Measuring and Monitoring IPv6

“You cannot manage what you cannot measure”

Ciprian Popoviciu, Nephos6

It is time to focus on the quality of IPv6 enablement, not just on the size of its footprint!

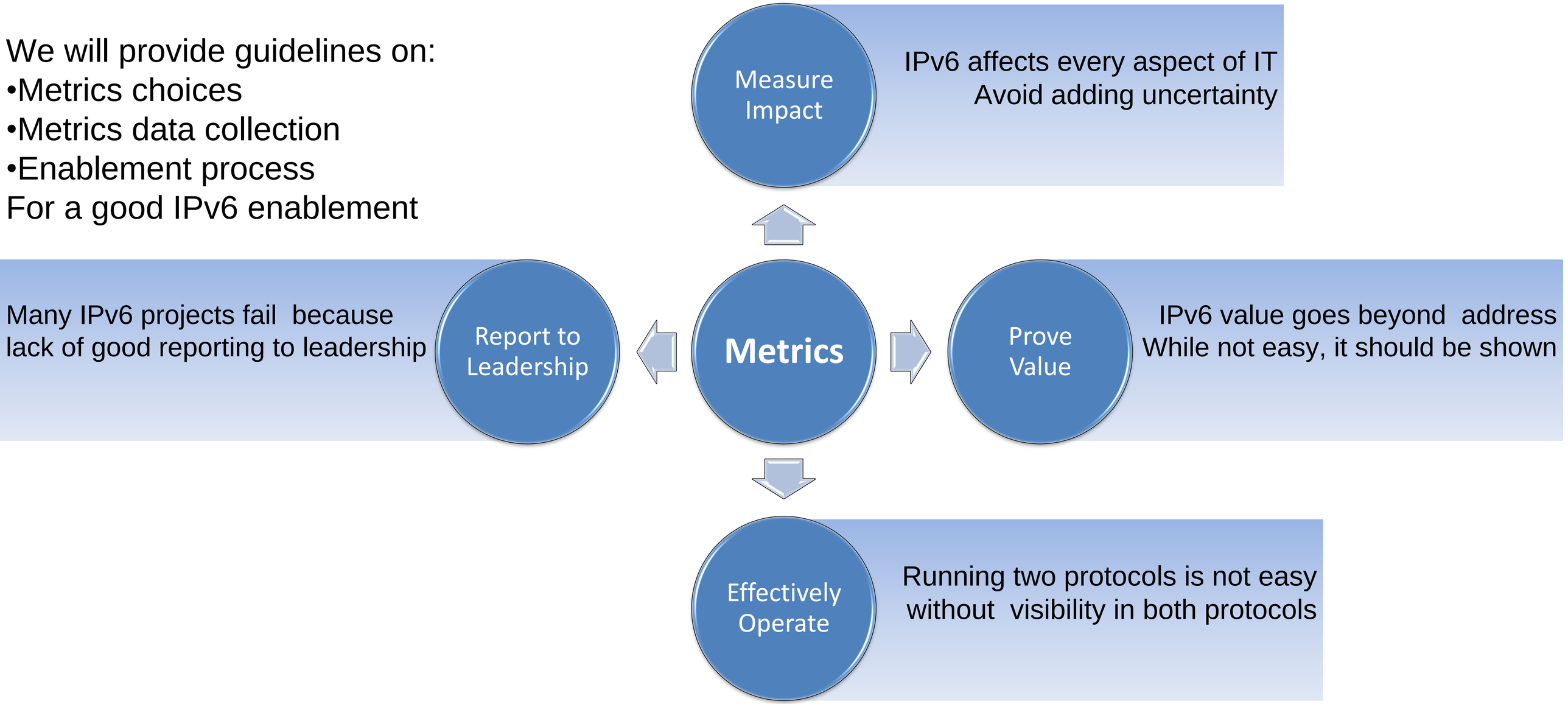
A good deployment could mean better user experience and a more scalable, easier to manage infrastructure

A bad deployment could mean poorer user experience, negative impact to the business, harder to troubleshoot issues

A Good IPv6 Enablement is Driven by Data

We will provide guidelines on:
- Metrics choices
- Metrics data collection
- Enablement process

For a good IPv6 enablement



IPv6 is The Plan of Record yet …

Monitoring tools are missing!

Emile Aben, RIPE

… and we all know we cannot manage what we cannot measure

Agenda

- Metrics for IPv6 Enablement and Operation
- IPv6 Measurement and Monitoring Considerations
- Data Collection
- IPv6 Performance Observations
- Conclusions

