IPv6 Addressing

To be
Presented to
St. Louis Unix Users Group
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By
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Who am I?

David Forrest graduated from Oregon State University in BA, Finance Emphasis, Physics & Mathematics. Lifelong hobbyist in IT from IBM 1401, Model 20, Model 30, Model 85, Sigma 7, XDS 7, SWTP 6800, M6809, 8080, 80286, 80386, OS2, and on to currently running XP, CentOS6/7, Raspbian, Mint, and Chrome on various local and cloud machines.

Why is IPv6 NECESSARY

- IPv4 was established in 1981 and provided over four billion separate routable addresses to specific sites.
- Over the past 37 years all addressable addresses have been assigned.
- Network Address Translation “NATing” has allowed expansion for those fortunate sites that have been assigned, but requires severe complication to securely implement.

What is “NATing”

- This red slide and the following 15 to the next red are a prologue “background” and will be largely skipped (TL;DR) in the actual presentation.
- This prologue to V6 addressing is an aside largely from Julia Evans site: https://drawings.jvns.ca/nat/ and wikipedia.
- Local addressing is routable only locally and can be “NATed” in the IPv4 system to use a public routable v4 site address (no longer available from the agreed regional international registries, RIRs,) to be shared by those lucky enough to own them.
- This prologue presentation will attempt to cover the local functions needed to implement the “sharing”.

My Thoughts on NAT

All of the confusion/complexities on NAT (although some still believe it gives them “safety through routing”) leads me to conclude that the new paradigm in IPv6 properly excludes such except in prefix NATing necessary for those using the “Unique (Universal) Local Address” scheme available in IPv6. IPv6 allows enough addresses to give safe and effective firewall routing control throughout our assigned internet addresses.

And maybe not NPT

IPv6-to-IPv6 Network Prefix Translation (**NPTv6**) is an experimental specification for IPv6 to achieve the address-independence at the network edge, given by network address translation (NAT) in IPv4. It has fewer architectural problems than traditional IPv4 NAT; it is for example stateless and preserves the reachability attributed to the end-to-end principal. However, the method still lacks solutions to translate embedded IPv6 addresses, for example in IPsec, and requires a more complex nameserver setup (split-horizon DNS).

NAT Summary

- NAT is not needed for address sharing, but maybe for other situations.
- In IPv4 networks, we solved the shortage of addresses by using NAT to share one public IP address between many hosts. In IPv6, we have no address shortage and do not need to share IP addresses any more. For other uses of NAT work is still going on to figure out how to solve these – but we will propably end up using NAT66 in some situations in our networks. By learning how the use of NAT and private address space breaks the network architecture and adds costs to projects like VoIP and causes additional delays in the network we will not add these by default when building IPv6 networks.

What is it?

IPv4 stack	IPv6 stack
1981	1999
32 bit	128 bit
192.168.0.0/32 (4 Octets)	C0A8::/32 (8 Hex Nibbles)
2^32 Addresses	2^128 (64 Prefix & 64 Link)
11000000 10201000::/32	11000000 10201000::/128

(in binary bits)

But WHY???

- For me, a customer requested I have her web site served in IPv6 for her relatives in China where IPv4 was blocked by the government. I knew that IPv6 existed but it was not used here (I thought). But this was the second house she bought for friends in China and she was planning a third so it was important for me to “make it happen”. My web site was used for coordination of the construction process by my customer, subcontractors and suppliers. Updated daily with photos, new installations, and plans.

The world's a'changing

- IPv6 is an entirely different stack and is handled internally completely differently from IPv4.
- Current thought seems to favor change in parallelism in lieu of meshing – new projects in dual stack and conversion of older into dual as maintenance requires.
- My adoption in 2006 was two steps: first – get IPv6 access publicly and second to add the address to my httpd.conf file.

IPv6 Address Planning

- My plan was simple: get one and use it. I only needed one and only to serve a web page or two.
- Much of what I want to talk about is here: https://www.internetsociety.org/policybriefs/ipv6
- Planning for local edge routers should have some familiarity with RFC 4291:

