“IPv6: It’s Not Going Away”

What Do I Need to Know?

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V2

“IPv6: It’s Not Going Away”

Today’s Outline

- Introduction & Background
- IPv6 Technology Fundamentals
- The IPv6 Business Case
- Migration Strategies
- Information For Further Study & References

Why? How? When?

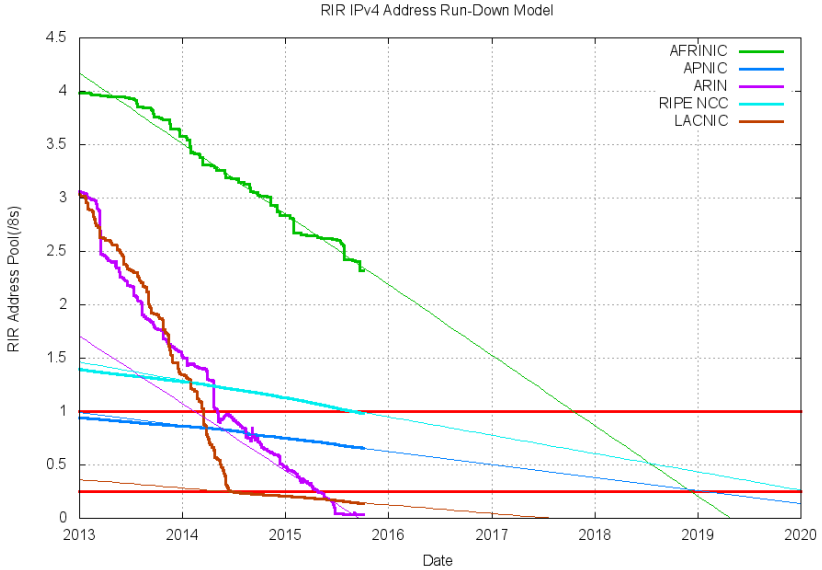
5 Regional Internet Registries

IPv4 Address Depletion

Updated:
10-4-15

http://www.potaroo.net/tools/ipv4/plotend.png

- As of February 2011 ALL IANA IPv4 Address Space Assigned!
- As of July 2015 ARIN Began Last /8 Allocation
- As of September 2015 ARIN IPv4 Space Depleted



IPv6 Address Space

IETF - RFC 2460

IPv6 Provides Expanded IP Address Space

2^{128} =

340,282,366,920,938,463,463,374,607,431,768,211,456

(three hundred forty **UNDECILLION** addresses)

3.4×10^{38}

The IPv6 Address

128-Bit Address Binary Format:

00100110000001111011100000000000011111010101000000000001100100001100101011001100010000111101111000100100000101000111100001

Subdivide Into Eight (8) 16-bit Groups:

0010011000000111 1011100000000000 0000111110101010 0000000000000011
0010000110010101 1001100010000111 1011110001001000 0010100011110001

Convert Each 16-bit Group to Hexadecimal:

(separate with a colon)

2607:b800:0faa:0003:2195:9887:bc48:28f1

2607:b800:faa:3:2195:9887:bc48:28f1

Address Summarization

128-Bit Address Represented as a 32 Hexadecimal Digits
Subdivided Into Eight Groups (Chunks, Quads, Quartets) of Four Hexadecimal Digits

(separated by colon)

2001:0000:0000:0000:0DB8:8000:200C:417A

or

2001:0:0:0:DB8:8000:200C:417A

or

2001::DB8:8000:200C:417A

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IPv6 Is More Than Address Space
"An Opportunity to Re-Engineer IPv4"

- Header Simplification for Performance Increase
- Improved Authentication and Security
- Host Auto-Configuration
- Mobility Incorporated

