IPv6 Addressing

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Agenda

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

Addressing scheme

- **RFC 4291 of 2006 (obsoletes 3513)** defines IPv6 addressing scheme
- 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
- **RFC 3587** defines IPv6 global unicast address format

Textual Address Format

- Base format (a 16-bytes **Global IPv6 Address) :**

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

- Compact Format :

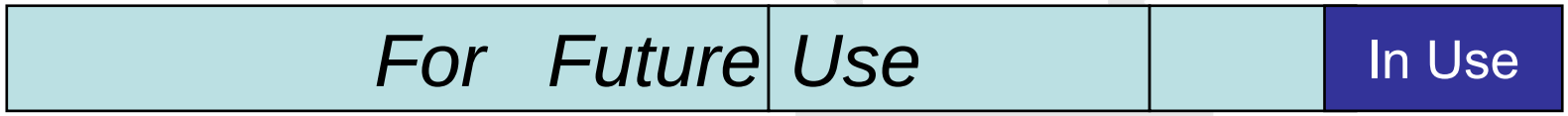
2001:660:3003:1::6543:210F

- Litteral representation

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

IPv6 Address Space
(RFC 3513+3879+4193 = RFC 4291)

Unspecified addresse	000… 00		
Loopback	000 … 01		
Multicast (FF00::/8)	**1111 1111**		1/256
Link-local unicast addresses (FE 80::/10)	**1111 1110 10**00		1/1024
Unique local unicast address (FC00::/7)	**1111 11**00 0000		1/128
Rest not starting with 000::/3 is unicast address, in particular			**RFC3587**
Aggregatable Global Unicast Addresses	001		**1/8**



