IPV4 TO IPV6 MIGRATION

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CEO
KeyOptions

MacSysAdmin 2011

IPv6 terminology relevant to this specification from the IPv6 Protocol [3], IPv6 Addressing Architecture [5], and IPv6 Stateless Address Autoconfiguration [17] is included below.

address	An IP layer identifier for an interface or a set of interfaces.
host	Any node that is not a router.
IP	Internet Protocol Version 6 (IPv6). The terms IPv4 and IPv6 are used only in contexts where it is necessary to avoid ambiguity.
interface	A node's attachment to a link.
link	A communication facility or medium over which nodes can communicate at the link layer, i.e., the layer immediately below IP. Examples are Ethernet (simple or bridged); Token Ring; PPP links, X.25, Frame Relay, or ATM networks; and Internet (or higher) layer "tunnels", such as tunnels over IPv4 or IPv6 itself.
link-layer identifier	A link-layer identifier for an interface. Examples include IEEE 802 addresses for Ethernet or Token Ring network interfaces, and E.164 addresses for ISDN links.
link-local address	An IPv6 address having a link-only scope, indicated by having the prefix (FE80::/10), that can be used to reach neighboring nodes attached to the same link. Every interface has a link-local address.
multicast address	An identifier for a set of interfaces (typically belonging to different nodes). A packet sent to a multicast address is delivered to all interfaces identified by that address.
neighbor	A node attached to the same link.

path M

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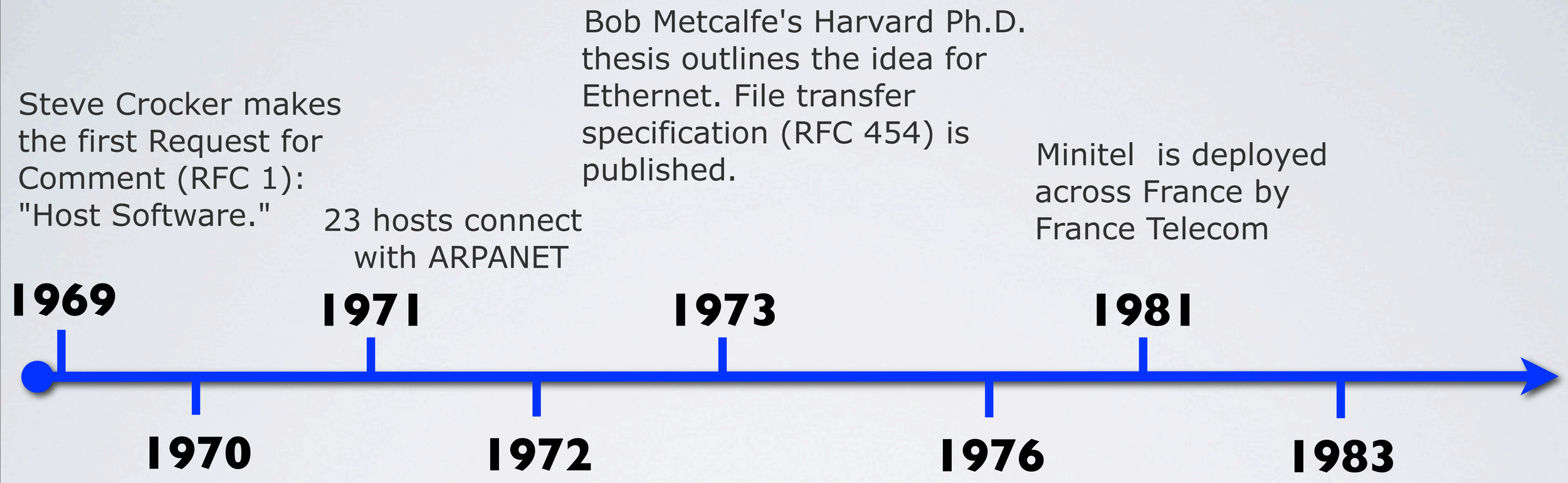
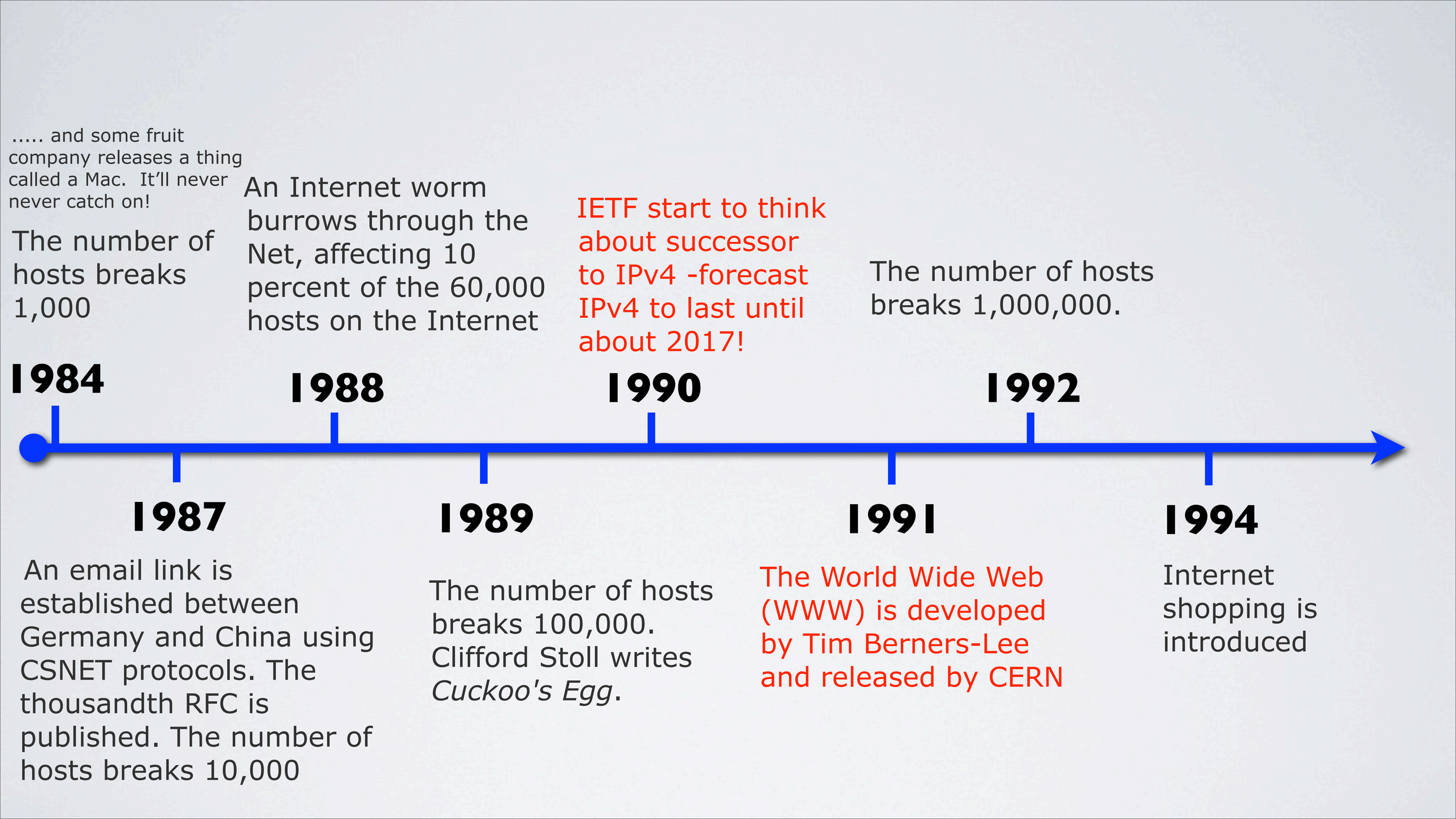
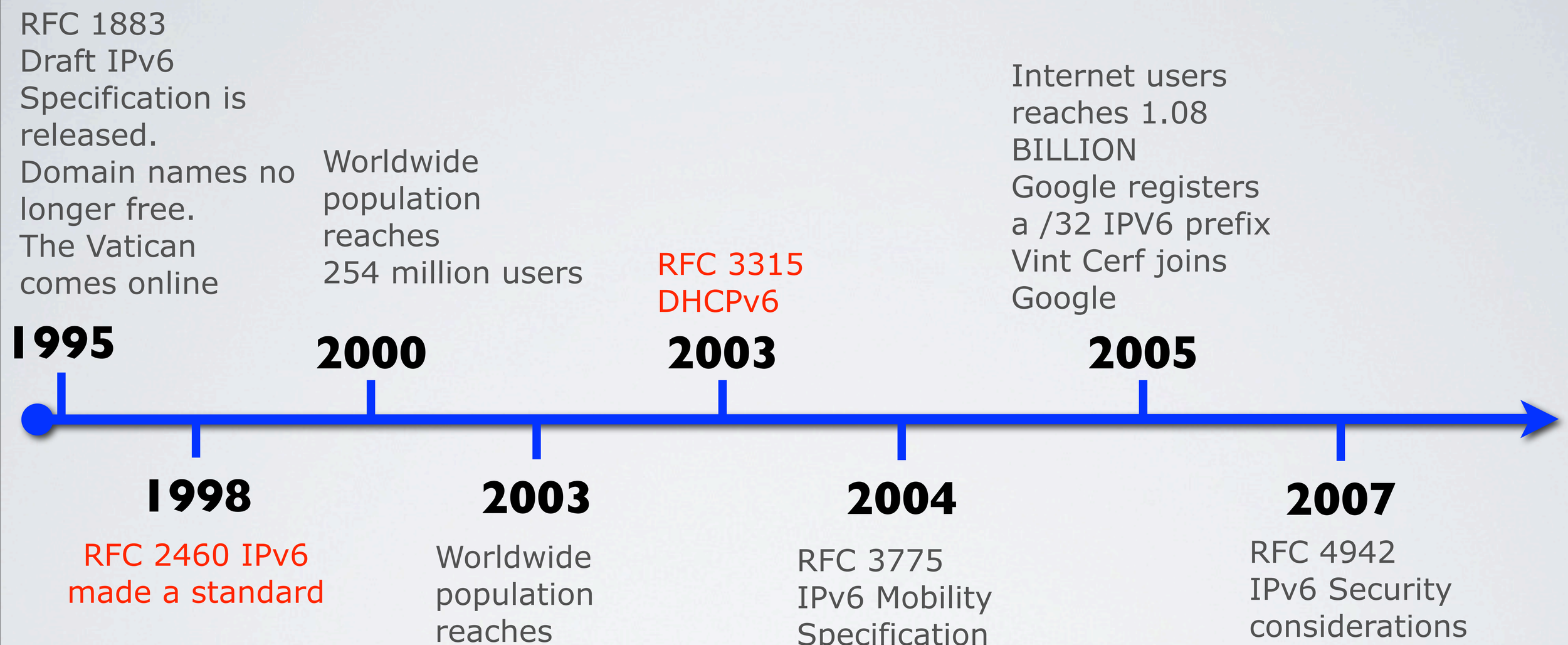
IP - A BIT OF HISTORY


