



IPv6 Addressing



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IPv6DISSEmination and Exploitation



Agenda

- IPv6 addressing scheme
- IPv6 address types
- IPv6 address formats
- IPv6 address allocation to LIRs



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Addressing scheme

- RFC 3513 defines IPv6 addressing scheme
- RFC 3587 defines IPv6 global unicast address format
- 128 bit long addresses
 - Allow hierarchy
 - Flexibility for network evolutions
- Use CIDR principles:
 - Prefix / prefix length
 - 2001:660:3003::/48
 - 2001:660:3003:2:a00:20ff:fe18:964c/64
 - Aggregation reduces routing table size
- Hexadecimal representation
- Interfaces have several IPv6 addresses



Textual Address Format

- Base format (a 16-byte Global IPv6 Address) :

```
2001:0660:3003:0001:0000:0000:6543:210F
```

- Compact Format:

```
2001:660:3003:1::6543:210F
```

- Litteral representation

```
[2001:660:3003:2:a00:20ff:fe18:964c]
```





IPv6 Address Space (RFC 3513)

Aggregatable Global Unicast Addresses	001	1/8	
Unique Local Unicast addresses	1111 1110 00		1/128
Link-Local Unicast Addresses	1111 1110 10		1/1024
Multicast Addresses	1111 1111	1/256	



More info : <http://www.iana.org/assignments/ipv6-address-space>



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IPv6 Addresses

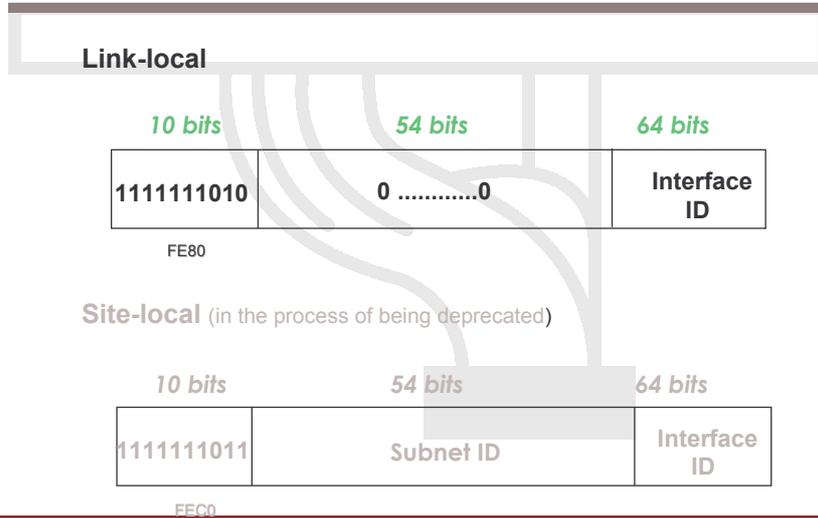
- Loopback ::1
 - Link local FE80:.....
 - Site local FEC0:.....
 - Global
 - 6bone: 3FFE:....
 - Official: 2001:....
 - IPv4 mapped
 - 6to4: 2002:.....
- Unicast
 - Multicast
 - Anycast
- specific to IPv4/IPv6 integration



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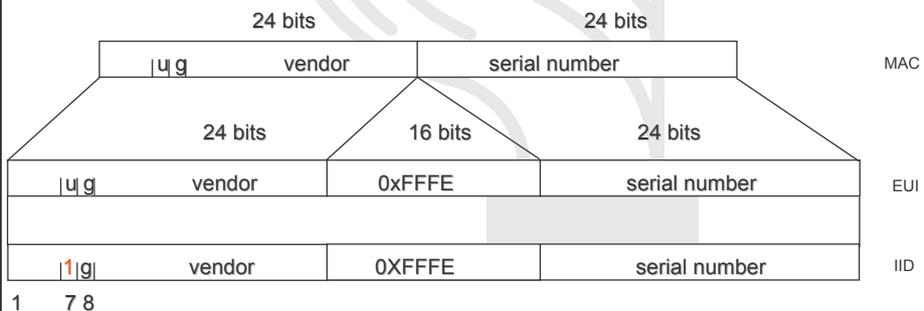
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Local Addresses



