IPV6 BASICS : PROTOCOL, ADDRESSING

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IPv6 Address Space

IPv4 32-bits

IPv6 128-bits

2^{32} = 4,294,967,296

2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456

$2^{128} = 2^{32} * 2^{96}$

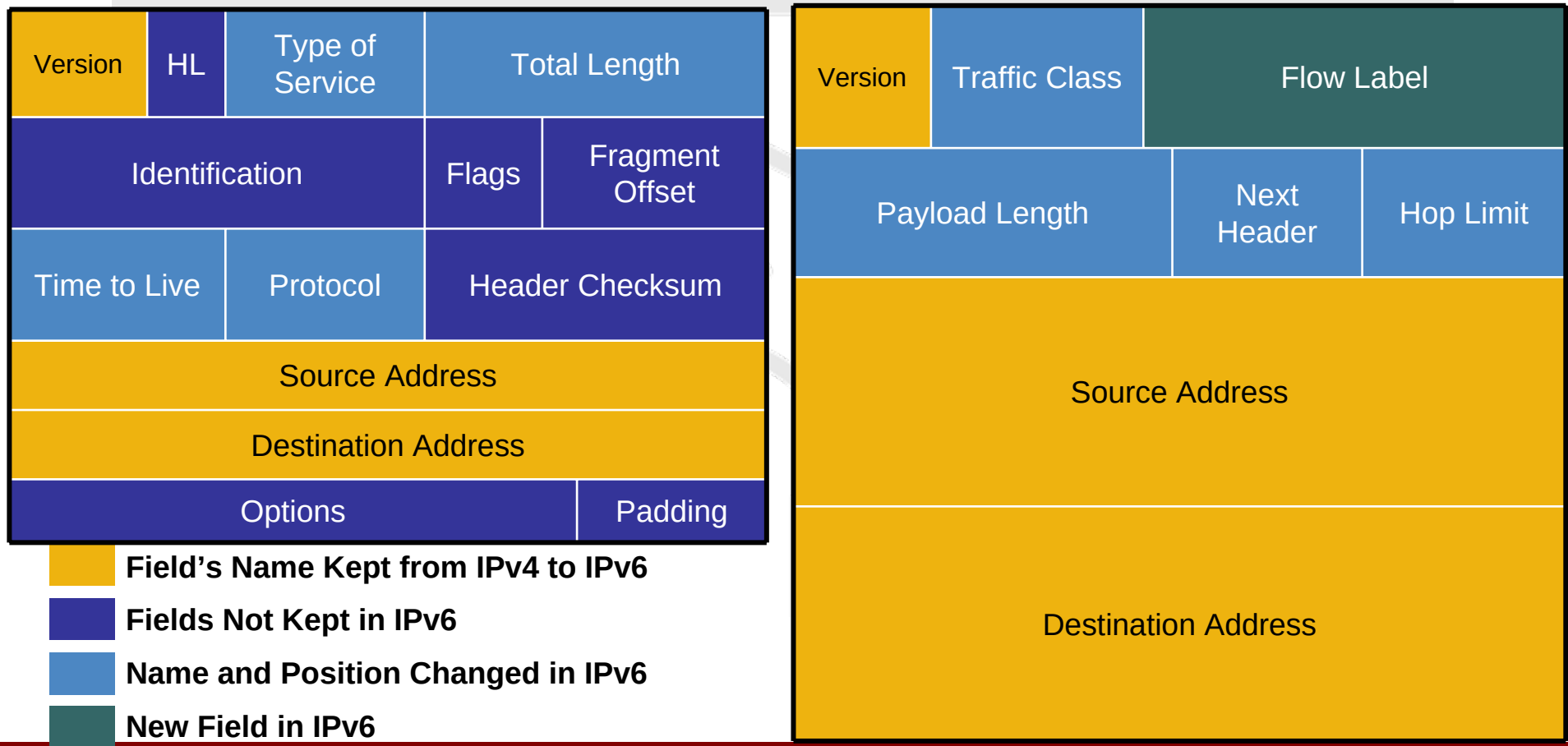
2^{96} = 79,228,162,514,264,337,593,543,950,336 times the number of possible IPv4 Addresses (79 trillion trillion)

IPv6 Header

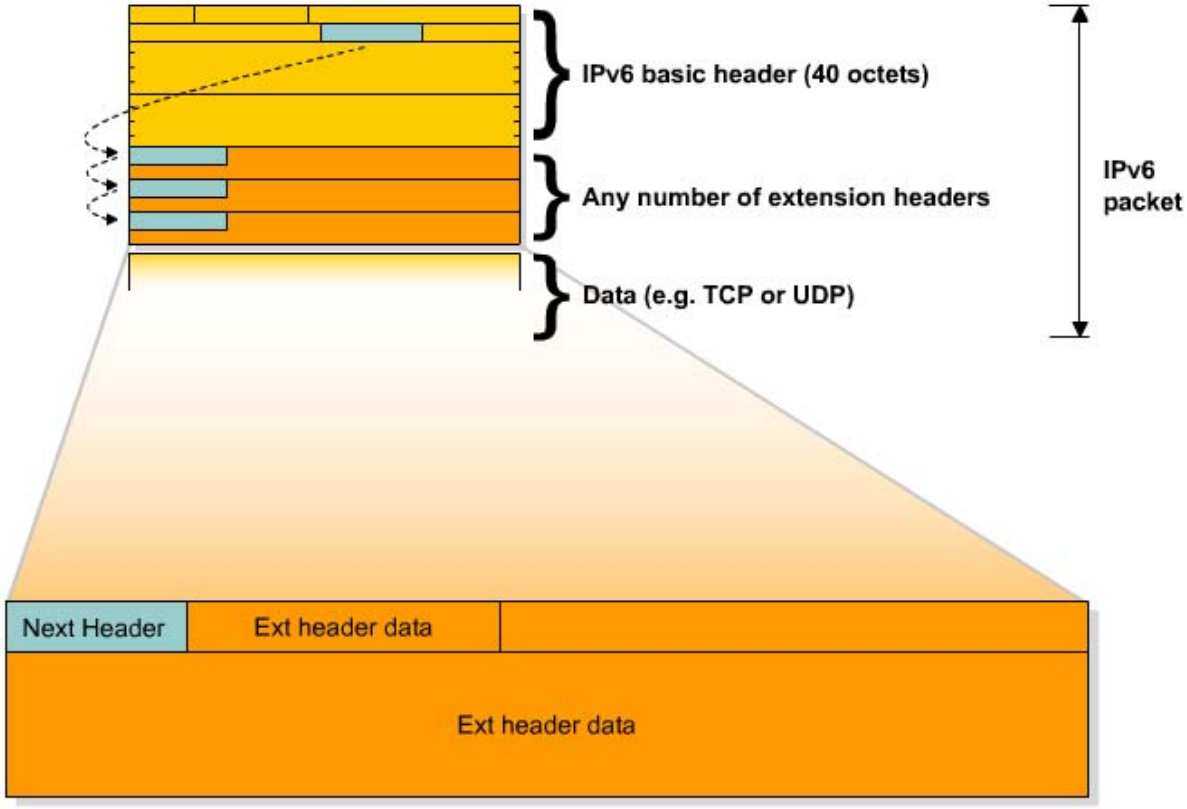
- The IPv6 header is redesigned.
- Minimize header overhead and reduce the header process for the majority of the packets.
- Less essential and optional fields are moved to extension headers

