



The future of the Internet, IPv6, and the long tail

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- Why did we do “IPng” (IP next generation, aka IPv6)?
- How are we doing with IPv6 deployment today?
- How to get an IPv6 address block from ARIN
- When is IPv4 going away?
- What does the future hold?

Why did we do IPng?

To Build A Better Internet!

In the early 90's, it was already apparent that the Internet had the very real potential of becoming a victim of its own success, and totally depleting the IPv4 space within 20 years...

- All of this growth being driven just by SMTP, FTP, and Telnet...
- And quite a different direction than both the multiprotocol corporate networks (IP, DECNET, IPX, CLNP, etc), and the telecommunications industry providing centralized “networking” with its ATM and frame-relay services

Steps to IPng:

- Routing and Addressing Group (ROAD)
- IETF Address Lifetime Expectations (ALE) WG
- IETF IP Next Generation Directorate
 - Solicitation of White papers
 - IPng proposals – TUBA, SIPP, CATNIP

IPng Requirements (RFC 1726)

- *Scale – Overcome IPv4's 32-bit address space limitation,*
- While maintaining IPv4's basic useful properties [Decentralized nature, Topological Flexibility, Performance, Robust Service, Media Independence, Unreliable Datagram Service, Dynamic Configuration, Multicast, and Control Protocol], and
- Adding some new things [Secure Network-layer Operation, and inherent Mobility Support], and
- Including most importantly – “a straightforward transition plan from the current IPv4.”

Not required: variable-length addressing, decoupling of network/transport identifiers, quality of service, policy-based routing, feature differentiation

Building A Better Internet

While the principal goal of IPv6 was larger address space, the overall goal was simply a better Internet.

“It is very difficult to change a protocol as central to the workings of the Internet as IP. Even more problematic is changing such a protocol frequently. This simply can not be done. We believe that it is impossible to expect the community to make significant, non-backward compatible changes to the IP layer more often than once every 10-15 years. In order to be conservative, we strongly urge protocol developers to consider what the Internet will look like in 20 years and design their protocols to fit that vision.” – RFC 1726 “IPng Technical Criteria”

The result was a recommendation that included additional functionality beyond address space expansion...

IPng/IPv6 Recommendation (RFC 1753)

The parts we got right –

- Scale – Larger address space (128-bit)
- Functionality – IPv4 basic functionality preserved
- Security (privacy/authentication headers)

The parts we probably didn't get right (and dealing with ever since) –

- Scale – Variable length network identifier
- Quality of Service (differential services/flow label field)
- Policy-based Routing (source routing header/RH0)
- Feature differentiation over IPv4
- Native Mobility support ...
- Simple Transition plan ...