Why

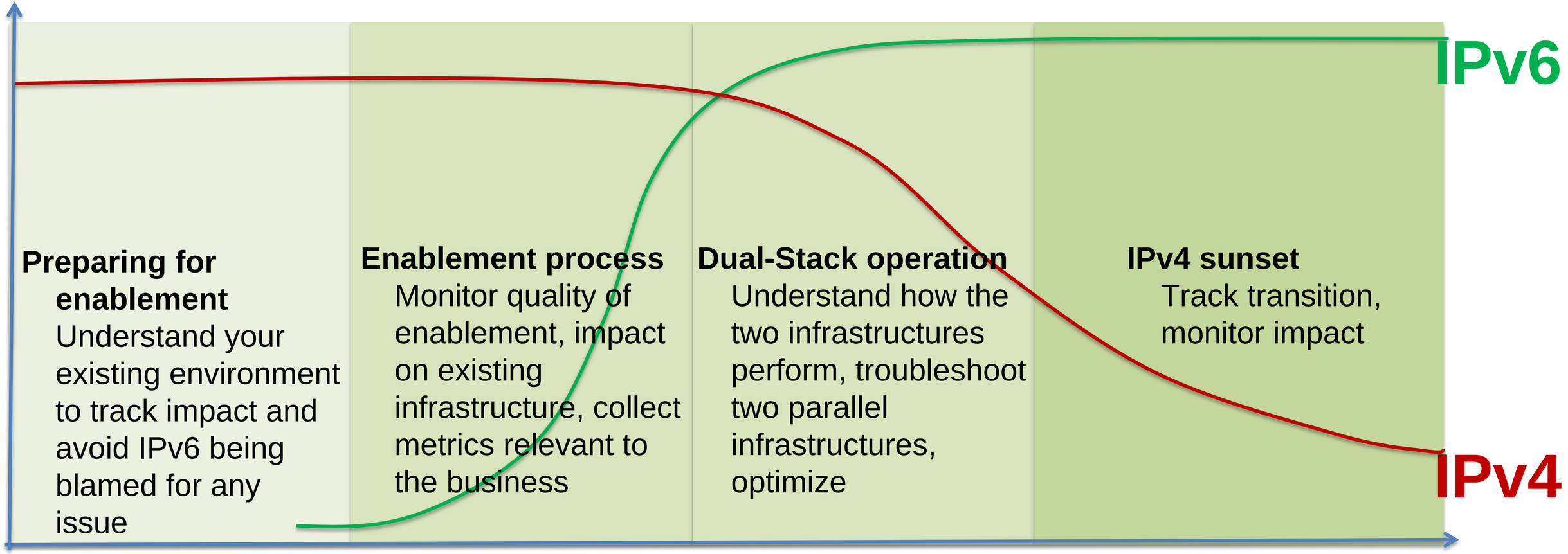
What

How

Metrics for IPv6 Enablement and Operation

Doing IPv6 Right, Not on a Prayer

Where do Metrics Help When Enabling IPv6?



Structural factors impacting UX such as deployment design
IPv6 specific factors impacting UX that related to management of IPv4-IPv6 co-existence

IPv6 Metrics Considerations

- User is not aware of IPv6. That means we need to understand how well the entire service is delivered over IPv6
- Multiple organizations and admin domains are involved in the end to end service delivery so it is not all up to us
- There are IP protocol selection mechanisms that were built in to make the transition smoother (Happy Eyeballs, DNS timing based selection)
- Networks are still in transitions, content access changes over time, support consistency not quite there yet

So What to Measure When it Comes to IPv6?

- Project related
  - Percentage enabled (e.g. 100% of Facebook data centers are IPv6 enabled)
  - Usage (e.g. 70% of Verizon mobile traffic is over IPv6)

IPv6 Marketing
Project Management
Variables

- Network related
  - DNS response time (some OSs make protocol selections based on this)
  - Round trip delay (impact on user experience)
  - TCP connect success rate and TCP connect times (Happy Eyeballs)

Explanatory Variables for a Good Deployment (data collected)

- Applications related
  - Application uptime over IPv6
  - User Experience
  - APDEX for IPv6 vs IPv4
  - IPv6 Effectiveness

Dependent Variables for a Good Deployment (relevant KPIs)

How to Measure?

Active Measurements (Causal, Proactive)	Passive Measurements (Correlation, Mainly Forensic)
▪ Sampling randomly from user machines (instrumented ad approach) ▪ Deterministic, periodic and controlled from agents acting as users	▪ Netflow 9 ▪ Inline traffic monitoring ▪ Logs ▪ Metrics at application level (if available)

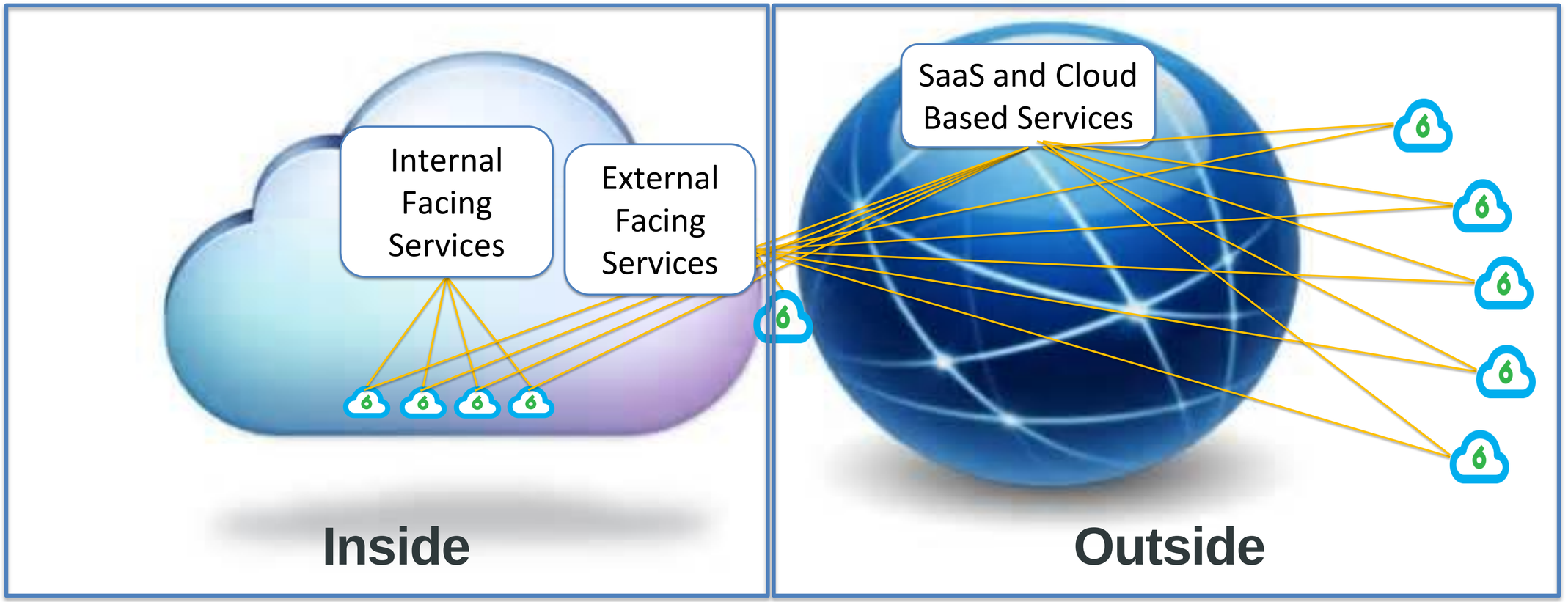
The focus of this presentation

When to Measure?

Periodic, Ongoing	Sampling, On Specific Observation Windows
▪ Events and changes impact the performance of the services over time ▪ Changes are not necessarily the same for IPv4 and IPv6	▪ Good for specific studies of performance ▪ Not helpful when issues occur and need more data or specific tests

The focus of this presentation

Two Perspectives – Outside vs Inside



1. Outside – Using Global Agents (Cloud Provider or Eyeball Networks)
2. Inside – Using agents Inside the Enterprise

A Note on IPv6 vs IPv4

- The metrics and methods used should be protocol independent, yet they should cover both
- It is important to be able to see the data side by side when running a dual-stack environment

The good thing is that you do not need to define target values for IPv6 metrics, you already have them from IPv4

The key goal is for your IPv6 metrics to be at least as good as the IPv4 ones as measured before you started IPv6 enablement

Unique opportunity to improve UX from day one!