IPv6 and IPv4 headers are not *interoperable!*

IPv4 and IPv6 Header Comparison

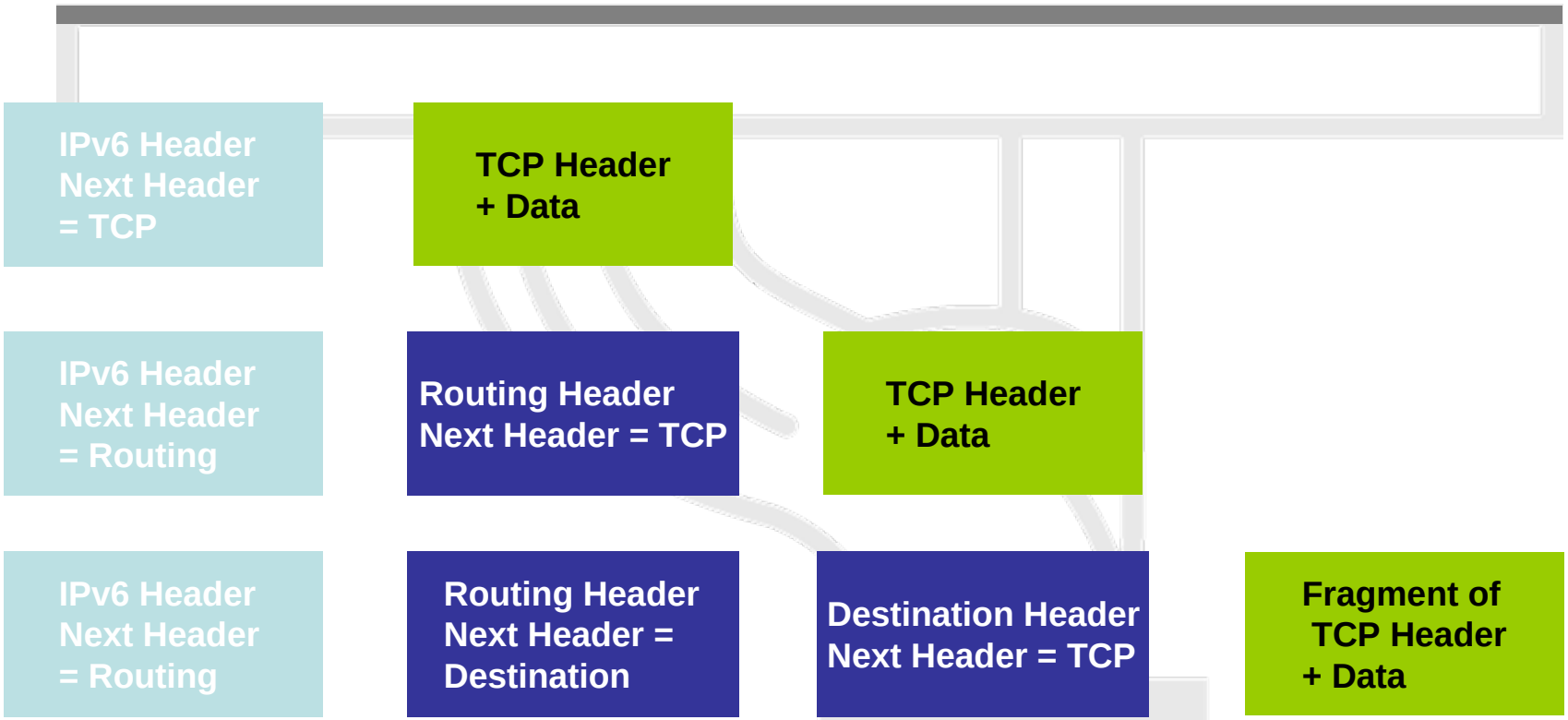


Extension Headers (RFC2460)



- **Processed only by node identified in IPv6 Destination Address field => much lower overhead than IPv4 options**
  - **exception: Hop-by-Hop Options header**
- **Eliminated IPv4's 40-octet limit on options**
  - **In IPv6, limit is total packet size, or Path MTU in some cases**