Steve Crocker makes the first Request for Comment (RFC 1): "Host Software."
1969
1970
ARPANET hosts start using Network Control Protocol (NCP)
23 hosts connect with ARPANET
1971
INWG is created with Vinton Cerf.
Telnet specification (RFC 318) is published
1972
Bob Metcalfe's Harvard Ph.D. thesis outlines the idea for Ethernet. File transfer specification (RFC 454) is published.
1973
Queen Elizabeth II sends an email
1976
Minitel is deployed across France by France Telecom
1981
The cutover from NCP to TCP/IP happens on January 1
1983


..... and some fruit company releases a thing called a Mac. It'll never never catch on!
The number of hosts breaks 1,000
An Internet worm burrows through the Net, affecting 10 percent of the 60,000 hosts on the Internet
IETF start to think about successor to IPv4 -forecast IPv4 to last until about 2017!
The number of hosts breaks 1,000,000.
1984
1988
1990
1992
1987
1989
1991
1994
An email link is established between Germany and China using CSNET protocols. The thousandth RFC is published. The number of hosts breaks 10,000
The number of hosts breaks 100,000. Clifford Stoll writes *Cuckoo's Egg*.
The World Wide Web (WWW) is developed by Tim Berners-Lee and released by CERN
Internet shopping is introduced


RFC 1883
Draft IPv6
Specification is
released.
Domain names no
longer free.
The Vatican
comes online
1995
1998
RFC 2460 IPv6
made a standard
Worldwide
population
reaches
254 million users
2000
2003
Worldwide
population
reaches
580 million
users
RFC 3315
DHCPv6
2003
2004
RFC 3775
IPv6 Mobility
Specification
Internet users
reaches 1.08
BILLION
Google registers
a /32 IPV6 prefix
Vint Cerf joins
Google
2005
2007
RFC 4942
IPv6 Security
considerations


RFC 5722
Handling of
overlapping IPv6
fragments
2009
IANA central
registry depleted
01 FEB 2011
World IPv6 day
08 June 2011
IPV4 - Let
the bidding
begin!!!!
2010
IANA allocation
guidelines for the
IPv6 routing
header
19 APR 2011
APNIC central
registry depleted
05 OCT 2011
The greatest
innovator since
Thomas Edison
passes away.....

The End Is Nigh!!!

NO MORE ALLOCATION
OF IPv4 addresses!

So What About IPv5?

- Was to be the Internet Streaming Protocol (ST, ST2, ST+)
- Developed in the late 70's and was suppose to be an addition to IPv4
- Really designed to transmit voice and other Real Time Apps
- Concentrated on QoS
- Really the pre-cursor to VOIP!

Potential IPv4 Replacements

- RFC 1752 Recommendation for the IP Next Generation Protocol (Pv6)
- RFC 1475: TP/IX: The Next Internet (IPv7)
- RFC 1621: PIP - The P Internet Protocol (IPv8)
- RFC 1374: TUBA - TCP and UDP with Bigger Addresses (IPv9)
- RFC 1606: A Historical Perspective On The Usage Of IP Version 9

IPv4 Addressing - 32 Bit

- IPv4 address: 192.168.1.10 IPv4 address:
- Four bytes
- 2^32 total addresses
- 2^32 total addresses - 4 billion
- Are you kidding?

IPv6 Addresses - 128 Bit

- IPv6 address
- 2001:05c0:1000:000b:0000:0000:0000:66fb
- Omitting unnecessary zeroes; - 2001:5c0:1000:b::66fb
- Eight fields, each 16 bits long 4 hexadecimal characters
- 2^128 total addresses

So What Is 2^128 ?

340 undecillion, 282 decillion, 366 noncillion,

920 octillion, 938 septillion, 463 sexillion,

374 quintillion, 607 trillion, 431 billion,

768 million, 211 thousand, 456

And So What.....

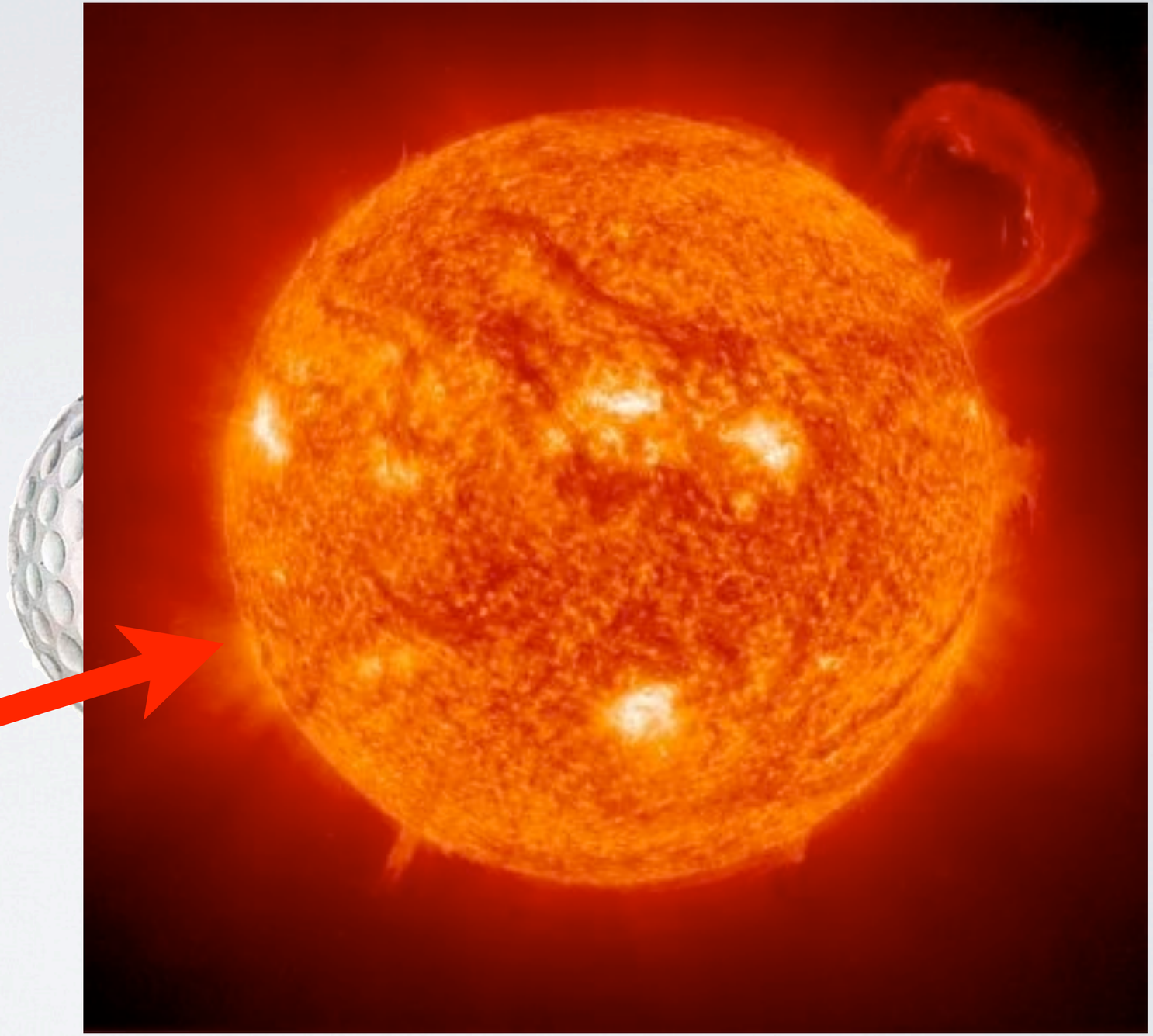
2^128/(2^33 x 2^64) - Assume remove the 64-bit address for the MAC address.

2,147,483,648 IPv6 addresses each!!