Data Collection

Using v6Sonar platform

Global Infrastructure – Outside View

- Agents deployed in dual-stacked CSPs
- Measuring (IPv6/IPv4):
  - DNS response
  - Ping
  - Traceroute (TCP)
  - TCP connect time
  - Full page load
- Polling every 10 minutes

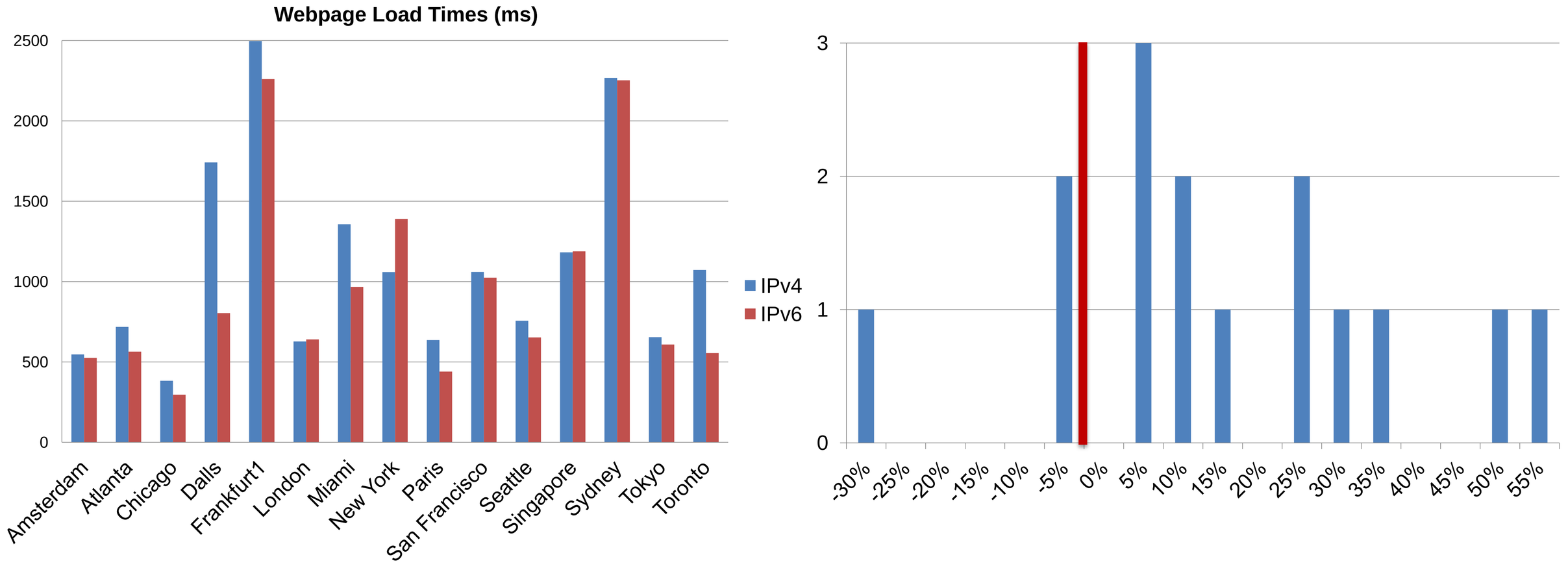
IPv6 Performance Observations

The Good, The Bad and The Ugly

General Observations – Outside View

- Service performance over IPv6 is different than over IPv4
- Performance changes over time and events in IPv6 infrastructure are not always congruent with those in IPv4 infrastructure
- Notable differences based on location
- Tunnels still make a difference
- CDN for IPv6 is different than for IPv4
- Many organizations have no idea how performance over IPv6 compares to performance over IPv4 until an event occurs
- Service or resources go off of IPv6 for long periods of time.

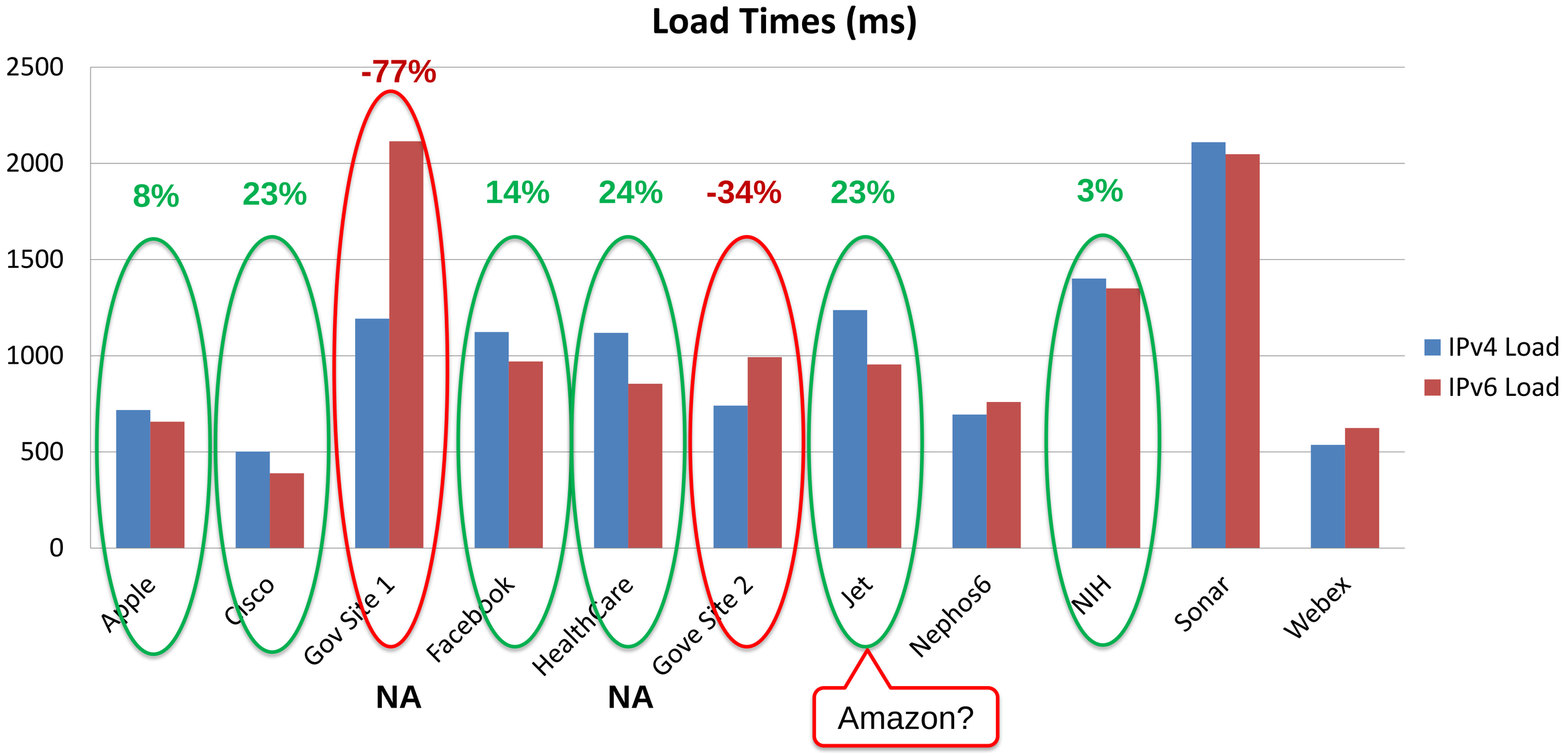
User Experience with Facebook is Better Over IPv6