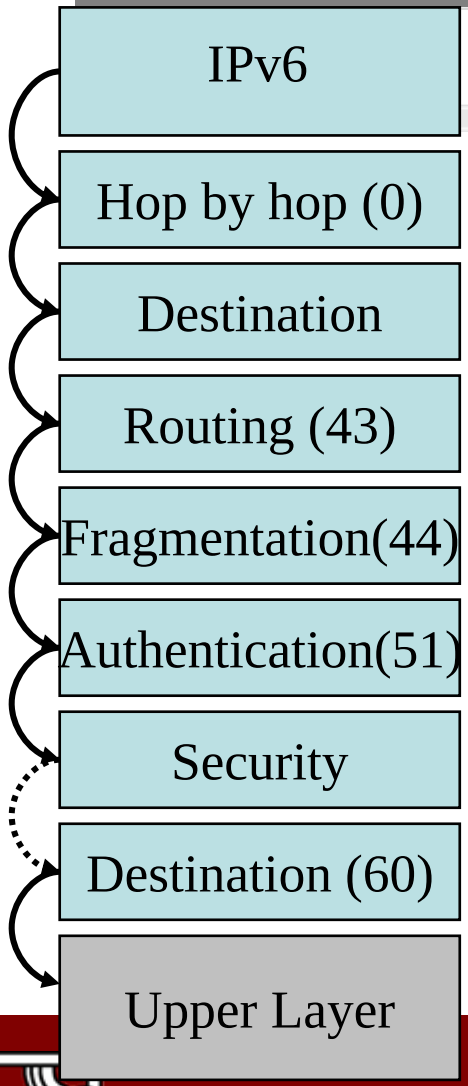
Extension Headers



Extension Headers Are Daisy Chained

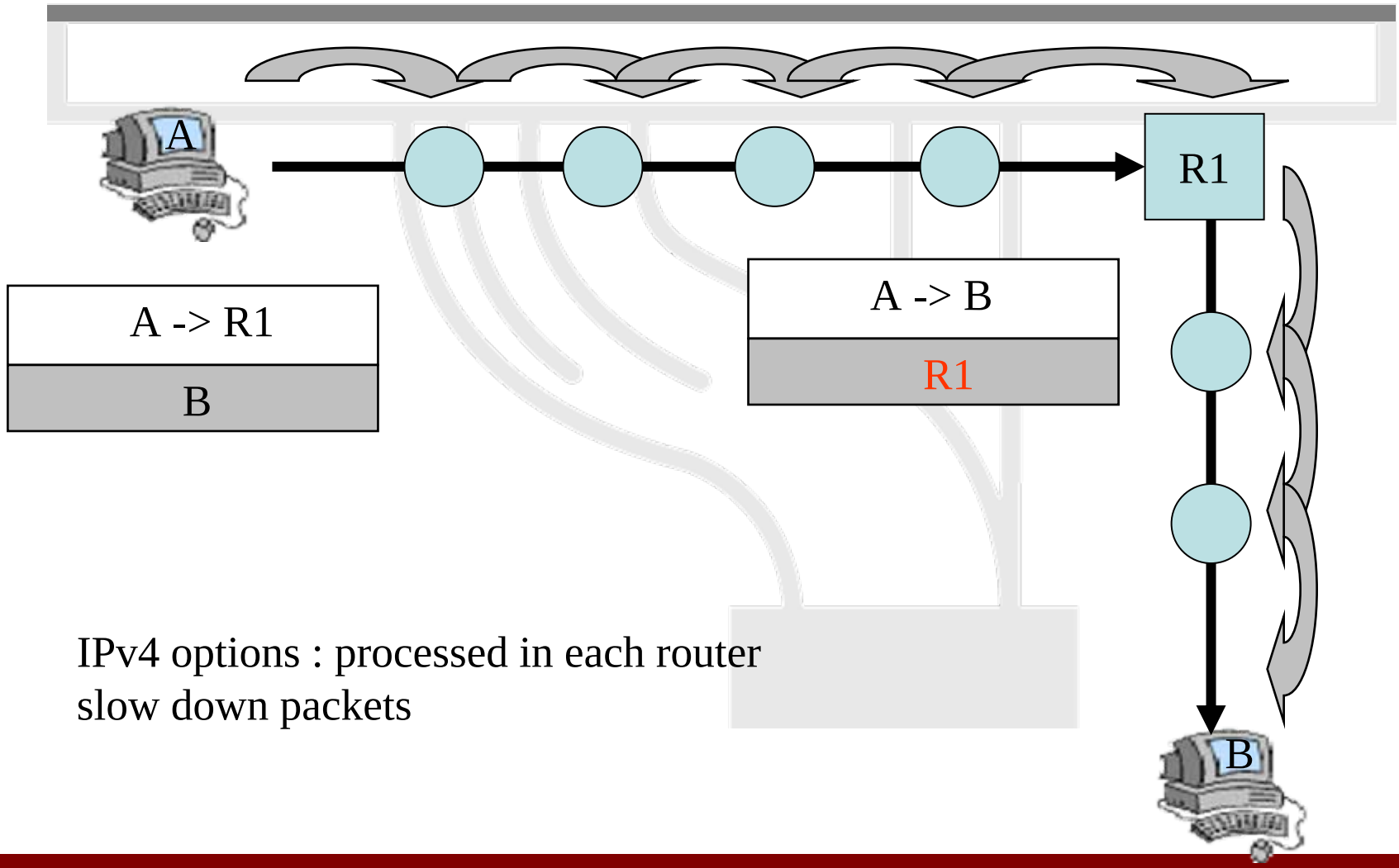
IPv6 extension headers: order is important