1/2 1/4 1/8 1/8

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

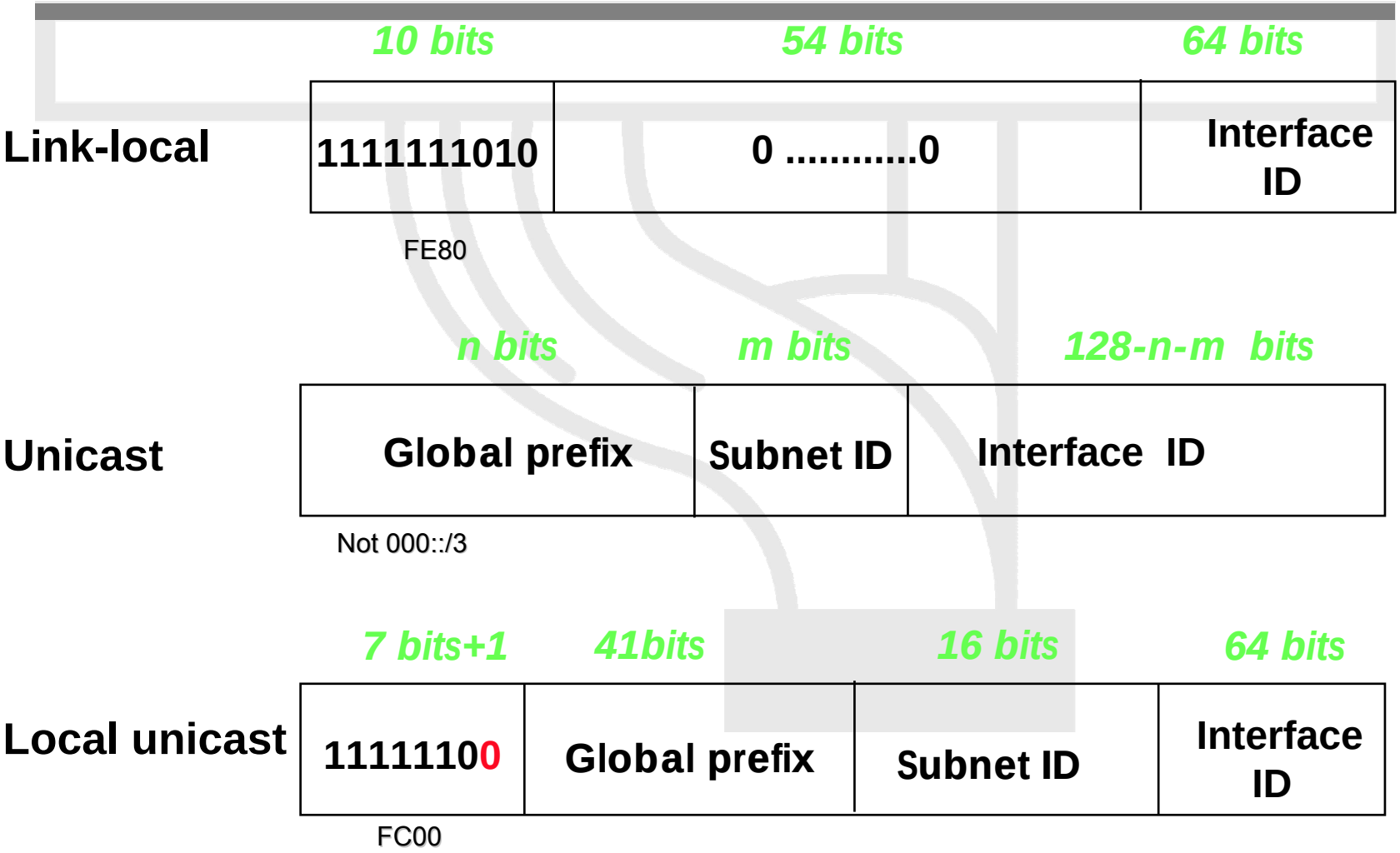
IPv6 Addresses

- Unicast
- Multicast
- **Anycast**
- Global unicast:
  - 6bone: 3FFE:… Historic. Stopped on 6/6/6
  - Official: 2001:… (as of 10/2006)

- **IPv4 mapped**
- **6to4**: 2002::…

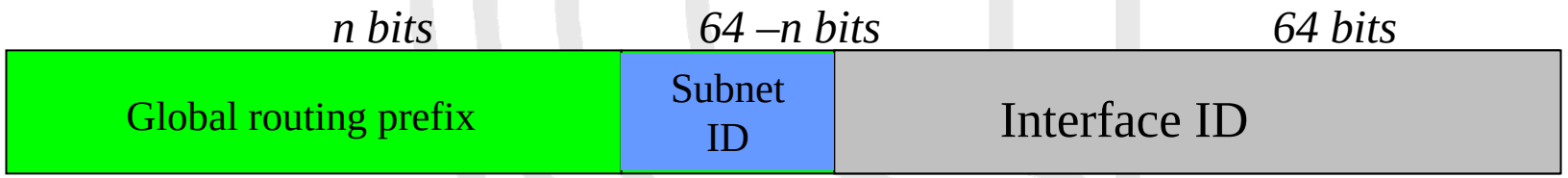
specific to IPv4/IPv6 integration

Unicast Addresses

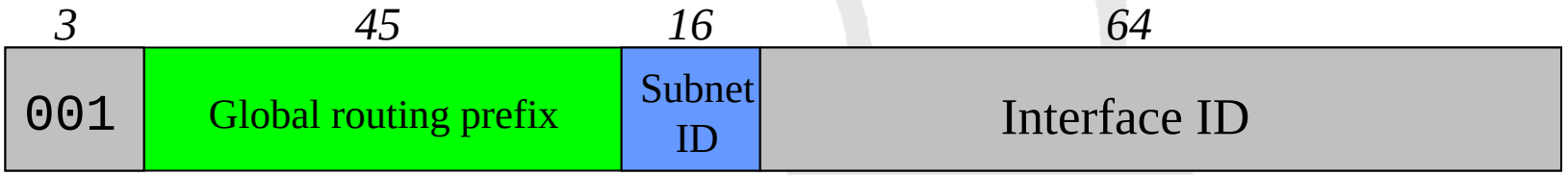


RFC 3587: Global Unicast address format

What the RFC proposes :