Interface Identifier

- 64 bits to be compatible with IEEE 1394 (FireWire)
- Eases auto-configuration
- IEEE defines the mechanism to create an EUI-64 from IEEE 802 MAC addresses (Ethernet, FDDI)





Interface Identifier (2)

- Links with non global identifier (e.g., the Localtalk 8 bit node identifier) → fill first left bits with 0
- For links without identifiers, there are different ways to proceed (e.g., tunnels, PPP):
 - Choose the identifier of another interface
 - Random number
 - Manual configuration
- **THEN** : Invert IEEE EUI-64 “u” bit to become an “interface identifier”



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Interface Identifier (3) (Privacy issues)

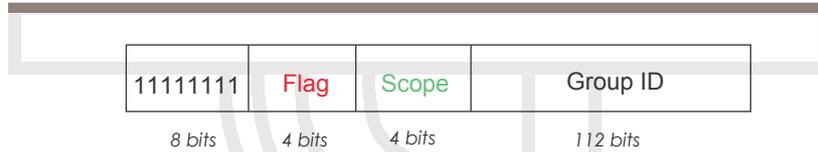
- IEEE 24 bit OUI can be used to identify HW:
 - <http://standards.ieee.org/regauth/oui/oui.txt>
- Interface Identifier can be used to trace a user:
 - The prefix changes, but the interface ID remains the same,
 - Psychological issue.
- Possibility to change Interface ID (RFC 3041 PS):
 - If local storage, use MD5 algorithm
 - Otherwise draw a random number



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Multicast Addresses



Flag bits: 0 R P T

T = 0 permanent addresses (managed by IANA)

T = 1 transient multicast addresses

- P = 1 derived from unicast prefix (RFC3306)
 - R = 1 embedded RP addresses (RFC 3956)

Scope

- 0 : Reserved
- 1 : Interface-local
- 2 : Link-local
- 4 : Admin-local
- 5 : Site-local
- 8 : Organization-local
- E : Global
- F : Reserved



Anycast Addresses (RFC 4291)

- « anycast: an identifier for a set of interfaces (typically belonging to different nodes) »
 - « a packet sent to an anycast address is delivered to one of the interface identified by that address ... »
 - « (they) are allocated from the unicast address spaces (of any scope), using any of the defined unicast address formats »
- ⇒ It cannot be distinguished from a Unicast address
- « it may be assigned to an IPv6 router only »
 - Reserved anycast addresses are defined in RFC 2526 (obsolete ?)
 - Required subnet router anycast address is predefined :





Required IPv6 addresses (RFC 4291)

- Node
 - Link local address
 - for each interface
 - Any additional unicast and anycast addresses (manually or automatically conf)
 - Loopback address
 - The all-nodes multicast address
 - Solicited-node multicast address for each of unicast and anycast address
 - Multicast addresses of all other groups the node belongs to
- Router
 - All addresses a host must recognized
 - The subnet-router anycast addresses for all interfaces ...
 - All other anycast addresses the router has been configured
 - The all-routers multicast addresses group.



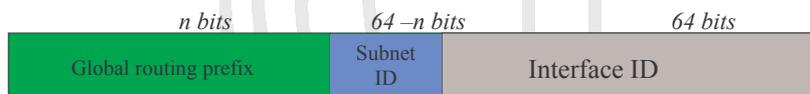
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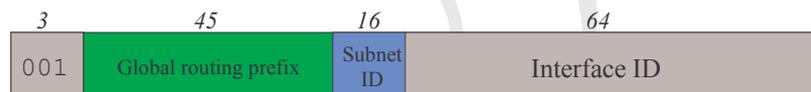


RFC 3587: Global Unicast address format

What the RFC proposes :



What the RIRs/IANA implement :

