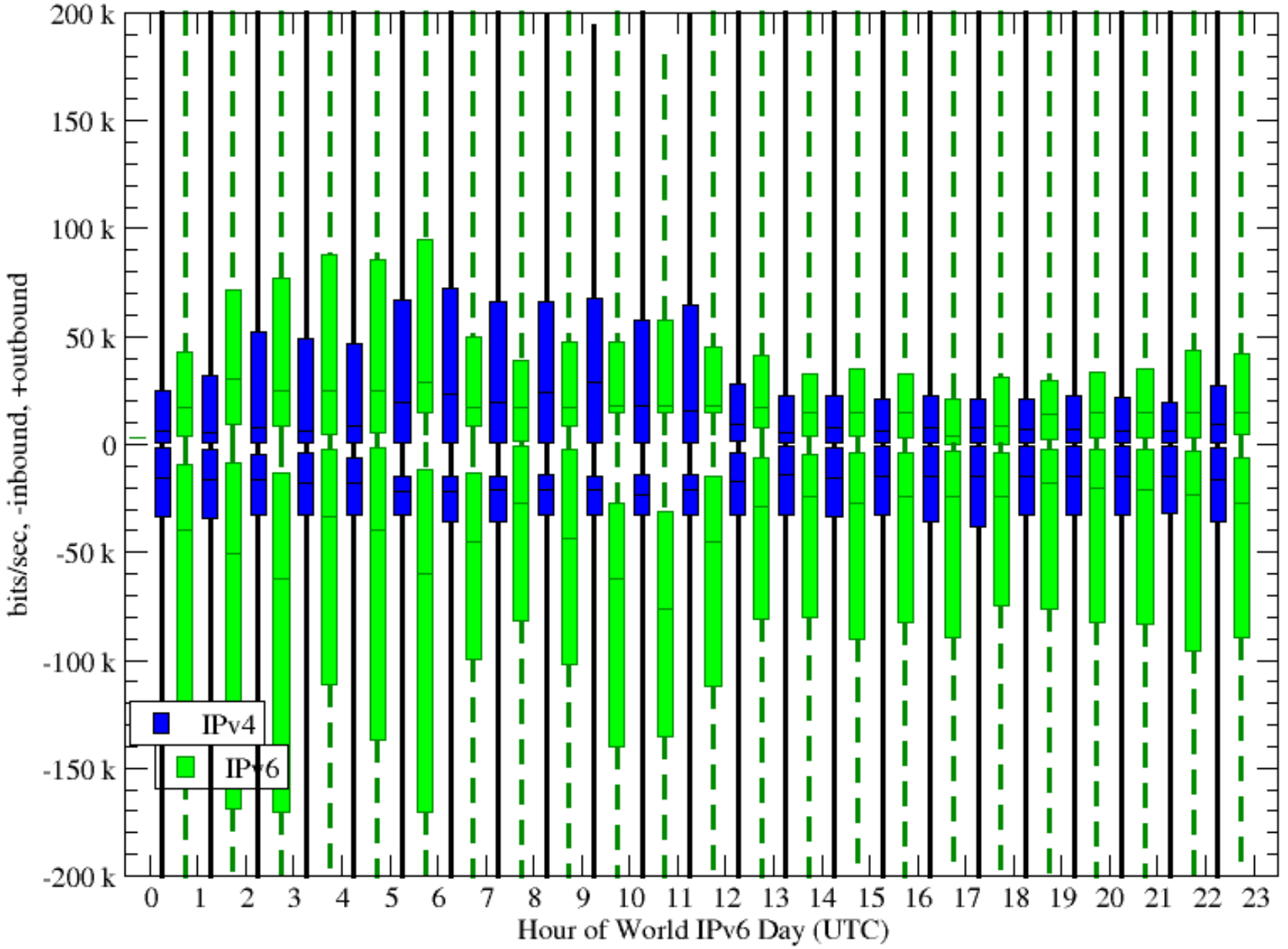
Facebook WWW Flow Bit Rates



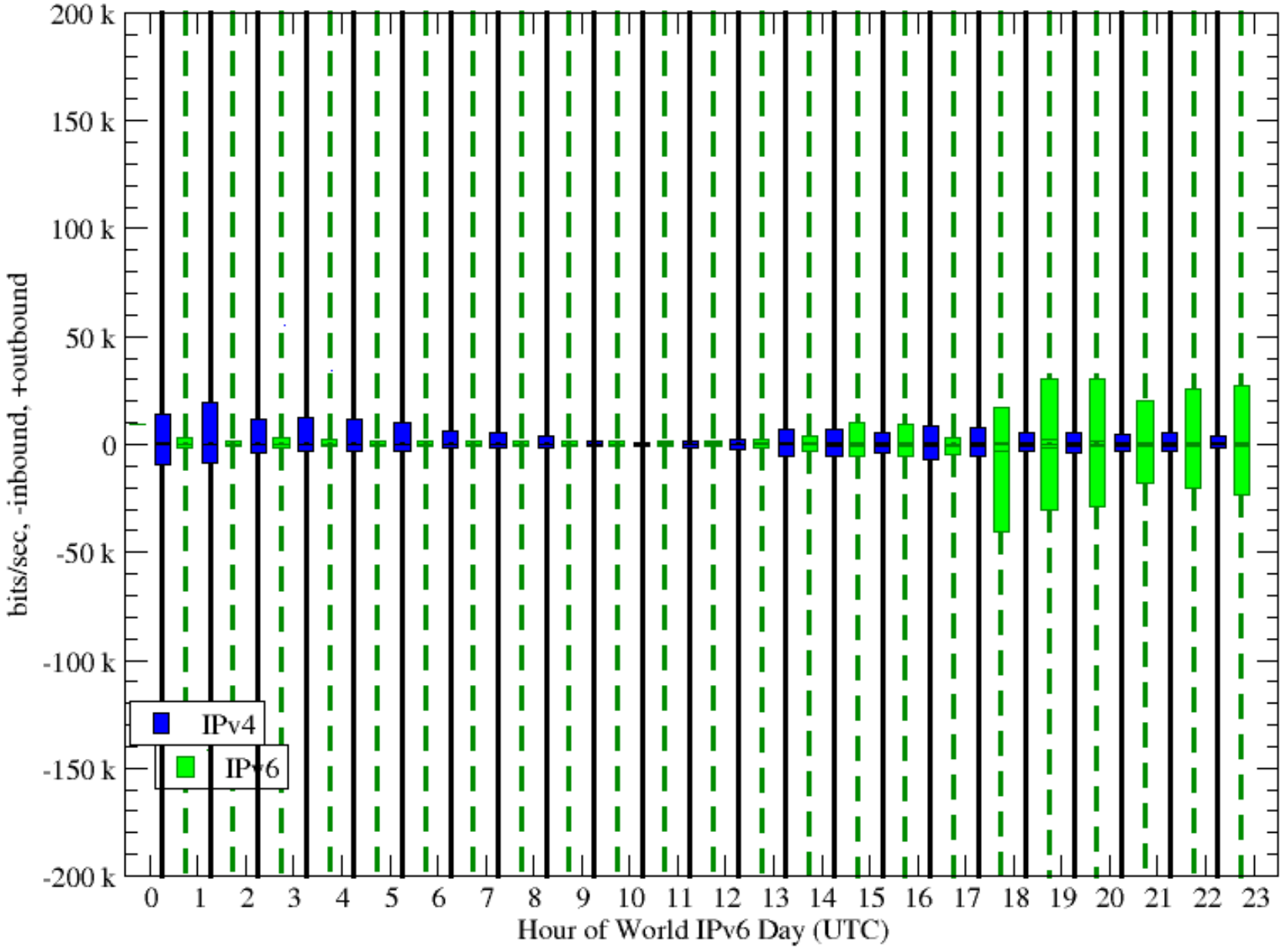
Gmail WWW Flow Bit Rates



Facebook WWW Flow Bit Rates (detail)



Gmail WWW Flow Bit Rates (detail)



Sharing Opportunities

- Use of dnsdb as basis for consensus labeling?
- Streams of anonymized recursive DNS query/responses?
- Tap other rendezvous mechanisms?
- Aggregate measurements, e.g. flow volumes, by DNS rendezvous?

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FIN

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