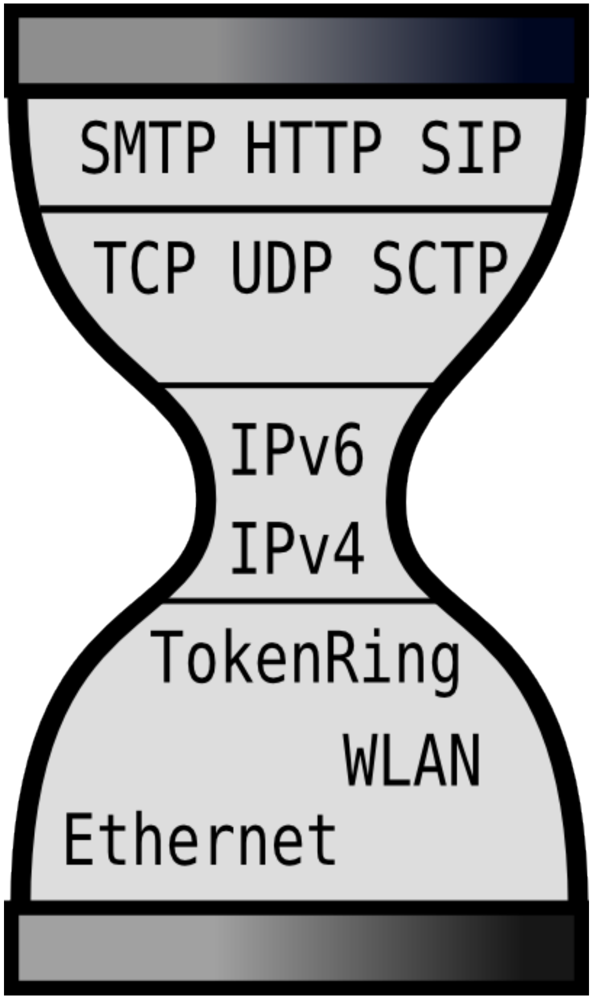
Meet the new IP,
Same as the old IP.

Paul Ebersman, IPv6 Evangelist
North American IPv6 Summit 2012

What you'll see immediately

- **More addresses**
  - – 340 undecillion
- **Bigger, beefier addresses**
  - – 2001:db8:dead:beef::1
- **Lots more addresses per interface**
- **More "magic"**

7 Layer View (Sorta)



Routing Efficiencies

- Fixed header size
- Extension header chain
- Flow labels in header
- No intermediate fragmentation (PMTUD)
- No checksums

Network Efficiencies

- No broadcast
- Multicast
- NS/Solicited Node, no ARP
- ICMPv6

Address Types

- Unicast
- Multicast
- Anycast

Address Scope

- Link Local
- Global Unicast
- Unique Local
- Transition
- Misc (Site Local, Reserved, Special)

Link Local

- Local (broadcast) Domain
- fe80::/64
- Similar to APIPA (169.254.0.0/16)
- Reusable on all interfaces

Global Unicast

- Globally routable
- Unique
- “Public”
- Use ‘em everywhere!

Unique Local

- Not globally routable
- Not unique (but registerable…)
- Replacement for RFC1918 (if you must)

More addresses per interface!

- Use ‘em; we’ll make more
- Multiple default routes
- Quiescence
- How do it know? (RFC 3484)

Subnet Planning

Sane Subnetting

- You can get enough IPv6 space
  - Do the architecture you want, not the one you're stuck with
  - Use GUA space everywhere, make NAT a choice
  - Map your subnets to your process/provisioning or business model
  - Do a scheme that aggregates and makes ACLs sane

Sample /32 Plan by Geography

Infoblox®

- 2001:db8:abcd::/36
  - **City**: 4 bits = 16 possible locations
- 2001:db8:abcd::/40
  - **Hub**: 4 bits = 16 possible hubs per city
- 2001:db8:abcd::/48
  - **Floor**: 8 bits = 256 floors per hub.
- 2001:db8:abcd:12xx::/56
  - **Switch**: 8 bits = 256 Switches per floor.
- 2001:db8:abcd:1234::/64
  - **VLAN:** 8 bits = 256 VLANs per switch.

