6to4 & 6rd

Explained

Februar 2010

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Why IPv6 in IPv4 Tunneling

- Site (CPE) is dual stack capable
- But network is IPv4 only (yet)
- Tunnel endpoint must be dual stack capable
- Use of IPv6 in IPv4 tunneling
  (IPv4 upper layer protocol (ULP) is 41, which is protocol number of IPv6)
- Used by
  a. Static tunneling (RFC 1933 ⇒ RFC 2893 ⇒ RFC 4213)
  b. 6to4 (RFC 3056)
  c. 6rd (RFC 5569)
  d. others ?

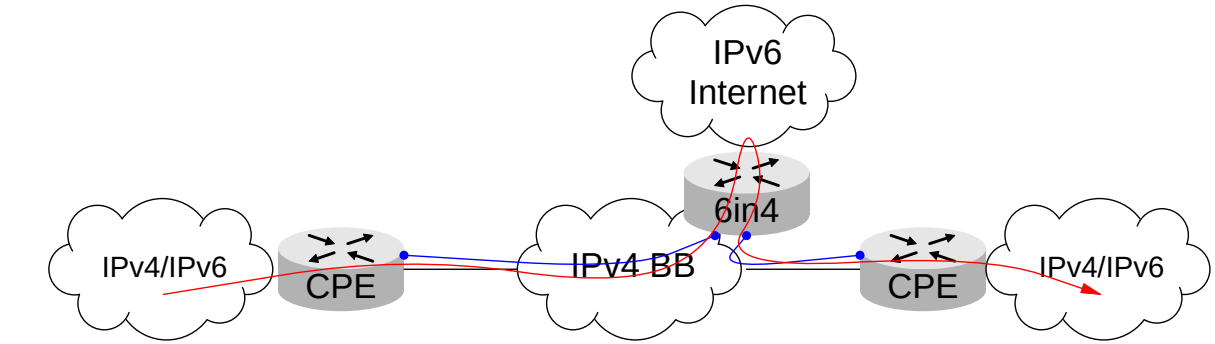
Static IPv6 in IPv4 Tunneling (RFC 4213)

- Linux „client“

```
ip tunnel add <tunnel-name> mode sit local <ipv4> remote <ipv4>
ip link set <tunnel-name> up
ip link set mtu 1280 dev <tunnel-name>
ip -6 addr add <local-ipv6>/64 dev <tunnel-name>
ip -6 route add ::/0 via <remote-ipv6> dev <tunnel-name>
```

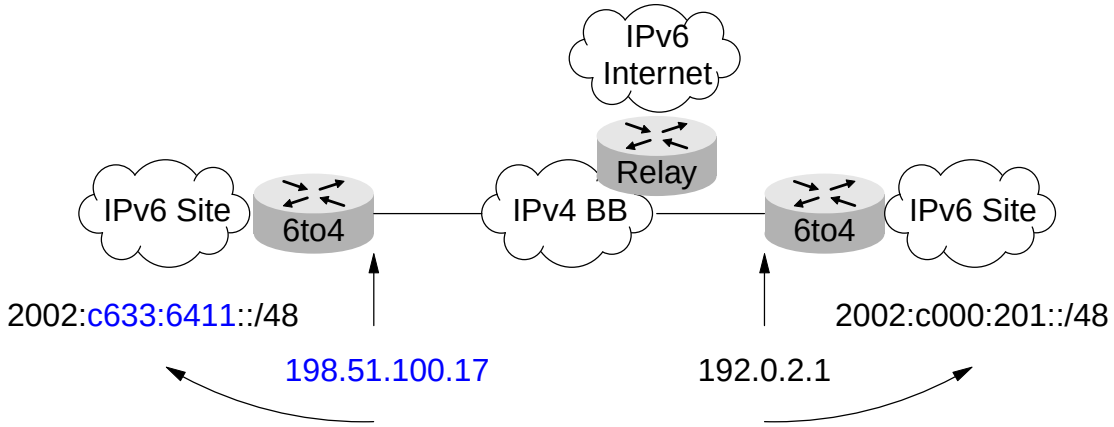
- Cisco „server“

```
int tunnel 6001
 description static IPv6 in IPv4 tunnel
 tunnel mode ipv6ip
 tunnel source lo145
 tunnel destination <remote-ipv4>
 ipv6 address <local-ipv6>/64
ipv6 route 2001:db8:6001::/48 tunnel 6001
```