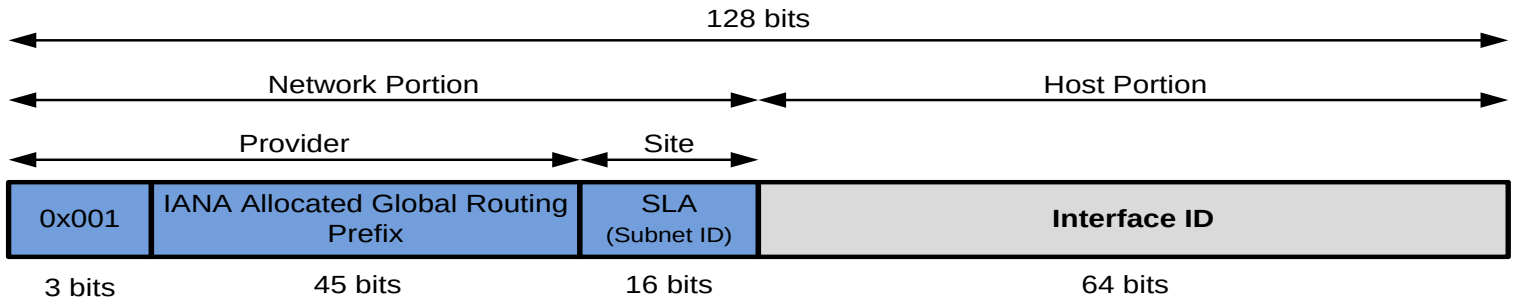
IPv6 Address Types

Expect Multiple Addresses per Interface

- **Unicast** – One-to-One Mapping
  - Global Unicast Address (Public Globally Routable)
  - Unique-Local Unicast Address (non-Routable or Private)
  - Link-Local Unicast (valid only on local network segment)
- **Multicast** – One-to Many Mapping
  - Multicast Groups Established
- **Anycast** – One-to-Nearest Mapping
  - Packets Are Delivered to the “Closest, Nearest, or Lowest-Cost” Interface
    - Global Anycast
    - Site-Local Anycast
    - Link-Local Anycast

Routed vs Host Address

- Every IPv6 Address is Divided Into:
  - Routed (Network) Portion
  - Host Portion
- The Block Size To-Be-Routed Specified by the Mask
- The Host Portion is the Interface Identifier



EXAMPLE: Global Unicast Address Format (Aggregatable & Routable)

IPv6 Address Subnet Notation

Classless Inter-Domain Routing “CIDR” Notation Utilized

CIDR Notation Represents An IP Address & Mask in a Shorthand Form:

IPv4: 165.95.240.136 /n

IPv6: 2607:b800:faa:: /n

Where **n** represents the number of bits in the subnet mask

IPv6 Relative Network Sizes

/128	1 IPv6 address	A network interface
/64	1 IPv6 subnet	18,446,744,073,709,551,616 IPv6 addresses
/56	256 LAN segments	Popular prefix size for one subscriber site
/48	65,536 LAN segments	Popular prefix size for one subscriber site
/32	65,536 /48 subscriber sites	Minimum IPv6 allocation
/24	16,777,216 subscriber sites	256 times larger than the minimum IPv6 allocation

IPv6 Address Assignment

- Service Provider: /32 — **2^{32}** /64 subnets
- Large End User: /48 — **65,536** /64 subnets
- Small End User: /56 — **256** /64 subnets
- SOHO: /64 — **1** /64 subnets

Recognize / Remember:

A /64 IPv6 subnet = 18,446,744,073,709,552,000 hosts

An Ipv6 Address You Can Remember

The IPv6 Loopback Address

::1

Summarized from:
0:0:0:0:0:0:0:1

Same Concept as IPv4 “127.0.0.1”

The IPv6 Business Case

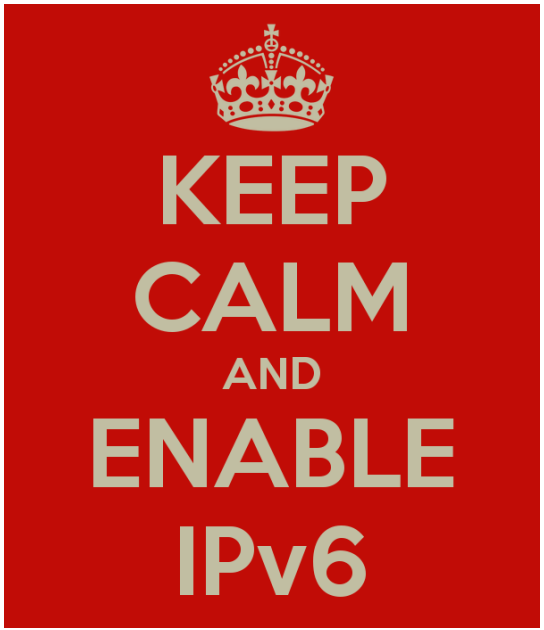
Suddenly, it dawned on Ronald that he needed to be on the right flight plan and IPv6 seemed to be just the ticket.

Why IPv6?

- Reduction of Dependency Upon IPv4 Address Space for Growth
- Restores the End-End Communications Path Model of the Global Internet
- Enhances Overall Routing Efficiency
- Improved Security Increases Security and Confidentially
- Enables Application Development to Meet Unknown Needs of the Future!