2 billion, 147 million, 483 thousand and 648

1.1.1.1 - 254.254.254.254

NOT TO SCALE



US Government IPv6 Transition Timeline

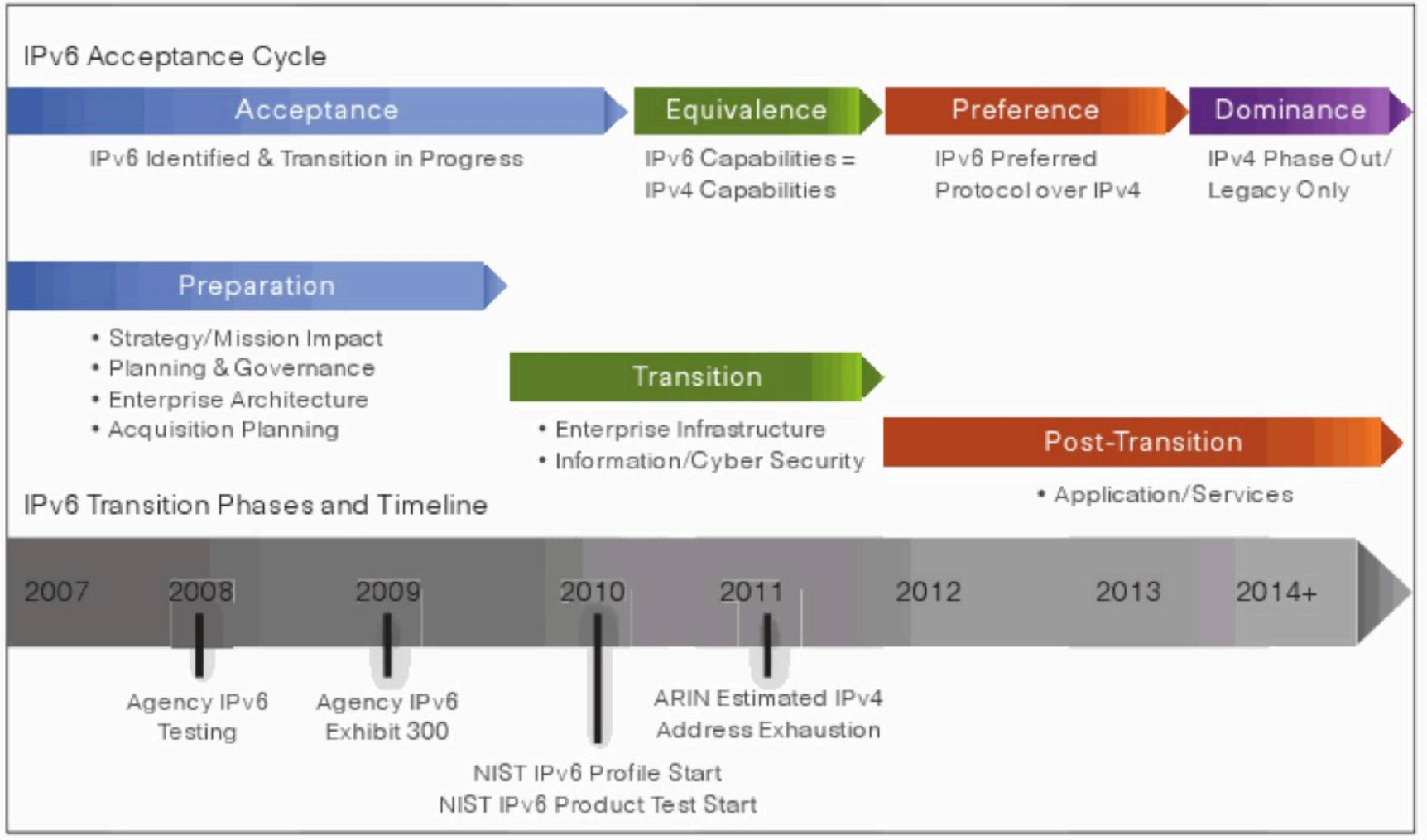


Figure 2: Federal IPv6 Transition Phases and Timelines

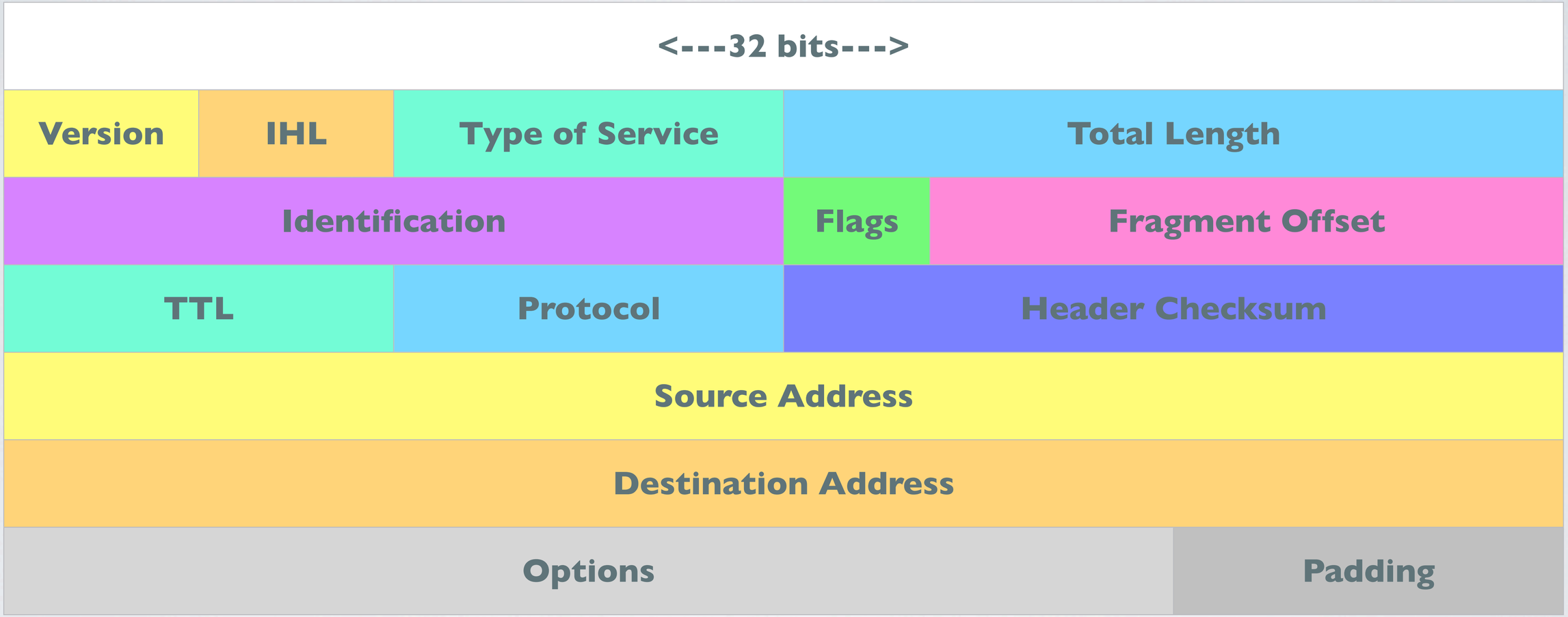
IPv4 And IPv6 Are Not The Same

- IPv4 ≠ IPv6 features
- IPV6 does not have ARP. It uses ICMPv6
- ICMPv6 is critical to IPV6 functionality
- DHCPv6 / Router advertisement.

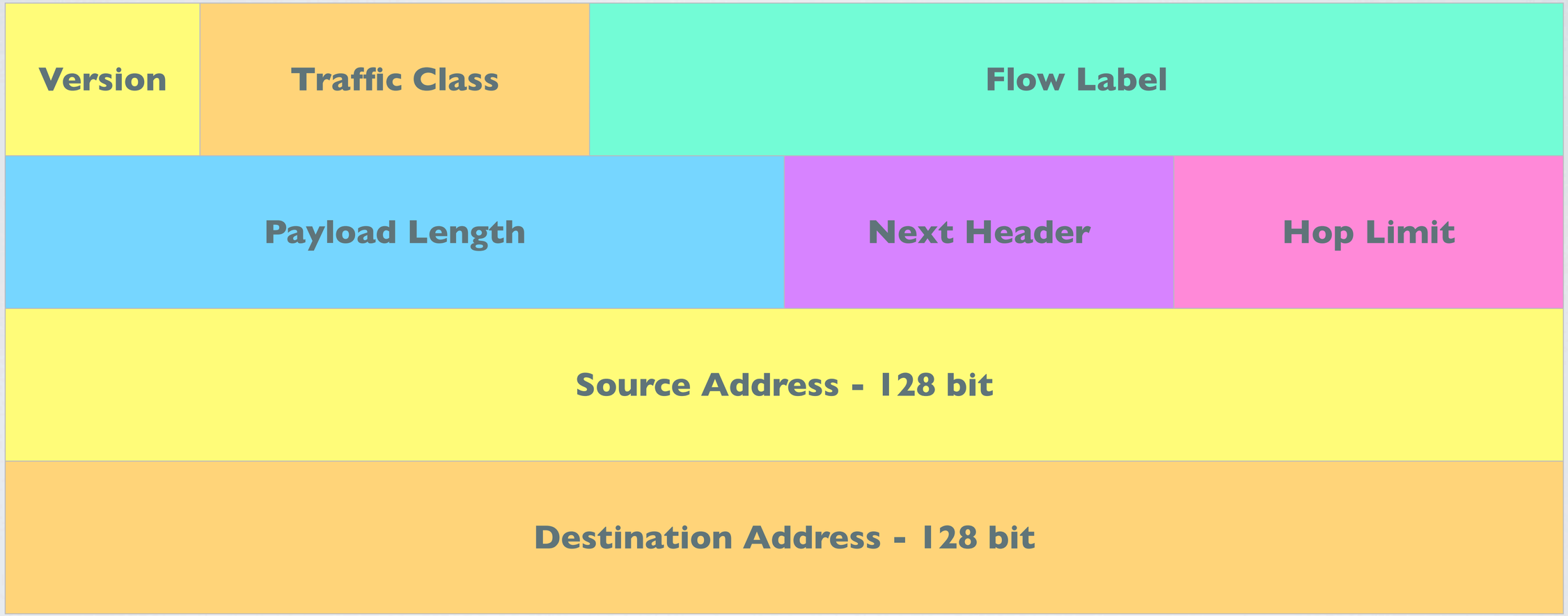
IPv4 & IPv6 - The Bottom Line

- We've run out of IPv4 address space
- IPv6 must be adopted for continued Internet growth
- IPv6 is not backwards compatible with IPv4
- We must maintain IPv4 and IPv6 simultaneously for many years
- IPv6 deployment has begun

IPv4 Header Format



IPv6 Header Format



IPV6 COMPARISONS

Common Misconception...

- The introduction of IPv6 puts our current IP infrastructure our networks and services at risk
- SLAAC will compromise my network.
- Our Internet Service Provider (ISP) does not offer IPv6 services, so we can't use it.
- It would be too expensive and complex to upgrade our backbone.
- We have enough IPv4 addresses; we don't need IPv6.

WRONG

What's New In IPv6

- Extended address space
- StateLess Address AutoConfiguration (SLAAC)
- Simplification of the Header format
- Mandatory security - IPSec
- Improved support for options and extensions.
- RADVD - Router Advertisement Daemon

Router ADVertisement Daemon

- Uses NDP to advertise IPv6 router addresses and prefixes on link-local networks
- RADVD used in SLAAC networks
- Manages responses - router advertisement (RA) to router solicitation requests (RS) to discover routers on the network.
- RA includes the routing prefix used, link MTU, and address of the responsible router.
- Airport extreme has RADVD embedded..... more later

IPv6 Mobility

- IPv6 allows you to have true mobility
- More efficient as it avoids triangular routing
- Really useful with voice calls over network boundaries

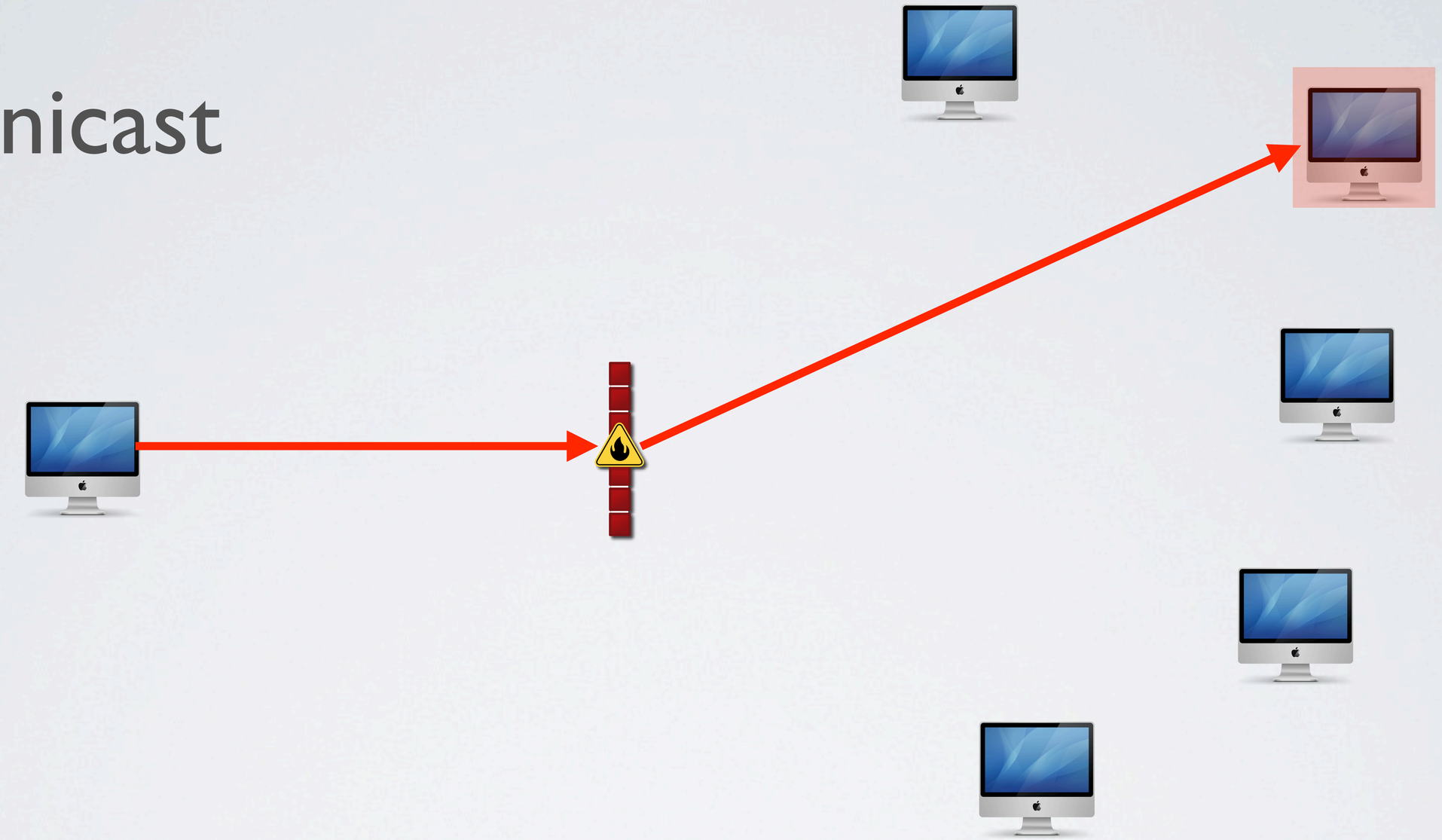
Jumbograms

- Theoretically can carry 4GB!!!
- Jumboframes limited to 9000 bytes
- Bonus points..... Extra performance due to not having to continuously transmit headers..