- **Facebook is faster over IPv6 by 14% on average**

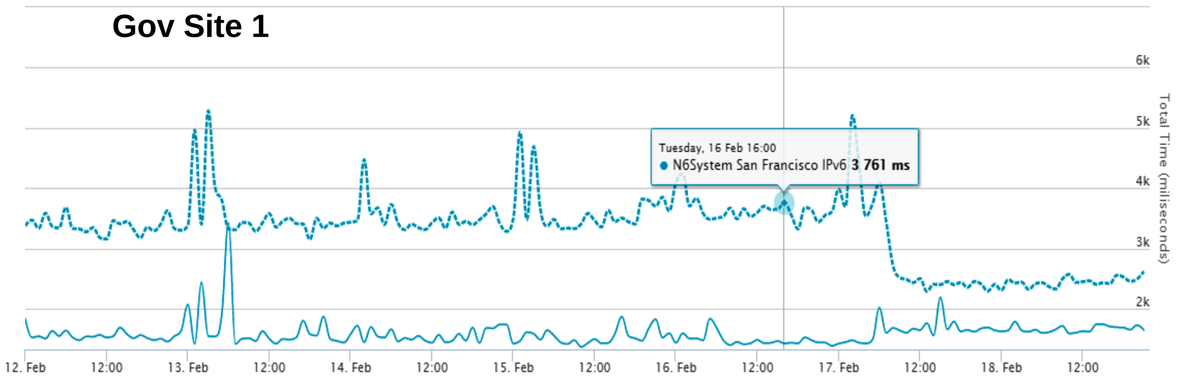
Data collected with www.v6sonar.com

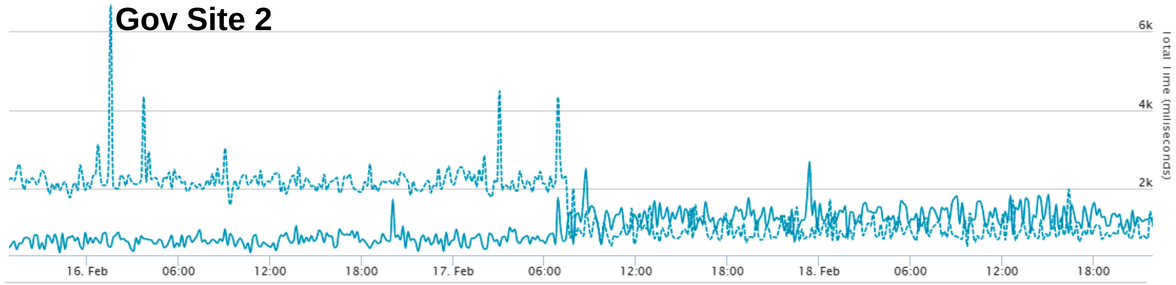
And Not Just Facebook

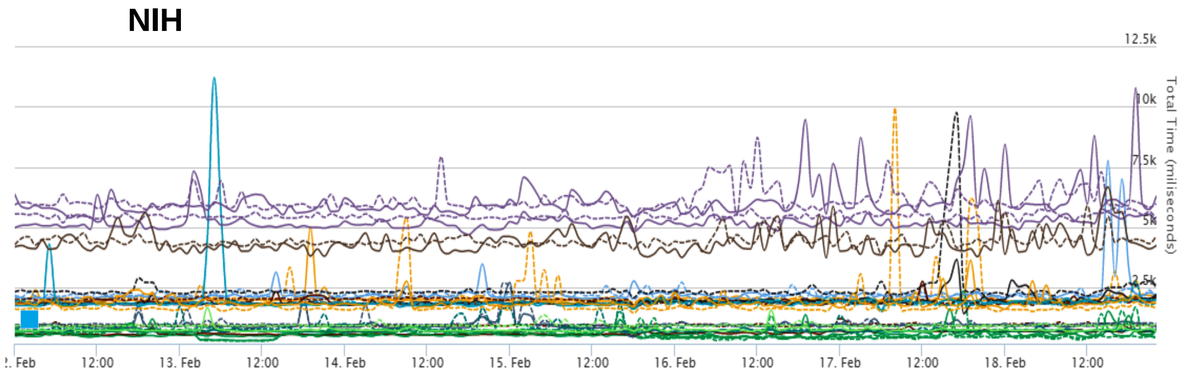


Data collected with www.v6sonar.com

It Does Not Depend Just on You to Do IPv6 Well







IPv4 Traceroute

Hop	ASN	Host	IP Address	Probe #1	Pro #2
1	AS14061	107.170.207.253	107.170.207.253	0.369ms	0.31
2	AS14061	198.199.99.253	198.199.99.253	0.328ms	0.27
3	AS2914	xe-0-0-0-23.r05.plalca01.us.bb.gin.ntt.net	129.250.204.117	2.673ms	2.65
4	AS2914	ae-15.r01.snjsca04.us.bb.gin.ntt.net	129.250.5.33	2.239ms	2.39
5	AS2914	ae-15.r01.snjsca04.us.bb.gin.ntt.net	129.250.5.33	2.291ms	2.07