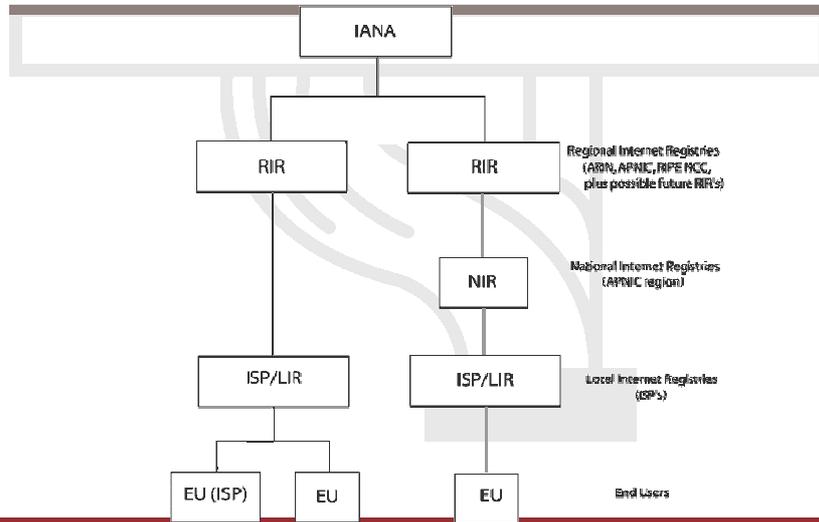


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Production Addressing Scheme



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Production Addressing Scheme (2)

Source :

<http://www.iana.org/assignments/ipv6-unicast-address-assignments>

IPv6 Prefix	Binary Value	Assignment
2000::/16	0010 0000 0000 0000	Reserved
2001::/16	0010 0000 0000 0001	Global Unicast
2002::/16	0010 0000 0000 0010	6to4 [RFC3056 et
2003::/18	0010 0000 0000 0011	RIPE NCC Global
2400::/x		
2600::/x		
2A00::/x		
3FFE::/16	001 1 1111 1111 1110	0x1FFE 6bone Testing [RFC2471]
3FFF::/16	001 1 1111 1111 1111	0x1FFF Reserved



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Production Addressing Scheme (3)

IPv6 Prefix	sub-TLA	Binary Values	Allocated to	Date
2001:0000::/23	0000	000X XXXX X	IANA	Jul 99
2001:0200::/23	0000	001X XXXX X	APNIC	Jul 99
2001:0400::/23	0000	010X XXXX X	ARIN	Jul 99
2001:0600::/23	0000	011X XXXX X	RIPE NCC	Jul 99
2001:0800::/23	0000	100X XXXX X	RIPE NCC	May 02
2001:0A00::/23	0000	101X XXXX X	RIPE NCC	Nov 02
2001:0C00::/23	0000	110X XXXX X	APNIC	May 02
2001:0E00::/23	0000	111X XXXX X	APNIC	Jan 03
2001:1000::/23	0001	000X XXXX X	(future assignment)	
2001:1200::/23	0001	001X XXXX X	LACNIC	Nov 02
2001:1400::/23	0001	010X XXXX X	RIPE NCC	Feb 03
2001:1600::/23	0001	011X XXXX X	RIPE NCC	Jul 03
2001:1800::/23	0001	100X XXXX X	ARIN	Apr 03
...
2001:FE00::/23	1111	111X XXXX X	(future assignment)	

where "x" indicates "0" or "1".
All other sub-TLA ID values not listed above are reserved.

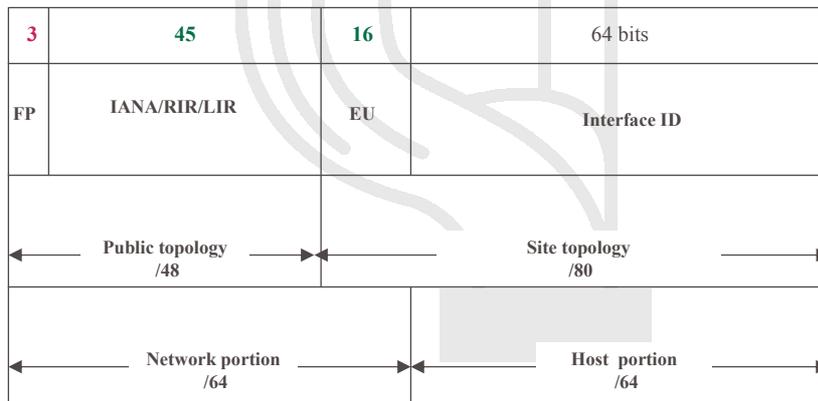


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Production Addressing Scheme (4)



