



IPV6 BASICS : PROTOCOL, ADDRESSING

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IPv6 Address Space

IPv4 32-bits

IPv6 128-bits

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

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

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

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



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

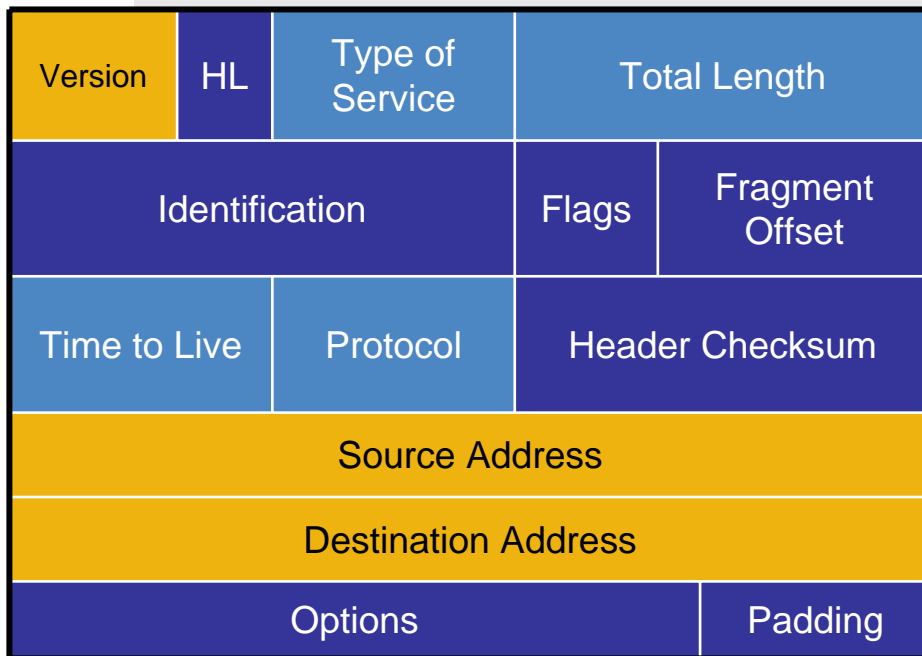
IPv6 and IPv4 headers are not *interoperable!*