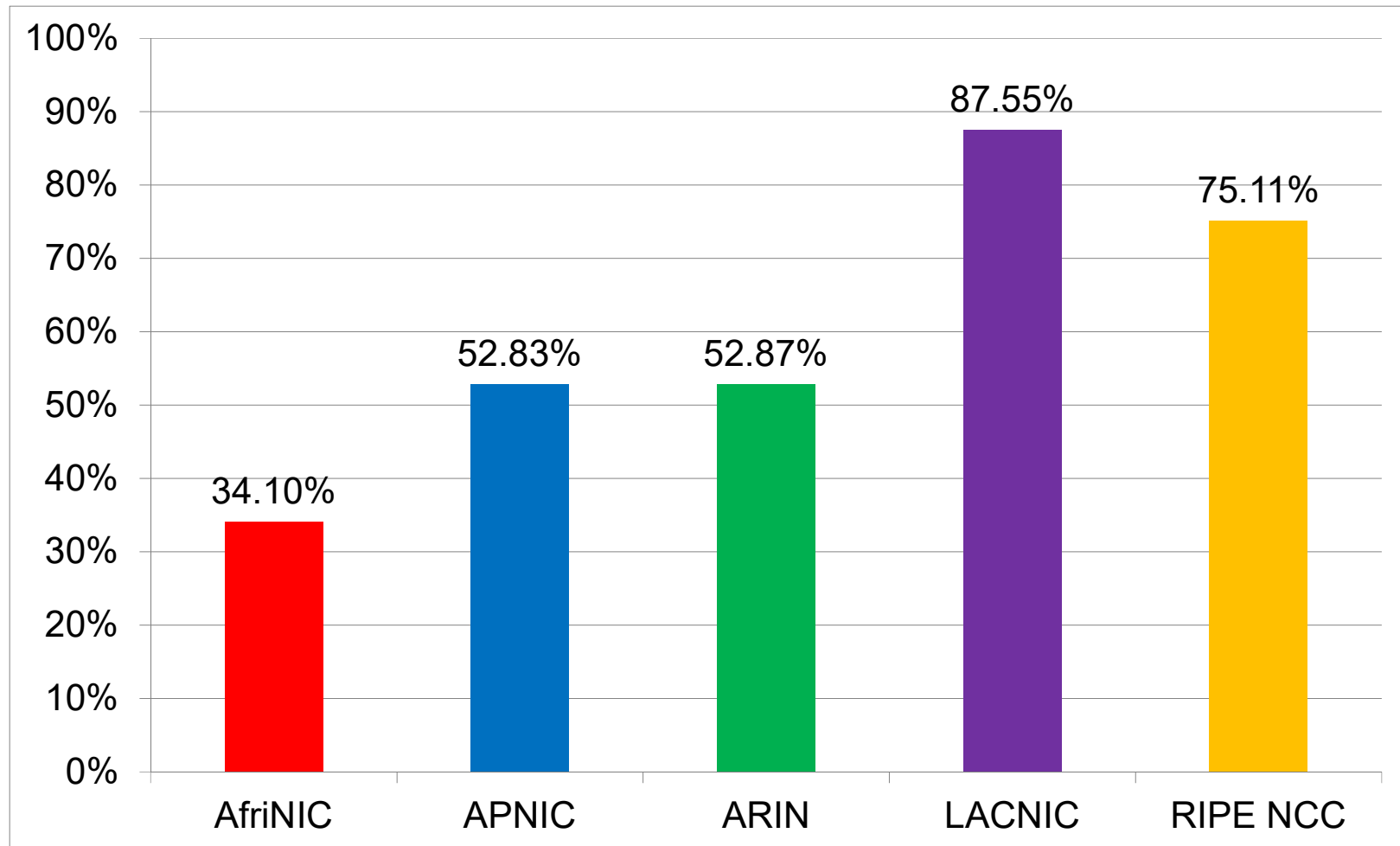
IPv6 Deployment Today

So how'd we do? Are we building a better Internet?

