Getting Started With IPv6

Walter Horowitz

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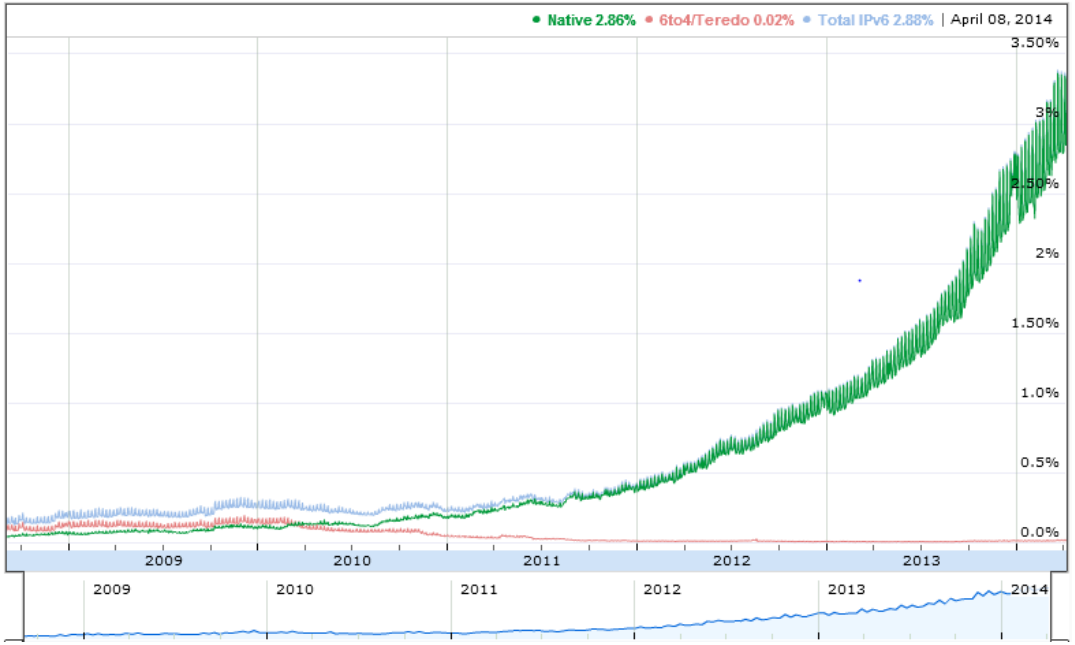
We Need IPv6

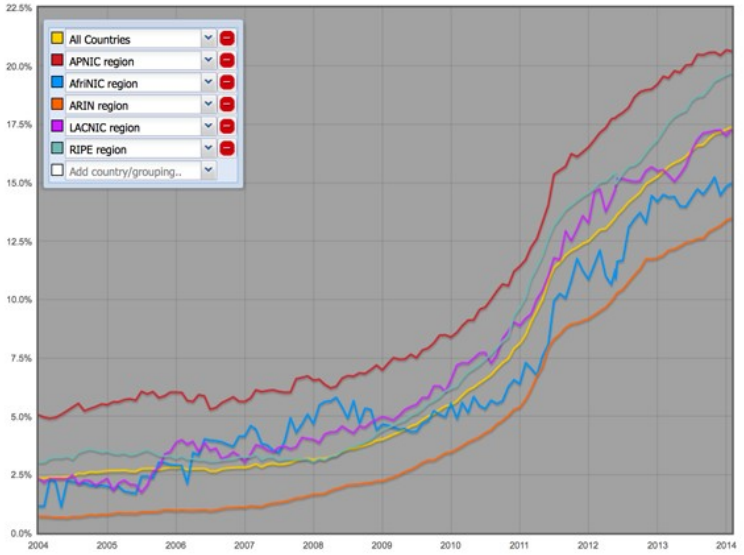
- Exponential growth of the Internet and the exhaustion of the IPv4 address space
  IANA's exhaustion on January 31 2011, APNIC's exhaustion on April 15 2011
- Growth of the Internet and the ability of Internet backbone routers to maintain large routing tables
- Need for simpler configuration
- Requirement for security at the IP level
- Need for better support for real-time delivery of data—also called quality of service (QoS)
- New services may be IPv6 only, some already are
- Federal Government has mandated the use of IPv6