IPv4 and IPv6 Header Comparison

IPv4 Header

IPv6 Header



 Field's Name Kept from IPv4 to IPv6

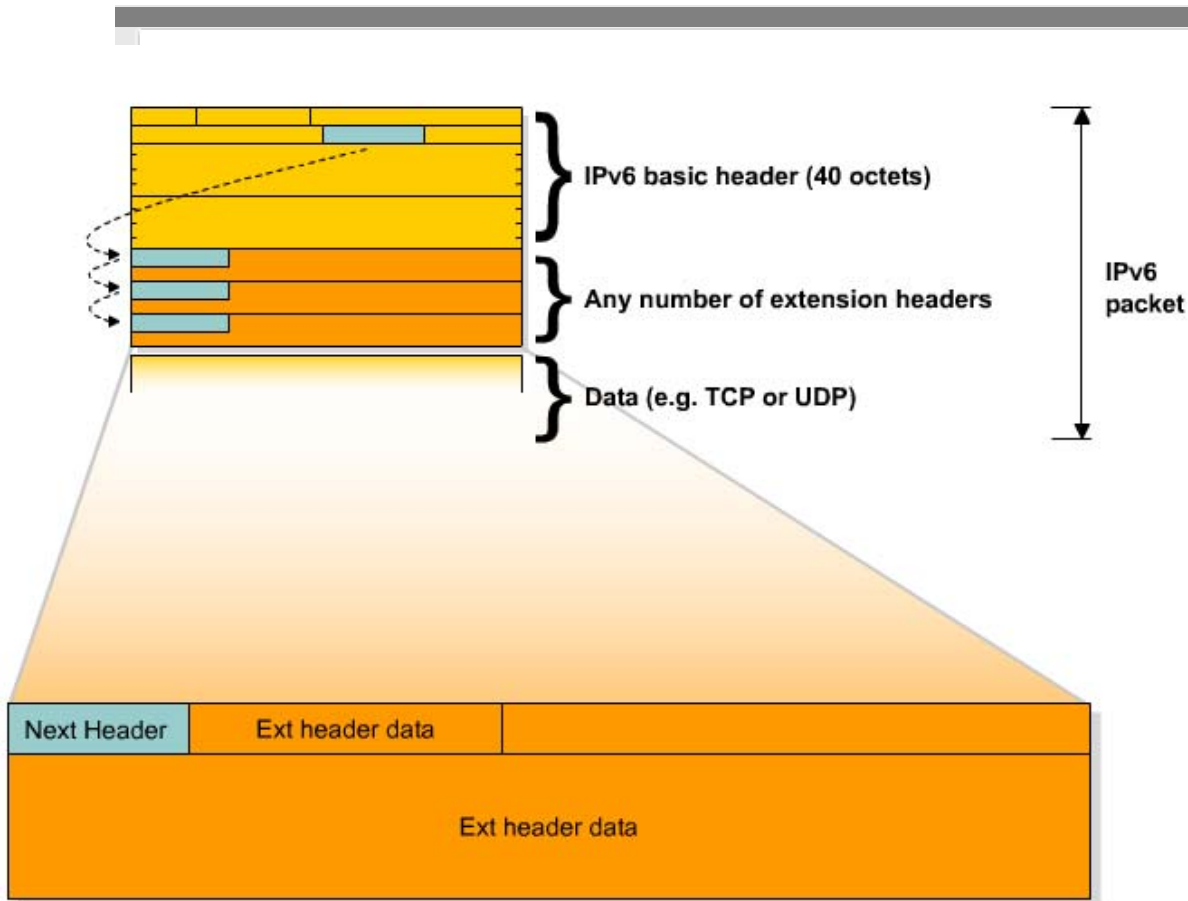
 Fields Not Kept in IPv6

 Name and Position Changed in IPv6

 New Field in IPv6



Extension Headers (RFC2460)



- Processed only by node identified in IPv6 Destination Address field => much lower overhead than IPv4 options