Prefix Lengths

- /48 is minimum routable chunk
- /64 for all non-p2p subnets
- /127 for p2p links (RFC 6164)
- /128 for loopbacks
- Use /64 each for p2p/lb, pair for each routing domain

Multi-homing and PI addresses

Infoblox®

- If you qualified in v4, you still do
- If PI space would have been useful in v4, it still is
- If you didn’t understand it in v4, v6 won’t help you…

SLAAC vs DHCP

SLAAC

- SLAAC == StateLess Address AutoConfiguration
- Uses Router Advertisement (RA) messages
- Network policy moved to the edge

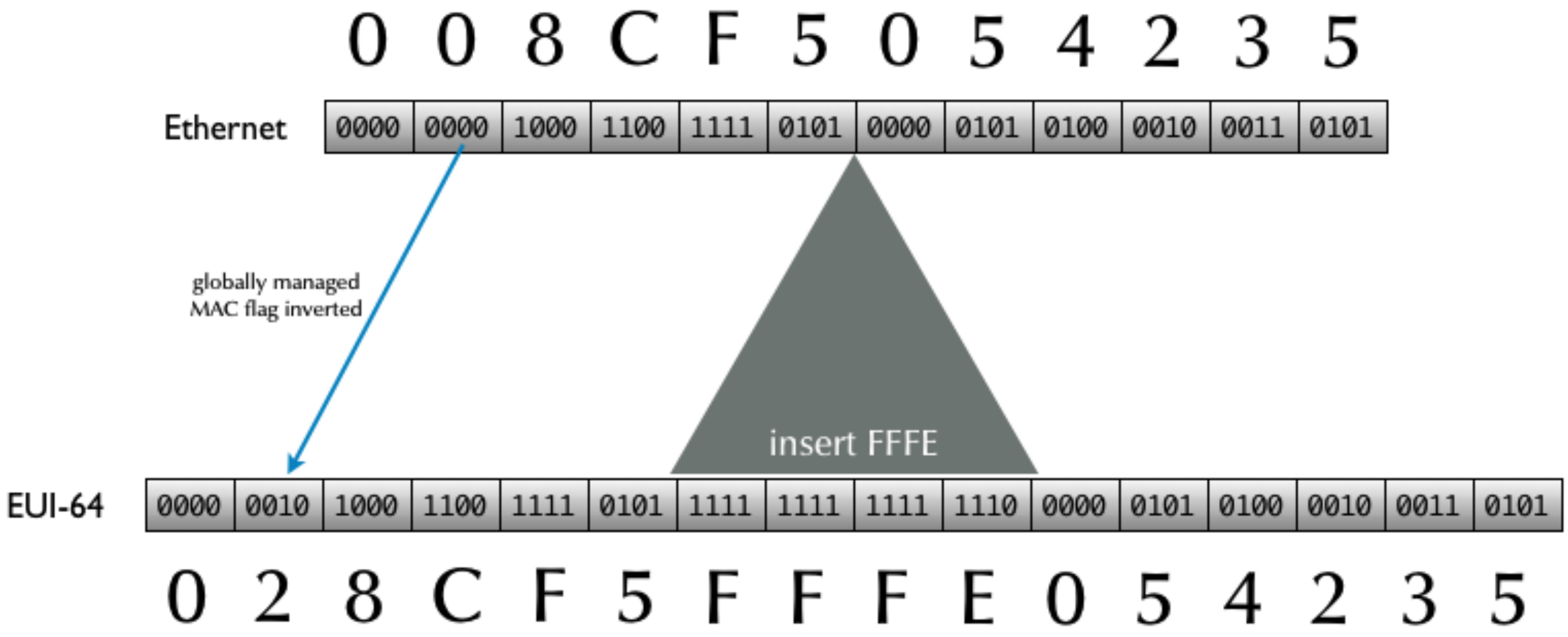
Interface ID generation

- EUI-64 uses the mac address and an algorithm to generate interface ID

- Windows7/Vista randomly generates interface ID by default

- Servers and LINUX/UNIX mostly use EUI-64

MAC address to Interface ID



0 0 8 C F 5 0 5 4 2 3 5

Ethernet 0000 0000 1000 1100 1111 0101 0000 0101 0100 0010 0011 0101

globally managed MAC flag inverted

insert FFFE

EUI-64 0000 0010 1000 1100 1111 0101 1111 1111 1111 1110 0000 0101 0100 0010 0011 0101

0 2 8 C F 5 F F F E 0 5 4 2 3 5

SLAAC Sequence

- **Client configures link-local address**
  - – Generates 64 bit host ID (EUID from MAC, random)
  - – Uses link local prefix and EUID to generate tentative address (such as fe80::028c:f5ff:fe05:4235)
  - – Does DAD (Duplicate Address Detection)
    - Sends a multicast Neighbor Solicitation message containing its new tentative address to the solicited node address
    - If no other node responds with a Neighbor Advertisement using that address, the host configures itself with that address

SLAAC Sequence cont.