IPv6 is now alive on the Internet

- April 2011 - World IPv6 Test
- June 6, 2012 - IPv6 World Launch



IPv6 connectivity to Google



percentage of IPv6-enabled Autonomous Systems

Major Services In IPv6

> www.google.com
Server: google-public-dns-a.google.com
Address: 8.8.8.8

Non-authoritative answer:
www.google.com internet address = 74.125.226.52
www.google.com internet address = 74.125.226.49
www.google.com internet address = 74.125.226.50
www.google.com internet address = 74.125.226.51
www.google.com internet address = 74.125.226.48
www.google.com AAAA IPv6 address = 2607:f8b0:4006:807::1011

Are You Using IPv6?

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- Option in Windows XP, Linux since 2.1.8
- Standard in Vista+, Linux 2.5.x and 2.6.x kernel
- MacOS X, Linux, BSD all prefer IPv6
  - Lion uses Happy Eyeballs (use fastest response)
- Windows HomeGroup breaks if you disable IPv6
- DirectAccess and Remote A require IPv6
- Your devices may be IPv6 re

Differences Between IPv4 & IPv6

Feature	IPv4	IPv6
Address length	32 bits	128 bits
IPSec support	Optional	Required
QoS support	Some	Better
Fragmentation	Hosts and routers	Hosts only
Packet size	576 bytes	1280 bytes
Checksum in header	Yes	No
Options in header	Yes	No
Link-layer address resolution	ARP (broadcast)	Multicast Neighbor Discovery Message
Multicast membership	IGMP	Multicast Listener Discovery (MLD)
Router Discovery	Optional	Required
Uses broadcasts	Yes	No
Configuration	Manual, DHCP	Automatic, DHCP
DNS name queries	Uses A records	Uses AAAA records
DNS reverse queries	Uses IN-ADDR.ARPA	Uses IP6.arpa

IPv6 Address Format

- IPv6 address in binary form:

```
0010000000000001110110111000001100000000000000000101111001110110000010101010100000000011111111111111000101000100111000101101000
```

- Divided along 16-bit boundaries:

```
0010000000000001   1101101110000011   0000000000000000   0010111100111011
0000010101010100   0000000011111111   1111111000101000   1001110001011010
```

- Each 16-bit block is converted to hexadecimal and delimited with colons:

  2001:DB83:0000:2F3B:02AA:00FF:FE28:9C5A

- Suppress leading zeros within each 16-bit block:

  2001:DB83:0:2F3B:2AA:FF:FE28:9C5A

Compress One Block of Zeros

- Some IPv6 addresses contain long sequences of zeros
- A single contiguous sequence of 16-bit blocks set to 0 can be compressed to “::” (double-colon)
- Example:
  - FE80:0:0:0:2AA:FF:FE9A:4CA2 becomes FE80::2AA:FF:FE9A:4CA2
  - FF02:0:0:0:0:0:0:2 becomes FF02::2
- Cannot use zero compression to include part of a 16-bit block

Key Address Prefixes

Prefix	Allocation	Example
2000::/3 to 3fff	Global Unicast	2002:AB::16/64
2001::DB8::/32 to 2001:DB8:FFFF	Documentation Prefix	2001:DB8:AA::/64
FC00::/7 to FDFE	Unique Local Unicast	FC00:AB::7/64
FE80::/10 to FEBF	Link Local Unicast	FE80::6AEF:BDFF:FE61:4D13
FF00::/8 to FFFF	Multicast	FF01::1 – All nodes int'f FF02::2 – All routers on link FF05::2 – All routers at site
::FFFF/96	IPv4 Mapped	Used to embed IPv4 addresses in an IPv6