IPv6 Traceroute

Hop	ASN	Host	IP Address	Probe #1	Probe #2	Pr #3
1	AS14061	2604:a880:1:20:ffff:ffff:ffff:fff1	2604:a880:1:20:ffff:ffff:ffff:fff1	0.316ms	0.275ms	0..
2	AS14061	2604:a880:1::501	2604:a880:1::501	0.226ms	0.261ms	0..
3	*	*	*	N/A	N/A	N/
4	AS2914	ae-15.r02.snjsca04.us.bb.gin.ntt.net	2001:418:0:2000::172	2.244ms	1.997ms	2..
5	AS2914	ae-10.r23.snjsca04.us.bb.gin.ntt.net	2001:418:0:2000::cd	1.821ms	1.843ms	11
6	AS2914	ae-3.r20.sttlwa01.us.bb.gin.ntt.net	2001:418:0:2000::156	21.117ms	20.052ms	20
7	AS2914	ae-0.r21.sttlwa01.us.bb.gin.ntt.net	2001:418:0:2000::e6	21.304ms	21.234ms	21
8	AS2914	ae-0.r24.nycmny01.us.bb.gin.ntt.net	2001:418:0:2000::72	97.834ms	98.83ms	97
9	AS2914	ae-1.r08.nycmny01.us.bb.gin.ntt.net	2001:418:0:2000::13e	91.778ms	99.403ms	99
10	AS2914	2001:418:0:5000::1c3	2001:418:0:5000::1c3	97.771ms	90.742ms	98
11	AS20940	2600:141b:4:188::2d7	2600:141b:4:188::2d7	90.89ms	84.774ms	98

IPv4 Traceroute

Hop	ASN	Host	IP Addr
1	AS14061	107.170.207.253	107.170.
2	AS14061	198.199.99.253	198.199.
3	AS2914	xe-0-0-0-23.r05.plalca01.us.bb.gin.ntt.net	129.250.
4	AS2914	ae-15.r01.snjsca04.us.bb.gin.ntt.net	129.250.
5	AS2914/AS16625/AS22773	a23-36-57-182.deploy.static.akamaitechnologies.com	23.36.57