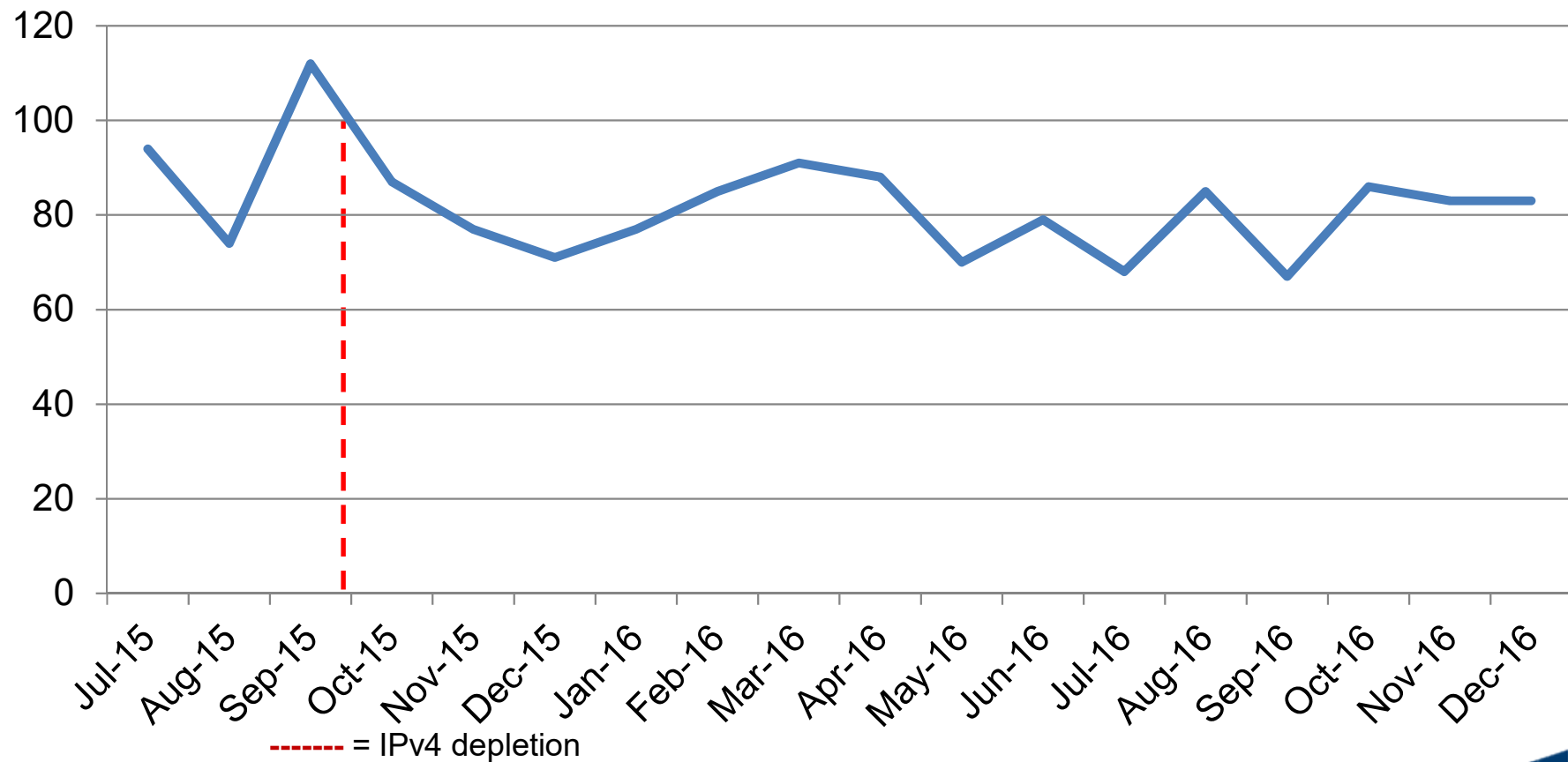
The answer all depends on where you look...