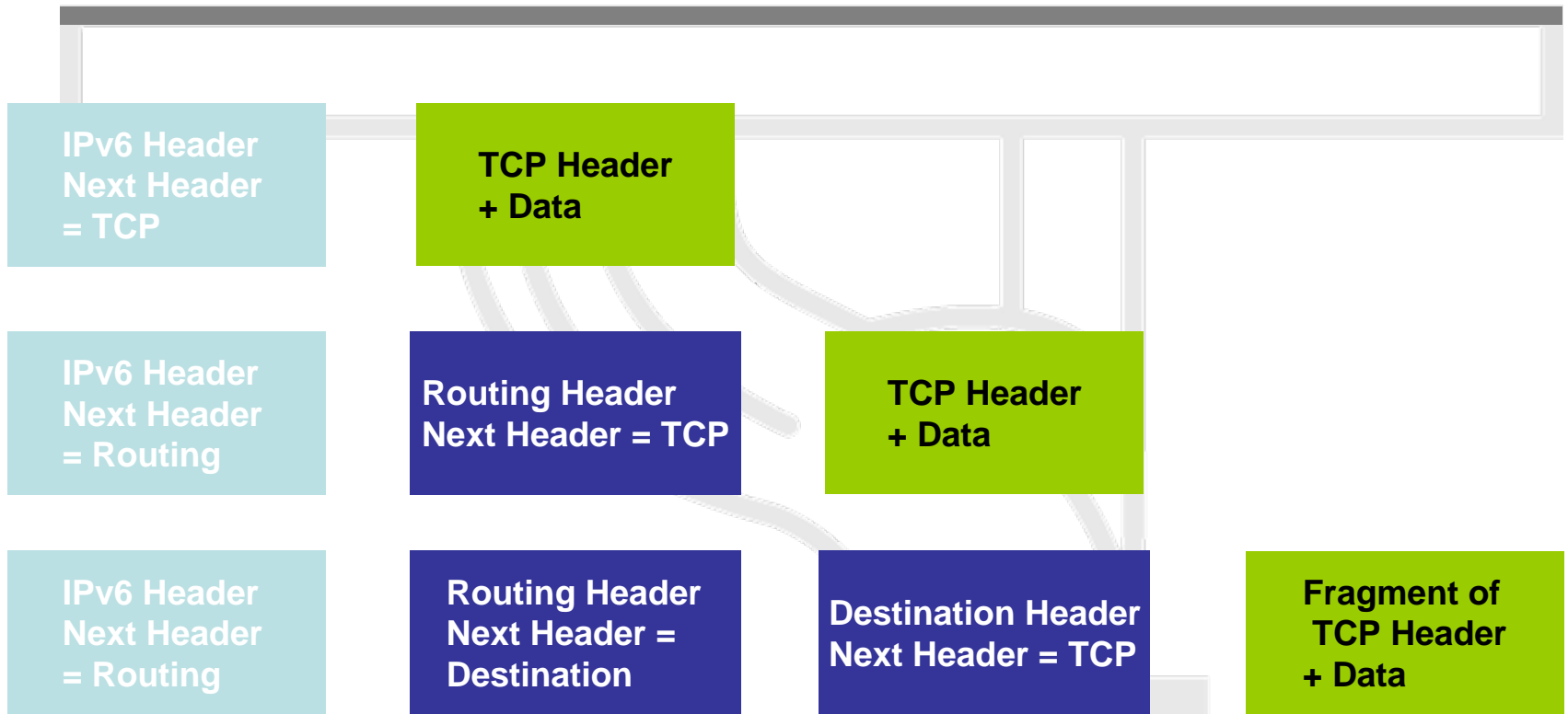
exception: Hop-by-Hop Options header

- Eliminated IPv4's 40-octet limit on options

In IPv6, limit is total packet size, or Path MTU in some cases



Extension Headers

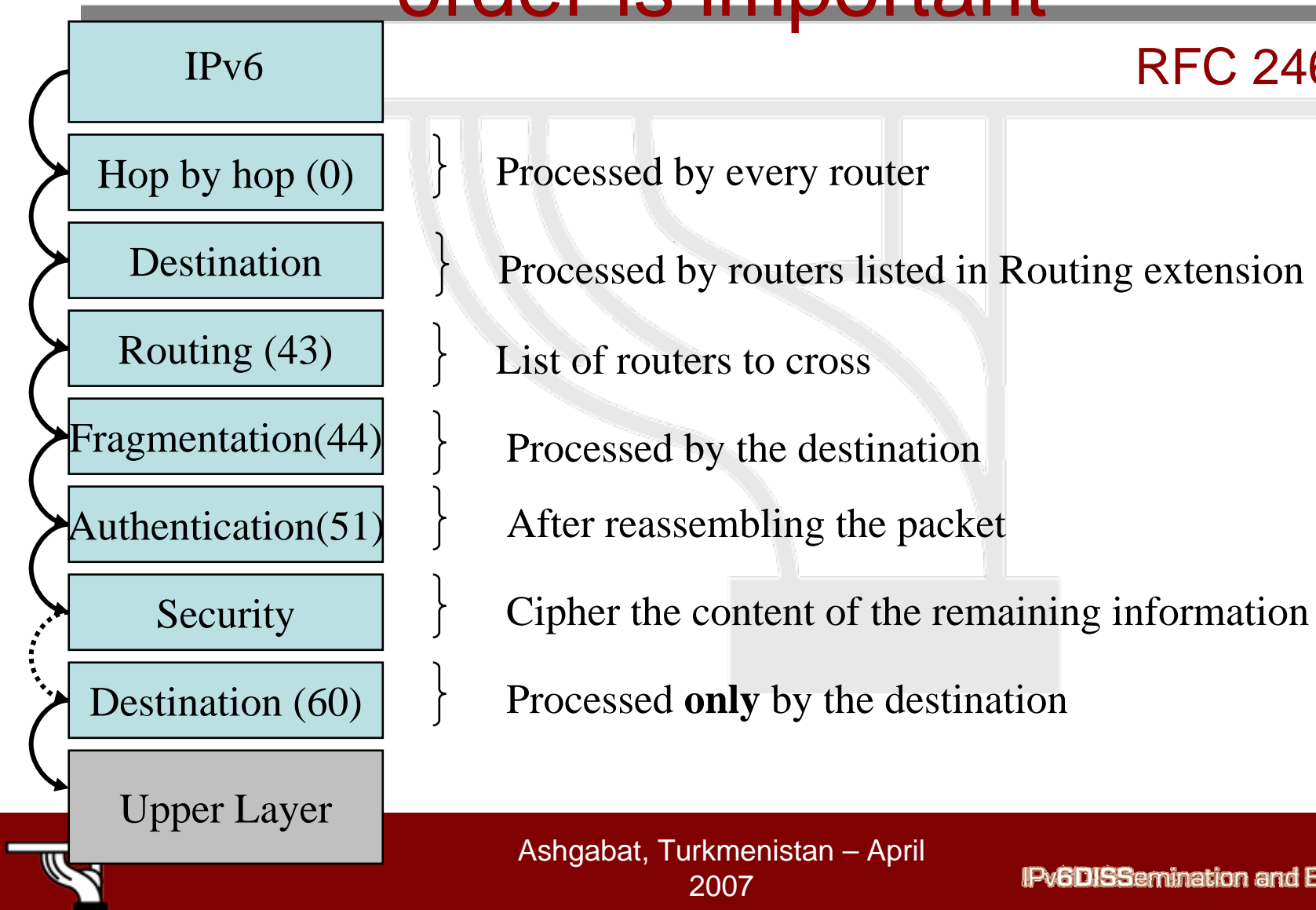


Extension Headers Are Daisy
Chained

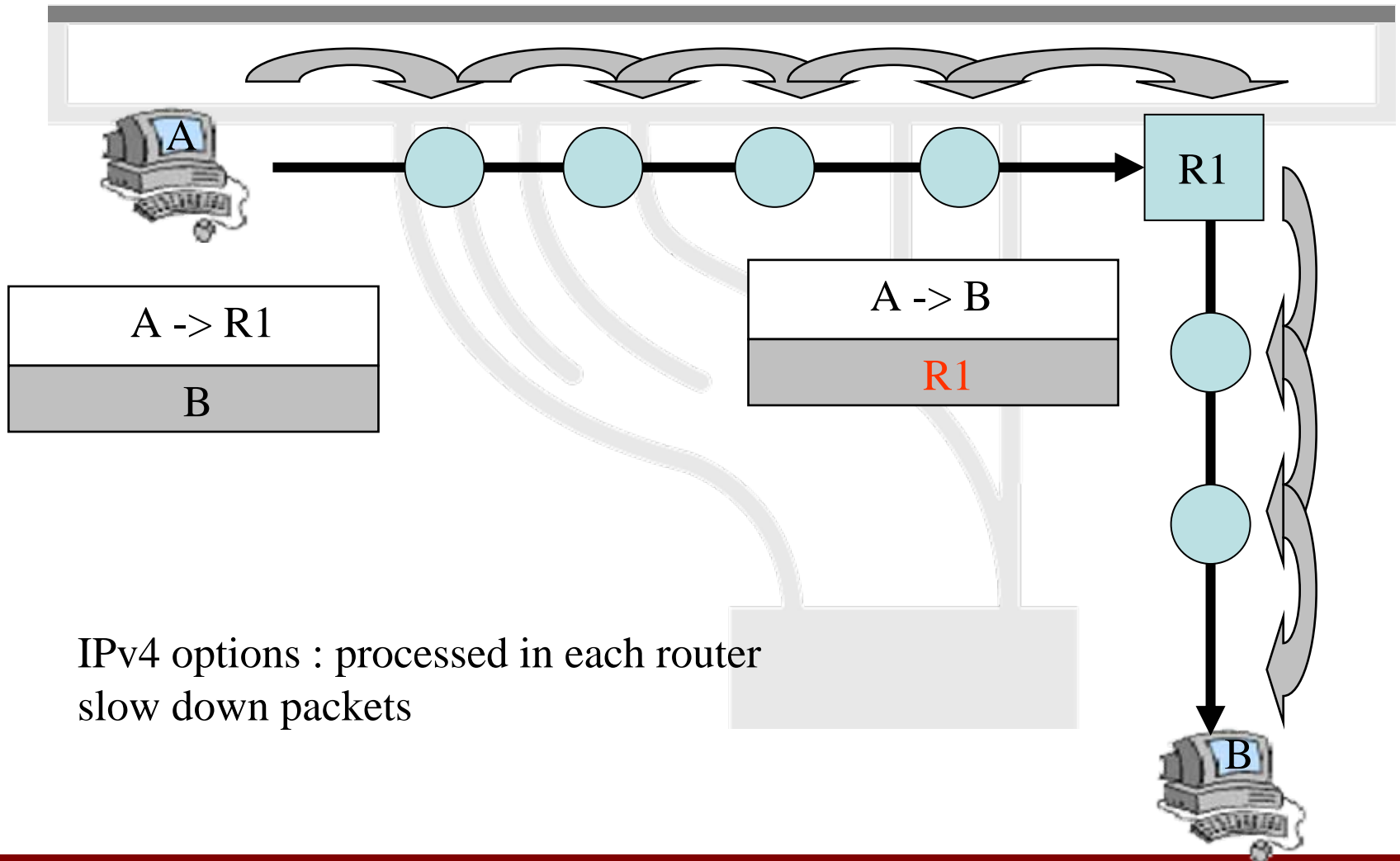