IPv6 Implementation

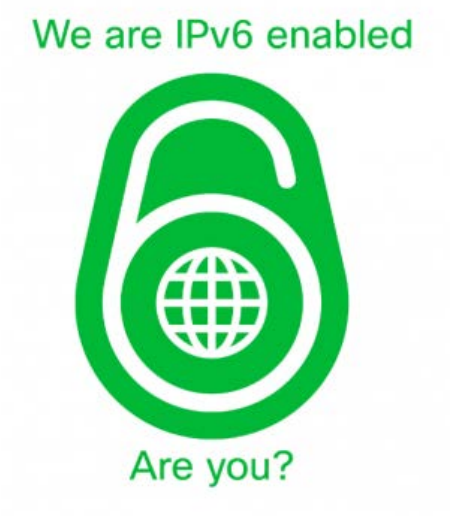
- Why Slow ?
  - The “FUD” Principle Occurs
  - US Has Largest Available IPv4 Allocations
  - ***“Does Not Apply to Me”***
    I Have Adequate IPv4 Address Space
  - Another IT Industry “Crying Wolf” Event
  - Low Priority – No “ROI” Seen



Migration Strategies

Can Have Different Impact for:

- Broadband Access Providers
- Internet Service Providers
- Internet Content Providers
- Enterprise Customers
- Equipment Vendors
- Government Organizations



Content or Eyes ?

“Producer of Content” or “Consumer of Content”

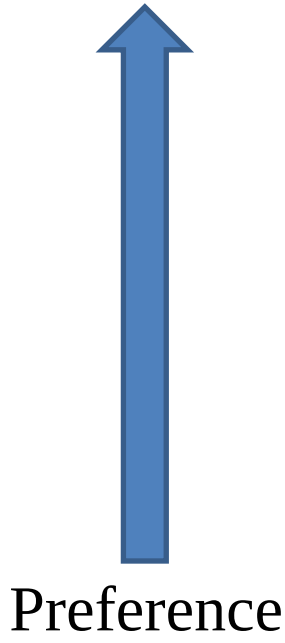
A Migration Approach

- Call to Action – **Content Providers or “Broadcaster”**
  - Be Reachable By New IPv6 Only Internet Customers
  - Be Reachable by IPv6 Without Translation Solutions
  - Provide the “Best Quality” Experience to Content Consumer
  - Provide “Outward” Facing Services in IPv4 and IPv6