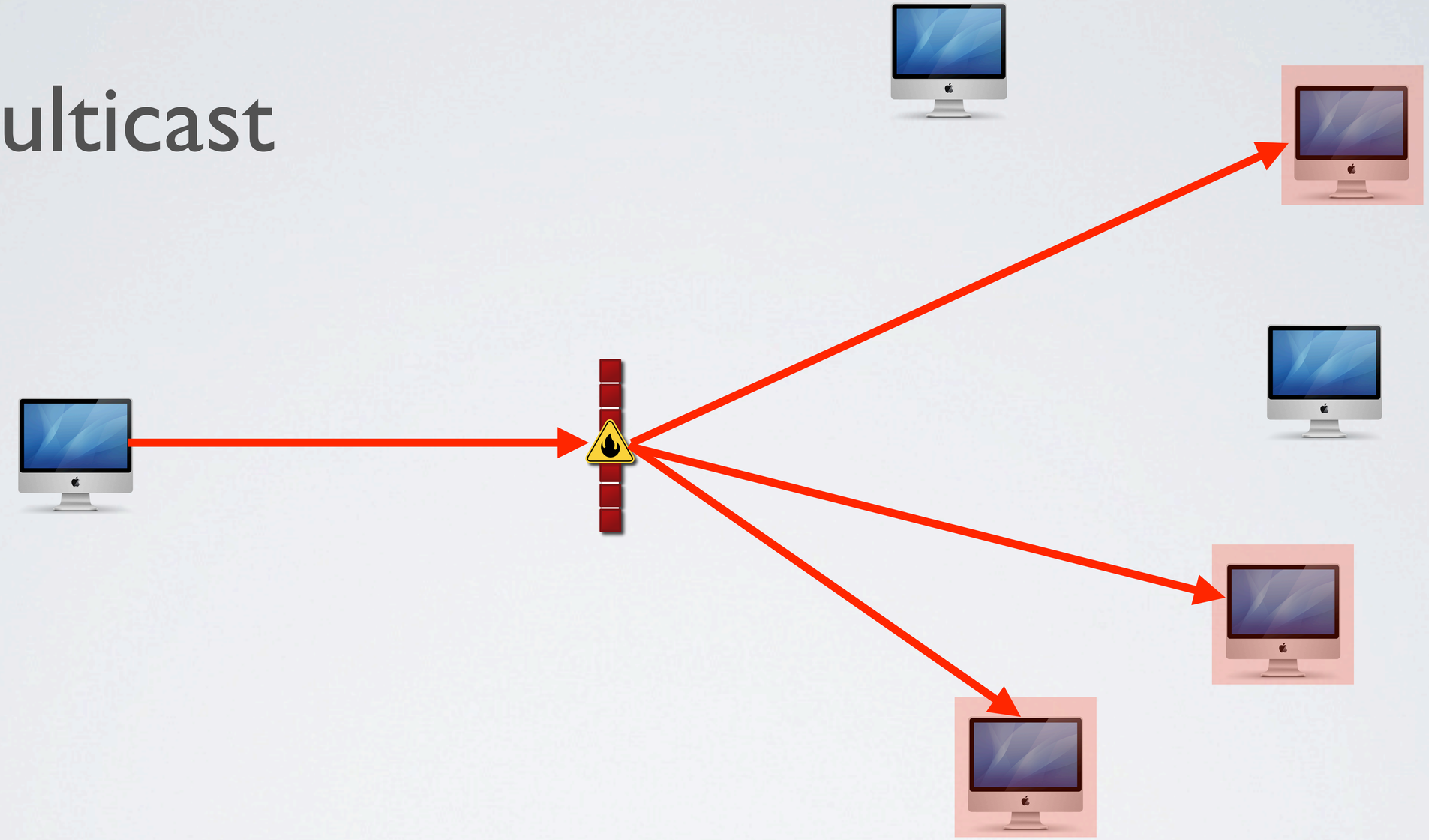
IPv6 Differences

- Allocation of networks are more efficient than IPv4 (partially resolved by CIDR - Classless inter-Domain Routing)
- Smallest network assignment is /64 - That 4 billion times larger than the current IPv4 range!)
- Some assignments are /56 (2^{72}) and /48 (2^{80}) addresses
- Multicast support

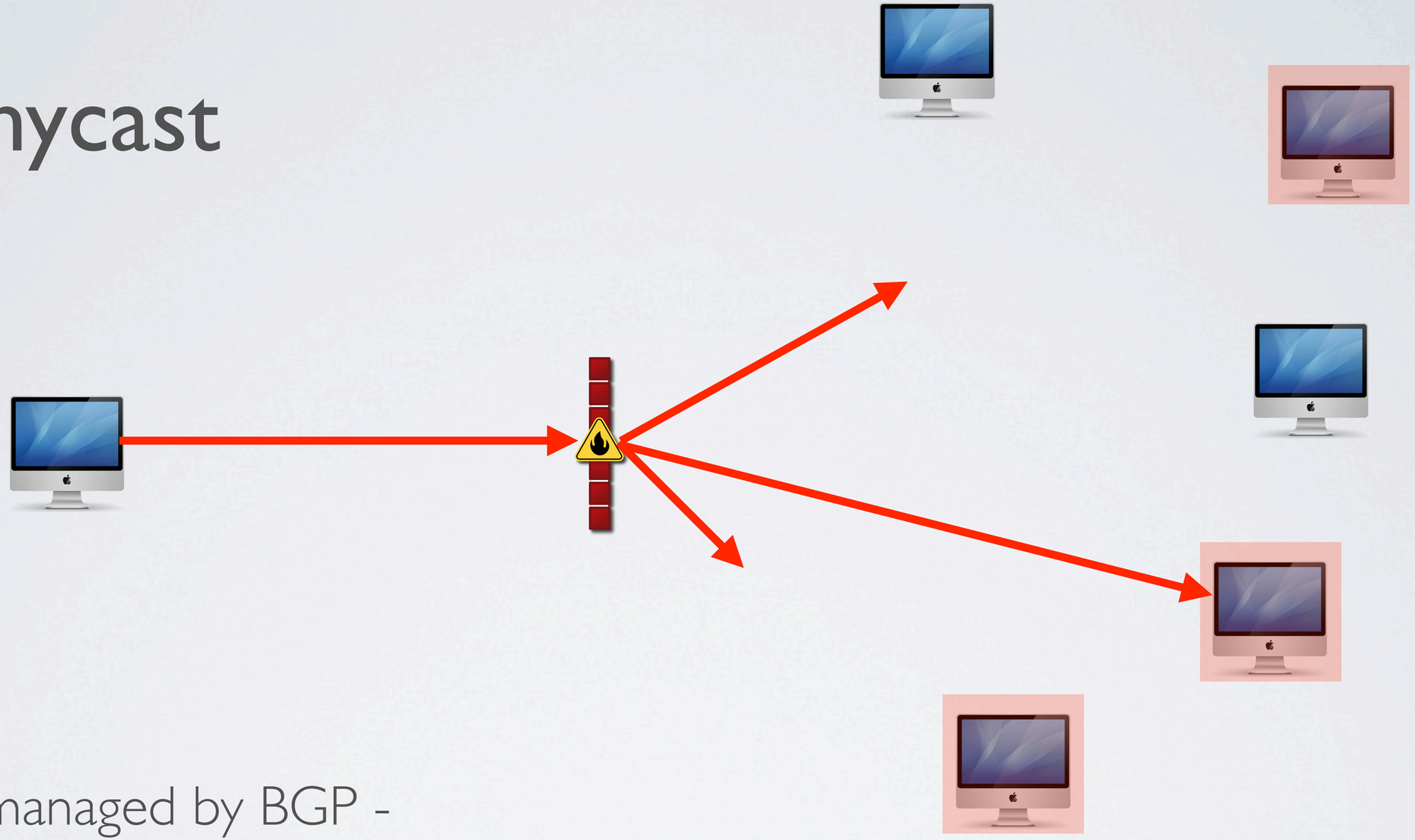
Unicast



Multicast



Anycast



Usually managed by BGP - traditional uses HA, LOAD Balancing and DNS

MIGRATE

Hardware/Software Support No Good

- Application and OS behavior is inconsistent
- Firewalls, IDS, etc have weak IPV6 support
  - except from the big guys
- A lot of switches, and load balancers also lack support

Caution

- Things may still break.....
  - IPv6 illegal gateway going to a black hole
  - delay in going to IPv4
- As time goes by this is getting less

Will It Break Email?

- Short answer ..... NO
- However if mail server are incorrectly configures yes.
- AND the old adage.. DNS DNS DNS!!!!!

No More NAT

- Will increase network speed
- Will help simplify networks
- Security concerns replaced by Stateful firewalls in IPv6 (amongs other techniques)

Future Users Will Be.....

- Public IPv4-only
- Shared IPv4-only
- Public IPv4 and IPv6
- Shared IPv4 and IPv6
- IPv6-only

Why Migrate?

RESISTANCE IS USELESS!

Everyone responsible for managing and maintaining the network should make a commitment, rip the Band-Aid off, start planning the migration, and just do it.

- David [illegible], vice president of IP services product management at network expert Global Crossing.

