TORREYPOINT

IPv6 Addressing

Methods and Challenges

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State of Assignments

- All of the registries, for the most part, assign initial blocks for
  - Service provider /32
  - Enterprise /48

What makes up a good addressing plan?

- Depends on the type of network, the size of the network, and problem to be solved
- Points to consider
  - Documentation
  - Ease of troubleshooting
  - Aggregation
  - Standards compliance
  - Growth
  - SLAAC
  - Existing IPv4 addressing plan
  - Human factors

Algorithmic Approaches

- Encode every IPv4 address in your network in an IPv6 address
- At first it seems relatively simple:

10.10.10.10 (A0A0A0A)

↓

2001:DB8:A0A0:A0A0::

Easy, right?

6to4?

- Don’t 6to4 and 6rd already do this?
  - No, 6to4 defines how to make IPv6-only resources available to devices that have only an IPv4 path
- 6to4 style allocation requires a /16
- Yes, it does define how to associate IPv4 addresses with IPv6 ones…

Algorithmic Approaches

- Requires a /32 assignment if a minimum subnet size of /64 is to be preserved
  - Do you have or can you get a /32?
  - Provides no information about the subnet mask
  - Results in very large subnets
  - Light documentation requirements as your existing IPv4 documentation is your IPv6 documentation

Algorithmic Approaches

- Subnetting issue

  10.10.10.0/24 (A0A0A0)

  ↓

  2001:DB8:A0A:A00::/56

Do we count the significant digits for the subnet?

2001:DB8:A0A:A00::/56

Algorithmic Approaches

- What to do about hosts??

  10.10.10.17/24 (A0A0A10)

  ↓

  2001:DB8:A0A:A10::/56?

Completely legal address, but some stacks are buggy or weird about the zero address

- At least for non-static addresses, SLAAC is functional with no collisions, but a /56? That can be wasteful even by IPv6 standards.

Algorithmic Approaches

- What if we “round down” to /64?

  10.10.10.17/24 (A0A0A10)

  ↓

  2001:DB8:AAA0::10/64?

Better, but let’s look at a point to point link.

Algorithmic Approaches

Point to Point Link Example

- Point to Point Link:

  10.10.10.1/30 (A0A0A10) for the remote site
  10.10.10.2/30 (A0A0A10) for the local site

  If we follow the previous rule to the letter we get:

  2001:DB8:AAA0::1/64
  2001:DB8:AAA0::2/64

  But using /64s on router-to-router links can be dangerous, causing loops on some platforms

Algorithmic Approaches

Point to Point Link Example

Better to use a /127:

2001:DB8:AAA0::1/127

2001:DB8:AAA0::2/127

Um, wait a minute. **What's wrong here?**

Algorithmic Approaches

Point to Point Link Example

2001:DB8:AAA0::1/127

2001:DB8:AAA0::2/127

- Those are **NOT** in the same subnet!! A /127 could be ::0 and ::1, or ::2 and ::3, but **NEVER** ::1 and ::2!!
- As a matter of fact, **NO** IPv4 /30 can ever cleanly map into a /127!!

Link Numbering Issues

- OSPFv3 masks this problem, unlike in IPv4
- Separation of addressing from the link state database means that OSPFv3 neighbor relationships will establish, even on links with mismatched addressing and/or masks
- Link-local based forwarding prevents address mismatches from being easily detected because traffic flows normally and traceroutes don’t appear too strange