RFC 2460



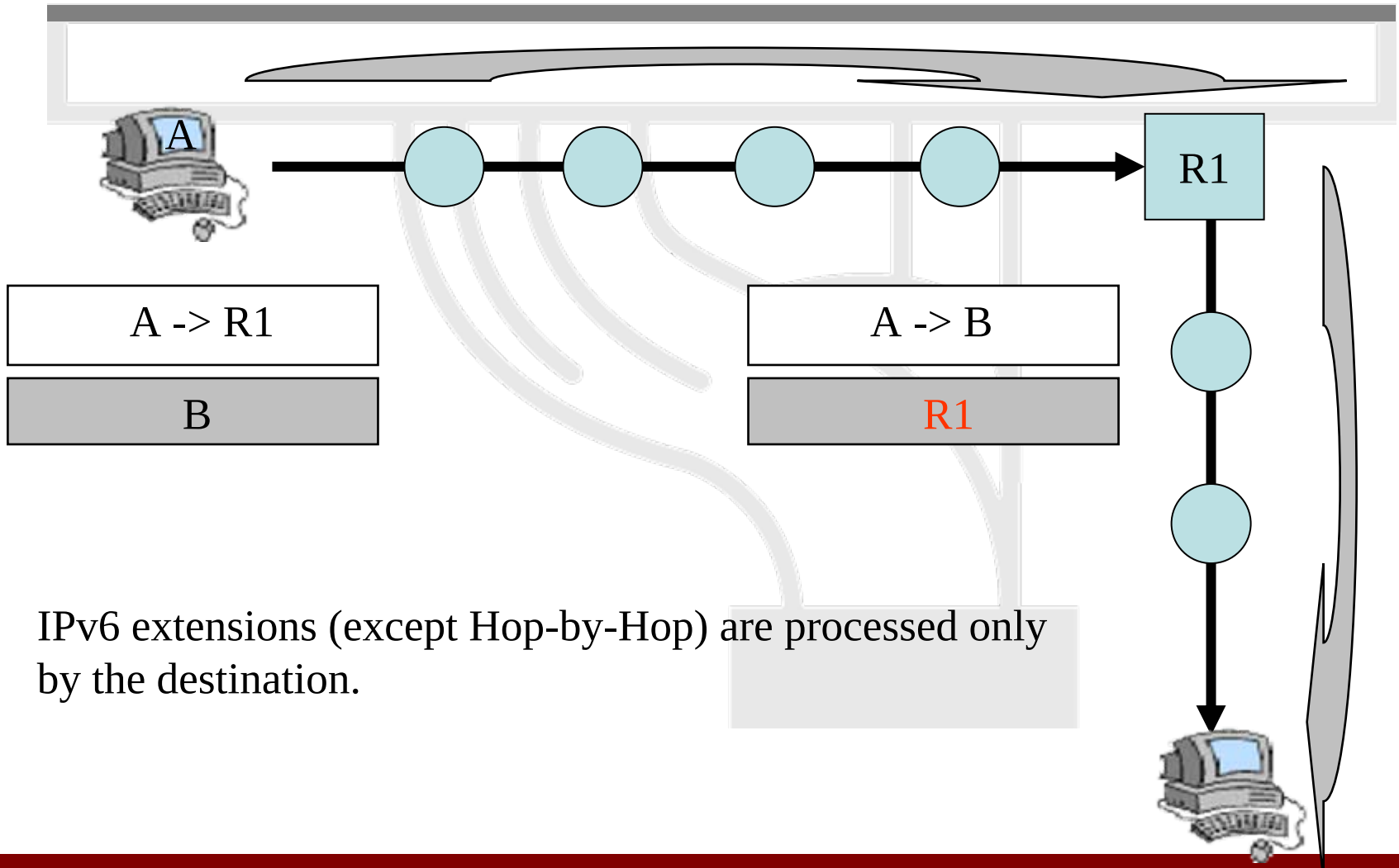
- Hop by hop (0): Processed by every router
- Destination: Processed by routers listed in Routing extension
- Routing (43): List of routers to cross
- Fragmentation(44): Processed by the destination
- Authentication(51): After reassembling the packet
- Security: Cipher the content of the remaining information
- Destination (60): Processed **only** by the destination

v4 options vs. v6 extensions



IPv4 options : processed in each router
slow down packets

v4 options vs. v6 extensions



IPv6 extensions (except Hop-by-Hop) are processed only by the destination.

IPv6 Address Representation (Example)

- Base format (16-byte)

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 Addressing

Prefix Representation

- Representation of prefix is just like CIDR [address prefix / prefix length]
- In this representation you attach the prefix length
  - IPv4 address: 198.10.0.0/16
  - IPv6 address: 3ef8:ca62:12FE::/48

IPv6 Address Representation

- **Loopback address representation**
  - 0:0:0:0:0:0:0:1=> ::1
  - Same as 127.0.0.1 in IPv4
  - Identifies self

- **Unspecified address representation**
  - 0:0:0:0:0:0:0:0=> ::
  - Used as a placeholder when no address available
  - (Initial DHCP request, Duplicate Address Detection DAD)

IPv6 Address Representation

- **IPv4 mapped**
  - 0:0:0:0:0::FFFF:IPv4 = ::FFFF:IPv4
  - 0:0:0:0:0:FFFF:192.168.30.1 = ::FFFF:C0A8:1E01
- **IPv4 compatible**
  - 0:0:0:0:0:0:IPv4 = ::IPv4
  - 0:0:0:0:0:0:192.168.30.1 = ::192.168.30.1 = ::C0A8:1E01

IPv6 Addressing Architecture

- IPv6 Addressing rules are covered by multiples RFC's
  - –Architecture initially defined by RFC 2373
  - –Now RFC rfc4291.txt (obsoletes 3513 which obsoletes RFC 2373)
- Address Types are :
  - –Unicast : One to One (Global, Link local, Site local, Compatible)
  - –Anycast : One to Nearest (Allocated from Unicast)
  - –Multicast : One to Many
- A single interface may be assigned multiple IPv6 addresses of any type (unicast, anycast, multicast)

IPv6 - Addressing Model

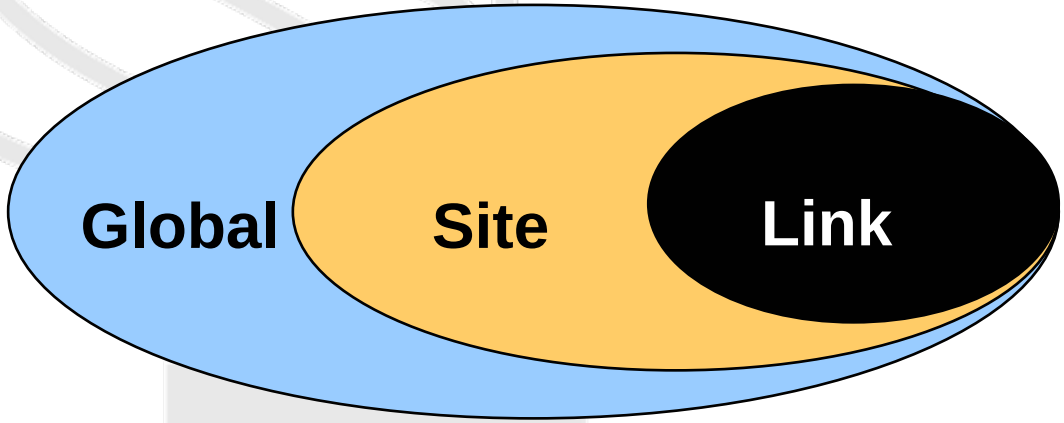
Addresses are assigned to interfaces

change from IPv4 model :

