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 ciscodude.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 breaken 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 Gatew
            2001:db8:c0de:10::2     Redundant Default Gatew
            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/
- 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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