IP version 6 And You

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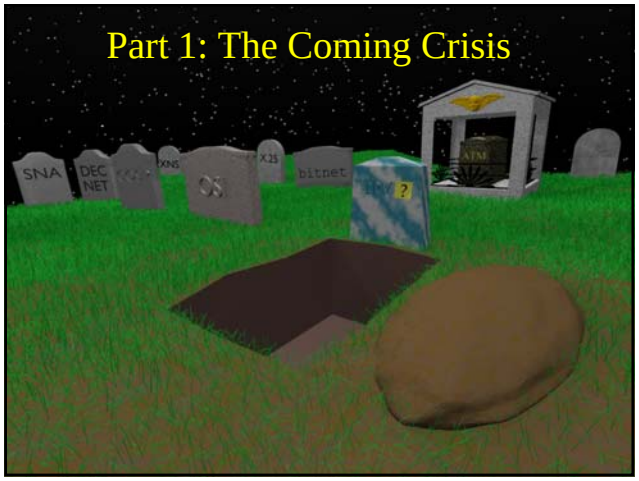
Prologue: Getting IPv6 Information

- There is much info on the Internet
- A large portion of it is not current
  - Things have changed, continually
  - A lot of it does not include a creation date
- When in doubt, a good starting point seems to be Wikipedia
- Practically all journalism about IPv6 is useless or inaccurate
- Trying to sort out details is like looking for your car keys after a flash-flood destroyed your house.
- (Today is the 4th anniversary of the 2004 UHM flash flood)

Part 1: The Coming Crisis



What Is IP?

- "IP" is the *Internet Protocol*
  - There are two operating versions
    - Version 4 (1981)
    - Version 6 (1998)
- IP entities have numeric IP addresses
  - 128.171.3.13, 168.105.211.22
  - 2607:f278:0:6:204:23ff:fe89:6238
- IP is the protocol that makes the Internet global
- Analogous to freight trains and container ships.

What Is “The Coming Crisis”?

- IPv4 address allocations expected to run out
- Addressing acquires new economy
- Global routing table will fill up
- Routers will be unable to keep up with changes
- (…)dogs and cats living together... mass hysteria!

Peter Venkman, Phd., Ghostbuster (copyright © 1984 Columbia Pictures Industries Inc. All rights reserved.)

Why a new IP?

- Address availability
- Route table size
- Security (IPSec et al)
- Less configuration
- Network Transparency

But wait, there’s *less*!

- Too Much Cookie Sharing
- IPSec was also developed for IPv4
- CIDR reduced address waste
  - Or rather stopped causing it
- Tech-pundits diss NAT, but Joe Plumber doesn’t care
- In the current climate, “transparency” sounds unlikely and creepy to many

Who’s In Charge Of Making Sure IPv6 Gets Deployed ?

- Well, nobody, actually
  - Which is also everybody
- The Internet is design by consensus
- There is leadership
  - Following is a personal choice
- equipment and software vendors cooperating more and more
  - No eating of own dog food occurring

IPv6 Drivers

- Japanese Government
- U.S. DoD, and etc.
- Research and Education Orgs
- Others

Edison Failed In The Phonograph Business

- Thomas Edison invented the phonograph in 1877
- For 3 decades, he improved and marketed the machine
- He pushed the technology in various ways and never seemed to realize that his competitors beat him not by selling phonographs,
- But by selling ***music***

"It is amazing how complete is the delusion that beauty is goodness."
- Tolstoy

- There are many smart people who believe that the better protocol will win out because it's better.
- They believe that "TRUTH", sound engineering and common sense will drive a global protocol exodus
- Betamax was better than VHS
- V6 needs advocacy more than it needs design to win the day.