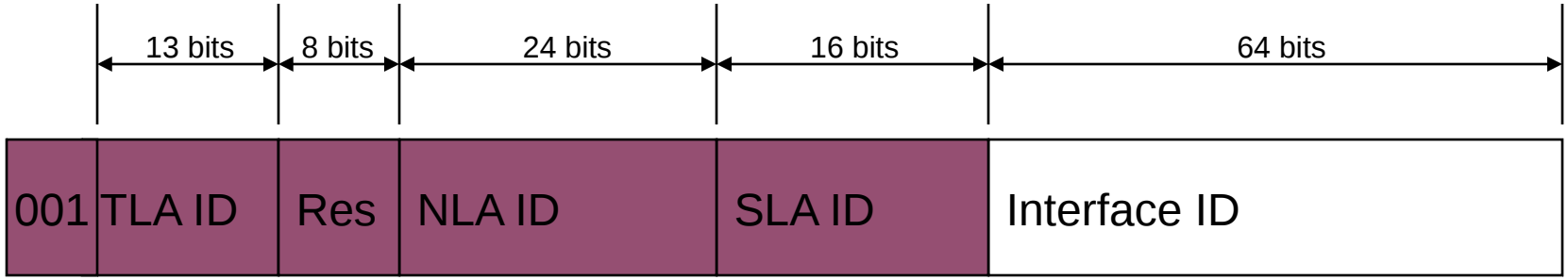
::/128 is the unspecified address
::1/128 is the loopback address

Types of IPv6 Addresses

- Unicast
  - Address of a single interface
  - One-to-one delivery to single interface
- Multicast
  - Address of a set of interfaces
  - One-to-many delivery to all interfaces in the set
- Anycast
  - Address of a set of interfaces
  - One-to-one-of-many delivery to the closest interface
- No more broadcast addresses

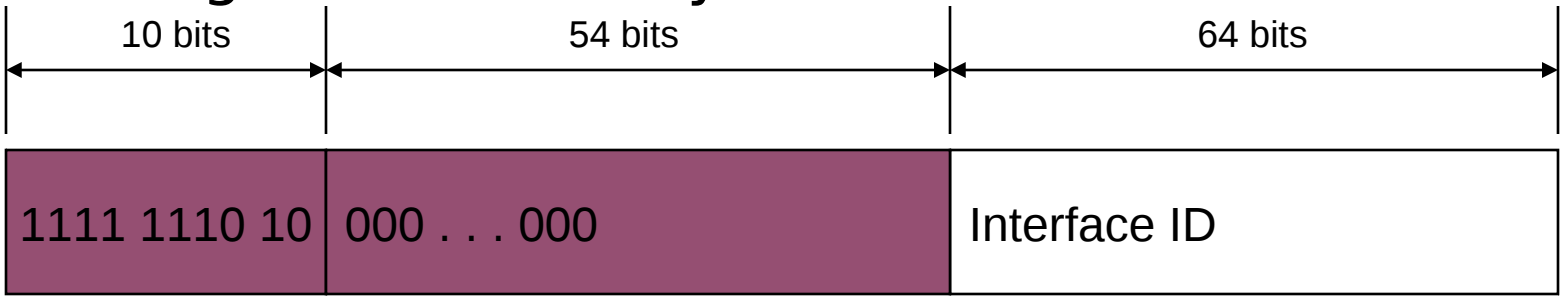
Aggregatable Global Unicast Addresses

- Top-Level Aggregation ID (TLA ID) **/16**
- Next-Level Aggregation ID (NLA ID) **/48 or /56**
- Site-Level Aggregation ID (SLA ID) **/64**
- Interface ID (MAC derived?)



Link-Local Addresses

- Format Prefix 1111 1110 10
  - FE80::/64 prefix
- Used for local link only
  - Single subnet, no router
  - Address autoconfiguration
  - Neighbor Discovery