Interface 'expected' to have multiple addresses

Addresses have scope

- **Link Local**
- **Site Local**
- **Global**

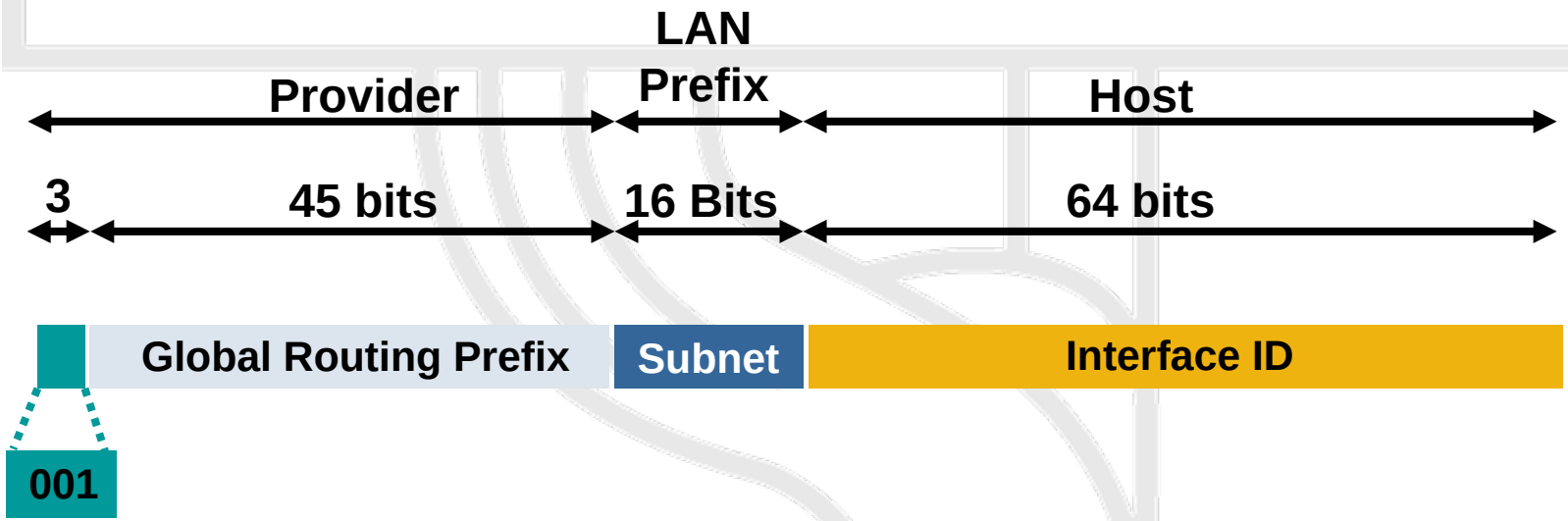


Addresses have lifetime

- **Valid and Preferred lifetime**

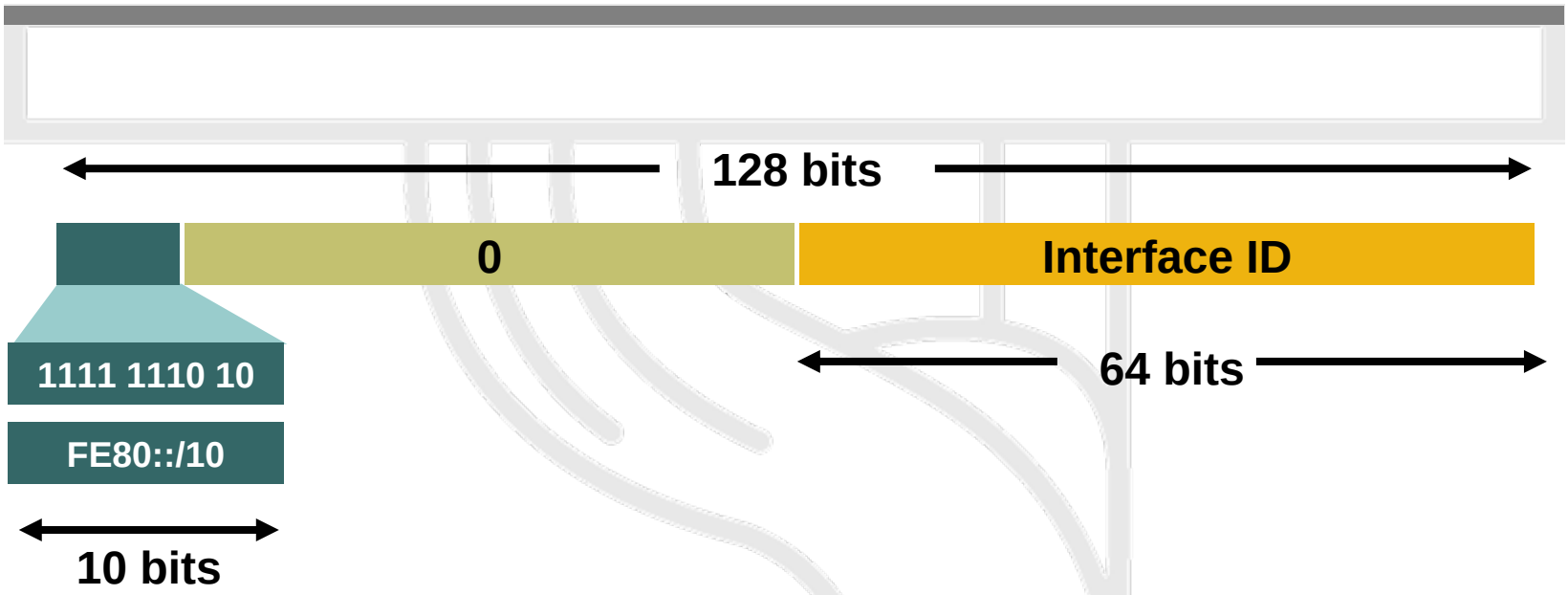
Site-Local Address Deprecated in RFC 3879 now it is Unique Local Address (ULA) RFC 4193

Aggregatable Global Unicast Addresses



- Aggregatable global unicast addresses are:
  - Addresses for generic use of IPv6
  - Structured as a hierarchy to keep the aggregation
- See RFC 4291

Link-Local



- Link-local addresses:
  - Have a limited scope of the link
  - Are automatically configured with the interface ID