- **Host now looks for Router Advertisement (RA) Messages**
  - Sends multicast Router Solicitation message
  - Listens for RA messages
  - Configures itself based on contents of RA message, including doing DHCPv6

RA Message Contents

- **Local prefix(es), including A (autonomous address configuration) flag**
- **Router info**
  - Router's link-level address
  - Lifetime of route
  - Router priority
- **Flags: M (ManagedAddress) flag and O (OtherConfiguration) flag**
- **Maximum Transmission Unit (MTU) of upstream link**

Not in RA Messages…

- RDNS server
- NTP or “other” configuration
- RFC 6106 for RDNS in RA
  - Lack of client support…

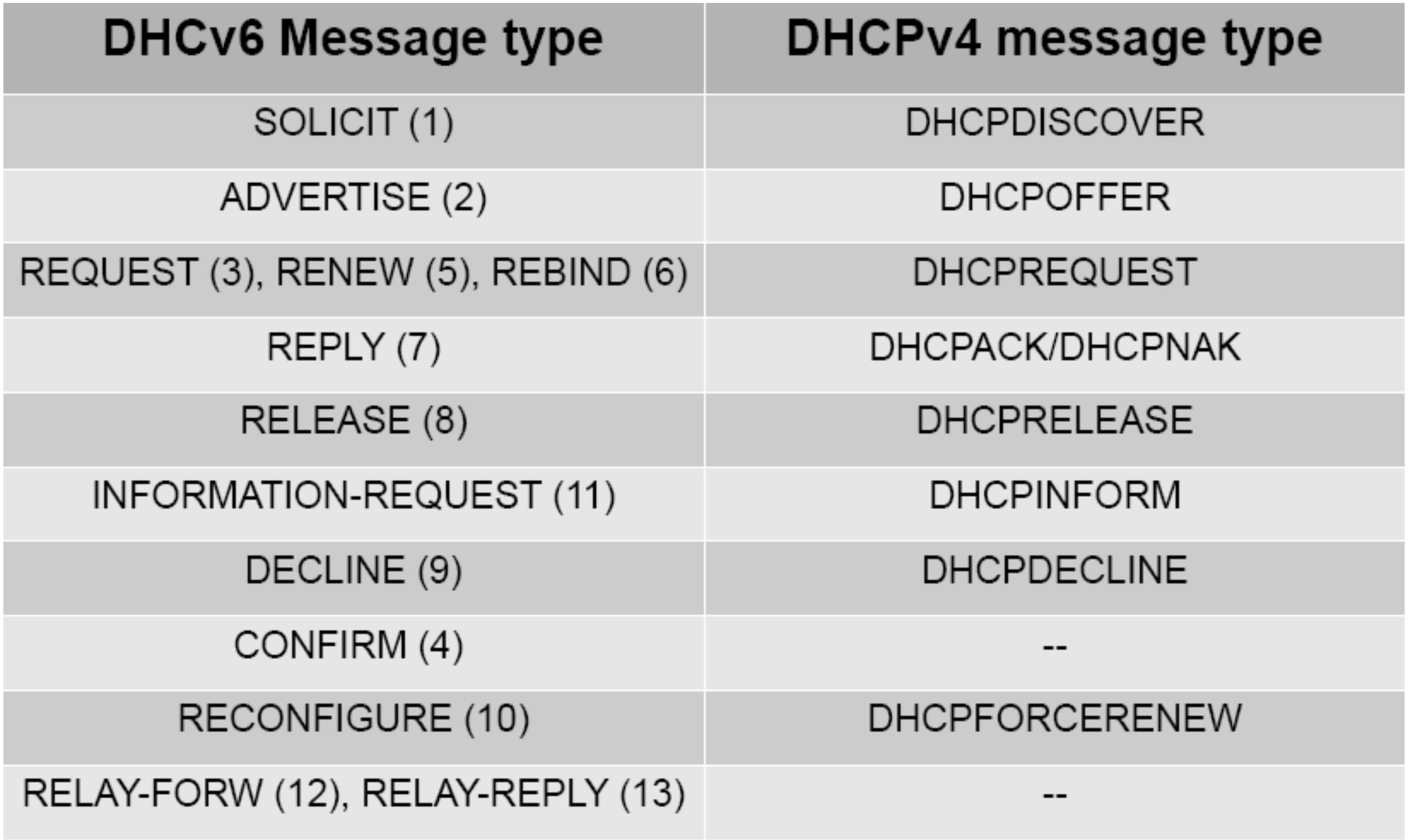
No Choice…

- **Must run both RA and DHCPv6 for most sites…**
  - No DHCPv6 without an RA message with M or O flag on
  - Many options not available to clients without DHCPv6
  - No default gateway in DHCPv6
  - Must configure DHCP and edges

DHCPv6 features

- Not BOOTP! ☺
- No broadcast!
- New ports (546, 547)
- Vendor options in TLV tuples
- Reconfigure now secure

DHCPv6 vs DHCPv4 messages



DHCv6 Message type	DHCPv4 message type
SOLICIT (1)	DHCPDISCOVER
ADVERTISE (2)	DHCPOFFER
REQUEST (3), RENEW (5), REBIND (6)	DHCPREQUEST
REPLY (7)	DHCPACK/DHCPNAK
RELEASE (8)	DHCPRELEASE
INFORMATION-REQUEST (11)	DHCPINFORM
DECLINE (9)	DHCPDECLINE
CONFIRM (4)	--
RECONFIGURE (10)	DHCPFORCERENEW
RELAY-FORW (12), RELAY-REPLY (13)	--

Use the whole /64!

- IPv4 address shortages made pool size precious
- IPv6 has plenty
- Protect from brute force scans
- Do pay attention, though…

Reconfigure

- Client and server must support and be configured for it
- Now has security
- With quiescence and reconfigure, renumbering is easy (mostly)

DUID > Mac address

Infoblox®

- **Mac address as ID is flawed:**
  - Not always unique
  - Can be altered
  - Multi-interface hosts confuse things
- **But it’s what most of the eyeballs on the Internet are ID’ed by currently**