6to4 (RFC 3056)

- One public IPv4 address required per side
- IPv6 address setup for each side is: `2002:IPv4-Addr::/48`
  - IPv4: `198.51.100.17`
  - Hex: `C6 33 64 11`
  - IPv6 Address: `2002:c633:6411::/48`
- CPE tunnels `2002::/16` prefix via IPv4 to 6to4 gateway
  - IPv6 destination is `2002:c000:201:a0b1:217:53ff:fe85:803b`
  - Encapsulate IPv6 packet into IPv4 packet to `192.0.2.1`
- Send native IPv6 packets (non 2002::/16) to a 6to4 relay router



6to4 (2)

- Every side/host with an public IPv4 address is able to use 6to4
  IPv6 for everyone

```
interface Tunnel2002
 description 6to4 tunnel (Prefix 2002:198.51.100.212::1)
 ipv6 address 2002:c633:64d4::1/128
 tunnel source Ethernet0
 tunnel mode ipv6ip 6to4
```

- Transparent data traffic for protocol 41 (IPv6) needed (No NAT)
- Default IPv6 route points to 6to4 relay (203.0.113.123)

```
ipv6 route 2002::/16 tunnel2002
ipv6 route ::/0 2002:cb00:717b::1/128
```

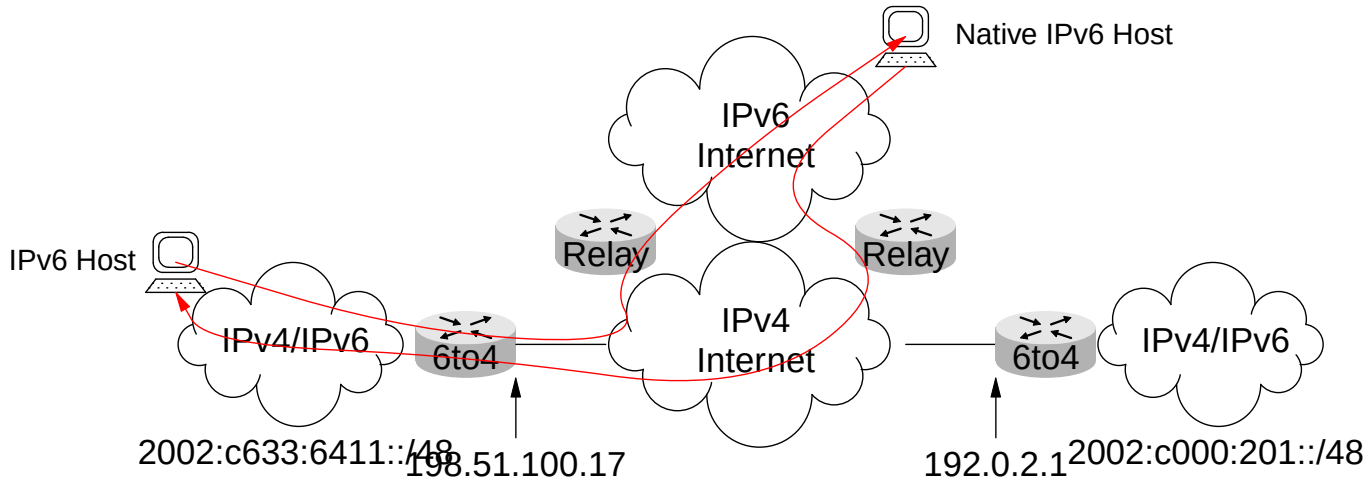
- Relay router often reachable via well known anycast IPv4 address (RFC3068) (`192.88.99.0/24`)

```
ipv6 route ::/0 2002:c058:6301::1
```

- Relay router must announce `2002::/16` prefix to the IPv6 internet
  No longer prefix!