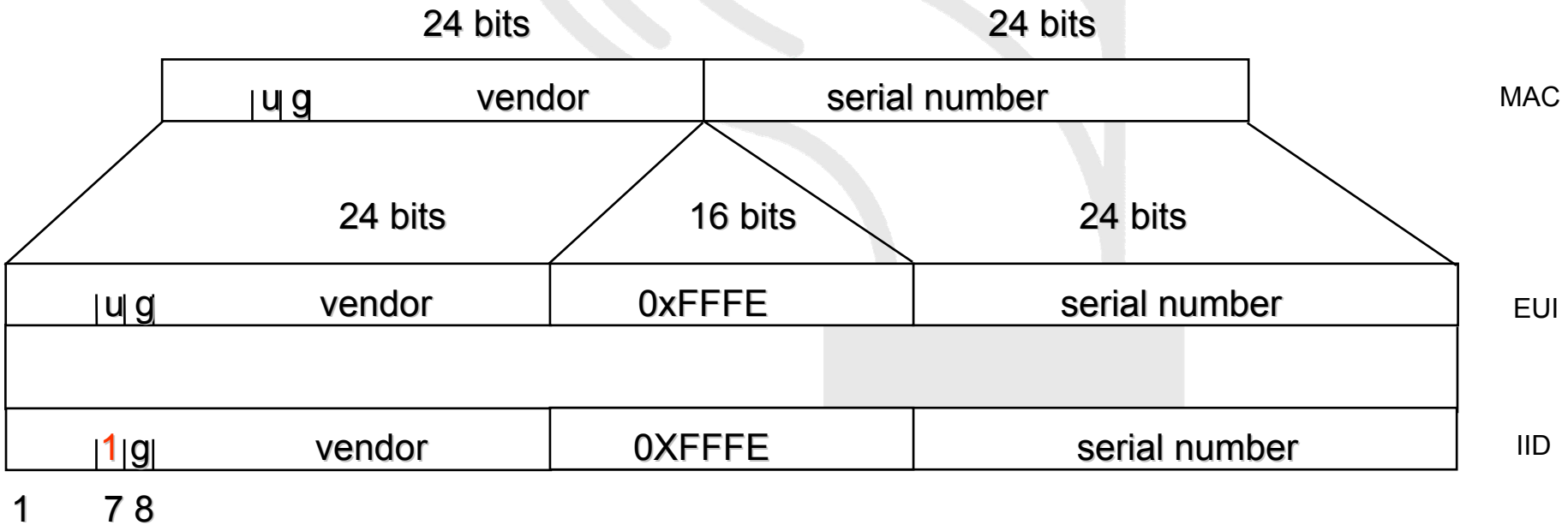


What the RIRs/IANA implement (at least for none domestic users):



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)



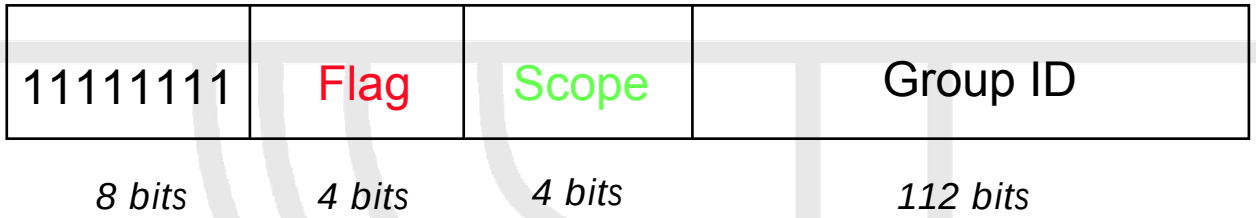
Interface Identifier (2)

- 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”

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

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. Host receiving anycast address must "know" this. Some routers must hold host route for them.**

- « it may be assigned to an IPv6 router only »
- *Reserved anycast addresses are defined in RFC 2526 (obsolete ?)*