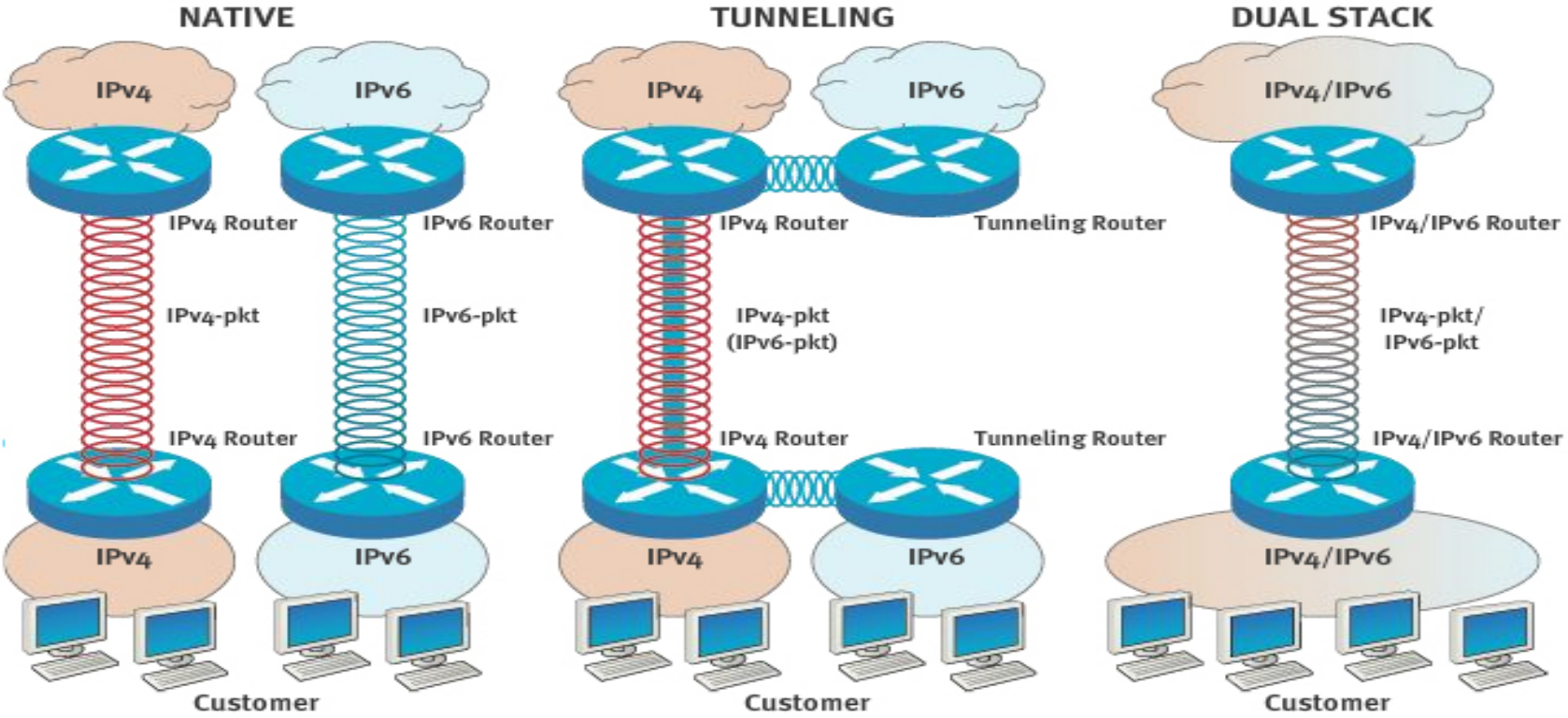
Viewing the Network

IPv6 Implementation Techniques

- **Native**
  - Separate IPv4 and IPv6 Networks
  - IPv4 and IPv6 “Dual Stack”
- **Tunnel**
  - Tunnel IPv6 Within an IPv4 Network
- **Translation Based**
  - Multiple Layer NAT – Carrier Grade NAT “CGN”
  - NAT64
  - NAT44



How?


NATIVE
IPv4
IPv6
IPv4 Router
IPv6 Router
IPv4-pkt
IPv6-pkt
IPv4 Router
IPv6 Router
IPv4
IPv6
Customer
TUNNELING
IPv4
IPv6
IPv4 Router
Tunneling Router
IPv4-pkt
(IPv6-pkt)
IPv4 Router
Tunneling Router
IPv4
IPv6
Customer
DUAL STACK
IPv4/IPv6
IPv4/IPv6 Router
IPv4-pkt/
IPv6-pkt
IPv4/IPv6 Router
IPv4/IPv6
Customer

Learn How ?

- Build an IPv6 Sandbox
  - Create a Lab Network
  - Your Home Network
  - “Hands-On” Experience

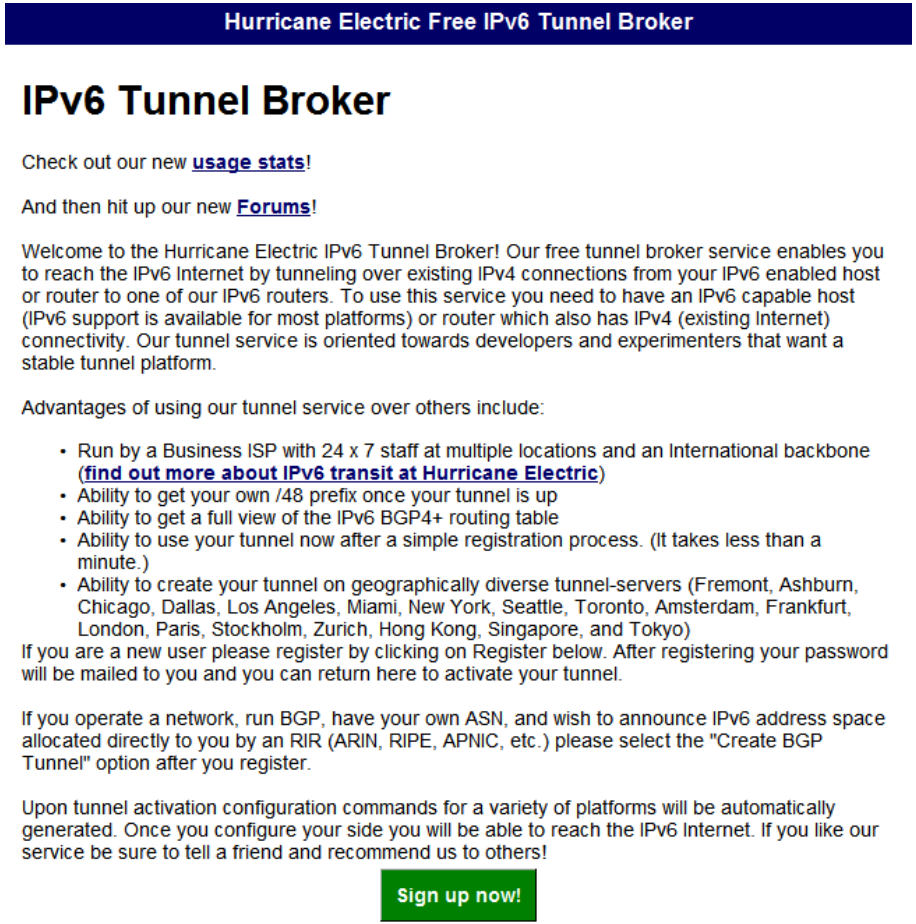
```
C:\Users\Wayne>ipconfig

Windows IP Configuration


Ethernet adapter Bluetooth Network Connection:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

Wireless LAN adapter Wireless Network Connection:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

Ethernet adapter Local Area Connection:

   Connection-specific DNS Suffix  . :
   IPv6 Address. . . . . . . . . . . : 2607:b800:faa:3:f1e2:65b7:5676:1984
   Temporary IPv6 Address. . . . . . : 2607:b800:faa:3:510c:f24c:30c7:cad4
   Link-local IPv6 Address . . . . . : fe80::f1e2:65b7:5676:1984%11
   IPv4 Address. . . . . . . . . . . : 165.95.240.130
   Subnet Mask . . . . . . . . . . . : 255.255.255.192
   Default Gateway . . . . . . . . . : fe80::20b:45ff:feb7:bdc0%11
                                       165.95.240.129

Tunnel adapter isatap.{3DFE4E48-6B0D-4870-8204-4A2654A17D41}:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

Tunnel adapter isatap.{F7A1142F-6167-4111-A51D-8806AFA6630A}:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

Tunnel adapter isatap.{E40D2776-7614-434C-A0C6-4351B45722E3}:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

Tunnel adapter Teredo Tunneling Pseudo-Interface:

   Connection-specific DNS Suffix  . :
   IPv6 Address. . . . . . . . . . . : 2001:0:4137:9e76:18ed:751:5aa0:f7d
   Link-local IPv6 Address . . . . . : fe80::18ed:751:5aa0:f7d%20
   Default Gateway . . . . . . . . . :
```