the bit slide

- Digital devices, networks, etc. represent information with "bits"
- A bit is an evaluation of the presence or absence of something,
  - A light being on or off (i.e. in optical fiber)
  - An electrical charge or lack of it (DRAM memory)
  - A magnetic field's strength, strong or weak, or its direction, right or left (hard drives, etc.)
  - An area either reflecting a light or not (CDs, DVDs)

the nybble slide

Four bits have 16 possible combinations:

0000 = 0	1000 = 8
0001 = 1	1001 = 9
0010 = 2	1010 = 10
0011 = 3	1011 = 11
0100 = 4	1100 = 12
0101 = 5	1101 = 13
0110 = 6	1110 = 14
0111 = 7	1111 = 15

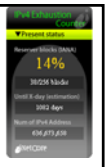
2^n

- Every time you add a bit, you double the number that can be represented.
- IPv4 addresses use 32 bits
  - 4,294,967,296
- IPv6 addresses use 128 bits
  340,282,366,920,938,000,000,000,000,000,000,000,000
  (give or take)
- Representations of bits are invented for ease of use, like:
  - 192.168.1.123
  - 2607:f278:0:6:230:48ff:fe71:31f1

If that address is so *numeric*, how come it has letters in it?

- consider 2607:f278:0:6:230:48ff:fe71:31f1
  - (a.k.a. http://net.its.hawaii.edu)
  - (a.k.a. 128.171.6.3)
- The number is represented in *hexadecimal* notation, otherwise known as base 16
- 0-9 are as you would expect, A-F (or a-f) represent decimal (regular numbers) 10 – 15
- Read http://en.wikipedia.org/wiki/Hexadecimal

Addressing



- According to the IPv4 "death clock" (my term)
  - http://inetcore.com/project/ipv4ec/index_en.html
  - The last of the IPv4 addresses will be allocated to address consumers
    - Sun Oct 16 2011
    - Give or take.
    - But nothing will probably happen until the following Monday, anyways.
- Of course, the estimated date will change, and allocation policy will shift as the un-allocated supply

Addressing (1)

- The global IPv4 address space, end-to-end, provides
  - 4,294,967,295 addresses
  - (4.3 billion)
  - including special use addresses
- A single "subnet" of IPv6 provides
  - 18,446,744,073,709,551,616 addresses
  - (18 billion billion)
  - Not including special use addresses

Addressing (2)

- What a huge waste! If we're running out of numbers now, why don't we allocate conservatively?
  - Because the failing of IPV4 addressing was that it was designed to be much too big for the projected Internet (1978), but made no provisions for the global Internet of 2008.
  - The extent to which the Internet would permeate everyday life wasn't even apparent in 1988, 10 years later.
  - Point: The original idea was to have so many addresses, it didn't matter; to assign enough addresses to each organization that they would not need more later.
  - We come from a shortage address economy. This is probably a good thing.

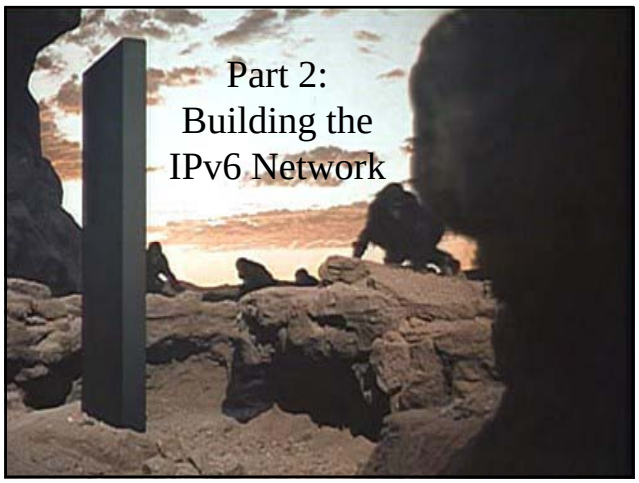
Address depletion

- Sometime between now and 3 years from now, all IPv4 addresses will be allocated.
- "Allocated" doesn't mean "used". There are many pools of addresses in the hands of various organizations which are unused.
- When the current sources of addresses are depleted, the value of the hidden supply will rise, and a market will form for trading in IPv4 addresses
- Also, address holders can continue to squeeze and re-organize their networks, to use a higher percentage of the addresses they hold
- Practically all existing networks use less than 50% of the numbers they hold. But saturation is increasing.