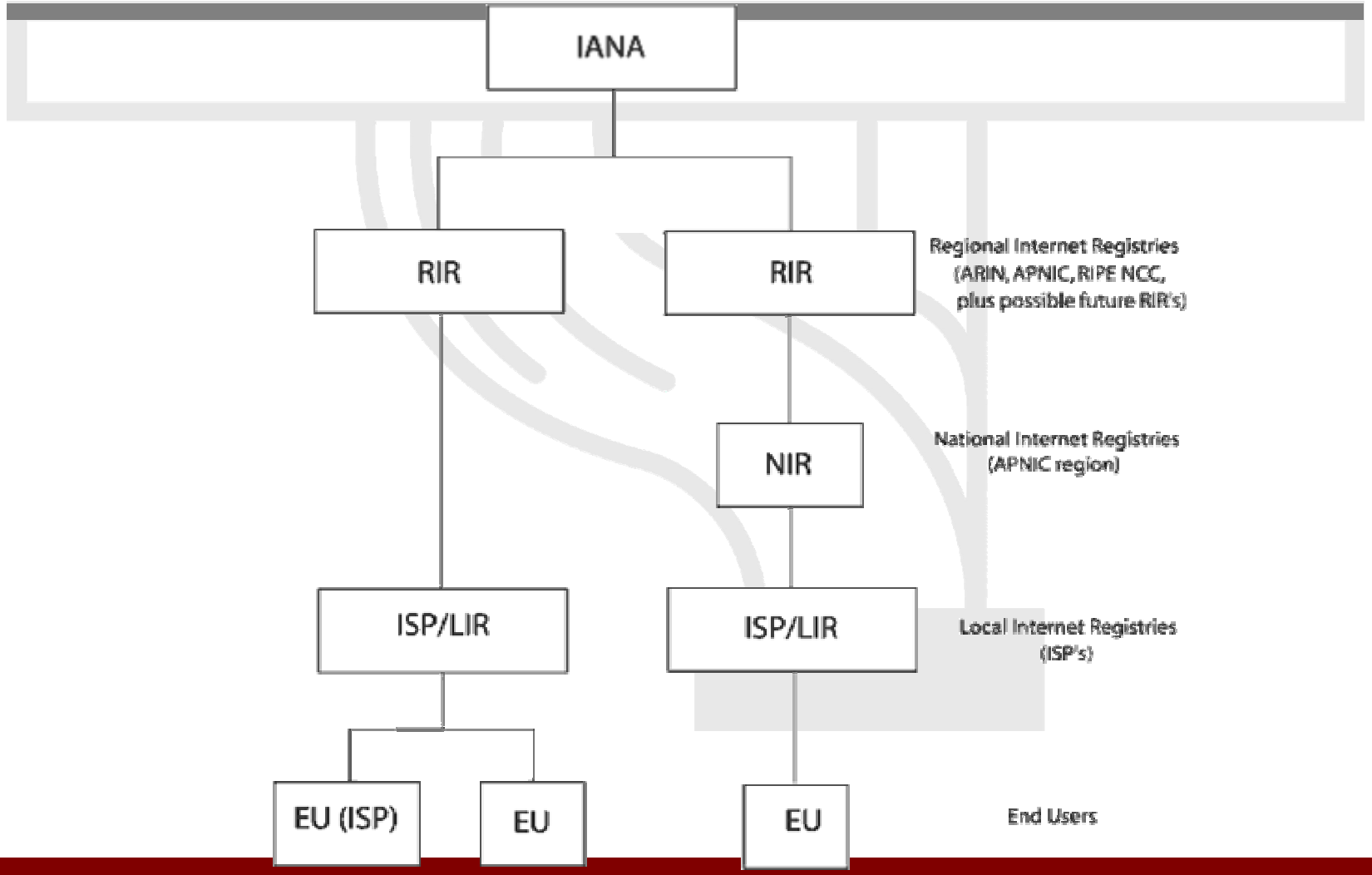
- **Required** subnet router anycast address is predefined :

n bits	*128 – n bits*
Subnet Prefix	00..00

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.