Build an IPv6 Network

But, My Provider is Not IPv6 Enabled!

Then "Tunnel" to an IPv6 Provider:

http://www.tunnelbroker.net/



Hurricane Electric Free IPv6 Tunnel Broker

IPv6 Tunnel Broker

Check out our new usage stats!

And then hit up our new Forums!

Welcome to the Hurricane Electric IPv6 Tunnel Broker! Our free tunnel broker service enables you to reach the IPv6 Internet by tunneling over existing IPv4 connections from your IPv6 enabled host or router to one of our IPv6 routers. To use this service you need to have an IPv6 capable host (IPv6 support is available for most platforms) or router which also has IPv4 (existing Internet) connectivity. Our tunnel service is oriented towards developers and experimenters that want a stable tunnel platform.

Advantages of using our tunnel service over others include:

- Run by a Business ISP with 24 x 7 staff at multiple locations and an International backbone (find out more about IPv6 transit at Hurricane Electric)
- Ability to get your own /48 prefix once your tunnel is up
- Ability to get a full view of the IPv6 BGP4+ routing table
- Ability to use your tunnel now after a simple registration process. (It takes less than a minute.)
- Ability to create your tunnel on geographically diverse tunnel-servers (Fremont, Ashburn, Chicago, Dallas, Los Angeles, Miami, New York, Seattle, Toronto, Amsterdam, Frankfurt, London, Paris, Stockholm, Zurich, Hong Kong, Singapore, and Tokyo)

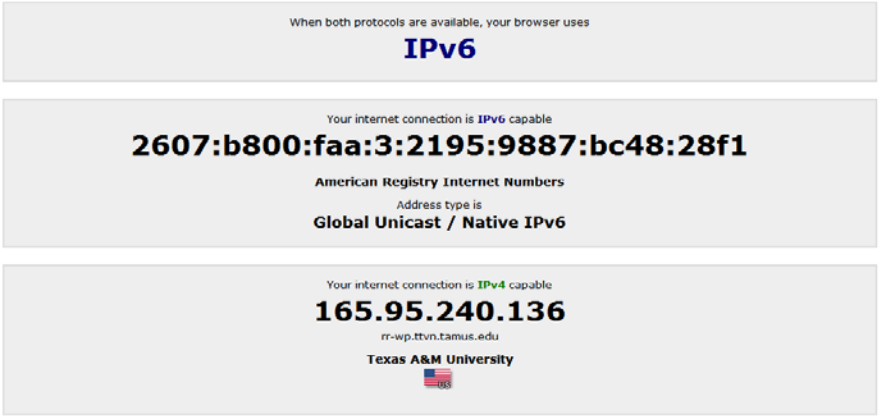
If you are a new user please register by clicking on Register below. After registering your password will be mailed to you and you can return here to activate your tunnel.