Link Numbering Issues

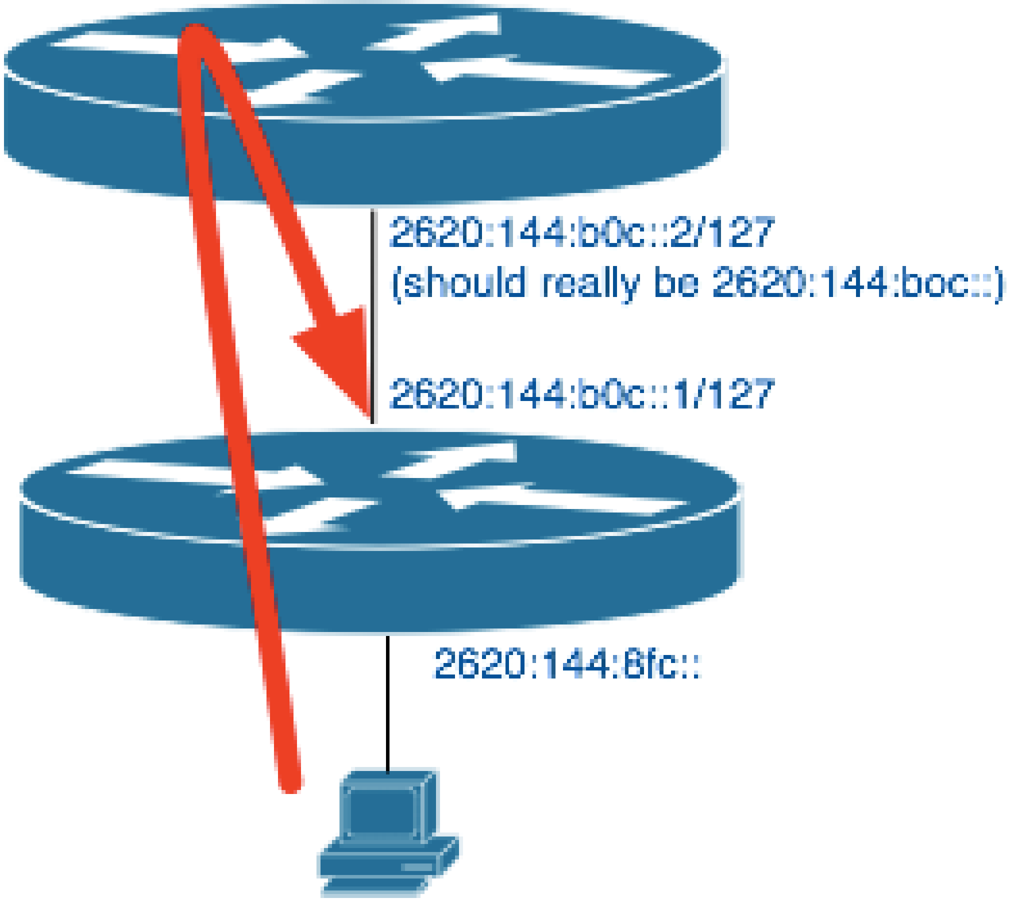
- To detect link numbering errors, look for “Uturn” routing:

```
$ traceroute6 2620:144:B0C::
traceroute to 2620:144:B0C:: (2620:144:b0c::), 30 hops max, 80 byte packets
 1  2620:144:8fc:: (2620:144:8fc::)  26.747 ms  26.730 ms  26.716 ms
 2  2620:144:b0c::2 (2620:144:b0c::2)  29.137 ms  29.222 ms  29.264 ms
 3  2620:144:8fc:: (2620:144:8fc::)  29.355 ms  29.335 ms  29.350 ms
 4  2620:144:8fc:: (2620:144:8fc::)  29.438 ms !H  29.433 ms !H  29.413 ms !H
```

Note hop 2 is the misnumbered address. This traceroute should have looked like this:

```
$ traceroute6 2620:144:B0C::
traceroute to 2620:144:B0C:: (2620:144:b0c::), 30 hops max, 80 byte packets
 1  2620:144:8fc:: (2620:144:8fc::)  32.473 ms  32.447 ms  32.427 ms
```