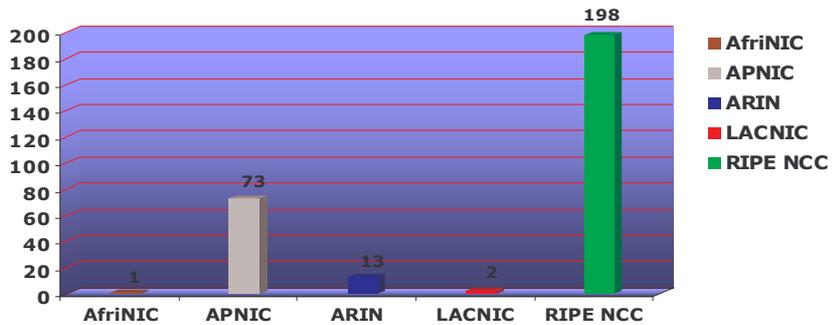
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NRO

IANA IPv6 Allocations to RIRs*



*number of /23s



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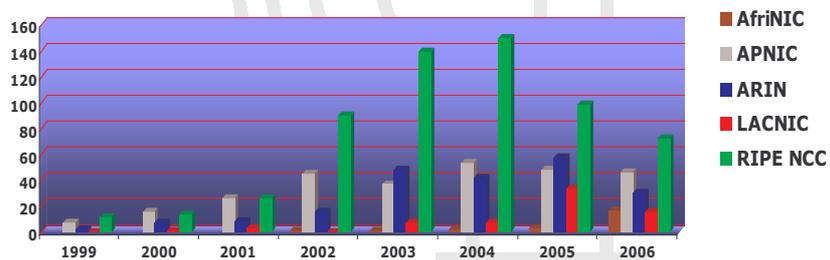
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NRO

IPv6 Allocations RIRs to LIRs/ISPs

Yearly Comparison



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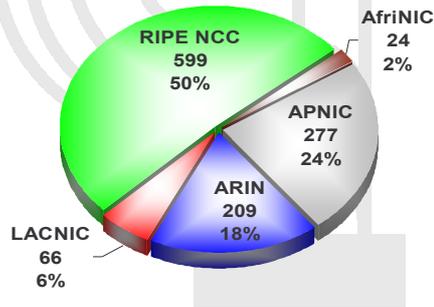
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NRO

IPv6 Allocations RIRs to LIRs/ISPs

Cumulative Total (Jan 1999 – Sept 2006)



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Initial RIR allocation Policy & Procedure

- Get the RIPE documents [246-250, 256, 261, 267, 274, 275, 280-282]
 - <http://www.ripe.net/ripe/docs/ipv6.html>
- Criteria: RIPE-267
 - <http://www.ripe.net/ripe/docs/ipv6policy.html>
- To qualify for an initial allocation of IPv6 address space, an organization must:
 - be an LIR : *not be an end site*
 - plan to provide IPv6 connectivity to organizations to which it will assign /48s, by advertising that connectivity through its single aggregated address allocation (/32 prefix)

and

 - have a plan for making at least 200 x /48 assignments to other organizations within two years.



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Links to RIR Statistics

- **RIR Stats:**
<http://www.nro.net/statistics/>
- **Raw Data/Historical RIR Allocations:**
<http://www.aso.icann.org/stats>
<http://www.iana.org/assignments/ipv4-address-space>
<http://www.iana.org/assignments/as-numbers>
<http://www.iana.org/assignments/ipv6-unicast-address-assignments>