ADDRESSING

Global Routing Prefixes

Allocation	Prefix
Unassigned	::0/8
Reserved	
Global unicast	2000::/3
Link-local unicast	FE80::/10
Local IPv6 address	FC00::/7
Private administration	FD00::/8
Multicast	FF00::/8

Address Notation - Pure IPv6

An IPv6 address has 128 bits, or 16 bytes:

2001:DB8:0000:0000:0202:B3FF:FE1E:8329

This can be abbreviated to:

2001:DB8:0:0:202:B3FF:FE1E:8329

or this:

2001:DB8::202:B3FF:FE1E:8329

Prefix Notation

- Prefix notation in the form
  - **IPv6 address / Prefix Length**

Start with this: 2001:DB8:0000:0056:0000:ABCD:EF12:1234/64

Short Version: 2001:DB8::56/64

Uncompress: 2001:DB8:0000:0000:0000:0000:0000:0056

What it should be: 2001:DB8:0:56::/64

Address Notation - Mixed

In networks where there is both IPv4 and IPv6, the address notation can be set as follows:

IPv4 address of 192.168.0.2

Can be represented as

0:0:0:0:0:0:192.168.0.2 or ::192.168.0.2

or more correctly

::C0AB:2

IPV6 And DNS

Your IPv4 DNS is

KOT.com. IN MX 10 Sydney.kot.com.
KOT.com. IN MX 10 Melbourne.kot.com.
Sydney.kot.com. IN A 4.2.2.1
Melbourne.kot.com. IN A 8.8.8.8

IPv6 DNS Becomes

KOT.com. IN MX 10 Sydney.kot.com.
KOT.com. IN MX 10 Melbourne.kot.com.
Sydney.kot.com. IN A 4.2.2.1
Sydney.kot.com. IN AAAA 2001:db8:10:133::1
Melbourne.kot.com. IN A 8.8.8.8
Melbourne.kot.com. IN AAAA 2001:db8:10:133::2

DEMO

SECURITY

Covert Channels

- IPv6 can be used as a covert channel because of the identification of the individual device in a network
- The 64 bit extension EUI-64
- Can protect from outside hackers by using IPSec
- Simplest way is to not use Stateless autoconfiguration
- Use DHCPv6 instead
- or use a firewall with IDS etc etc (the usual rules apply)

Trojan And Wormhole Propagation

- All modern OS's have IPv6 enabled by default
- Most of the OS's try to encapsulate IPv6 in IPv4 packets
- IPV6 traffic becomes undetected to IPS's etc.
- Solution.....
  - Deploy IPv6 on the intranet so tunnels will be disabled.
  - Can apply same security policies as IPv4

Privacy Address

- Using privacy extensions on SLAAC is good for the client
- In effect the address changes dynamically
- Not so good for servers.

What About Servers?

- Server will have static addresses so in effect are vulnerable
- Will need to make sure all security measures are in place
- Consider implementing MT6D - Moving Target IPv6 Defence
  - Ensures anonimity of server on the internet whilst allowing persistent connections.
  - Developed by Virginia Tech ..... Check it out

ICMPv6 Filtering

- Blocking ICMP on firewalls will break it IPv6!
- Unlike ICMP, ICMPv6 does:
  - Pathe MTU discovery, Router discovery, Neighbour Discovery, Mobile IPv6, multicast mangement and address reconfiguration.
- So let it on through!!
- RFC 4890 provides guidelines for filtering ICMPv6

Other Risks

- Many security appliances are not ready for IPv6, so it often bypasses them
- Torrents run over IPv6
- Some VPN appliances are not ready, so IPv6 connections must bypass them

Privacy Risks

- Anyone who has your IP address also has your MAC address!
- There is a "Privacy Extensions" technique to avoid this, enabled by default.

SO WHATS THE PLAN MOVING FORWARD?

Waht Needs To Be Done?

- ISPs need to plan for a migration plan
- Content providers need to plan for dual support
- Business and education need to plan for migration and dual support
- Equipment Manufacturers need to have dual stack support
- Need to look at adoption needs across a whole organisation and beyond

IPv6 Adoption Needs

- IPv6 address space
- IPv6 connectivity (native or tunnelled)
- Operating systems, software, and network management tool upgrades
- Router, firewall, and other hardware upgrades
- IT staff and customer service training

TRANSITION MECHANISMS

So What Are Your Choices?

- Ignore IPv6: Stay on IPv4-only
- Gateways: Devices that convert IPv6 to IPv4
- Tunnel IPv6 over IPv4
- Dual-Stack: IPv4 and IPv6 together
- Nirvana: IPv6-only

IPv6 Tunnels

- Fast and easy to set up
- Not the best for security or performance
- Free IPv4-to-IPv6 Tunnels
  - Gogo6.com
  - Sixxs.net
  - Tunnelbroker.com

Teredo / Miredo

- Provides IPv6 connectivity behind NATs
- Done by tunnelling IPv6 within UDP
- Teredo (Miredo) is specified in RFC 4380
- Teredo IPv6 service Prefix : 2001:0000: / 32

SO WHAT ABOUT OSX AND IOS ?

IPv6 And OSX

READY NOW

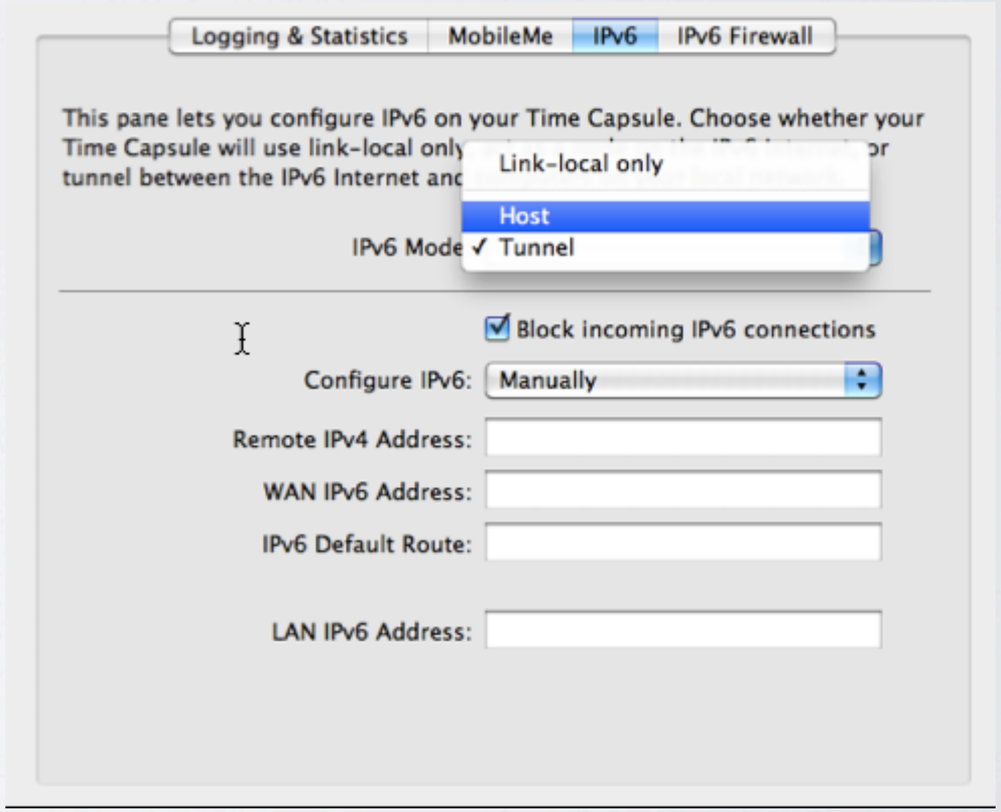
So What About Lion?

- DHCPv6 works
- Privacy / Temporary SLAAC addresses enabled by default

LOOKING FOR A CHEAP IPV6 GATEWAY?

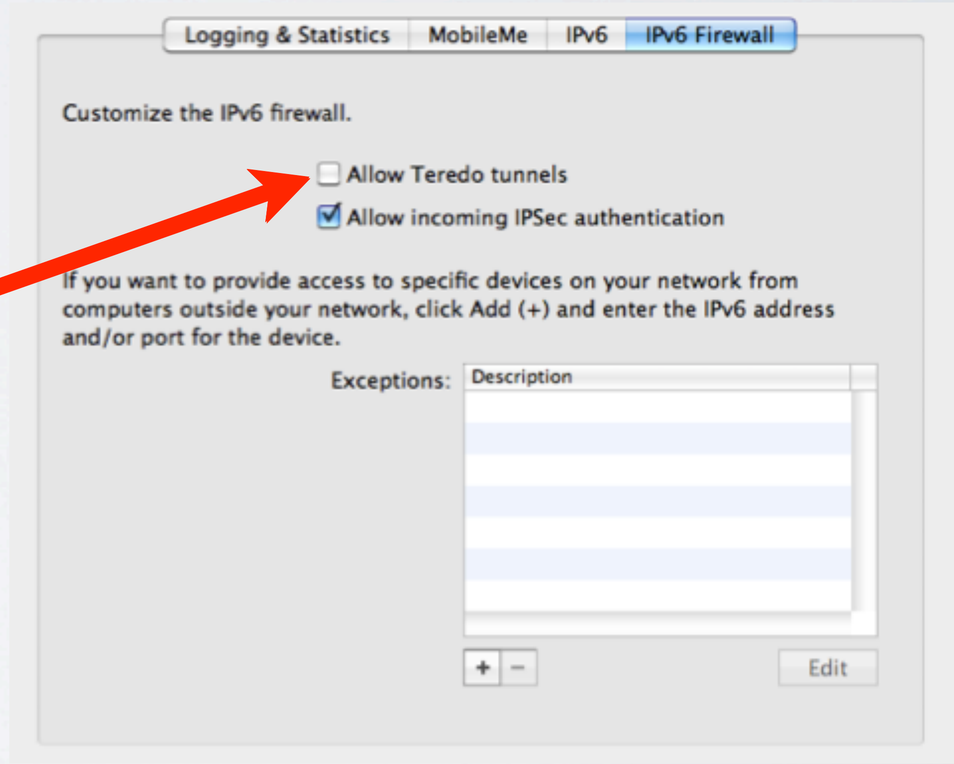
Airport Extreme!! Yes Really!

- Best to have Firmware 7.5.2 or better
- Does 6to4 tunnelling
- Has radvd enabled (bonus points)
- No DHCPv6 (..... well yet anyway)
- And security.....



Basic Firewall And Teredo Support

- IPv6 firewall only enabled if blocking incomming IPv6 Connections
- Simple filtering



Bonus Points!!

What About IOS?

- Absolutely
- No fallback from IPv6 to IPv4 if the connection “blackholes”
- However, if the error is generated by the network, it will fail over
- Should be addressed in latest iOS updates
- IPv6 cannot be disabled in iOS (YAY!!!)