If you operate a network, run BGP, have your own ASN, and wish to announce IPv6 address space allocated directly to you by an RIR (ARIN, RIPE, APNIC, etc.) please select the "Create BGP Tunnel" option after you register.

Upon tunnel activation configuration commands for a variety of platforms will be automatically generated. Once you configure your side you will be able to reach the IPv6 Internet. If you like our service be sure to tell a friend and recommend us to others!

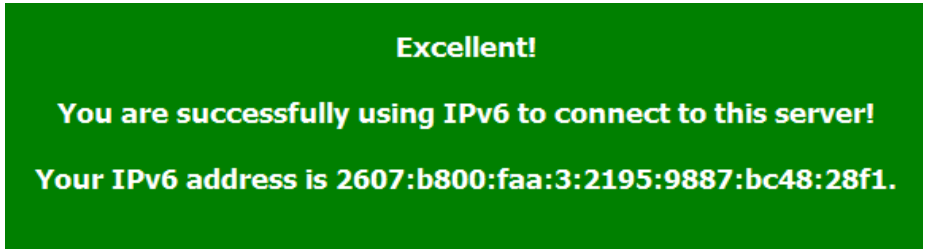
Sign up now!

IPv6 Test Web Sites



http://ipv6-test.com/

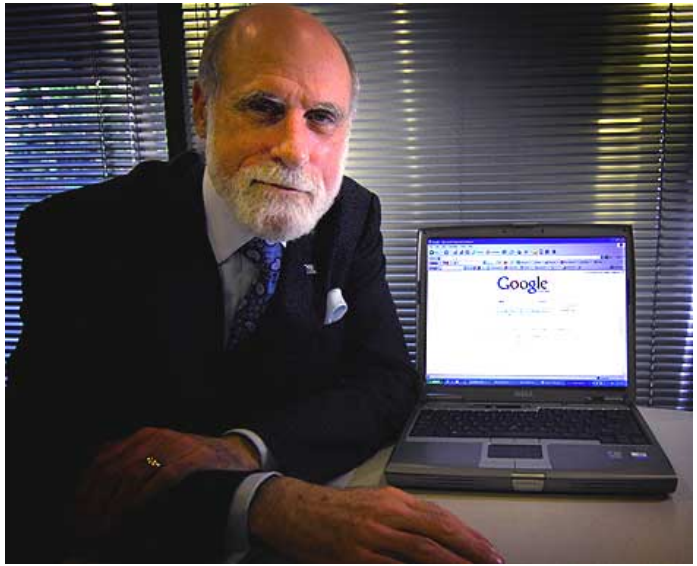
http://v6.testmyipv6.com/



www.ARIN.net

Vinton Cerf

“One of the Fathers of the Internet”



"Who the hell knew how much address space we needed for an experiment?“

“The experiment has not ended”

“Vint” Cerf comments on his & colleagues 1977 decision to use 32-bit IP Numbers

Some Final IPv6 Trivia

What Happened to Version 5 or IPv5 of the Internet Protocol?

"IPv5 Simply Does Not Exist!"

*Version 5 was intentionally skipped to **avoid** confusion, or at least to rectify it. The problem with version 5 relates to an experimental TCP/IP protocol called the Internet Stream Protocol, Version 2, originally defined in RFC 1190. This protocol was originally seen by some as being a peer of IP at the Internet Layer in the TCP/IP architecture and these packets were assigned IP version 5 to differentiate them from "normal" IPv4 packets. This protocol never went anywhere, but to be absolutely sure that there would be no confusion, version 5 was skipped over in favor of version 6."*

IPv4 and IPv6 Comparison

IPv4

Developed: 1973-1977
Deployed: 1981
2^{32} or 4.3 Billion Addresses

"More Than Anyone Could Possibly Use"