Link-Local

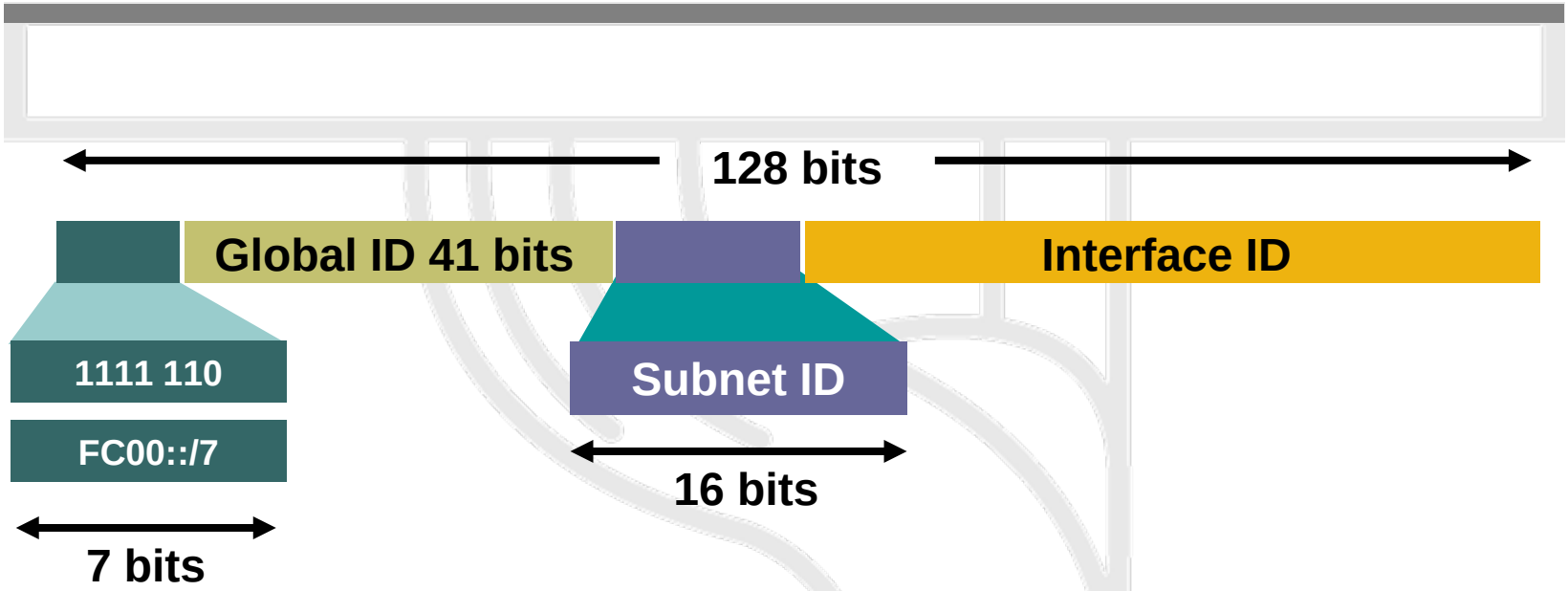
Aggregatable Address

2001::4:	204:9AFF:FEAC:7D80

Link-Local Address

FE80:0:0:0	204:9AFF:FEAC:7D80

Unique-Local

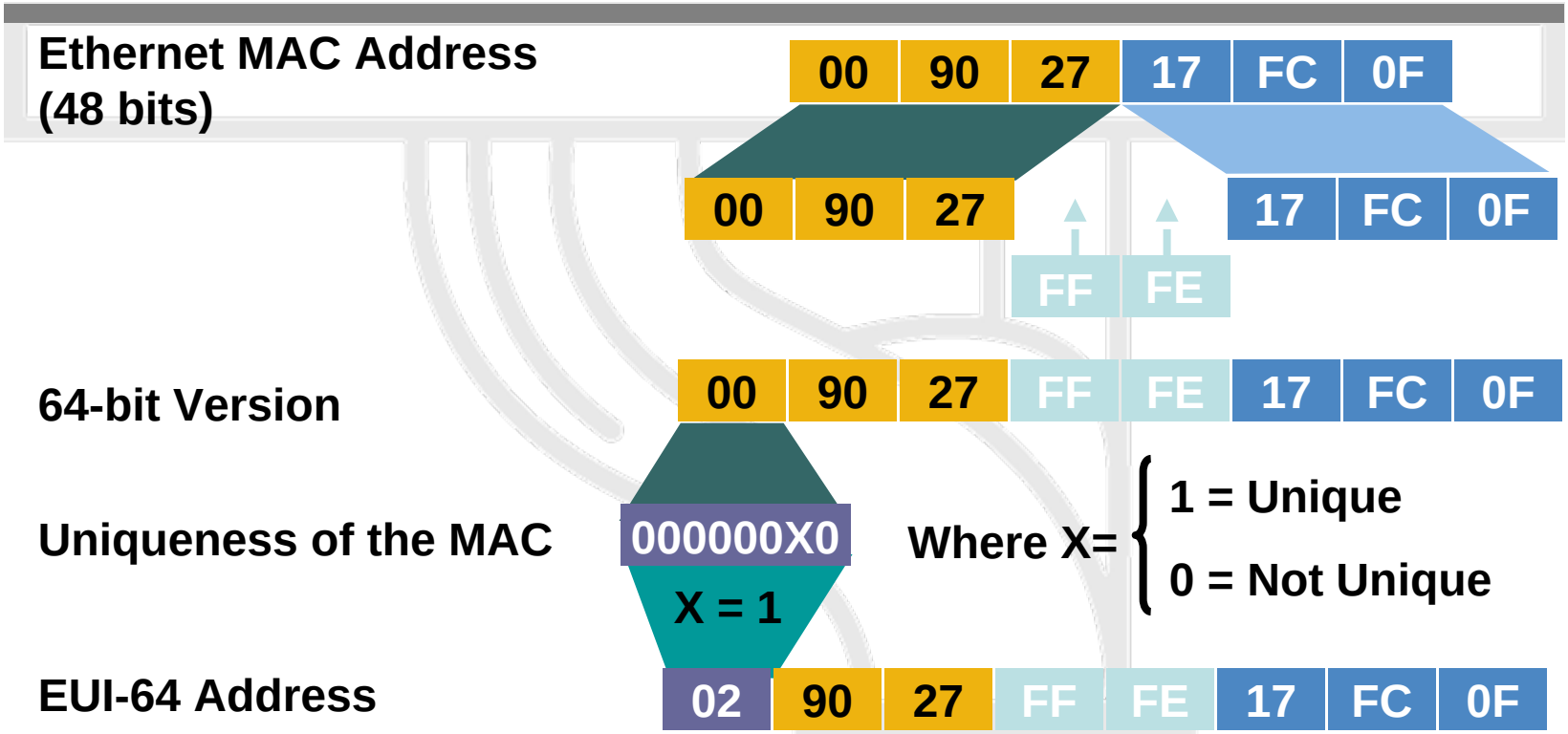


- Unique-local addresses used for:
  - Local communications
  - Inter-site VPNs
  - Not routable on the Internet