Address Explosion At ComCast

(Alain Durand, June 2006 NANOG)

- Comcast Cable serves 20 million customer households
- Comcast customers average 2.5 set-top-boxes per household, 2 IP addresses per box
- This is Cable TV, no Internet, no Voice services
- C.C. was assigning IP addresses from 10.0.0.0/8 to home cable boxes
- Until 2005 when they used up the last of the 16.8 million addresses in that block
- Primary address explosion driver is new service (voice/Internet) growth, secondary is Cable TV growth
- Resulting in the ideal application of IPv6 addresses



UH Net V4-V6 Transition

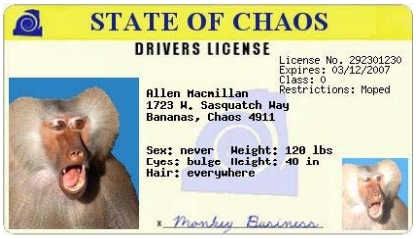
- Addresses come first (we have them)
- Routing and DNS come next.
  - IPv6 under DNS is…
    - "interesting"
- Then services
- UH ITS has allocated addresses for every facility on UH Net and is including the deployment of IPv6 in our daily work.
- If you need or want it, express an interest, and we will prioritize
- Currently there are IPv6 networks in Manoa and Honolulu CC. Maui CC is next.

Not All Sweet Sweet Candy

- Experience has shown that deploying a second IP protocol alongside the first needs to occur smoothly, with sharp eye and open mind
- There will still be show-stoppers in router capabilites, etc. but they will be overcome presently.

What can I reach with IPv6?

- You just have to know where to look.
- These tend to work:
  - http://ipv6.google.com
  - http://www.ietf.org
  - http://www.twaren.net/ ftp://ftp.twaren.net/
- tunnelbroker.net
- At UH: http://net.its.hawaii.edu

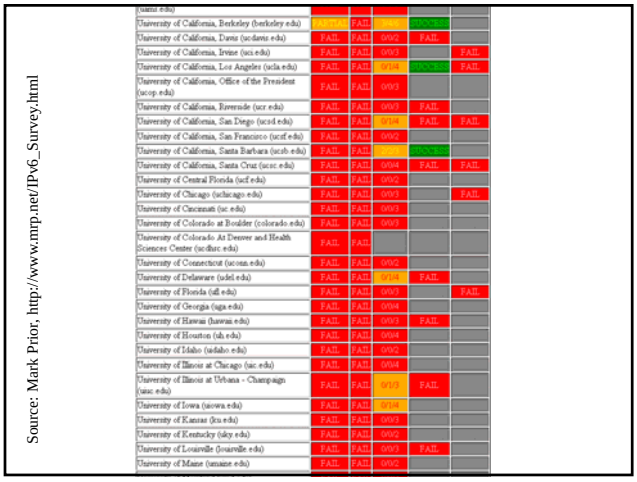


Part 3: State Of Implementations

IPv6 Implementations

- Cisco, Juniper, Foundry, 3Com, etc.
- Apple, Microsoft, IBM, Linuxes, BSDs, etc.
- Sun, SGI, Trumpet Winsock (yes, Trumpet Winsock), etc.
- Infoblox, Netscreen, Checkpoint, Nokia, etc.
- There are many prolific players in the marketplace.