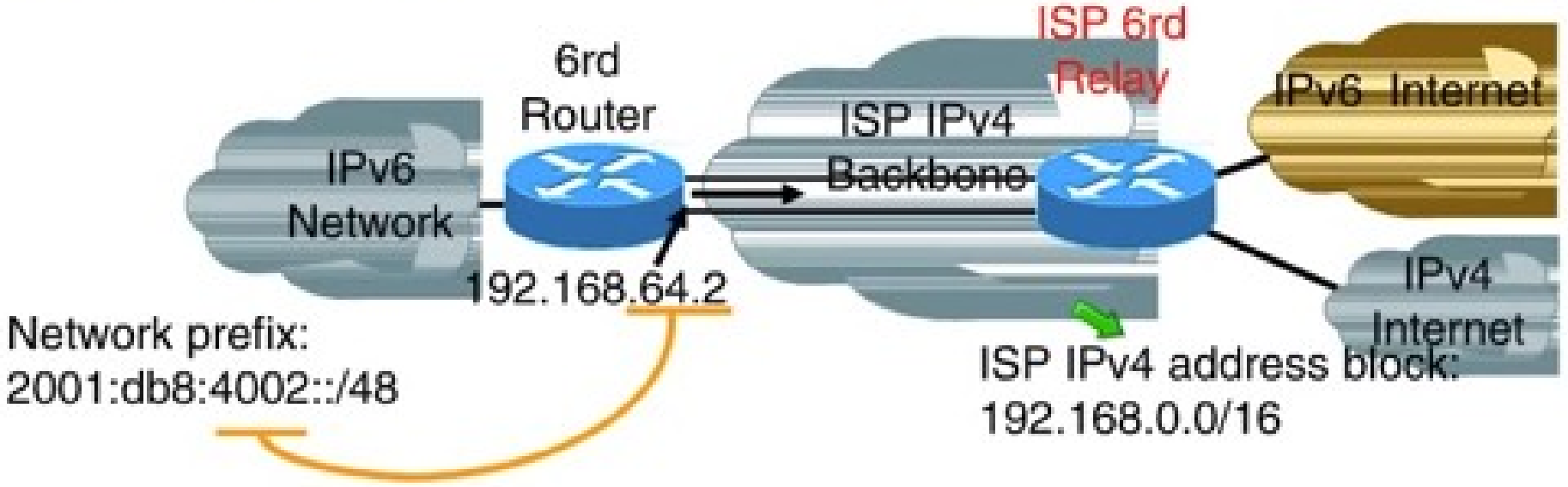
  http://www.rfc-base.org/txt/rfc-4291.txt

My IPv6 Site Assignments

- Hurricane Electric: 2001:470:c416:0001::1/48

  Charter Spec. 6rd: 2602:100:6023:b392::1/64
- HE's 48 bits of my 64 bit network leaves me the ability to filter the last 16 bits, 65,536 separate networks, as best suits my organizational needs (sigh - tunneled).
- $ host erl.maplepark.com
- 1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0. \ (# link-local fe80::1) 1.0.0.0.6.1.4.c.0.7.4.0.1.0.0.2.ip6.arpa
- domain name pointer erl.maplepark.com.

6rd Tunnel



- 6rd (example):
  - ISP has 192.168.0.0/16 IPv4 address block
  - ISP has 2001:db8::/32 IPv6 address block
  - Final 16 bits of IPv4 address used on customer point-to-point link to create customer /48 → customer uses 2001:db8:4002::/48 address space
  - IPv6 tunnel to ISP 6rd relay bypasses infrastructure which cannot handle IPv6

ARIN


ARIN
American Registry for Internet Numbers
RIPE NCC
RIPE NETWORK COORDINATION CENTRE
APNIC
lacnic
AFRINIC

American Registry of Internet Numbers

- About IPv6:
  https://www.arin.net/knowledge/ipv6_info_center.html
- Everything you wanted to know about IPv6
  https://youtu.be/rWJZfShWE6g
- A reserved IPv4 /24 for deployment of IPv6!

Various Plans

- Surf-net

  https://ipv6forum.com/dl/presentations/IPv6-addressing-plan-howto.pdf
- Infoblox

  https://www.infoblox.com/wp-content/uploads/2016/04/infoblox-whitepaper-ipv6-addressing-plan-basics_1.pdf
- Ipspace

  http://blog.ipspace.net/2015/04/how-do-i-start-my-ipv6-addressing-plan.html
- Dren http://www.v6.dren.net/AddressingPlans.pdf