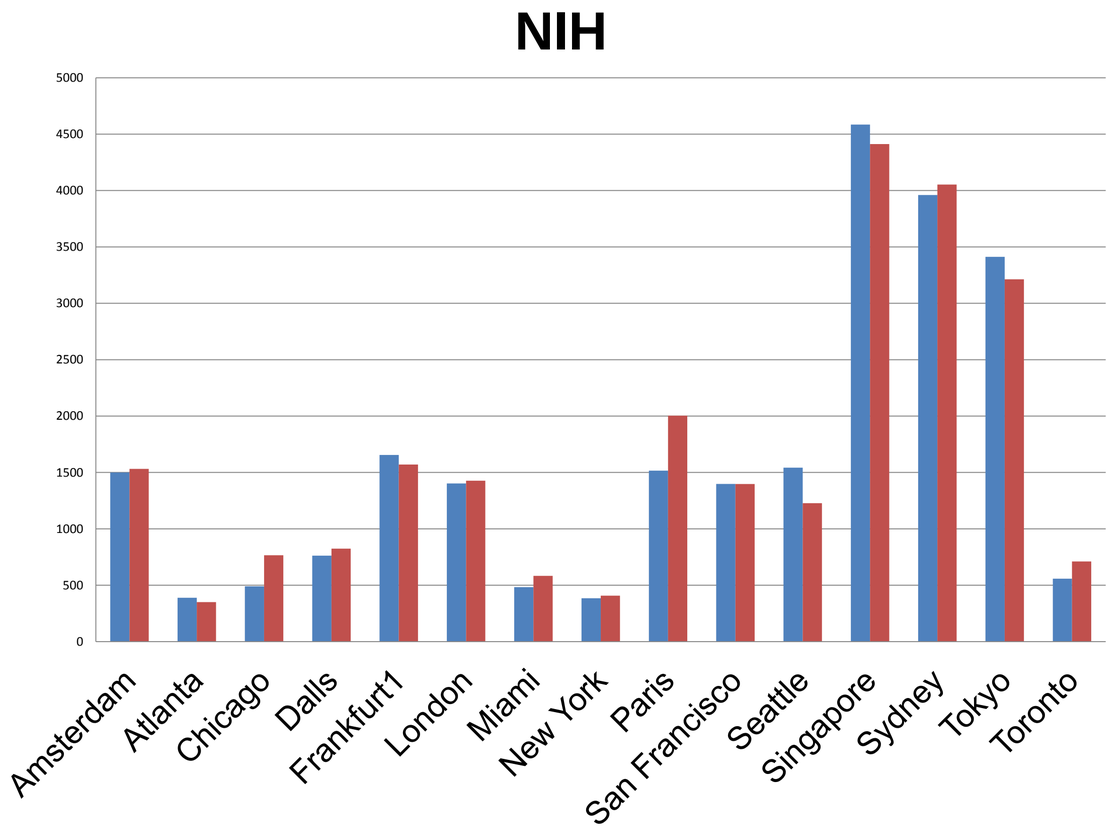
IPv6 Traceroute

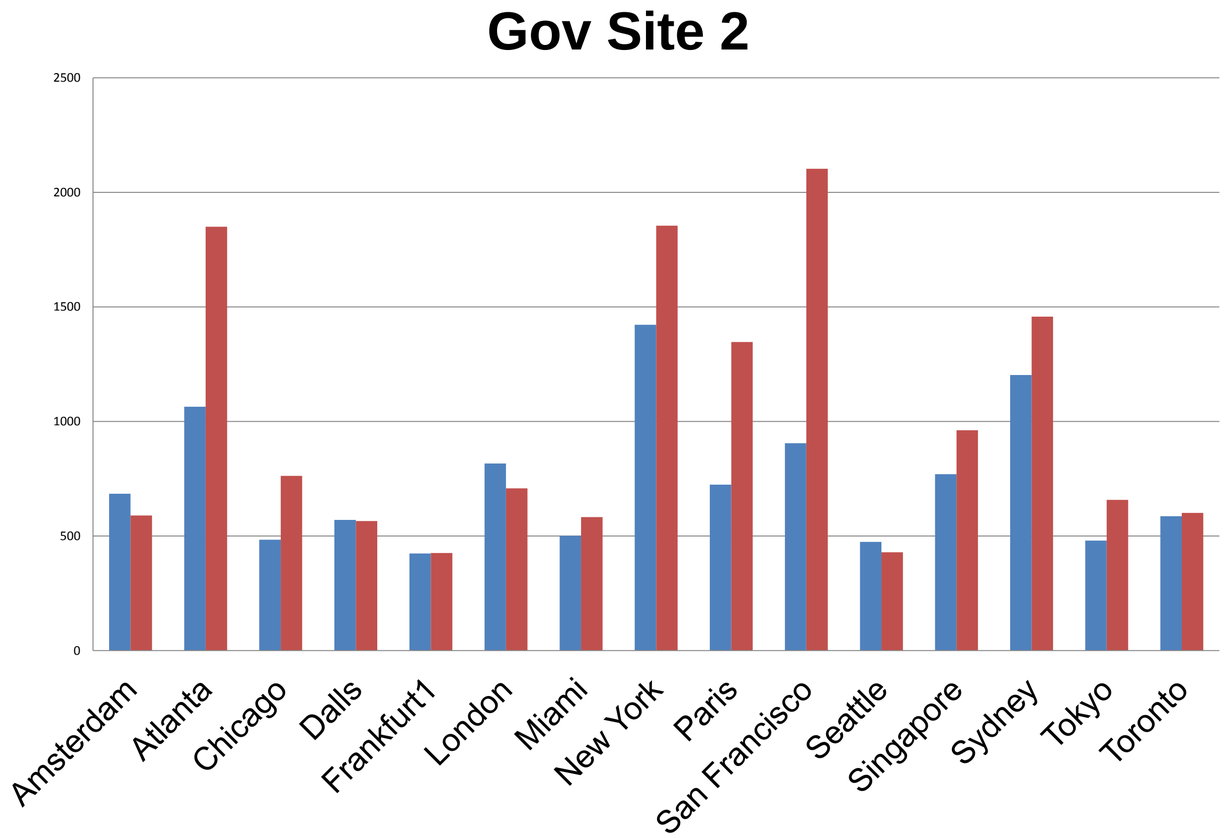
Hop	ASN	Host	IP Address	Probe #1	Probe #2	Probe #3
1	AS14061	2604:a880:1:20:ffff:ffff:ffff:fff1	2604:a880:1:20:ffff:ffff:ffff:fff1	0.693ms	0.544ms	0.494ms
2	AS14061	2604:a880:1::501	2604:a880:1::501	0.266ms	0.32ms	0.358ms
3	AS14061	2604:a880:1::301	2604:a880:1::301	0.313ms	0.305ms	2.308ms
4	AS1299	sjo-b21-link.telia.net	2001:2000:3080:a96::1	2.305ms	2.38ms	2.503ms
5	AS1299	akamai-ic-301048-sjo-b21.c.telia.net	2001:2000:3080:721::2	2.664ms	2.223ms	2.531ms

Is your CDN doing it right?

