

IPv6 Introduction

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SkullSpace Hackathon

Online HTML5 Slides

Presentation source/download available at
github.com/tbaschak/ipv6-intro-presentation

Who I Am

- ▶ Primary Network Administrator of VOI Network Solutions – Winnipeg-based commercial Internet Service Provider and carrier.
- ▶ Involved with both Internet Exchanges in Winnipeg.
 - ▶ Elected member on the Board of Directors for MBIX.
 - ▶ Also involved with the creation and technical operations of WpgIX.
- ▶ Avid opensource software user/fanatic, and recently, contributor.

My Life with IPv6

- ▶ Running IPv6 since ~2004.
 - ▶ Over tunnels for many, many years.
 - ▶ Native IPv6 since December 2012, via Voi Networks BGP address space.
- ▶ My own network currently runs IPv6/OSPFv3 routing protocol.
 - ▶ 2604:4280:d00d::/48
 - ▶ Most ciscocode.net/henchman21.net services are IPv4/IPv6 enabled.

IPv6 Address Basics

- ▶ The IPv6 address space is 128-bits (2^{128}) in size, containing 340,282,366,920,938,463,463,374,607,431,768,211,456 IPv6 addresses.
- ▶ Like IPv4, Network and Host bits.
- ▶ Unlike IPv4, Network and Host bits are usually equal.
- ▶ 1 or more 0 blocks can be shortened/replaced with :: but only once per address.
- ▶ Leading zero's can be dropped.

IPv6 Addressing (rfc4291)

► Valid Host Addresses

- 2001:0DB8:0:0:8:0800:200C:417A =
2001:DB8::8:800:200C:417A
- 2604:4280:d00d::443 = 2604:4280:d00d:0:0:0:0:443
- 2604:4280:14:866::225:2 = 2604:4280:14:866:0:0:225:2
- ::1 (loopback) = 0:0:0:0:0:0:0:1
- :: = 0:0:0:0:0:0:0:0

IPv6 Address Sample

- ▶ My IPv6 privacy address at the time of writing:
2604:4280:d00d:202:1986:feb8:ccb0:78e1
- ▶ Lets break that down:
 - ▶ Prefix: 2604:4280:d00d
 - ▶ Network: \$PREFIX:202
 - ▶ Host: 1986:feb8:ccb0:78e1

rfc4291 (cont)

- ▶ Valid Network Addresses

- ▶ 2001:0DB8:0000:CD30:0000:0000:0000:0000/60
- ▶ 2001:0DB8::CD30:0:0:0:0/60
- ▶ 2001:0DB8:0:CD30::/60
- ▶ ::/0

ARP -> ND (rfc4861)

- ▶ Uses link-layer multicast instead of broadcast.
- ▶ Subcomponents include
 - ▶ Address Resolution
 - ▶ Duplicated Address Detection
 - ▶ Neighbor Unreachability Detection
- ▶ Makes use of a number of predefined multicast addresses (much like routing protocols)
 - ▶ all-nodes (FF02::1)
 - ▶ all-routers (FF02::2)
- ▶ Many components require use of /64 subnet size.

SLAAC / DHCPv6

- ▶ DHCP for autoconfiguration has been replaced with SLAAC, and/or DHCPv6.
- ▶ SLAAC uses Neighbor Discovery, ICMPv6 RA discovery, to autoconfigure addresses.
- ▶ DHCPv6 does not currently send a default gateway, so SLAAC/RA is still required.
- ▶ IPv4 untrusted layer 2 issues have followed to IPv6.
 - ▶ Rogue DHCP -> Rogue RA & Rogue DHCPv6.
 - ▶ DHCP Snooping -> RA Guard in switches to mitigate.

v4 vs v6 Subnets

- ▶ Where a /24 is often used on LANs with IPv4, /64's are strongly encouraged with IPv6.
- ▶ Recommended Site Prefix: /48 allows 64k /64's.
- ▶ Residential providers often using DHCP6pd to allocate /60's to Customer routers (Including Xplornet).
- ▶ Not using a /64 subnet prefix length will break many features of IPv6, including Neighbor Discovery, Secure Neighbor Discovery [RFC3971], privacy extensions [RFC4941], and Site Multihoming by IPv6 Intermediation [SHIM6], among others.