ARIN on IPv6 Anatomy

- How is IPv6 Different than IPv4?
- IPv6 differs from IPv4 in many ways, including address size, format, notation, and possible combinations. We've created a quick video to highlight some of the differences.
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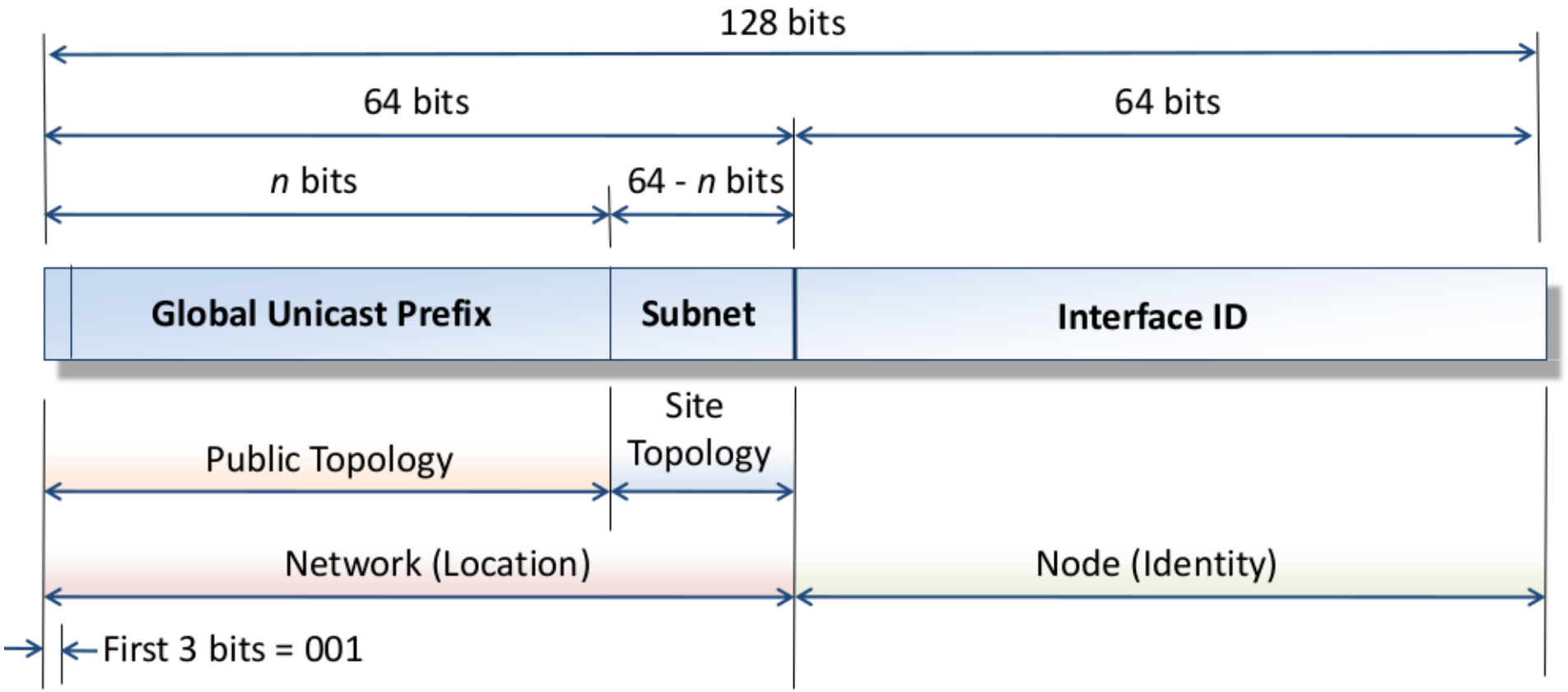
- An IPv6 address consists of 128 bits (as opposed to the 32-bit size of IPv4 addresses) and is expressed in hexadecimal notation. The IPv6 anatomy graphic below represents just one possible configuration of an IPv6 address, although there are many different possibilities.

IPv6 Anatomy

IPv6 Global Unicast Address Structure



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It’s really 128 bits!

- The routing, subnet, and interface together is the IPv6 address. When an internet “Socket” is established (connected), it is similar to a hard wired connection.
- A network socket is an internal endpoint for sending or receiving data within a node on a computer network. Concretely, it is a representation of this endpoint in networking software (protocol stack), such as an entry in a table (listing communication protocol, destination, status, etc.), and is a form of system resource.

Socket

- The term socket is analogous to physical female connectors, communication between two nodes through a channel being visualized as a cable with two male connectors plugging into sockets at each node. Similarly, the term port (another term for a female connector) is used for external endpoints at a node, and the term socket is also used for an internal endpoint of local inter-process communication (IPC) (not over a network). However, the analogy is strained, as network communication need not be one-to-one or have a dedicated communication channel.

DREN

- Defense Research and Engineering Network
- This presentation is from them in 2011 – old, old, and older – but says a lot!

  http://maplepark.com/~drf/RemoteReads/DREN_AddressingPlans.pdf

  http://www.v6.dren.net/AddressingPlans.pdf

Fin

- And that's it, folks!
- I'm open and interested in questions (?)

Thanks,