Data collected with www.v6sonar.com

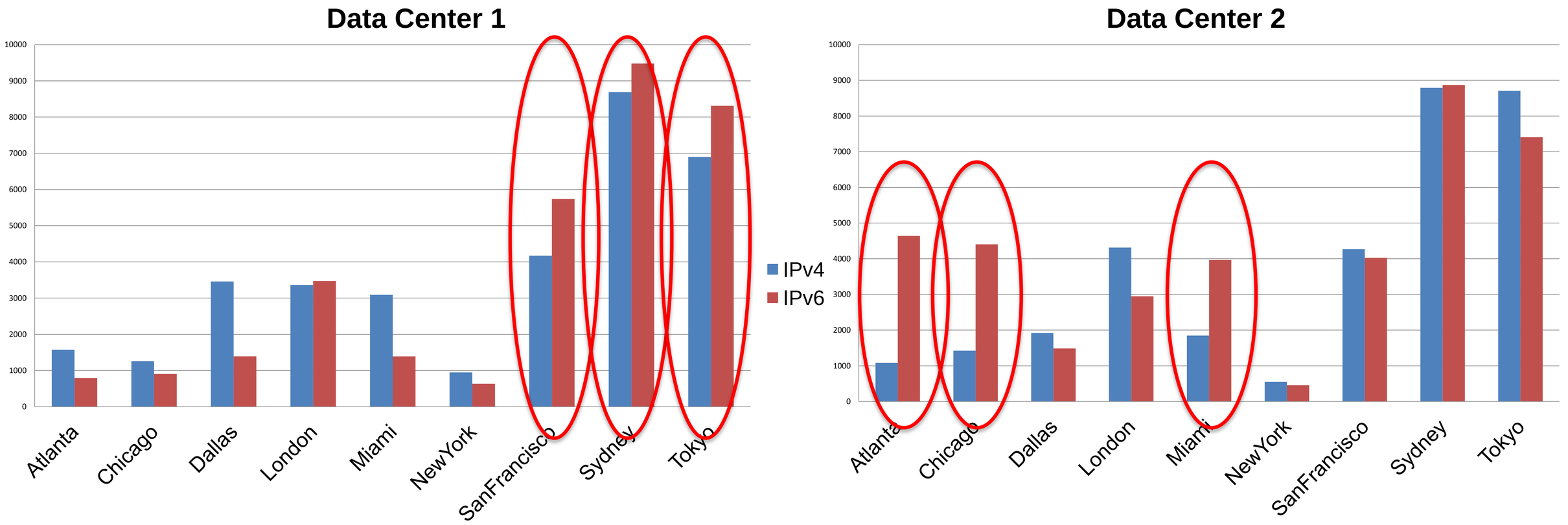
NIH – Gov Site 2





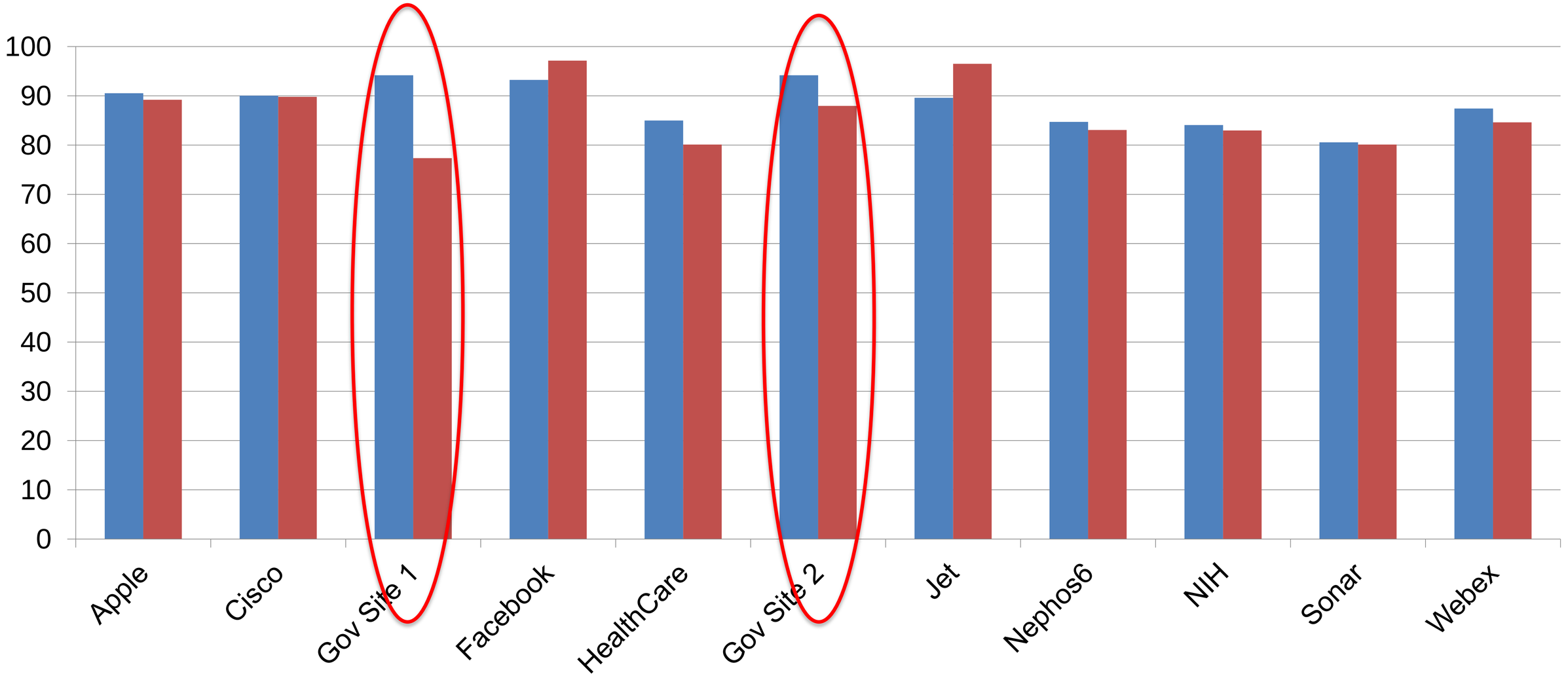
Data collected with www.v6sonar.com

Same Site, Different DCs



Data collected with www.v6sonar.com

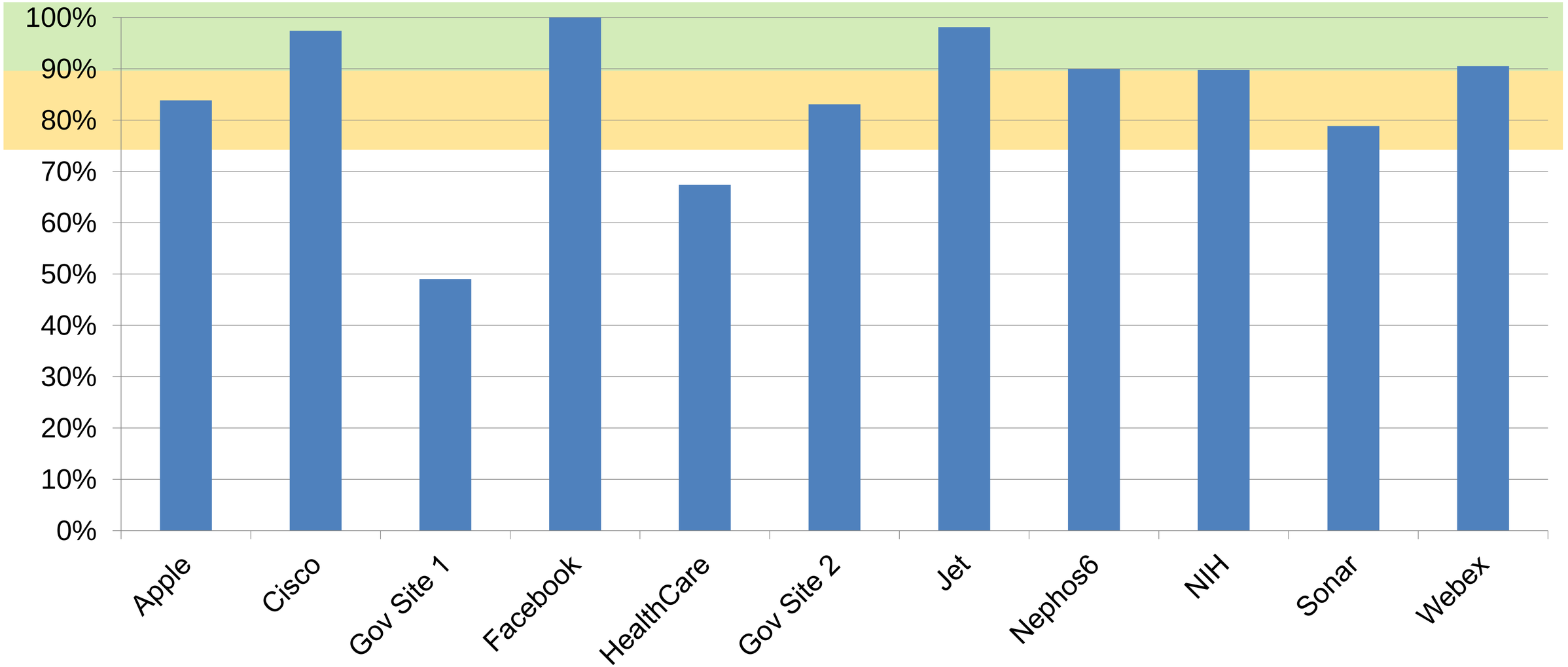
User Satisfaction



Data collected with www.v6sonar.com

IPv6 Effectiveness – Relative to Facebook

IPv6 Effectiveness = P1(DNS) * P2(TCP Connect) * P3(Full load time)

