

# IPv6 Introduction

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SkullSpace Hackathon

# Online HTML5 Slides

Presentation source/download available at  
[github.com/tbaschak/ipv6-intro-presentation](https://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.

# NAT IS STUPID

- ▶ From a network admin's perspective at least.
- ▶ NAT is NOT a firewall, it rewrites/masquerades source addresses in IP headers, and keeps track of those translations.
- ▶ Issues that arise from broken end-to-end connectivity from NAT:
  - ▶ Accepting direct Inbound connections of any sort.
    - ▶ Direct Audio / Video Conferencing.
    - ▶ P2P Applications (Online Games, Skype, Torrents, etc).
  - ▶ Accountability - Logs/Monitoring outside a NAT lose valuable source details.

# 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 ::
  - ▶ Only once per address though.
- ▶ Leading zero's can be dropped.

# rfc4291: Addressing

## ▶ 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

## rfc4861: ARP -> ND

- ▶ 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.

## Subnet Example

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

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

2001:db8:c0d0:10::/64 VLAN10 Servers

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

# Privacy Addresses (rfc4941)

- ▶ Extension to SLAAC.
- ▶ New random secondary privacy addresses regenerated periodically.
- ▶ Can cause havok 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

# Transition Mechanisms

- ▶ Many methods of translating/tunneling V4 over V6 and vice versa:
  - ▶ Teredo (v6, over v4 UDP/3544)
  - ▶ NAT64/DNS64 (v4, over v6)
  - ▶ Stateless IP/ICMP Translation/SIIT (::ffff:0:a.b.c.d)
  - ▶ 6rd (v6, over v4)



# FreeBSD Server

- ▶ /etc/rc.conf snippet

```
ifconfig_em0_ipv6="inet6 2001:db8:c0de:10::443/64"  
ipv6_defaultrouter="2001:db8:c0de:10::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 2001:db8:c0de:10::78
gateway 2001:db8:c0de:10::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/](https://ipv6.he.net/certification/)
- ▶ [www.sixxs.net/tools/grh/ula/](https://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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