About the Author

Fred Bovy

- 15 years experience in **IPv6**
  - IPv6 Forum Certified Gold Engineer
  - IPv6 Forum Certified Gold Trainer
  - 7 years Cisco IOS IPv6 Software Engineer (NSSTG Group)

- 20+ years experience with **CISCO, TCP/IP**
  - 15 years **CCIE** #3013 (it was only R&S in 1997!)
  - 18 years **CCSI** #33517 since 1994 (it was #95003)
  - 3 years Cisco Network Consultant (CA Group)

- 12+ years experience in **MPLS**

Meet me on:

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From 6to4 to 6RD

- 6to4
- Dual-Stack 6in4
- NAT-PT
- 6BONE
- 6VPE
- DS-Lite
- 6PE
- 6rd
- NAT64
- NAT464
- dIVI-pd
- IPv4 in IPv6 Tunnels
- NAT444
- DS-Lite
- A+P
- IETF Taipei 82 – Nov 2011
- Testing
- Standardization
6to4: The 6RD Origin

- Tunnel destination IPv4 address is embedded in the IPv6 address!

2002:C044:1::/48 prefix comes from 192.68.0.1

2002:C046:1::/48 prefix comes from 192.70.0.1
Access to the Internet with Public Relay cannot be controlled by the SP:

- 6to4.ipv6.microsoft.com
- Anycast: 192.99.88.1
6RD: 6to4 with customized IPv6 Prefix

- RG=Residential Gateway, BR=Border Router
- Native dual-stack IPv4/IPv6 in the home or office
- Simple, stateless, automatic IPv6-in-IPv4 encap and decap functions
- IPv6 traffic automatically follows IPv4 routing between CPE and BR
- BRs placed at IPv6 edge, addressed via anycast for load-balancing and resiliency
- Standardized in RFC 5969
Residential Gateway Implementation

LAN-Side:
Production Native IPv6 Service +
Global or Natted IPv4

IPv6 +
IPv4 Dual
Stack

IPv6 Internet Access delivered to
home, subscriber IPv6 prefix
derived from WAN IPv4 address

6RD lives here

WAN-Side:
Global or Natted IPv4

IPv4 SP
Network

IPv4-only SP Access Network

Most RG can support 6RD thru open source, e.g. DD-WRT and OpenWrt
RG Supported by many CPEs
CISCO IOS
Linux 6RD HOWTO
http://www.litech.org/6rd/
6RD RG Configuration

- 6RD RG configuration, 3 main parameters
  1. ISP 6rd IPv6 prefix and length
  2. IPv4 common bits
  3. 6RD border relay IPv4 address
- All these parameters need to be defined by the service provider. One set of such configurations is considered one 6RD domain.
- Configuration can be pushed via the following
  - TR-69
  - DHCP option 212
  - PPP IPCP option
6RD Free Domains Example

- By carrying fewer IPv4 bits in the IPv6 prefix, the SP can have more room to assign shorter prefixes to customer.
- Each domain will have a mapping of the 6RD prefix and IPv4 address block, defined by BR address and common bits.
- Configuration for each domain is different. The SP may have operation overhead to do with the complexity.
My FREE 6RD Configuration Example

My IPv6 address is 2a01:0e35:2f26:d340:f0ca:a3be:601e:dc

- RIPE prefix: 2a01:0e00::/26
  - bits 27 and 28 are reserved and meaningful:
    - 0: Network admin reserved
    - 1 and 2: Reserved for future use
    - 3: Dedicated to 6RD (that is, 2a01:0e30::/28)

- My Prefix: 2a01:0e35:2f26:d340::/64

- Built from my Public IPv4 Address: 82.242.109.52
  - 82d=0x52
  - 242d=0xf2
  - 109d=0x6d
  - 52d=0x34
My 6RD Home Access

Test your IPv6 connectivity.

Power-Mac-G5-de-Fred-Bovy:~ fredbovy$ traceroute6 -n www.fredbovy.com
traceroute6 to fredbovy.com (2001:41d0:1:1b00:213:186:33:87) from 2a01:e35:2f26:d340:f0ca:a3be:601e:dc, 64 hops max, 12 byte packets
1 2a01:e35:2f26:d340:: 0.953 ms 0.373 ms 0.291 ms
2  * * *
3 2a01:e00:2:d::1 21.601 ms 20.351 ms 21.417 ms
4 2001:41d0::541 104.400 ms 60.678 ms *
5 2001:41d0::512 21.062 ms * 21.681 ms

Congratulations, this website is IPv6 ready!

You can help raise awareness and show your commitment to IPv6 deployment to your users, by adding an IPv6-test validator button to your site:
6RD BR Setup and Provisioning

1. BR must have IPv6 reachability (Native, 6PE, GRE Tunnel, etc).
2. An access-network-facing IPv4 address (BR address configured in RG)
3. ISP 6RD IPv6 prefix and length
   - One BR may serve one or more 6RD domains
   - More 6RD domains means more efficiency
6RD Packet Encapsulation within Domain

ISP 6rd IPv6 Prefix = 2001:1001:100::/40 IPv4 common bits=8, BR = 10.1.1.1

If (dstv6) match ISP 6rd IPv6 Prefix, then (dstv4) derived from (dstv6)
6RD Packet Encapsulation Out of Domain

ISP 6rd IPv6 Prefix = 2001:1001:100::/40  IPv4 common bits=8, BR = 10.1.1.1

If (dstv6) not match ISP 6rd IPv6 Prefix, then (dstv4) = BR
Border Relay via Anycast

- 6RD is **stateless**, so no need for packets within a flow to traverse the same relay
- Allows use of IPv4/IPv6 routing for load-balancing, resiliency, and redundancy
- Border relays are installed only in **strategic locations** where native IPv6 is available:
  - IPv6 Internet uplinks
  - Edge of internal IPv6-enabled network
  - BR placement is a function only of IPv6 traffic, not the number of sites
Combining NAT44 and 6RD

- Addresses IPv4 run-out and enables incremental IPv6 subscriber connectivity over existing IPv4 infrastructure.
- 6RD connectivity becomes a NAT44 offload as more and more IPv4 content becomes IPv6-accessible.
- Carrier, content provider, and user benefit when traffic runs over IPv6.
6RD Deployment at Free (Illiad Group, France)

IPv4 only access & aggregation network

Freebox DSLAM

IP-STB

Freebox ADSL

IPv4 / IPv6 core network

6RD Gateway (ASR1K)

IPv4 Internet

IPv6 Internet

IPv4 / IPv6 access & aggregation network

IPv4 / IPv6 access & aggregation network

IP-STB

Freebox FTTH

Freebox FTTH Access

100 Mbit/s

Native IPv6

IPv6 encapsulated in 6RD

Source: http://www.ripe.net/ripe/meetings/ripe-58/content/presentations/ipv6-free.pdf
6RD Summary

- Delivers production-quality IPv6 by only touching edge points around your network
- Capitalizes on what access networks do well, provisioning and transport of IPv4, adapted for carrying IPv6
- Stateless operation, simple to provision, low overhead
- Proven deployment, RFCs published
- Fast TTM to enable dual stack services
- 6RD BR is running on ASR or IOS, the RG is running in Linksys devices or IOS.
Thank you for attending!

This concludes 6RD Presentation!
For the sound, please check out my 6RD video on youtube...

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CISCO 18 years CCSI #33517 (before was #95003)

Meet me on
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