6to4 (3)

6to4 issues



- Asymmetric routing (different relays to/from the native IPv6 world)
- Relay router is not under the same administrative organisation
- Unique public IPv4 address required
  So this wouldn't help on IPv4 address exhaution
- „Second-rate" IPv6 address
  Everyone knows that this is a tunneled connection

6to4 (4)

- From host perspective 6to4 is the same as native v6
- Host gets netprefix via RA (/64) and builds unique IPv6 address

```
$ ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:16:41:58:30:7A
          inet addr:145.253.100.48  Bcast:145.253.100.63  Mask:255.255.255.224
          inet6 addr: 2002:91fd:6426:1:216:41ff:fe58:307a/64 Scope:Global
          inet6 addr: fe80::216:41ff:fe58:307a/64 Scope:Link
```

- Host (mostly) prefers IPv6 over IPv4
- Latterly configurable via RFC 3484 „Default Address Selection for IPv6“
  - RFC 3484 define rules for getaddrinfo()
  - see `/etc/gai.conf` on newer Linux systems
  - Prefers "similar" prefixes (if possible)

```
<cite>
   One effect of the default policy table is to prefer using native
   source addresses with native destination addresses, 6to4 [5] source
   addresses with 6to4 destination addresses, and v4-compatible [1]
   source addresses with v4-compatible destination addresses.  Another
   effect of the default policy table is to prefer communication using
   IPv6 addresses to communication using IPv4 addresses, if matching
   source addresses are available.
</cite>
```

6rd (RFC 5569)

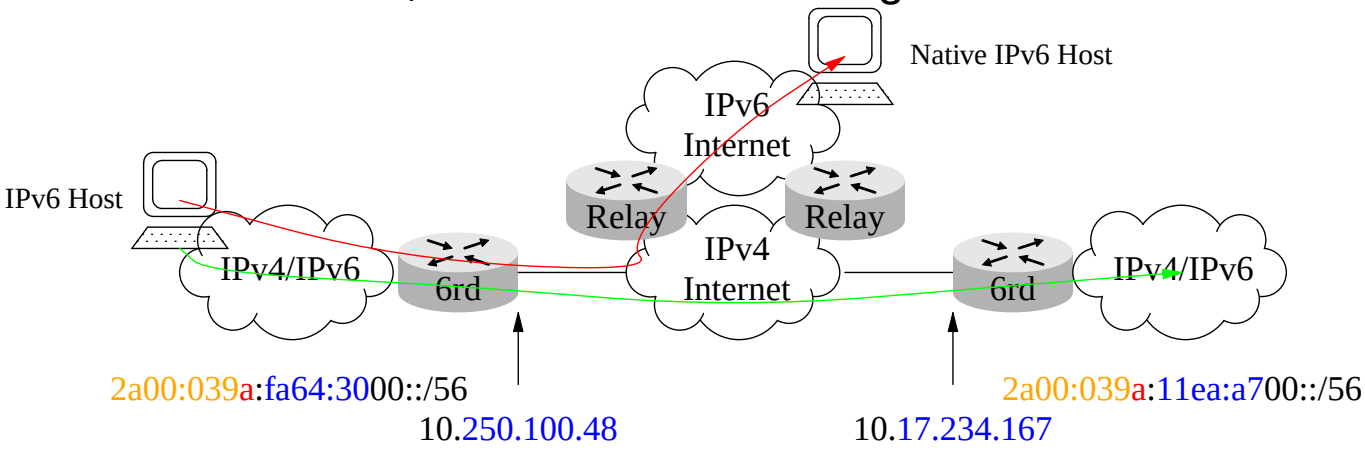
- 6rd == „IPv**6** **R**apid **D**eployment on IPv4 Infrastructures“
- Basic idea:
  - use same technic as 6to4
  - but with ISP specific IPv6 prefix instead of `2002::/16`
- e.g. `2a00:0380::/28` + public IPv4 `145.253.100.48/32` ⇒ `::/60`

128 Bit				
64 Bit Netzpart				64 Bit Hostpart
VF	6rd	/48 IPv4 a	/64 ddr net	Interface/Host ID
2a00	/28 0389	1fd6	/60 4300	0000:0000:0000:0000

- ISP prefix size is not fixed: `::/24` allows customer prefix of `::/56`
- Works also with private RFC 1918 networks e.g. `10.0.0.0/8`
  Save some netbits: 2a00:03a0::/28 + 4 alloc bits + 10.x.y.z (24bits) ⇒ `::/56`
- Slightly modified CPE and relay routers required

6rd (2)

- Several 6rd Prefixes possible
  e.g.: 2a00:039a::/32 for Class A network 10.x.y.z
- Only remaining 24 bits (last 3 bytes) necessary to build unique prefix
- This saves 4 bits, so the customer can get a `::/56`



- Traffic to 6rd sites is going via 6in4 tunnel to remote site
- Traffic to native IPv6 sites is going via 6in4 tunnel to relay router
- Relay router announce 6rd prefix in the native IPv6 world

Questions and Discussion

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