Big Subnetting

2001:db8:c0d0::/44 Example Multisite Company

2001:db8:c0d0::/48 Primary Office - Site 1

2001:db8:c0d0:20::/64 VLAN20 Users

2001:db8:c0d0:25::/64 VLAN25 Users Wireless

2001:db8:c0d0:30::/64 VLAN30 Phones

2001:db8:c0d0:300::/64 VLAN300 Guest

2001:db8:c0da::/48 Branch Office - Site 11

2001:db8:c0da:20::/64 VLAN20 Users

2001:db8:c0da:25::/64 VLAN25 Users Wireless

2001:db8:c0da:30::/64 VLAN30 Phones

2001:db8:c0da:300::/64 VLAN300 Guest

2001:db8:c0de::/48 Server Colo - Site 15

2001:db8:c0de:10::/64 VLAN10 Servers

2001:db8:c0de:10:::1 Redundant Default Gateway

2001:db8:c0de:10:::2 Redundant Default Gateway

2001:db8:c0de:10:::25 SMTP Server

2001:db8:c0de:10:::1:53 Auth DNS 1

2001:db8:c0de:10:::2:53 Auth DNS 2

Privacy Addresses (rfc4941)

- ▶ Extension to SLAAC.
- ▶ New random secondary privacy addresses regenerated periodically.
- ▶ Can cause havoc for Session based applications which tie the session to your IP (which is often recommended to prevent session hijacking).

ULA (rfc4193)

- ▶ Stands for Unique Local IPv6 Unicast Addresses.
- ▶ Similar to RFC1918 addresses, for use within LANs and/or isolated/non-connected networks.
- ▶ Supposed to be generated using a specific algorithm, they are guaranteed of being somewhat globally unique as well.
 - ▶ SiXXs ULA Generator

FreeBSD Server

- ▶ /etc/rc.conf snippet

```
ifconfig_em0_ipv6="inet6 2604:4280:d00d::443/64"  
ipv6_defaultrouter="2604:4280:d00d::1"
```

- ▶ In FreeBSD `ipv6_enable="yes"` is required to enable SLAAC.
- ▶ SLAAC addresses can cause issues for mail and other servers where outbound traffic is expected to originate from a specific address.

Debian Server

- ▶ /etc/network/interfaces snippet

```
iface eth0 inet6 static
address 2604:4280:D00D::78
gateway 2604:4280:D00D::1
netmask 64
pre-up echo 0 > /proc/sys/net/ipv6/conf/$IFACE/autoconf
```

- ▶ The pre-up command disables SLAAC (where required).

Resources

- ▶ ipv6.he.net/certification/
- ▶ www.sixxs.net/tools/grh/ula/
- ▶ ipvfoo chrome extension
- ▶ ipvfox firefox extension

Useful IPv6 RFCs

- ▶ RFC2460: IPv6 Specification
- ▶ RFC6434: IPv6 Node Requirements
- ▶ RFC4291: IPv6 Addressing Architecture
- ▶ RFC3484: Default Address Selection
- ▶ RFC4193: Unique Local IPv6 Unicast Addresses (ULA)
- ▶ RFC4443: ICMPv6
- ▶ RFC3315: DHCPv6 client
- ▶ RFC4862: SLAAC
- ▶ RFC4861: Neighbor Discovery
- ▶ RFC6177: IPv6 Address Assignment to End Sites

Even More IPv6 RFCs

- ▶ RFC1981: Path MTU Discovery
- ▶ RFC4213: Basic Transition Mechanisms for IPv6 Hosts and Routers
- ▶ RFC3596: DNS protocol extensions for incorporating IPv6 DNS resource records
- ▶ RFC2671: DNS message extension mechanism
- ▶ RFC3226: DNS message size requirements
- ▶ RFC5095: Deprecation of Type 0 Routing Headers in IPv6
- ▶ More info at: <http://www.ripe.net/ripe/docs/ripe-554>
- ▶ BIG GIANT list at: <http://ipv6now.com.au/RFC.php>

Questions / End

- ▶ Question & Answer period as time permits.

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