Address Based Assignment Unit /32

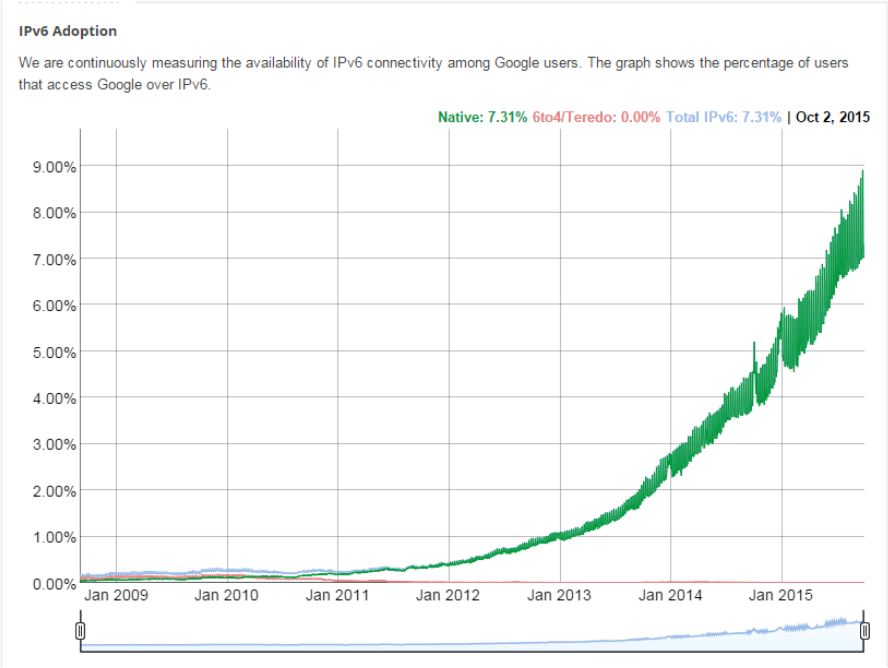
IPv6

Developed: mid 1990's
Deployed: 1999
2^{128} or 340 Undecillion Addresses

"More Than Anyone Could Possibly Use"

Network Based Assignment Unit /64

Deployment Today



Facebook News Feeds Load 20-40% Faster Over IPv6

Want to read your Facebook News Feed faster? Ask your Internet Service Provider (ISP) if you can get IPv6! That's one of the key quotes to me in this article published this month on ComputerWorld:

> *As for the speed boost that may come with IPv6, it's too early to say whether you'll see it or not.* ***Facebook says it has seen users' News Feeds loading 20 percent to 40 percent faster on mobile devices using IPv6.*** *Tests at Time Warner Cable have shown a 15 percent boost.*

Now, yes, there is the caveat from Facebook's Paul Saab that they are "still trying to clarify the data" and understand exactly *why* IPv6 users are seeing the speed increase. (And Paul explains further starting about 19 minutes into his recent v6 World Congress presentation.)

Takeaways

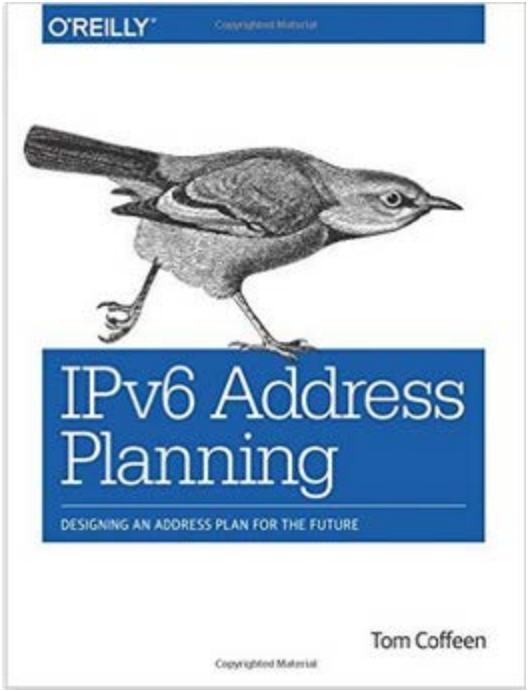
- The Industry is Predominantly IPv4 Based Today
- IPv4 Demand Continues…..IPv4 Availability Pool About Depleted
- Translation is Not the Solution – Especially With Real-Time Media
- IPv6 Must Be Adopted for Continued Growth
- IPv6 is NOT Backward Compatible With IPv4
- Expect IPv4 and IPv6 To Be Maintained for Many Years to Come
- IPv6 Address Allocation Focuses Upon Subnet Allocation, NOT Address Allocation
- As a Broadcaster:
  - You Must Be Reachable By New Internet Customers – Think “QoE”
  - Provide IPv4 and IPv6 Connectivity Today
- IPv6 Is Still IP!