Aggregatable Global Unicast Addresses

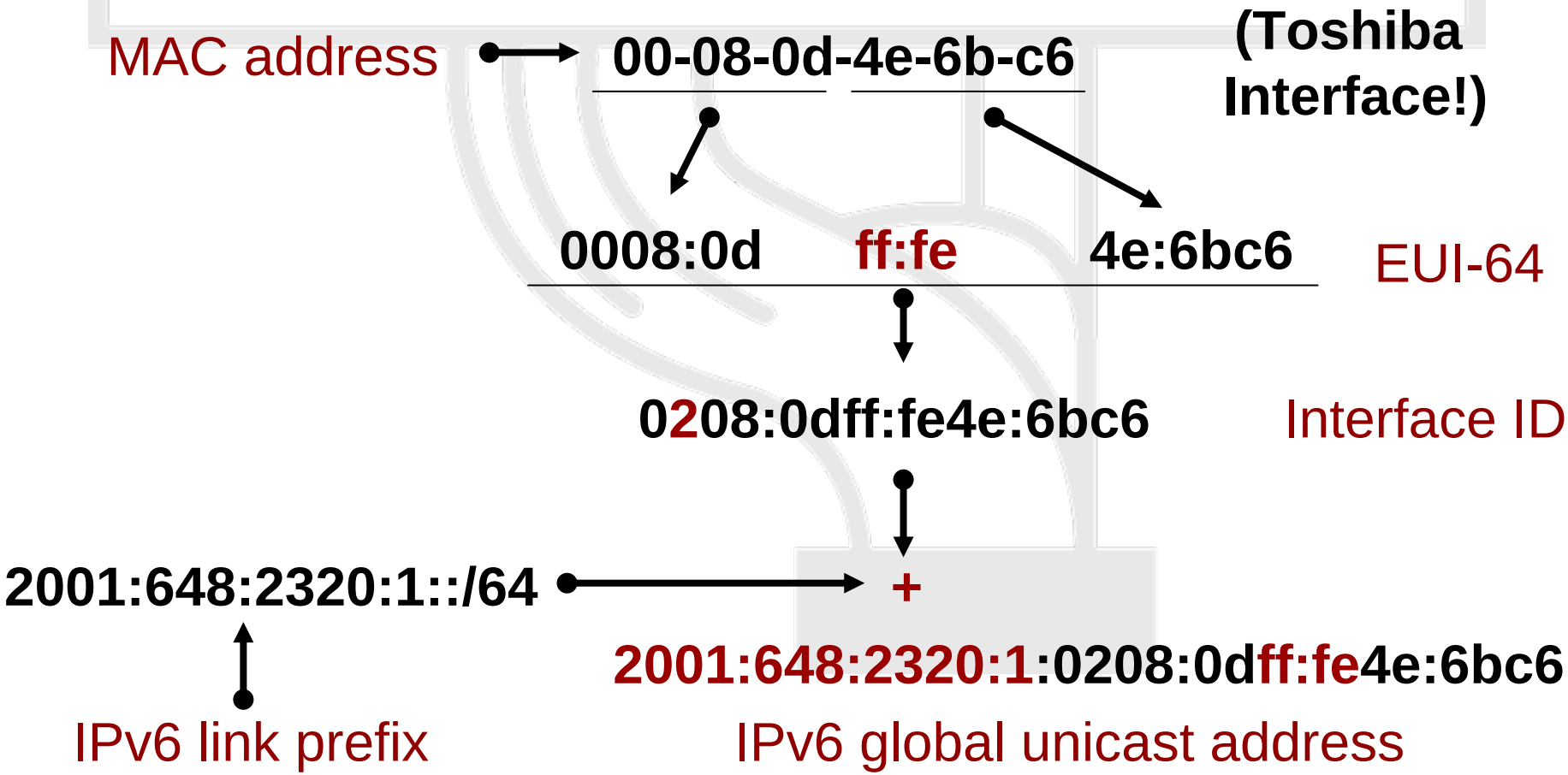
- Lowest-order 64-bit field of unicast addresses may be assigned in several different ways:
  - Manually configured
  - Auto-configured from a 64-bit EUI-64, or expanded from a 48-bit MAC address (e.g. Ethernet address)
  - Auto-generated pseudo-random number (to address privacy concerns)
  - Assigned via DHCP

EUI-64



- EUI-64 address is formed by inserting "FFFE" and ORing a bit identifying the uniqueness of the MAC address