Production Addressing Scheme



Production Addressing Scheme (2)

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

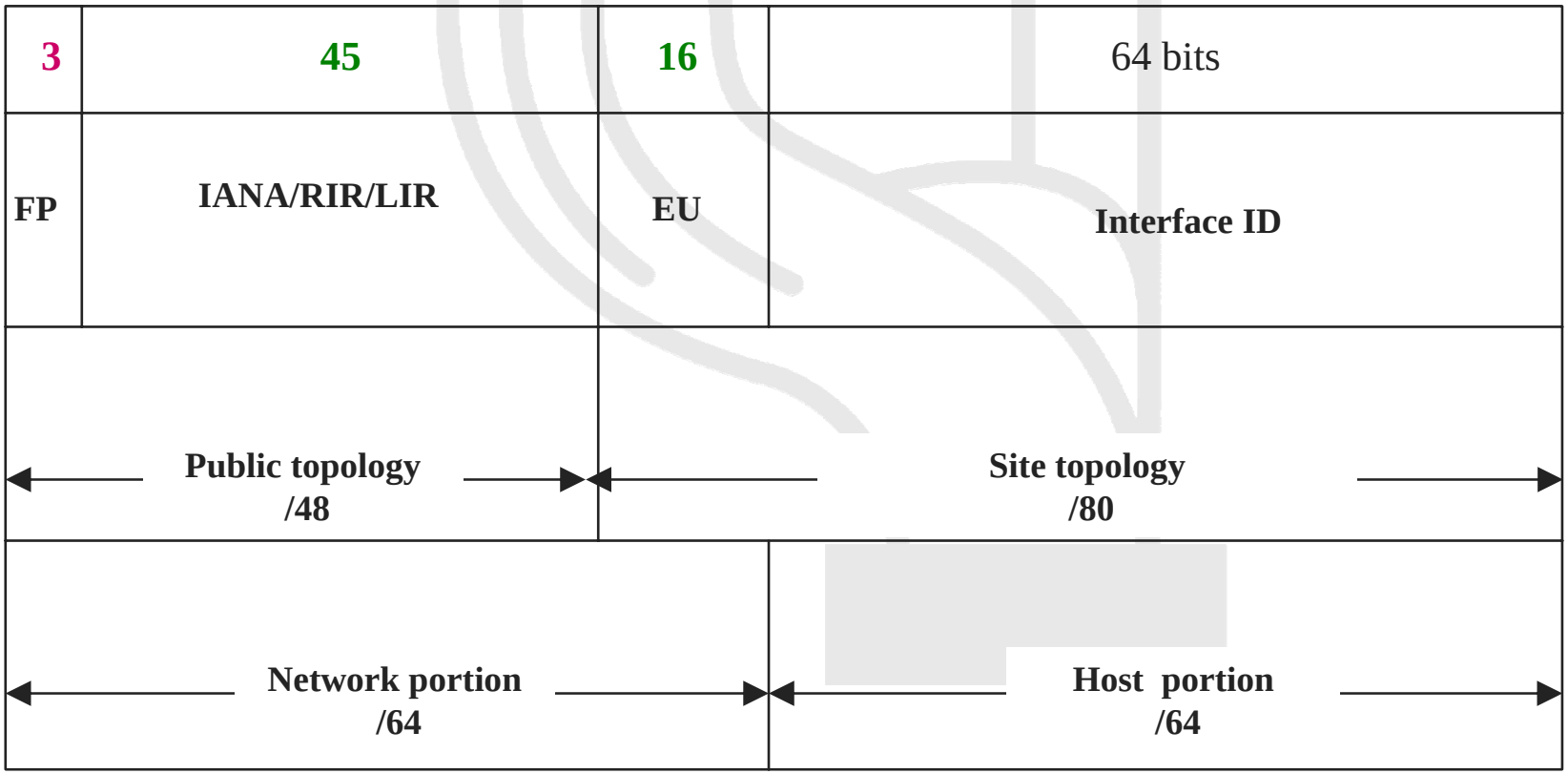
IPv6 Prefix	Binary Value		Assignment
2000::/16	0010 0000 0000 0000		Reserved
2001::/16	0010 0000 0000 0001		Global Unicast Assignments [RFC3513]
2002::/16	0010 0000 0000 0010		6to4 [RFC3056 et 3068]
2003::/18	0010 0000 0000 0011		RIPE NCC Global Unicast Assignments [RFC3513]
2400::/x			APNIC
2600::/x			ARIN
2A00::/x			RIPE NCC
3FFE::/16	001 1 1111 1111 1110	0x1FFE	6bone Testing [RFC2471]
3FFF::/16	001 1 1111 1111 1111	0x1FFF	Reserved