Troubleshooting IPv6 Connections

- MacOSX resolver cache IPv4 addresses
- If an IPv4 address is already cached with FQDN, then it won't find the IPv6 address
- Manually clear the DNS cache
  - **sudo dscacheutil -flushcache**

Determining The KAME Version

- This is the project to create an IPv6 stack and tools - concluded 2006
- Most of the components moved to FreeBSD, NetBSD and MacOSX
  - **sysctl -a | grep kame_version**

OSX - IPv6 Privacy Addresses

- Enabled by default in Lion
- to enable in Snow Leopard
  - # sysctl -w net.inet6.ip6.use_tempaddr=1

OSX Server Issues

- Server Admin does not support IPv6
- To use IPv6 firewall on OSX Server:
  - Edit /etc/ipfilter/ip_address_groups.plist

```
<key>IPv6Mode</key>
<string>NoRules</string>
<key>IPv6Control</key>
<false/>
```

http://blog.atariwiki.strotmann.de/roller/cas/entry/managing_the_macos_x_ipv6

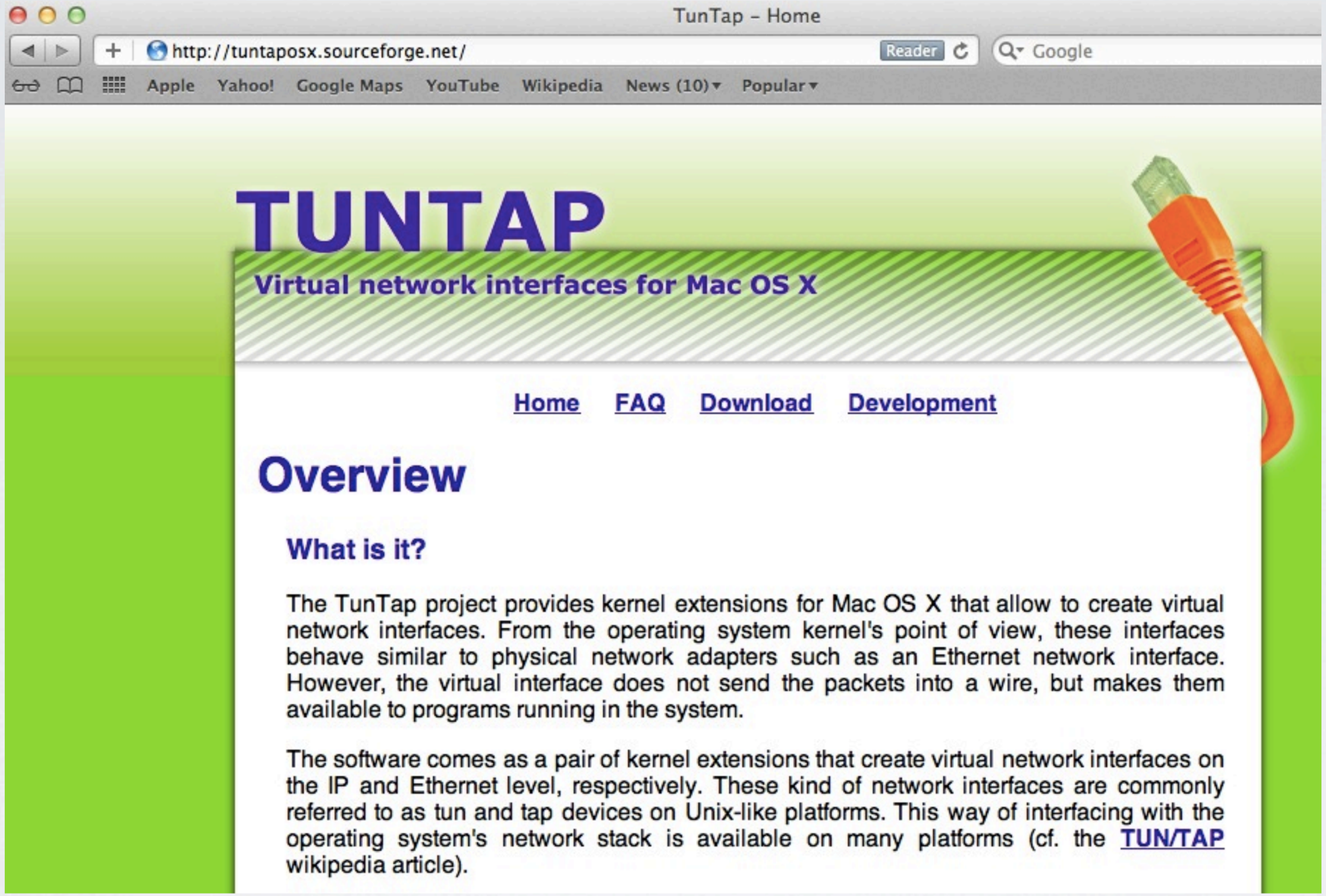
IPv6 Changes In 10.7

- IPv6 privacy addresses are enabled by default.
- DHCPv6 is supported.
- NFS client supports IPv6.
- SMB client supports IPv6.

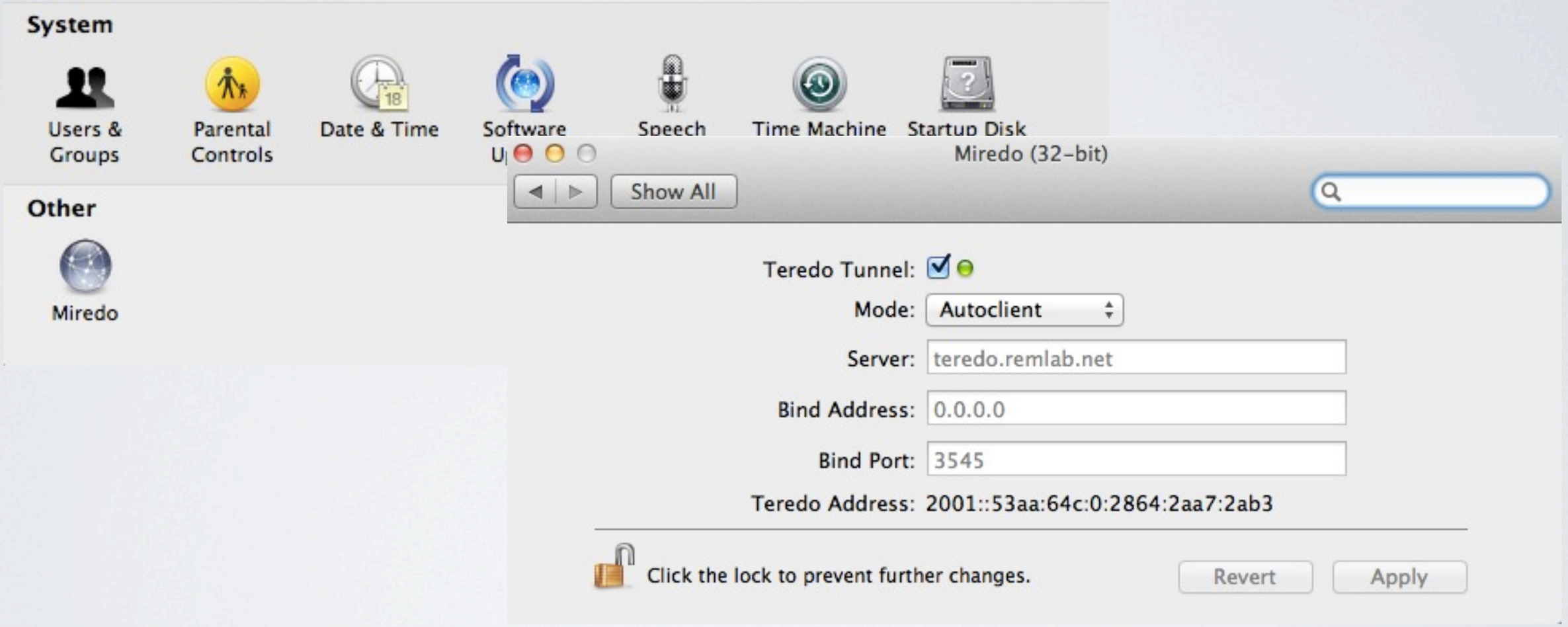
HERE'S SOMETHING I PREPARED EARLIER....