Interface Identifier: Example



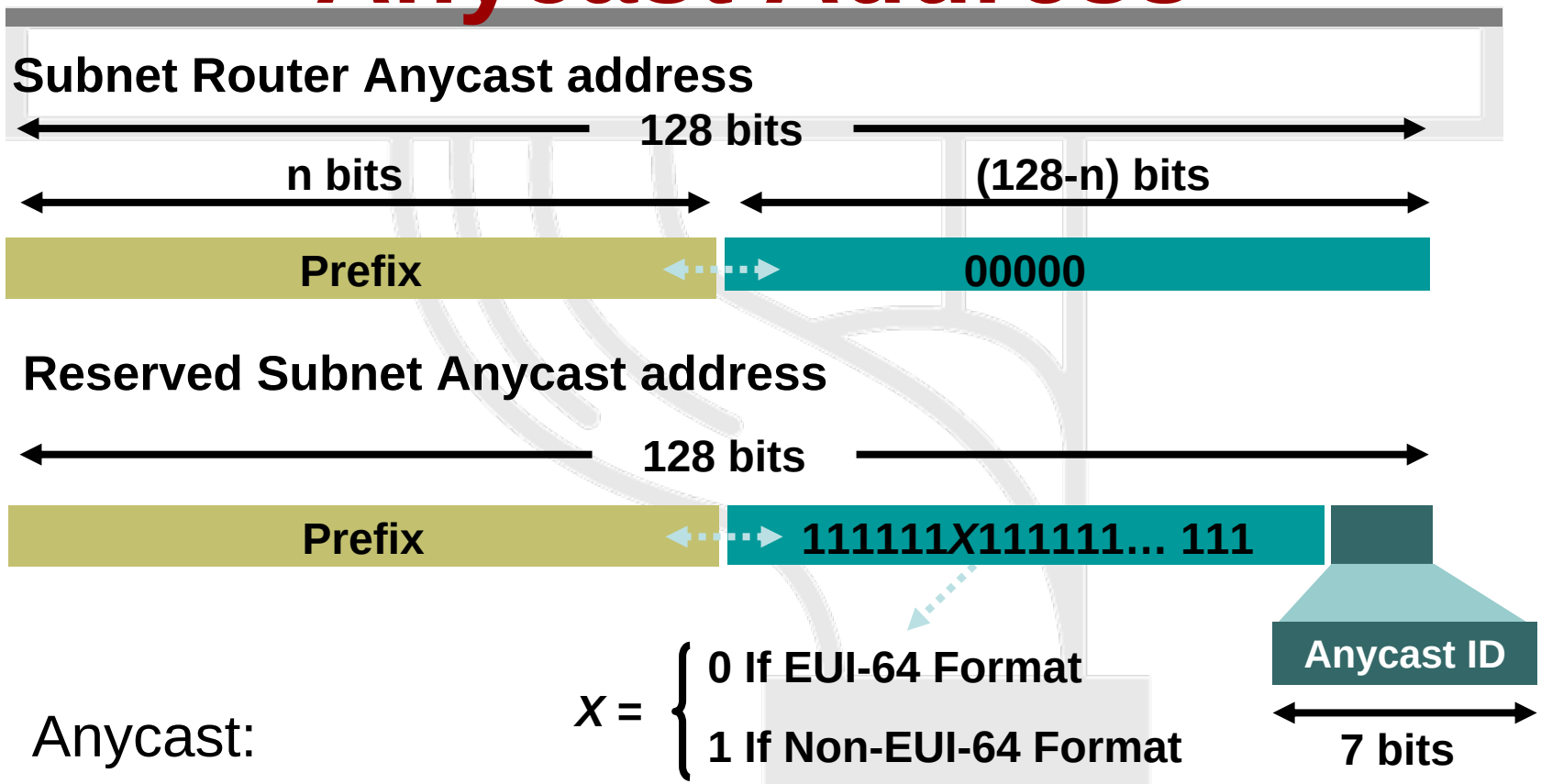
Anycast Addresses (RFC 3513)

- «Anycast addresses allow a packet to be **routed to one of a number** of different nodes all responding to the same address »
- «Anycast addresses are taken from the unicast address spaces (of any scope) and are not syntactically distinguishable from unicast addresses … it may be assigned to an IPv6 router only »

Anycast Addresses (RFC 3513)

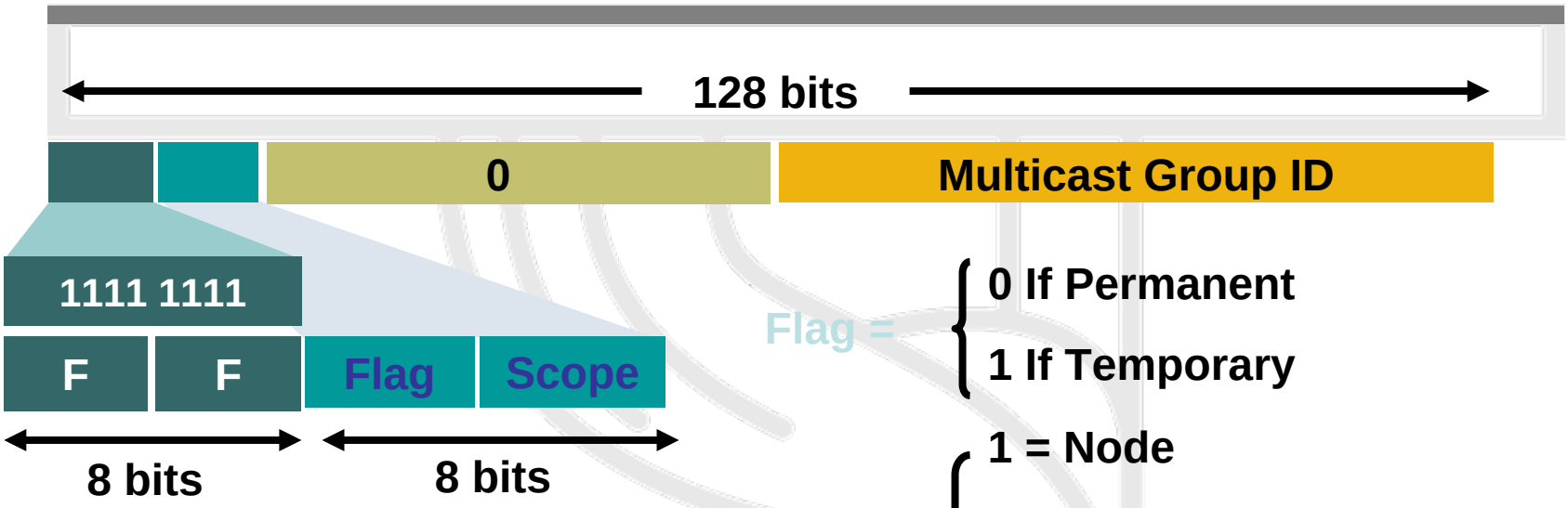
- Anycast address …
  - … can not be a used as a source address of an IPv6 packet
  - … must be assigned only to routers
- Reserved anycast addresses are defined in RFC 2526

Anycast Address



- Anycast:
  - Syntactical the same as a Unicast address
  - Is one-to-nearest type of address
  - Has a current limited use

Multicast



- Multicast is used in the context of one-to-many
- A multicast scope is new in IPv6