Source: Ron Broersma, DoD/DREN



Source: Mark Prior, http://www.mrp.net/IPv6_Survey.html

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Standards Bodies

Organisation (domain)	Web	Mail	DNS	NTP	XMPP
AEEMA (aeema.asn.au)	FAIL	FAIL	0/0/2		
AfriNIC (afrinic.net)	SUCCESS	FAIL	0/2/6		
APNIC (apnic.net)	SUCCESS	FAIL	0/0/5	SUCCESS	
ARIN (arin.net)	PARTIAL	SUCCESS	1/1/1		FAIL
AUDA (auda.org.au)	FAIL	FAIL	0/0/2		
AusRegistry (ausregistry.com.au)	FAIL	FAIL	0/0/4		
ICANN (icann.org)	SUCCESS	FAIL	0/2/6	FAIL	
IEEE (ieee.org)	FAIL	FAIL	0/0/8		
IETF (ietf.org)	SUCCESS	SUCCESS	1/6/6		
IPv6 Forum (ipv6forum.com)	SUCCESS	SUCCESS	0/2/2		
IPv6 Forum Downunder (ipv6forum.org.au)	SUCCESS	FAIL	0/1/4		
IPv6 TF (ipv6tf.org)	SUCCESS	SUCCESS	0/3/3		
ISOC AU (isoc-au.org.au)	SUCCESS	FAIL	0/1/4		
ITU (itu.int)	FAIL	FAIL	0/0/3	FAIL	
LACNIC (lacnic.net)	PARTIAL	SUCCESS	1/1/1		
RIPE (ripe.net)	FAIL	FAIL	1/1/1		

Trying Out Your IPv6

- It's hard to know whether you are using it.
  - **ShowIP** add-on for Firefox helps
- It's hard to know whether the old program has been updated, or a new one was added.
- Most common OS implementations lack something

Stateless Auto-configuration (SLAAC)

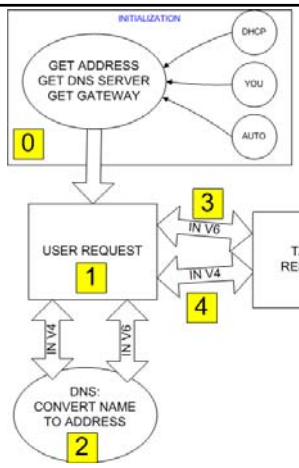
- Many operating systems have IPv6 turned on by default
- With SLAAC, if your router interface is using v6, then you are too. You may use v6 without realizing it
- Your machine determines your IPv6 address, and adds it to the prefix advertised by the router
- Some OS build the RH 64 bits using the MAC address
- Others will make up random (currently only Vista)

EUI-64 Address Assembly

- consider 2607:f278:0:6:230:48ff:fe71:31f1/64
- One character is equivalent to 4 binary bits
- The "/64" refers to how many bits are determined by the network
- Since there are a total of 128 bits in an IPv4 address, that leaves 64 for the host to determine
- The University Of Hawaii System's IPv6 address allocation is:
  - 2607:F278::/32
  - The host's MAC address is: 00:30:48:71:31:F1, which gets a FFFE insterted in the middle, completing the RH 64 bits

Getting a DNS Server address

- Stateless auto-configuration gets you an address and gateway
- But no DNS server
- Of course, if you have DNS through IPv4, you will learn v6 addresses through that DNS server
- Currently, the only way for a v6-only host to auto-learn the name server address is DHCPv6
- Attachments to SLAAC are proposed
  - RFC 5006 (IPv6 Router Advertisement Option for DNS)



IP Host Function

In order to reach the "Basic Functionality" milestone, each computer on the network Will need to provide certain services to the user's applications. Currently, Windows Vista is closest to the Goal. Mac OS can use Extra software, and Windows XP will be abandoned. Popular Linux/Unixes are already well-equipped for the IPv6 Internet.