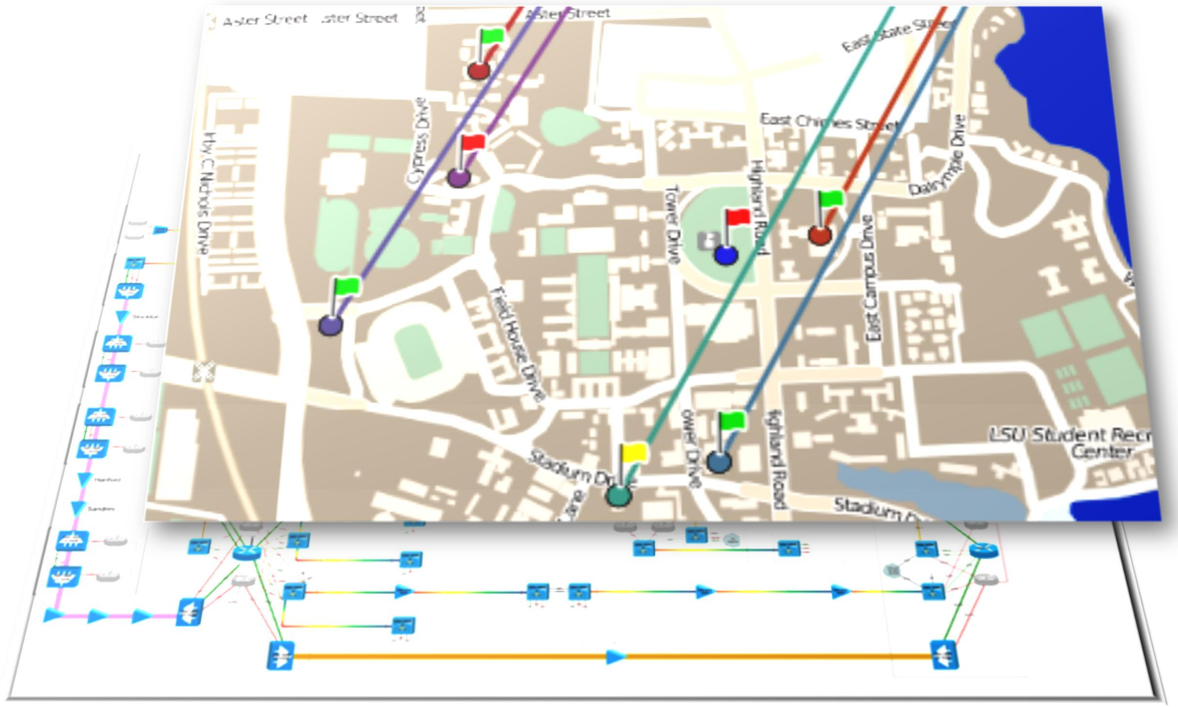


However … You Must Focus on Doing IPv6 Right

Origin AS's with High IPv6 Failure Rates

Geoff Huston, Feb 2016

AS	Failure Rate	Samples	AS Name
AS13679	97.33%	374	Centros Culturales de Mexico, A.C.,MX
AS201986	93.69%	222	ARPINET Arpinet LLC,AM
AS17660	65.14%	1,374	DRUKNET-AS DrukNet ISP,BT
AS10349	60.29%	763	TULANE - Tulane University,US
AS21107	46.97%	692	BLICNET-AS Blicnet d.o.o.,BA
AS20880	42.65%	762	TELECOLUMBUS Tele Columbus AG,DE
AS12779	36.70%	109	ITGATE IT.Gate S.p.A.,IT
AS46261	35.64%	101	QUICKPACKET - QuickPacket, LLC,US
AS9329	35.29%	119	SLTINT-AS-AP Sri Lanka Telecom Internet,LK
AS52888	27.92%	265	UNIVERSIDADE FEDERAL DE SAO CARLOS,BR
AS30036	27.55%	60,228	MEDIACOM-ENTERPRISE-BUSINESS - Mediacom Communications Corp,US
AS45920	25.77%	163	SKYMESH-AS-AP SkyMesh Pty Ltd,AU
AS210	25.04%	571	WEST-NET-WEST - Utah Education Network,US
AS28343	24.57%	985	TPA TELECOMUNICACOES LTDA,BR
AS7477	21.72%	488	TEREDONN-AS-AP SkyMesh Pty Ltd,AU
AS24173	21.48%	256	NETNAM-AS-AP Netnam Company,VN
AS28580	21.48%	1,341	CILNET Comunicacao e Informatica LTDA.,BR
AS32329	20.63%	126	MONKEYBRAINS - Monkey Brains,US
AS17451	19.35%	248	BIZNET-AS-AP BIZNET NETWORKS,ID
AS5707	19.35%	155	UTHSC-H - The University of Texas Health Science Center at Houston,US



- **Google blacklist:** https://www.google.com/intl/en_ALL/ipv6/statistics/data/no_aaaa.txt

UCSC (AS5739), CITI (AS3081), ATT (AS7018), HE (AS6939)

Data collected with www.v6sonar.com

General Observations – Inside View

- Service performance over IPv6 is different than over IPv4
- Performance changes over time and events in IPv6 infrastructure are not always congruent with those in IPv4 infrastructure
- Notable differences based on location
- Tunnels still make a difference
- CDN for IPv6 is different than for IPv4
- Many organizations have no idea how performance over IPv6 compares to performance over IPv4 until an event occurs
- Service or resources go off of IPv6 for long periods of time.

Conclusions

You cannot claim to have deployed IPv6 unless you monitor it

Takeaways

- Some need to keep working on getting IPv6 and IPv4 on par
- It is important to monitor from all the same angles and perspectives we do it for IPv4 and more
- Must keep the service not just the protocol in mind, users don’t know
- Baseline IPv4 -> Monitor IPv4 impact -> Baseline IPv6 -> Monitor IPv6

Operationalize IPv6!

Thank You!

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