Link Numbering Issues



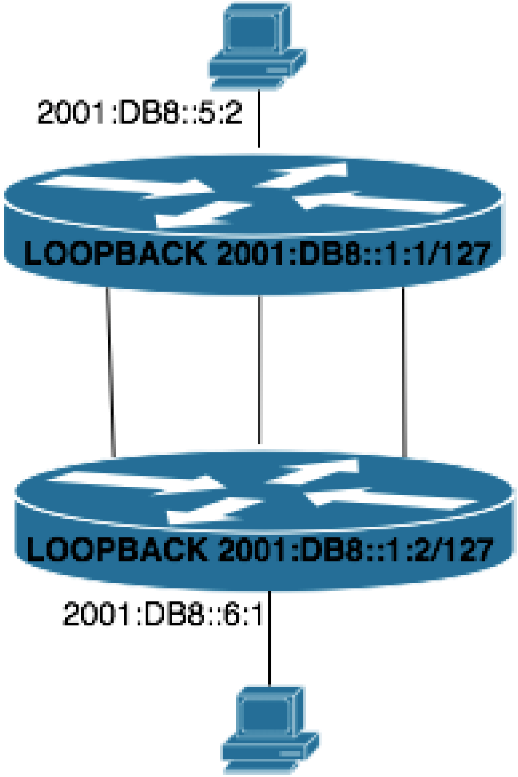
Link Numbering Issues

- Should you number your links at all or just use link-local?
- Loopback interfaces usually show up so you know which routers traffic is following, so why waste address space on links?

Using equal cost multipath?

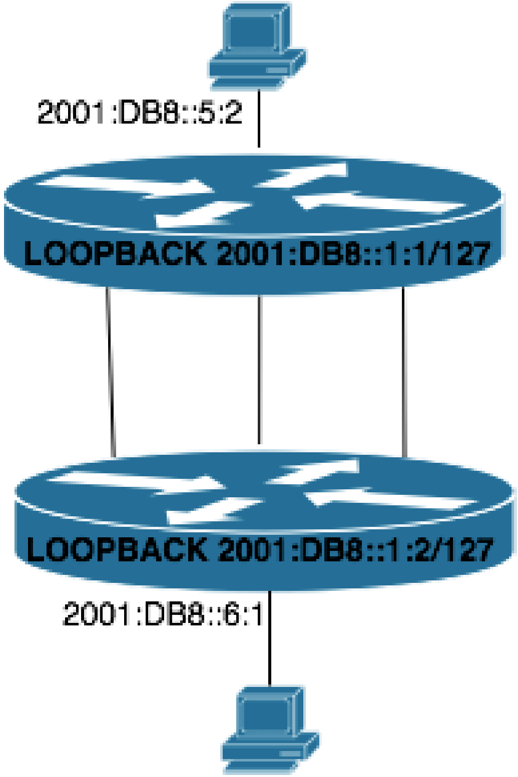
```
$ traceroute6 2001:DB8::5:2
traceroute to 2001:DB8::5:2 (2001:DB8::5:2),
30 hops max, 80 byte packets
 1  2001:DB8::6:1 (2001:DB8::6:1)  22.723 ms
26.730 ms  26.716 ms
 2  2001:DB8::1:1 (2001:DB8::1:1)  80.233 ms
* ms  72.173 ms
 3  2001:DB8::5:2 (2001:DB8::5:2)  * ms
99.223 ms  29.350 ms
```

Which link did it take?