IPv6: Apple OSX 10.5

- On by default
- Missing DHCP6
  - Dead set against it, apparently

Apple OS X Applications

- Firefox – should browse IPv6, but didn't
- Safari – does browse IPv6
- ping – works with separate "ping6"
- traceroute – works with separate "traceroute6"
- SSH client – works
- telnet – works to router: fe80::209:7bff:fedc:400%en0
- email – no server to test to yet

IPv6: Windows XP (SP2+)

- You can add it to an interface with the inerfaces “Properties” pane, just like IP(v4) or IPX/SPX or NetBIOS
- Once added, there is no GUI config, although some things can be accomplished with the command line
- Will not do DNS queries in IPv6 packets
- Will receive IPv6 info from DNS in IPv4 packets
- Is Ultimately doomed.

Windows XP Applications

- Firefox – will browse IPv6
- IE7 – will browse IPv6
- ping – works
  - Tries first address as returned by DNS
- tracert – works
  - Tries first address as returned by DNS
- Telnet – doesn’t appear to work
- Thunderbird – no server to test to yet

IPv6: Windows Vista

- On by default
- Does DHCP6
- Implementation currently more complete than XP or Mac OS X

Windows Vista Applications

- Firefox – will browse IPv6
- IE7 – will browse IPv6
- ping – works
  - Tries first address as returned by DNS
- tracert – works
  - Tries first address as returned by DNS
- Telnet – doesn’t appear to work
- Thunderbird – no server to test to yet

IPv6: Ubuntu 8

- On by default
- Does DHCP6, if you install it
- Since Linux (and BSD OS) are typically used for reference implementations, support is pretty good

Ubuntu Linux Applications

- Firefox – will browse IPv6
- ping – works as "ping6"
- traceroute – works as "traceroute6"
- Telnet – doesn't appear to work

- ***Linux is a kernel***.
  - Linux *distributions* are operating systems. They differ as to what apps they provide for various roles.
  - "Distributions" means, Red Hat, Ubuntu, Suse, Debian, Slackware, etc.

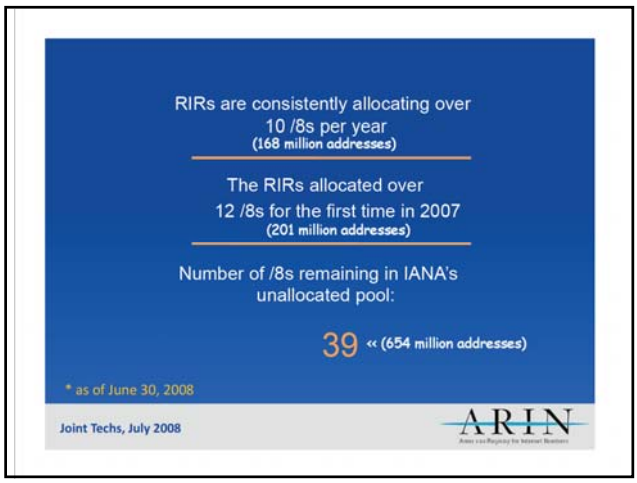
The AAAA/A Turnaround Test

Load a page from a host with an AAAA record, but with the IPv6 interface address deleted on the http server. How long will it take?

- Windows XP SP2 – 22.9 Sec.
- Mac OSX (10.5.3) - 15.3 Sec.
  - Firefox didn't work; used Safari
- Windows Vista - (shorter)
- Ubuntu HH Linux 2.6.24 - 3.0 Sec.

(IP version 5 was assigned to the Internet Stream Protocol, which was proposed as a peer, not a replacement to IPv4. The Internet Stream Protocol is not in use today.)

Journalists, the uninformed, dogs, and children have made up several stories about how version 5 was mistakenly or accidentally assigned, when nobody was looking. None of them are true.


RIRs are consistently allocating over
10 /8s per year
(168 million addresses)
The RIRs allocated over
12 /8s for the first time in 2007
(201 million addresses)
Number of /8s remaining in IANA's
unallocated pool:
39 << (654 million addresses)
* as of June 30, 2008
Joint Techs, July 2008
ARIN