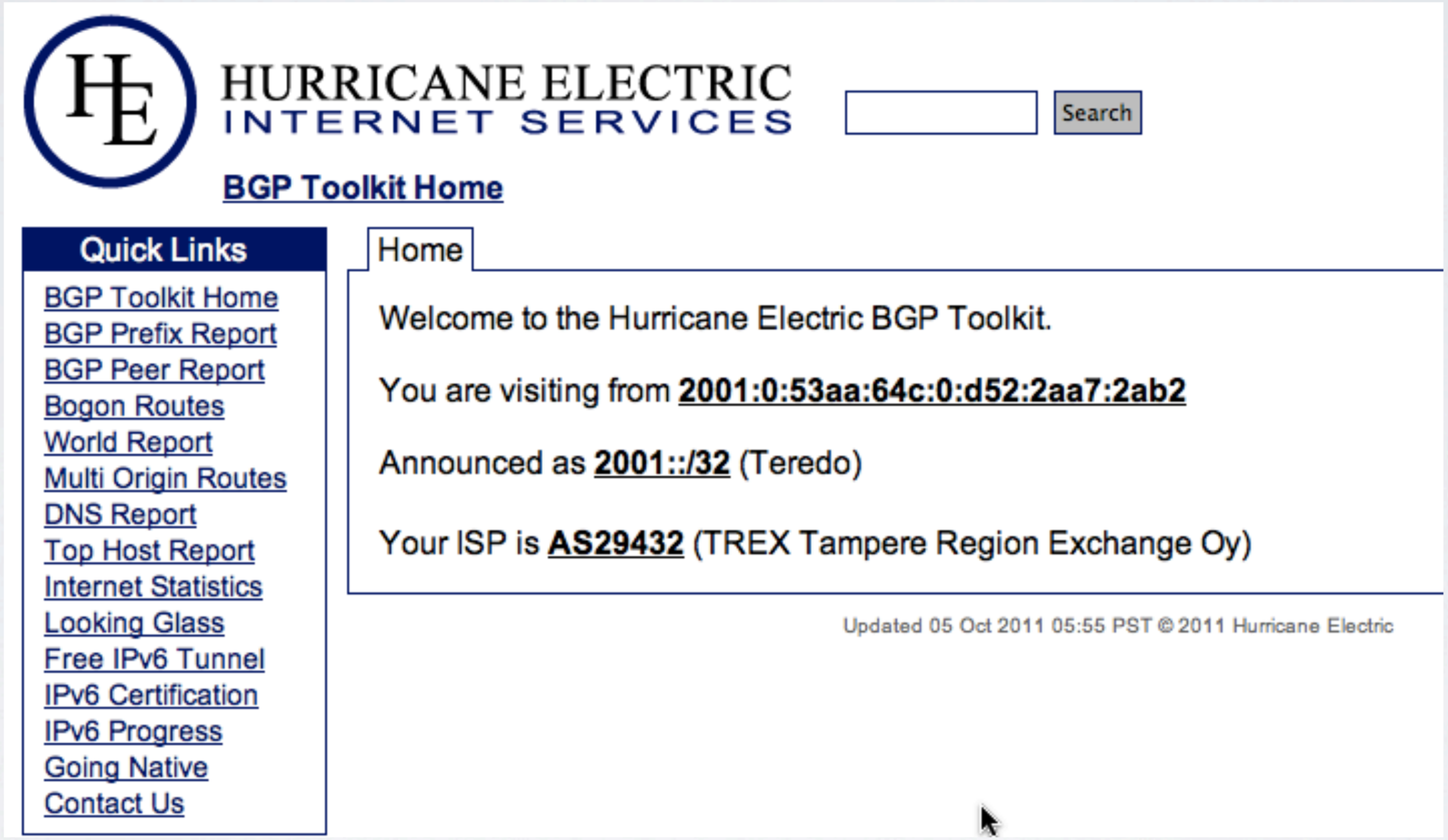
Deepdarc - Teredo For OSX

TUNTAP - Fixes 32-bit Problem

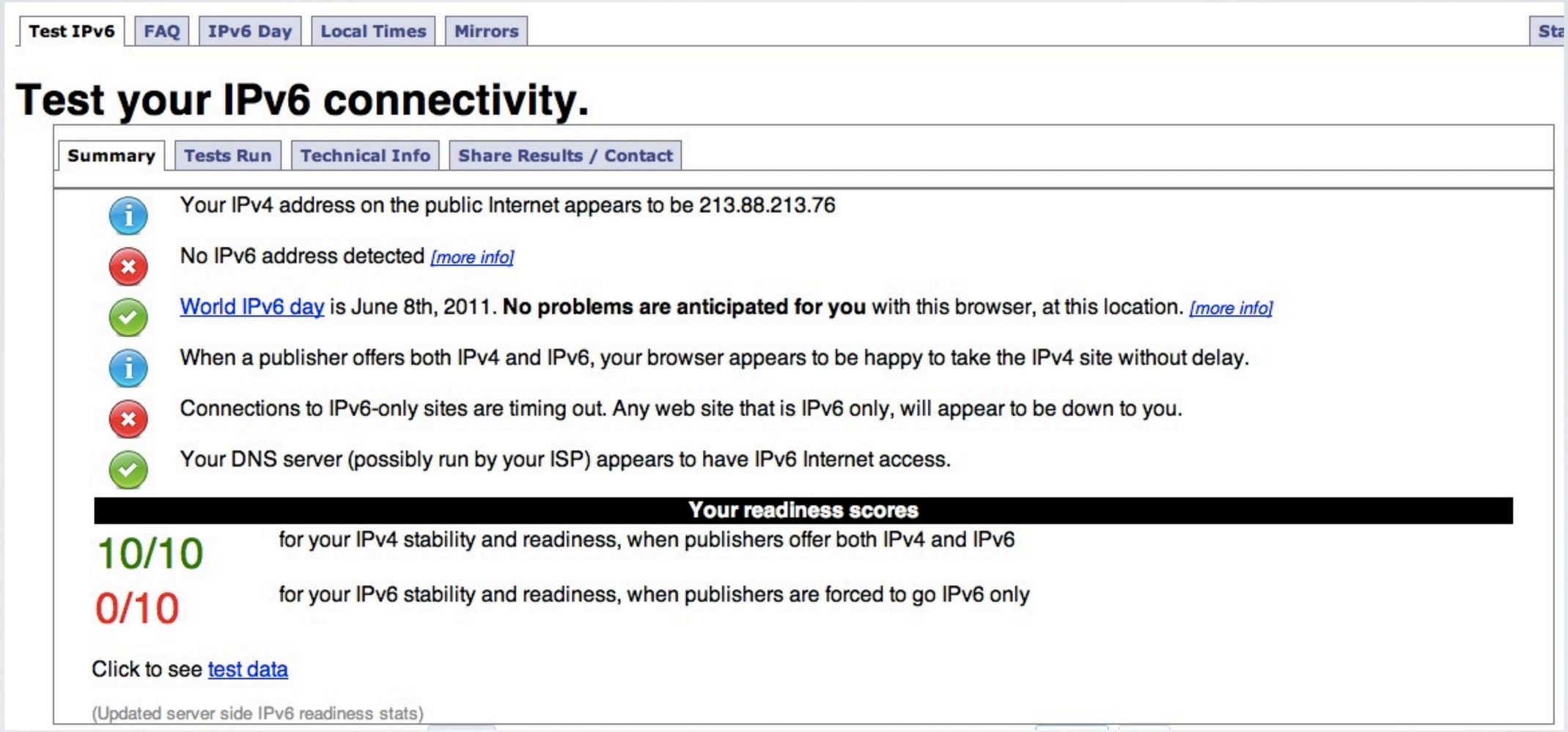


Miredo For OSX

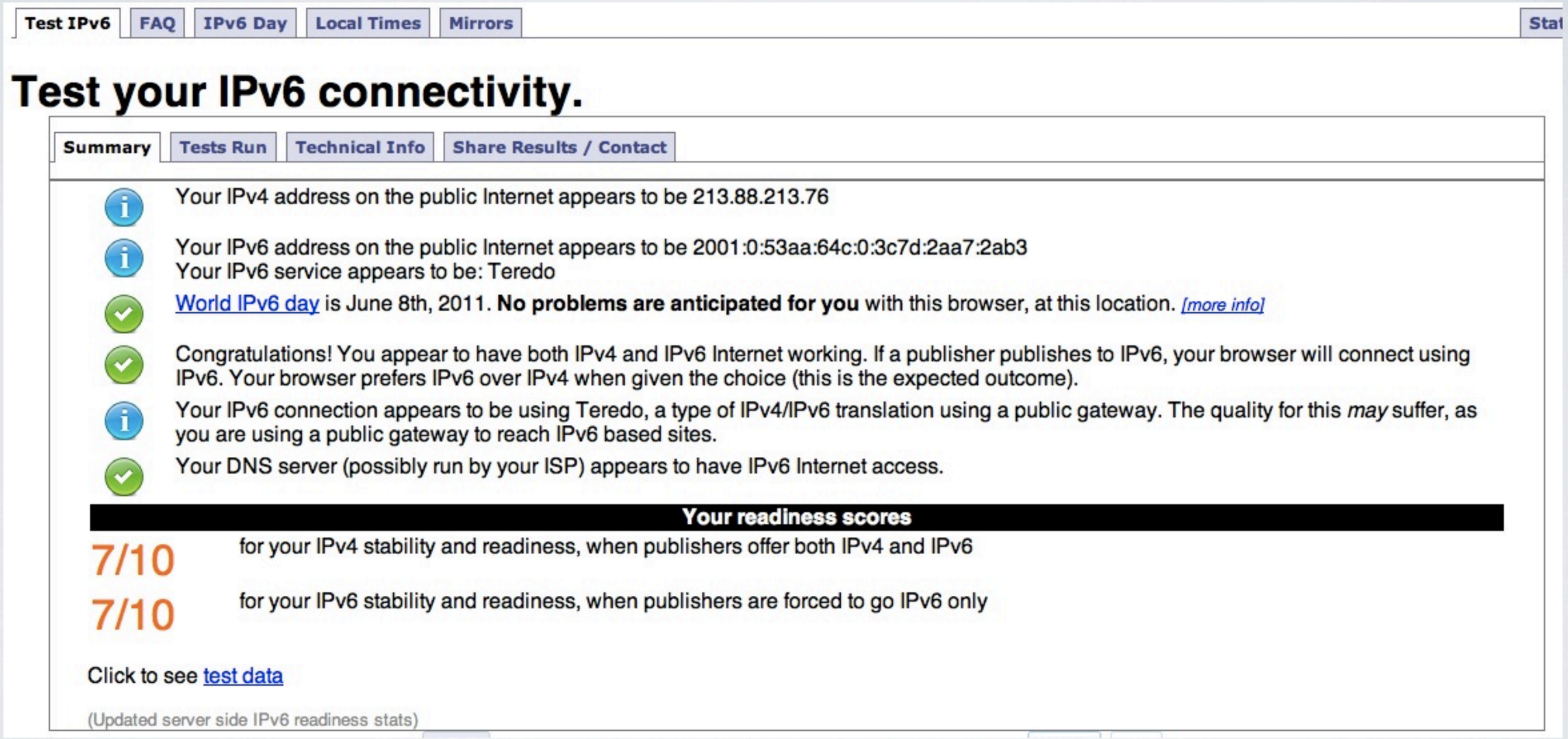



HURRICANE ELECTRIC
INTERNET SERVICES
Search
BGP Toolkit Home
Quick Links
BGP Toolkit Home
BGP Prefix Report
BGP Peer Report
Bogon Routes
World Report
Multi Origin Routes
DNS Report
Top Host Report
Internet Statistics
Looking Glass
Free IPv6 Tunnel
IPv6 Certification
IPv6 Progress
Going Native
Contact Us
Home
Welcome to the Hurricane Electric BGP Toolkit.
You are visiting from 2001:0:53aa:64c:0:d52:2aa7:2ab2
Announced as 2001::/32 (Teredo)
Your ISP is AS29432 (TREX Tampere Region Exchange Oy)
Updated 05 Oct 2011 05:55 PST © 2011 Hurricane Electric