Production Addressing Scheme (3)

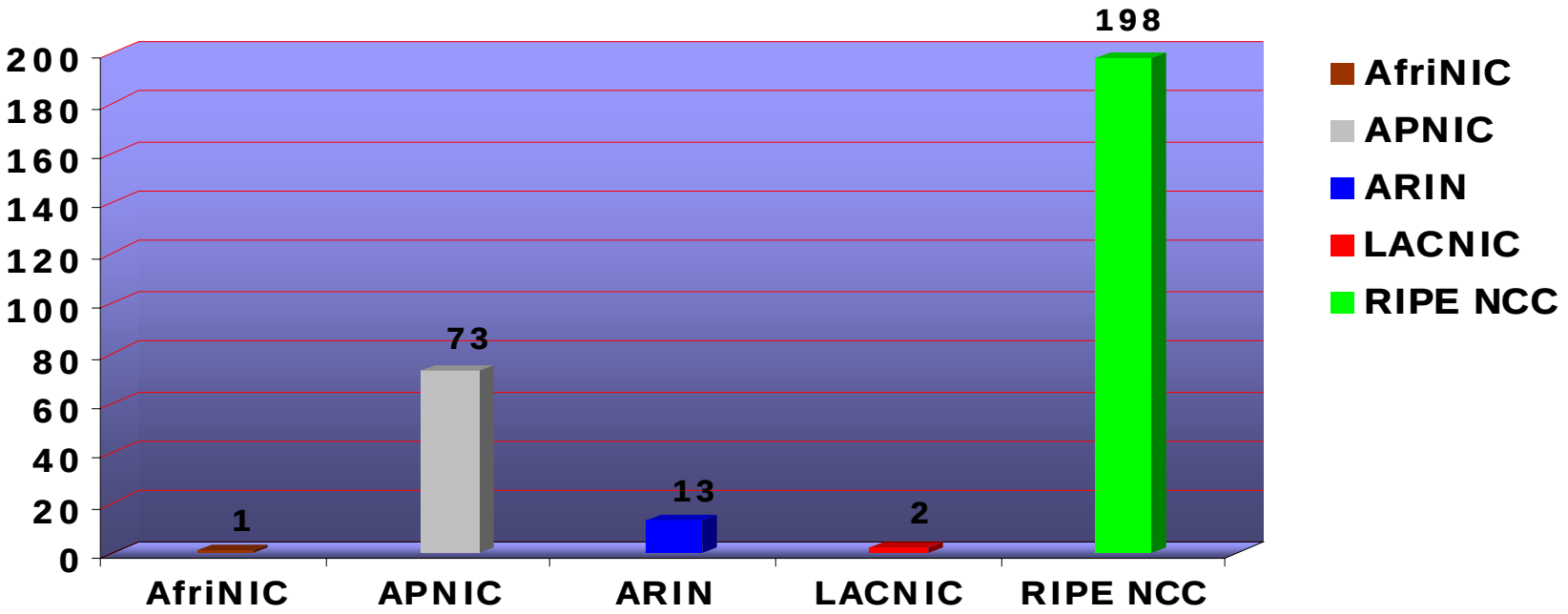
IPv6 Prefix sub-TLA	Binary Values	Allocated to	Date
2001:0000::/23	0000 000X XXXX X	IANA	Jul 99
2001:0200::/23	0000 001X XXXX X	APNIC	Jul 99
2001:0400::/23	0000 010X XXXX X	ARIN	Jul 99
2001:0600::/23	0000 011X XXXX X	RIPE NCC	Jul 99
2001:0800::/23	0000 100X XXXX X	RIPE NCC	May 02
2001:0A00::/23	0000 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.