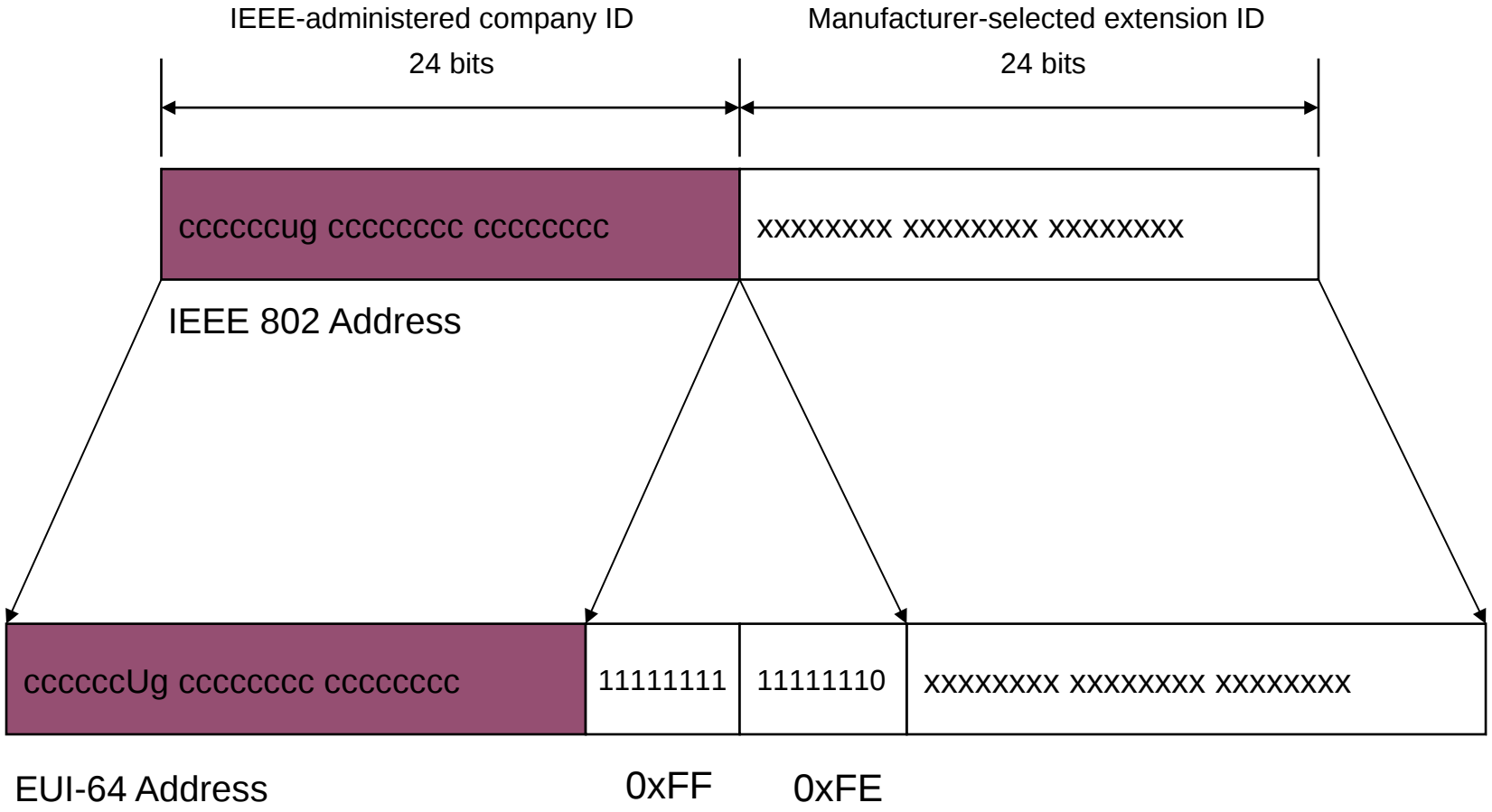
IPv6 Addresses for a Host

- Unicast addresses:
  - A link-local address for each interface
  - Unicast addresses for each interface (unique-local or global addresses)
  - A loopback address (::1)
- Multicast addresses:
  - The node-local scope all-nodes multicast address (FF01::1)
  - The link-local scope all-nodes multicast address (FF02::1)
  - The solicited-node address for each unicast address
  - The multicast addresses of joined groups

IPv6 Interface Identifiers

- The last 64 bits of unicast IPv6 addresses
- Interface identifier based on:
  - Extended Unique Identifier (EUI)-64 address
    - Either assigned to a network adapter card or derived from IEEE 802 addresses
  - Temporarily assigned, randomly generated value that changes over time
  - A value assigned by a stateful address configuration protocol
  - A value assigned during a Point-to-Point Protocol connection establishment
  - A manually configured value