- How many networks have an IPv6 block?
- How much traffic is using IPv6?

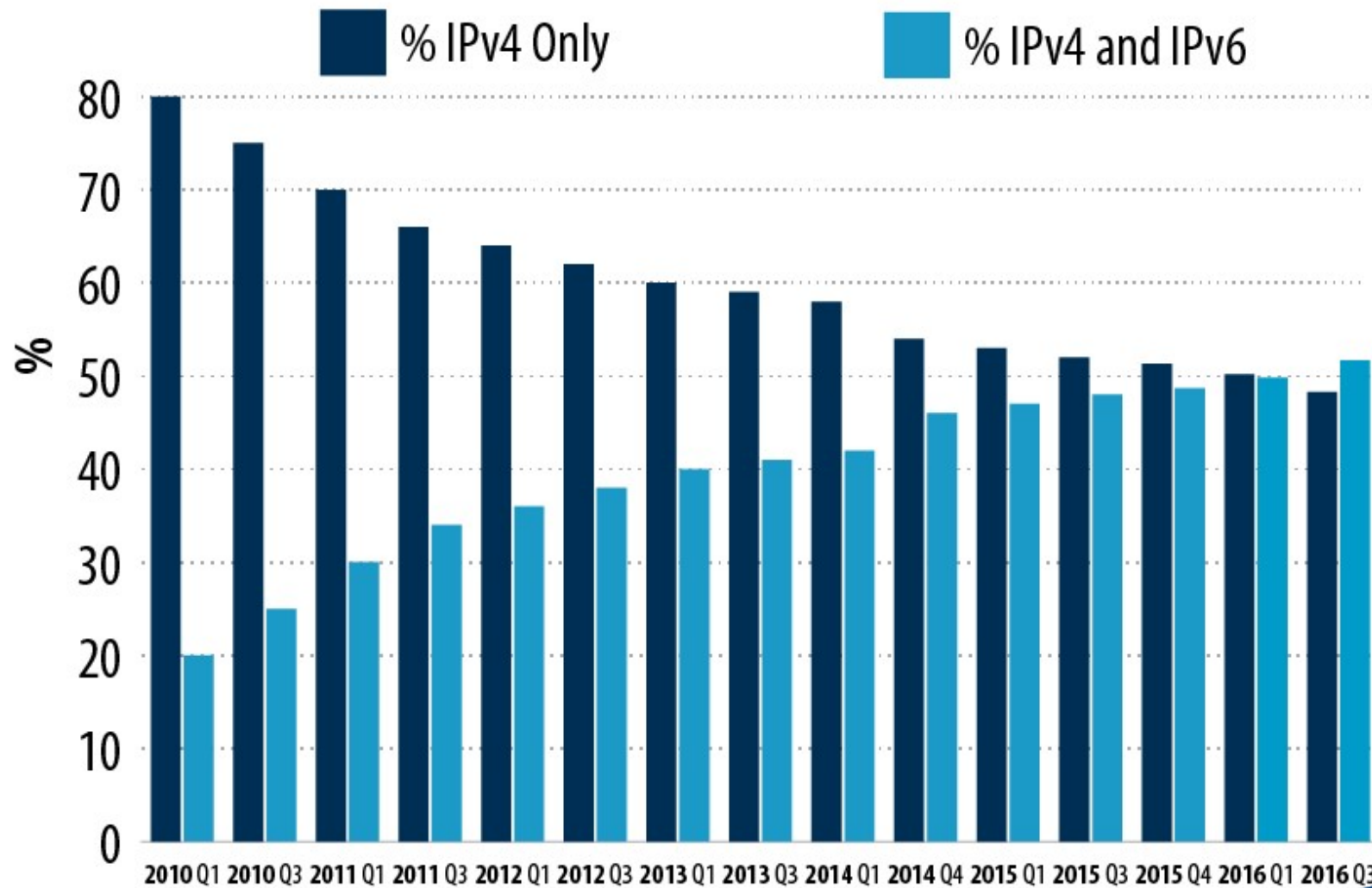
Percentage of Members with IPv6



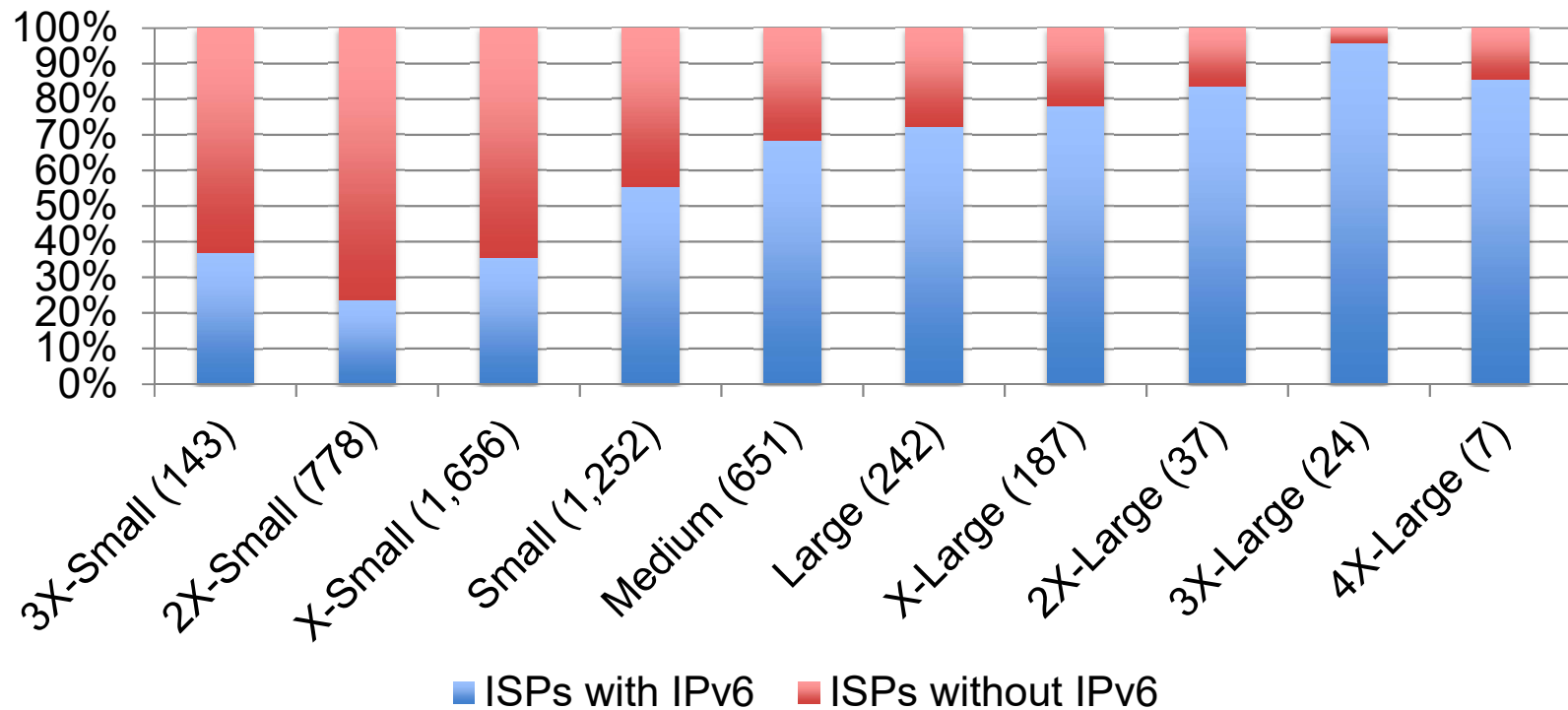
IPv6 Requests Since Depletion



ARIN ISP Members with IPv4 & IPv6



IPv6 Adoption by ISP Size



Getting an IPv6 address block from ARIN

ARIN's Registration Services Department (RSD) Help Desk –

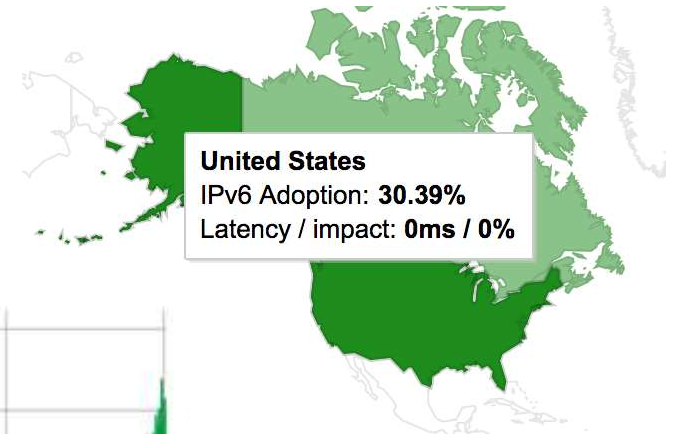
Telephone +1 703 227 0660

Email (hostmaster@arin.net)