Production Addressing Scheme (4)

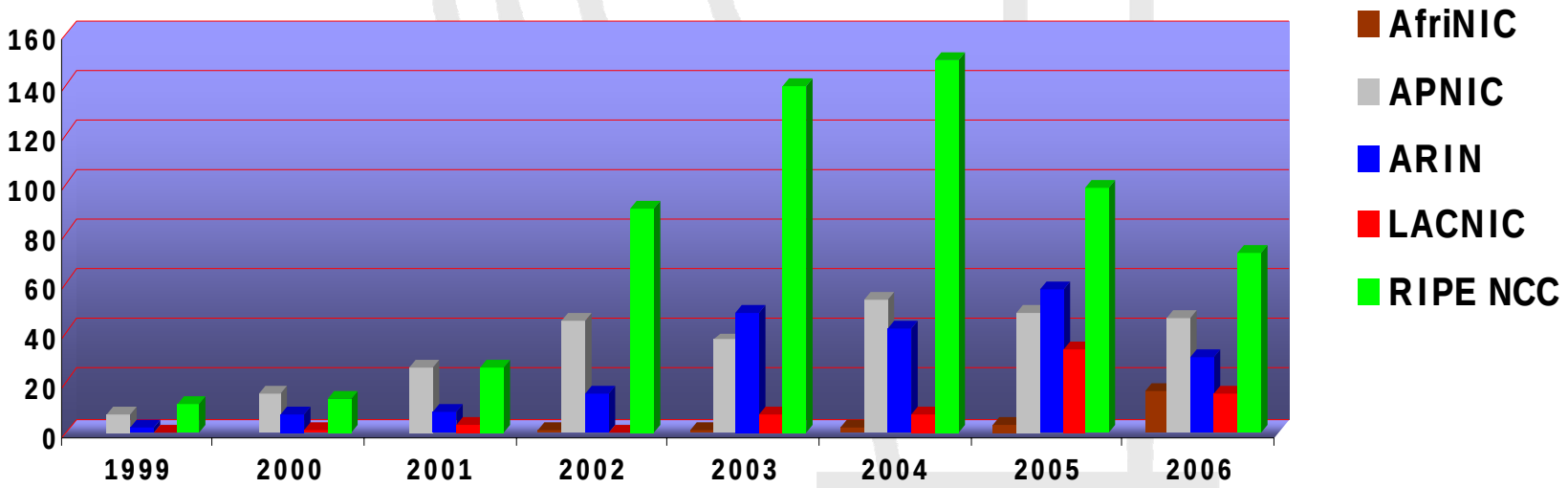


IANA IPv6 Allocations to RIRs*

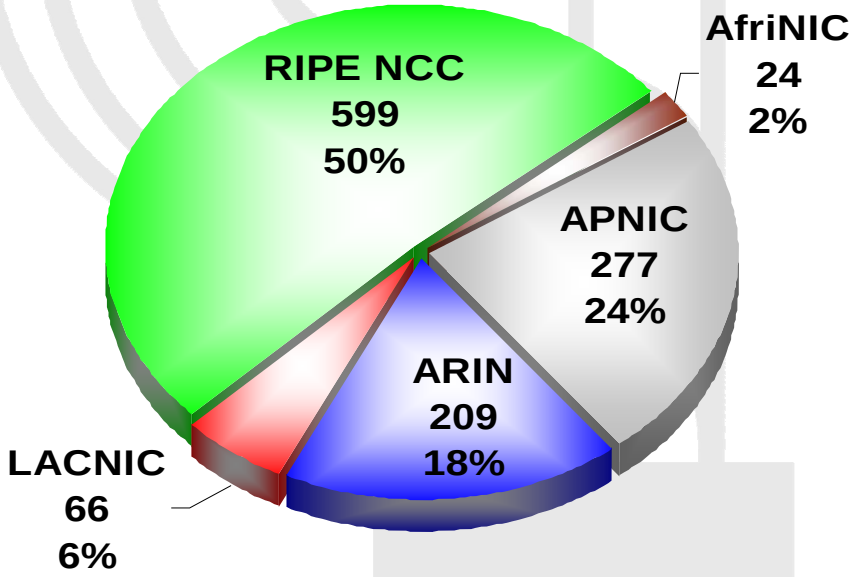


*number of /23s

IPv6 Allocations
RIRs to LIRs/ISPs
Yearly Comparison



IPv6 Allocations
RIRs to LIRs/ISPs
Cumulative Total (Jan 1999 – Sept 2006)



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.

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