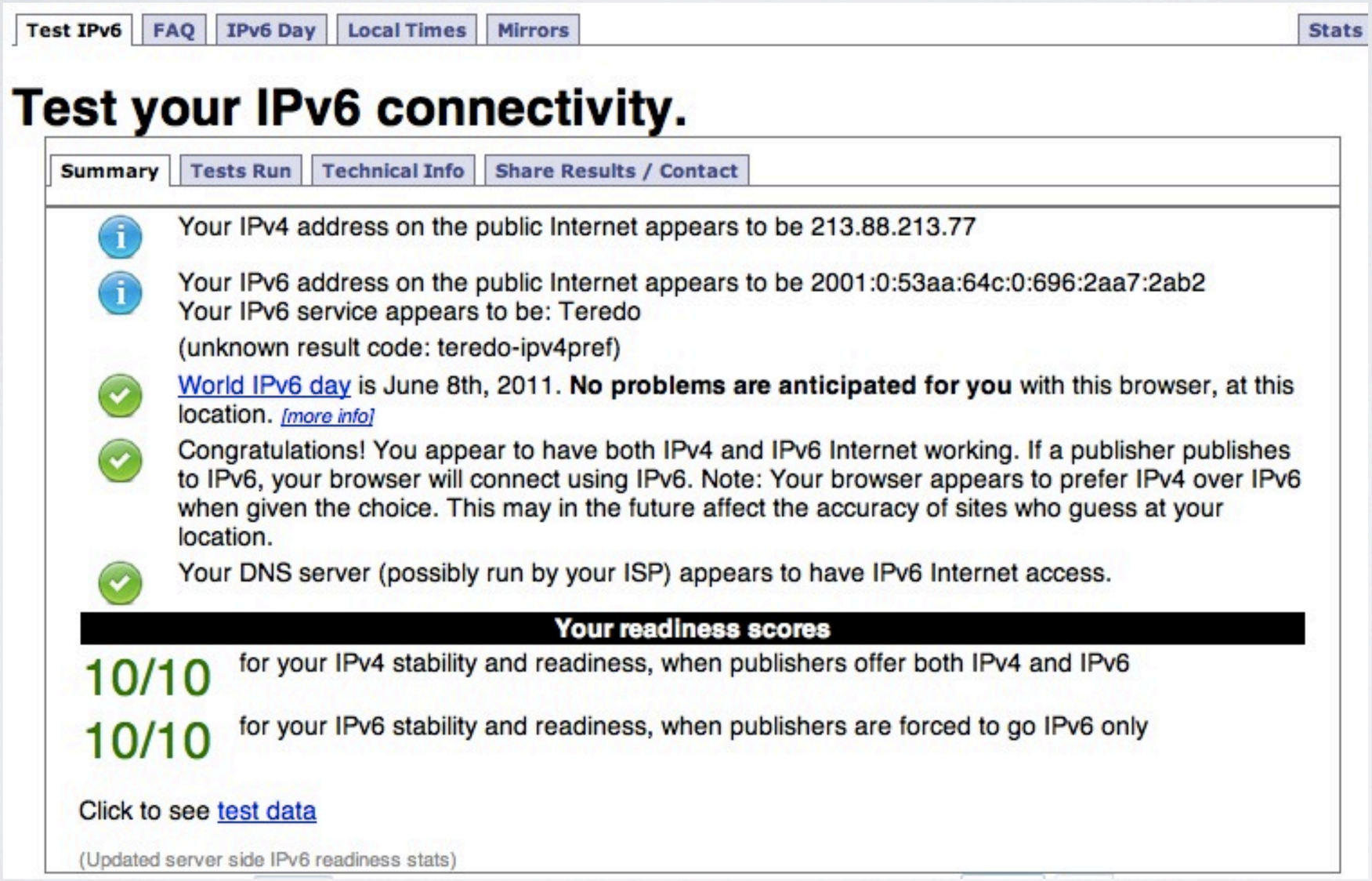
IPV4 Test 10.6.8

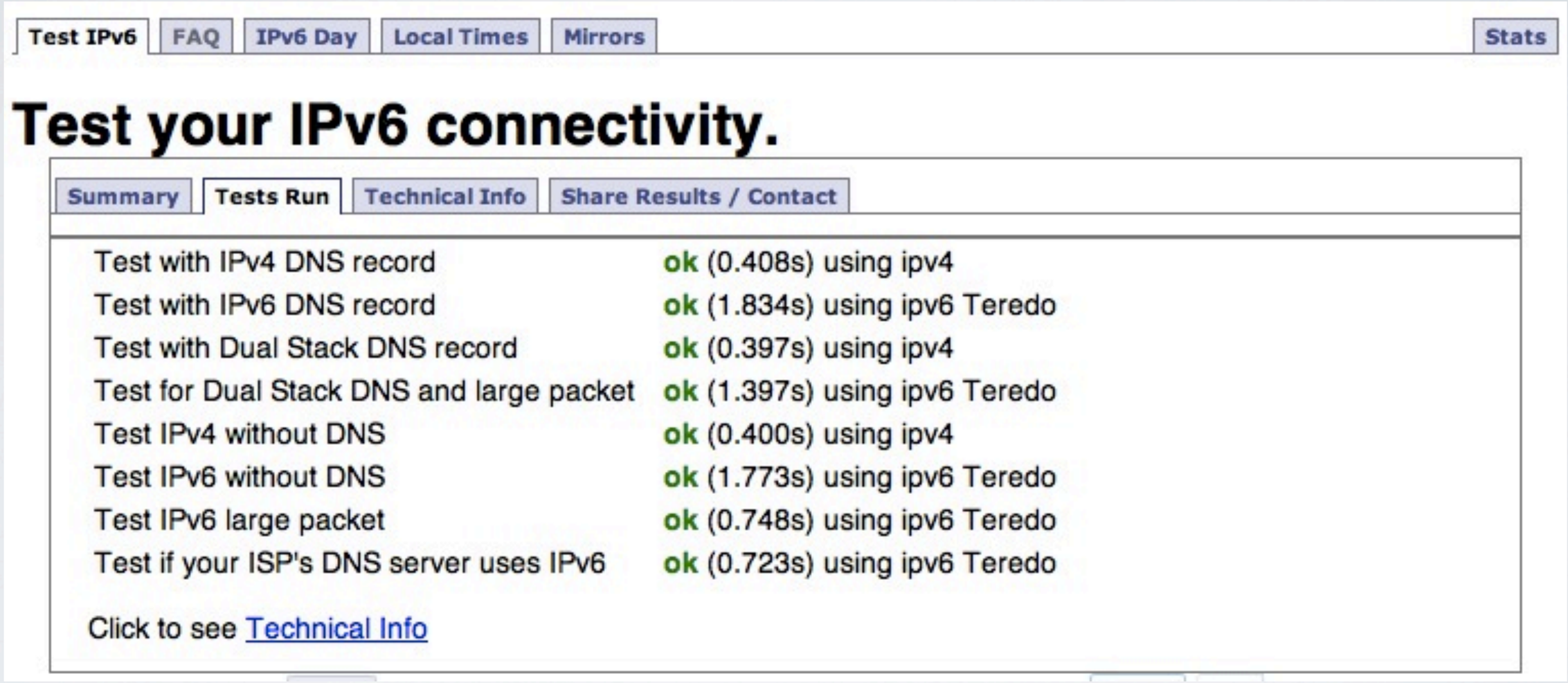


IPv6 Test 10.6.8



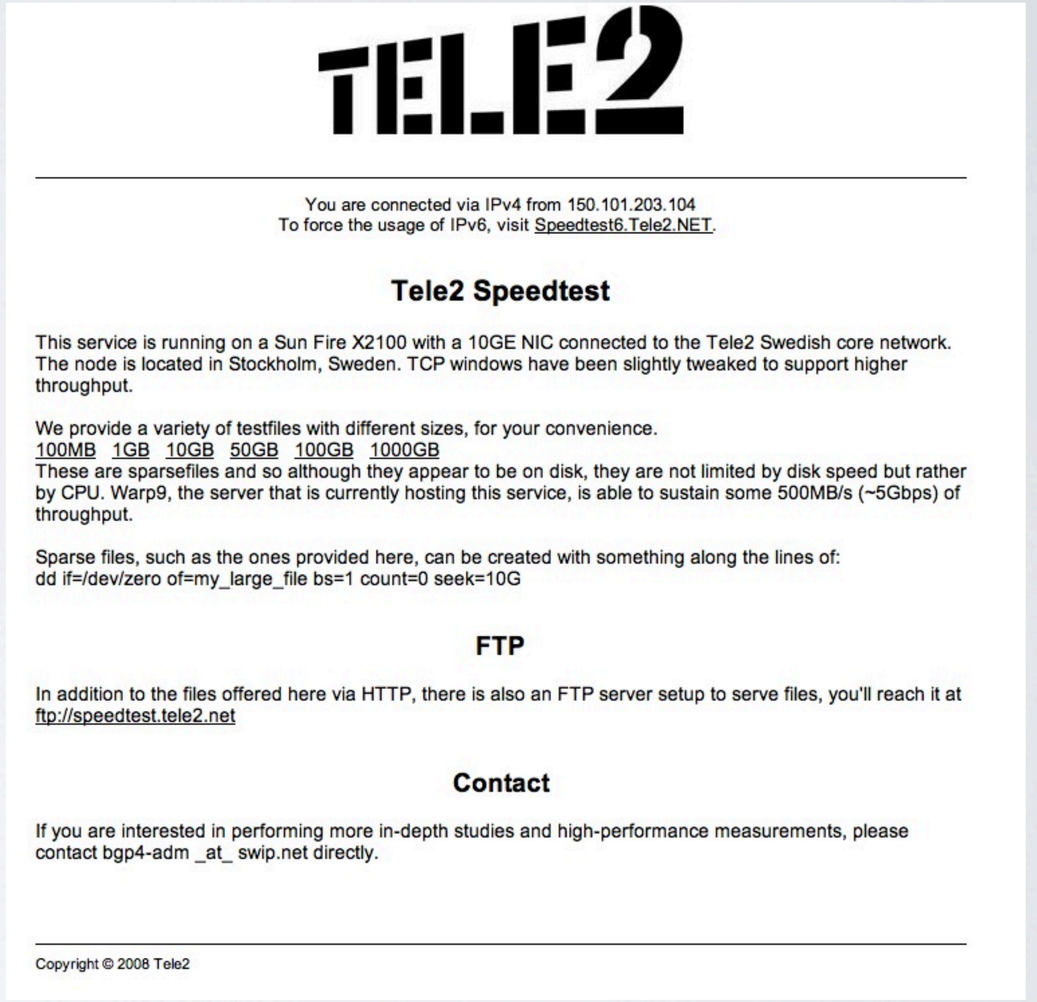
Test IPv6 10.7.1




Test IPv6
FAQ
IPv6 Day
Local Times
Mirrors
Stats
Test your IPv6 connectivity.
Summary
Tests Run
Technical Info
Share Results / Contact
Test with IPv4 DNS record ok (0.408s) using ipv4
Test with IPv6 DNS record ok (1.834s) using ipv6 Teredo
Test with Dual Stack DNS record ok (0.397s) using ipv4
Test for Dual Stack DNS and large packet ok (1.397s) using ipv6 Teredo
Test IPv4 without DNS ok (0.400s) using ipv4
Test IPv6 without DNS ok (1.773s) using ipv6 Teredo
Test IPv6 large packet ok (0.748s) using ipv6 Teredo
Test if your ISP's DNS server uses IPv6 ok (0.723s) using ipv6 Teredo
Click to see Technical Info

Performance Testing

- Don’t get funky, just use HTTP or FTP file transfers.
- Use WireShark to Monitor
- Example http://speedtest.tele2.net -
- Operated bt Tele2 Sverige AB



TELE2

You are connected via IPv4 from 150.101.203.104
To force the usage of IPv6, visit Speedtest6.Tele2.NET.

Tele2 Speedtest

This service is running on a Sun Fire X2100 with a 10GE NIC connected to the Tele2 Swedish core network. The node is located in Stockholm, Sweden. TCP windows have been slightly tweaked to support higher throughput.

We provide a variety of testfiles with different sizes, for your convenience.
100MB 1GB 10GB 50GB 100GB 1000GB
These are sparsefiles and so although they appear to be on disk, they are not limited by disk speed but rather by CPU. Warp9, the server that is currently hosting this service, is able to sustain some 500MB/s (~5Gbps) of throughput.

Sparse files, such as the ones provided here, can be created with something along the lines of:
dd if=/dev/zero of=my_large_file bs=1 count=0 seek=10G

FTP

In addition to the files offered here via HTTP, there is also an FTP server setup to serve files, you'll reach it at ftp://speedtest.tele2.net

Contact

If you are interested in performing more in-depth studies and high-performance measurements, please contact bgp4-adm _at_ swip.net directly.

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KAMOLOSO

SO WHAT IS THE REAL STATUS OF IPV6 AROUND THE GLOBE?

So.....

- http://www.mrp.net/IPv6_Survey.html
- Looks at 5 things
  - Web servers accessible via IPv6
  - Email deliverable via IPv6
  - DNS names servers accessible via IPv6
  - NTP service accessibe by IPV6
  - Jabber service accessibel via IPv6

RESOURCES

RFC's

Mobile IPv6 RFC 3775
RFC 2117 (documents router alert option)
RFC 2676 (documents QoS routing mechanisms)
RFC 2460 - Internet Protocol, Version 6 (IPv6) Specification

Cool Sites

http://www.subnetonline.com/pages/subnet-calculators/ipv4-to-ipv6-converter.php

http://www.potaroo.net/

http://www.mrp.net/IPv6_Survey.html

http://ipv6.he.net

http://www.sixxs.net

http://bgp.he.net/

IPv6 Resources

Pv6 Intelligence
http://ipv6int.net/systems/mac_os_x-ipv6.html

Derek Morr's *Living with IPv6* blog
http://www.personal.psu.edu/dvm105/blogs/ipv6/

SIXXS
http://www.sixxs.net/wiki/SixXS_Wiki

ARIN IPv6 Wiki
http://whois.arin.net/index.php/Main_Page

IPv4/IPv6: The Bottom Line
http:// arin.net/knowledge/v4-v6.html
http://www.teamarin.net

http://www.kame.net

Theres is no Plan B: Why the IPv4-to-IPv6 transition will be ugly:
http://arstechnica.com/business/news/2010/09/there-is-no-plan-b-why-the-ipv4-to-ipv6-transition-will-be-ugly.ars

Hurricance Electric:
http://ipv6.he.net

Teredo Overview
http://technet.microsoft.com/en-us/library/bb457011.aspx

Miredo:
http://www.remlab.net/miredo/

THANK YOU