Conversion of an IEEE 802 Address to an EUI-64 Address



Complement the universally/locally administered (U/L) bit

Plan for your IPv6 Move

- Obtain an IPv6 Network Address
- Enable Dual Stack in machines
- Plan for your Network subnets
- Enable IPv6 in Routers
- Enable IPv6 in Services
  - DNS
  - DHCP
  - Mail

How to Get an IPv6 Address

- Ask your ISP
  - You should get a /48 address block - 65,536 subnets
  - You can get a bigger block if necessary
  - Home users may get less /52 4096 subnets, /56 is 256
  - http://www.tunnelsup.com/subnet-calculator
- Ask your Regional Internet Registry
  - For Multihoming sites only, multiple ISP
- Test with a Tunnel Broker
  - Hurricane Electric
  - SixXs.net
  - gogo6.com

Plan Your Address Allocation

- Expect significant growth for each subnet
- Use a good tool
  - https://osl.uoregon.edu/redmine/projects/netdot
  - http://sourceforge.net/projects/haci/
  - Others
- Get a manual
  - http://www.ripe.net/lir-services/training/material/IPv6-for-LIRs-Training-Course/Preparing-an-IPv6-Addressing-Plan.pdf

Transitional Technologies

- 6to4 – Not recommended
  - http://tools.ietf.org/html/draft-ietf-v6ops-6to4-to-historic-05
- 6over4
  - Requires IPV4 multicast – not worth your time
- ISATAP
  - Uses DNS to find potential routers, Intra-Site only
- Teredo
  - Tunnel IPv6 packets within UDP
- Does your ISP support 6rd? (IPv4 tunnel)
- NAT64/DNS64 – NAT only IP4 only sites
- **Dual Stack is Preferred**
- **Code for “Happy Eyeballs”**

Add IPv6 to a router

- Cisco
  - ipv6 unicast-routing
  - Ipv6 cef
  - Interface x
    - Ip v6 address x/y (e.g. 2001:db8::2345.2345/126)
  - ipv6 route address/bits interface
    - ipv6 route ::/0 Serial2/0 (i.e. default route to Serial 2/0)
- Tunnel if necessary
- Insure you have correct Firewall rules

DNS and IPv6

- Don’t give out IPv6 addresses if you can’t reach them.
- AAAA records for IPv6 name to address resolution
- IP6.arpa type PTR records for address lookup
  - http://www.zytrax.com/books/dns/ch3/#ipv6-calculator
- Test for IPv6 capability
  - http://test-ipv6.com/
  - (Cox talks about having IPv6, Verizon started

DHCP and IPv6

- Not required – stateless address assignment
- Do you want to be able to trace problems back to a specific user? Windows 7+, Mac OSX 10.7+ use Privacy Extensions by default.
- PE can be Enabled in Linux, default disabled in Ubuntu
  - **net.ipv6.conf.eth0.use_tempaddr=2**
- Available in Windows Server 2008 R2 & Linux
  - Set DNS Recursive Name Server

Linux and IPv6

- HOWTO at
  - http://www.tldp.org/HOWTO/Linux+IPv6-HOWTO/
- Is your kernel IPv6 ready?
  - test -f /proc/net/if_inet6 && echo "kernel is IPv6 ready“
  - modprobe ipv6
- Commands
  - ping6 & traceroute6 (from iputils) eg. ping6 ff02::1

```
uwhorowit@VBUbuntu12:~$ ifconfig
eth1      Link encap:Ethernet  HWaddr 08:00:27:32:46:40
          inet addr:10.0.2.15  Bcast:10.0.2.255  Mask:255.255.255.0
          inet6 addr: fe80::a00:27ff:fe32:4640/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:57 errors:0 dropped:0 overruns:0 frame:0
          TX packets:114 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:23112 (23.1 KB)  TX bytes:14644 (14.6 KB)
```