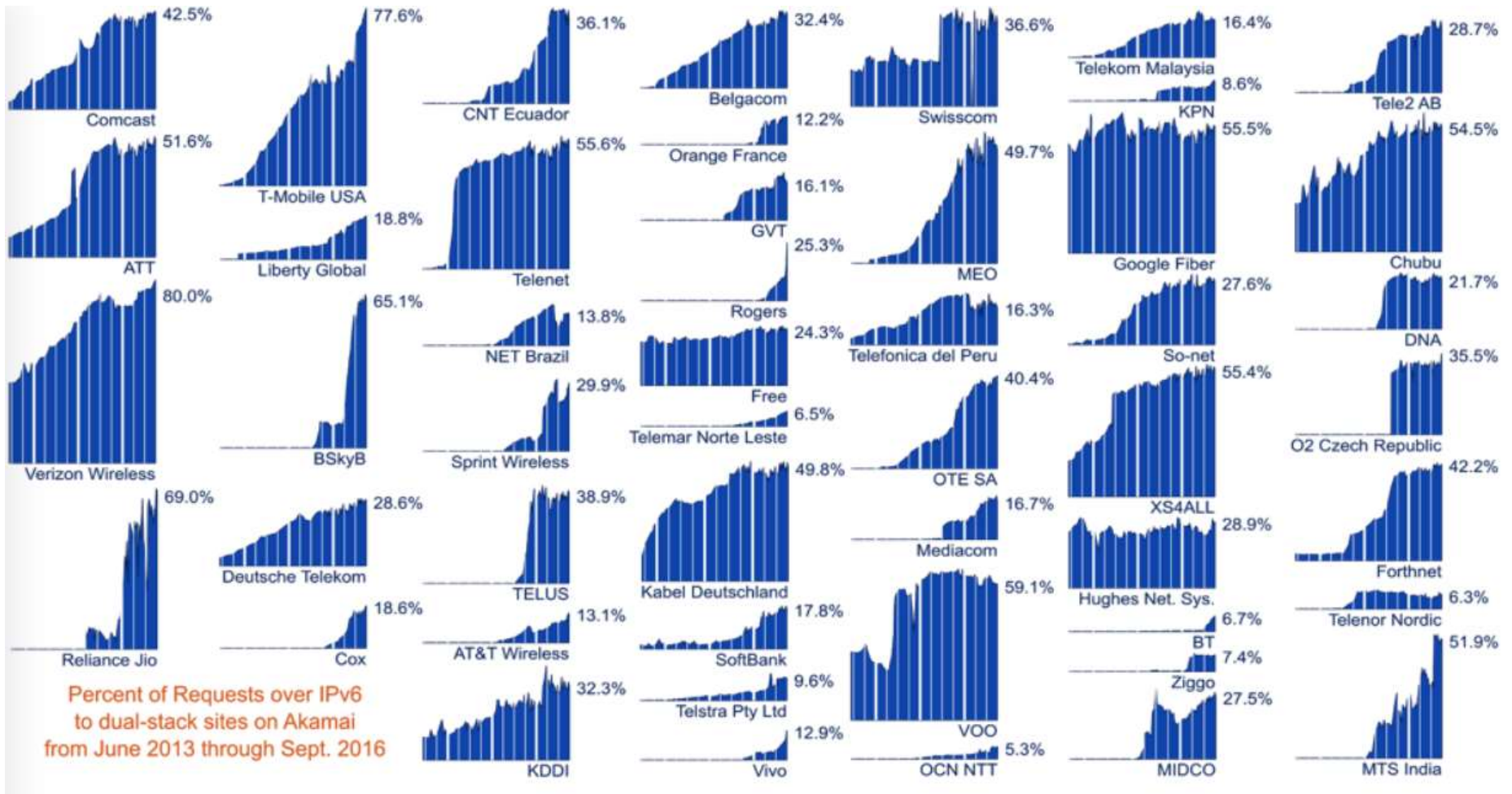
Staffed 7 AM to 7 PM ET M-F

Also: “Ask ARIN” via *ARIN Online*

IPv6 Traffic Growth (Google)



Mobile is driving IPv6 traffic



The mobile Internet is growing via IPv6, and a growing Internet is definitely a better Internet

When is IPv4 going away?

Better question: Why should you care?

Just as IPX, DECNET, and CLNP are no longer in common use, the same fate eventually awaits IPv4 if we continue to build a better Internet via IPv6...

The challenge is that Internet connectivity is an aggregate service, each user making use of different web sites, applications, etc. If you consider each possible Internet destination to be a product, then we have the prototypical “Long tail” situation... i.e. Each customer wants connectivity to many possible points, and even if 80% of the Internet traffic is over IPv6, nearly every customer will still have numerous IPv4-only sites that they wish to reach.

There is no reason to go looking for a killer IPv6-only app, since again connectivity is in the aggregate, and a single app only on IPv6 will not drive purchase behavior.

Effectively, we have redefined Internet Service to be “Connect to anything on either the IPv4 or IPv6 Internet”

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What does the future hold?

“The best way to predict the future is to create it.”

– Peter Drucker

- With the deployment IPv6, we’ve done an amazing thing – we have changed the very definition of what “Internet service” means without adversely impacting the inherent openness of the Internet (its ability to foster “permissionless innovation”)
- It has required more than technical protocol specifications, since there are abundant choices that each service provider has to make regarding how to deliver both IPv6 and IPv4 services
- Now it is time to think very carefully about what we want the Internet to look like in 15 to 20 years (when “on the Internet” is taken to mean IPv6-reachable and gatewaying to IPv4 is legacy capability feature)

What do we want the future Internet to look like?

- The characteristics of the IPv6-Internet will determine the longevity of the IPv4-Internet, and the characteristics of IPv6-Internet will largely be determined by the operational practices of ISP IPv6 deployment (i.e. will be determined by the people in this room...!)
- Planning for long-term predominantly IPv6 Internet requires providing a differentiation of Internet service despite a lack of differentiation in technical capabilities over IPv4.
- The current IPv4 Internet's amazing growth and incorporation into everyday life was the result of its open participation and innovation model (unlike the central control models of earlier telecommunication paradigms), but it is not without its own price to pay...

The future Internet lies between

- The next innovation in the Internet will not be technical – we've reached the point where technology is indistinguishable from magic for the average user; increasing layers of technical capabilities, risks, and countermeasure are boring...
- Governments are looking at an increasing part of their economy operating over the Internet, and are have significant concerns about its stability and protection of basic rights such security from attack, access to legal recourse, etc.
- The IPv6 Internet is a seed of a future Internet, and it does not have to replicate all of the mistakes of the IPv4 Internet (e.g. lack of routing hygiene which enables DDoS and botnet attacks, blacklist based spam filters rather than whitelist mediated email network, etc.)
- The question faced is whether the future Internet enabled by IPv6 is simply network protocol change for bigger addresses or a conscious effort to build a Better Internet... The latter requires less technical work in standards bodies but far more coordination in operational norms in bodies such as this one...

Questions?