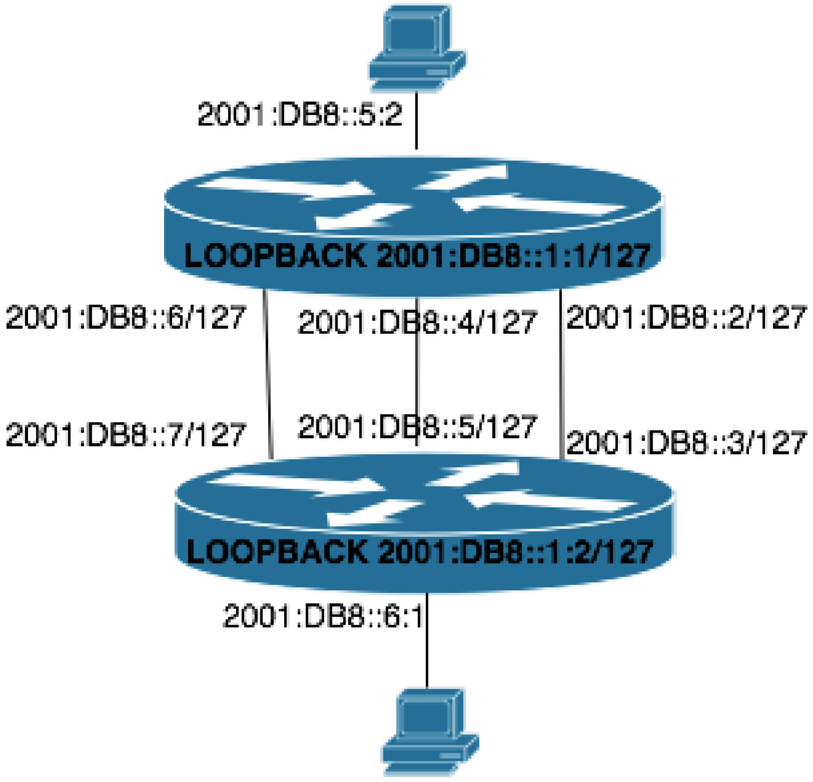
Does your management system use link numbering for monitoring or circuit identification?

Are you really saving any significant addressing by not assigning addresses?



```
$ traceroute6 2001:DB8::5:2
traceroute to 2001:DB8::5:2
(2001:DB8::5:2), 30 hops max, 80 byte
packets
 1  2001:DB8::6:1 (2001:DB8::6:1)
22.723 ms  26.730 ms  26.716 ms
 2  2001:DB8::4 (2001:DB8::4)  * ms
88.322 ms  * ms
 3  2001:DB8::5:2 (2001:DB8::5:2)  * ms
90.123 ms  100.110 ms
```

Better, now we know which link is having issues.



Algorithmic Approaches

- Hybrid Approach for multiple netblocks (Interop example)

  For example:

  199.45.0.0/21

  199.45.8.0/22

  45.0.0.0/15

Interop Example

199.45.0-11

199.45 is not significant, it's the same across the space

45.0.0.0/15

45 is not significant, everything else is

Interop Example

- At first thought, just drop the insignificant digits:

  199.45.1.0 becomes 1.0 becomes 2001:DB8:100::/48 (or smaller subnet if desired)

  Cool. 45.1.0.0 is 10.0.0 which is 2001:DB8:…

  uh oh!

Interop Example

- Because of the re-occurrence of the 199.45.0.0 and 45.0.0.0 we couldn't even just drop the 199 to disambiguate
- Why not just use the whole address?
- We only have a /32 to work with… how do we convert both 199.45.1.32/30 and 45.1.32.0/23

Interop Example

- Let's take just the significant octets from the 199.45 space:

  199.45.**8.10**

- We'll just encode those digits right after our prefix:

  2620:144:810::/64

Interop Example

- What if we make a rule that the minimum IPv4 allocation size in 45/15 is /24?
- Now we only have a single significant digit: 45.**10**.1.2
- But since it overlaps with the 199.45 space, we'll add 128: 10+128=138

→ 2620:144:BA00::/48

Standards Compliance

- Networks smaller than /64 can be desirable, especially using /127s for point to point links
- To avoid future breakage, allocate a /64 in your documentation but use the smaller block
- Similarly, reserve /48s for EVERYTHING you can, there's no reason to allocate densely, there's plenty of space
- If you have a complex network, allocate in a sparse way to enable easy aggregation

Conclusion

- You can indeed add convenience and save on documentation by using an algorithmic approach
- But **ONLY** if you have reasonably few IPv4 blocks, if you have 100s, you'll probably need a different approach unless you can get a large enough v6 allocation

Questions?

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- See us at booth #8