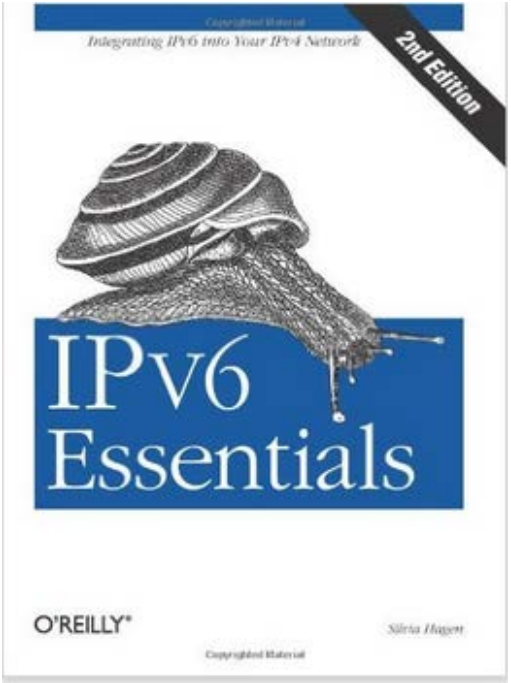
Keep in Mind!

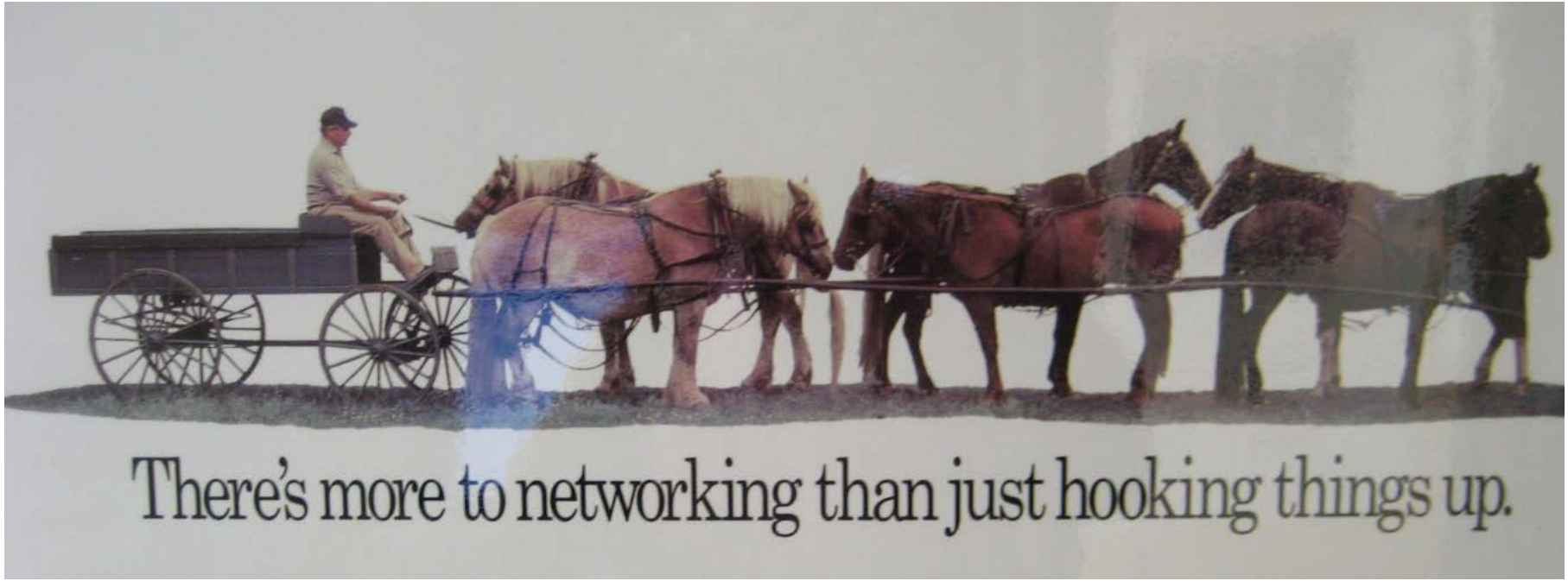
- **You Need a New Mindset for IPv6 Implementation**
- Forget Host Address Allocation – Think Network Allocation!
- /48 IPv6 Network = 65,536 Subnets
- /64 IPv6 Network = 1 Subnet
- Each IPv6 Subnet Can Support 18 Quintillion Devices / Hosts
  (18,446,744,073,709,551,616 hosts)

Further Study

- **IETF - RFC Documents:** www.rfc-editor.org
- **IP Address Block Size Chart:** https://www.arin.net/knowledge/cidr.pdf
- **IPv6 Reference Websites:**
  - www.arin.net
  - www.getipv6.info
  - www.GoGo6.com






There's more to networking than just hooking things up.

? Questions ?

Thank You for Attending!

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