Free IPv6 Certification

- https://ipv6.he.net/certification/
- Prove that you have IPv6 connectivity
- Prove that you have a working IPv6 web server
- Prove that you have a working IPv6 email address
- Prove that you have working forward IPv6 DNS
- Prove that you have working reverse IPv6 DNS for your mail server
- Prove that you have name servers with IPv6 addresses that can respond to queries via IPv6
- Prove your knowledge of IPv6 technologies through quick and easy testing

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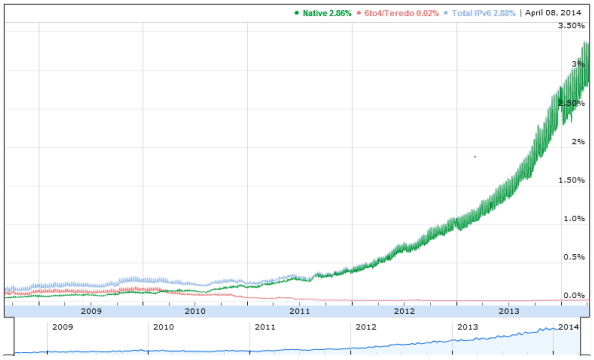

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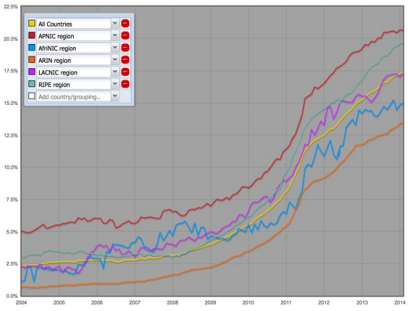

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FF00::/8 to FFFF ::/128 is the unspecified address ::1/128 is the loopback address	Multicast	FF01::1 – All nodes int'f FF02::2 – All routers on link FF05::2 – All routers at site
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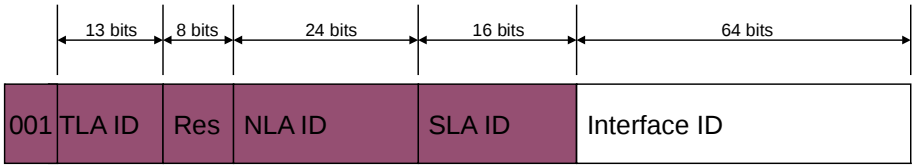

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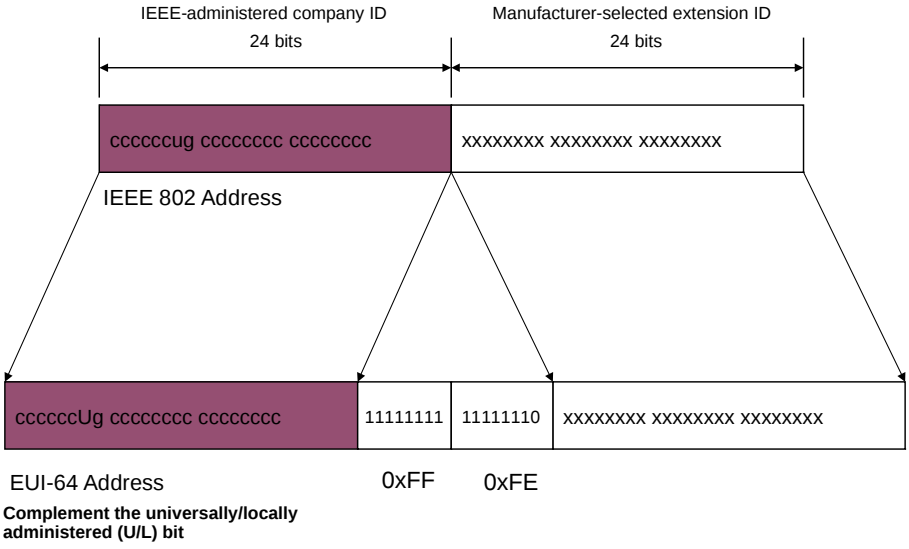

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          inet6 addr: fe80::a00:27ff:fe32:4640/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:57 errors:0 dropped:0 overruns:0 frame:0
          TX packets:114 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:23112 (23.1 KB)  TX bytes:14644 (14.6 KB)
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