- **DUID (DHCP Unique Identifier) is the replacement in IPv6**

DUID issues

- **Yes, mac addresses sucks.**
- **DUIDs suck differently.**
  - Can’t correlate v4 and v6 addrs to same host
  - Can’t get mac address from DUID
  - Persistent storage of DUID may cause surprises

What DUIDs do right

- One DUID per DHCP server or client
- One Identity Association (IA) per network interface on a host
- A host can DHCP for all interfaces via DUID/IA as unique key

Identity Associations

- **Types:**
  - **IA_TA**: temporary address(es), i.e. privacy addrs
  - **IA_NA**: non-temporary address(es), i.e. not privacy addrs
  - **IA_PD**: prefix delegation

Prefix Delegation

- Delegate a prefix to a device
- Device can delegate longer prefixes to its own clients
- Likely scenario is home/CPE routers
- Lots of potential but not lots of gear available now

ICMPv6

ICMPv6

- Required for:
  - DAD
  - Finding routers (RA/SLAAC)
  - Finding servers (DHCP)
  - PMTUD
  - Connectivity (echo request/response)
  - Network errors

ICMPv6 Filtering

- **Filter it all and you don't have a useful network**

- **ICMPv6 much more detailed/precise in types and functions**

- **RFC 4890 has excellent filtering practices**

Security

Security

- Most issues much the same as IPv4
- Misconfiguration more likely than malice
- Untested code and lack of experience
- Security vendor claims must be validated

Security improvement claims

- Subnet size makes brute force scanning pointless (if you really use it…)
- Privacy addresses
- IPSec

Security realities

- Bad host numbering schemes
- IPSEC:
  - Good news: just like IPv4
  - Bad news: just like IPv4
  - Exception: Microsoft DirectAccess…

Security homework

- Test all your firewall and security appliances for IPv6
  - ACLs for IPv6
  - Detect various tunneling (ISATAP, Teredo, 6in4, 6to4, etc)

- Make sure all your NMS and logging deal with IPv6, both for transport and data

Infoblox®

Thanks!