IPv6 extension headers: order is important

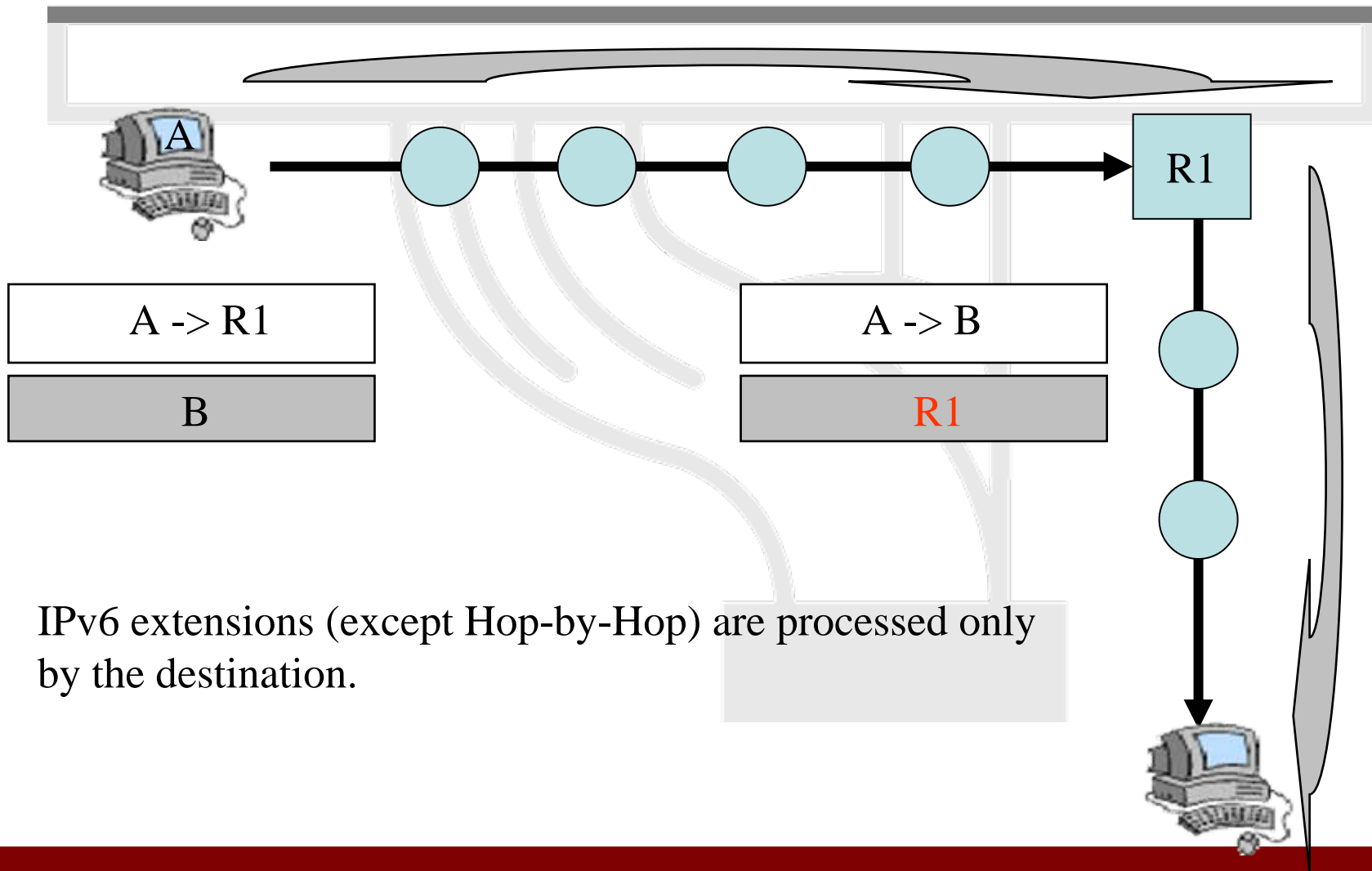
RFC 2460



v4 options vs. v6 extensions



v4 options vs. v6 extensions



IPv6 Address Representation (Example)

- Base format (16-byte)

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

- Compact Format:

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

- Literal 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**

- $0:0:0:0:0:0:0:1 \Rightarrow ::1$
- Same as 127.0.0.1 in IPv4
- Identifies self

- **Unspecified address representation**

- $0:0:0:0:0:0:0:0 \Rightarrow ::$
- 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 :

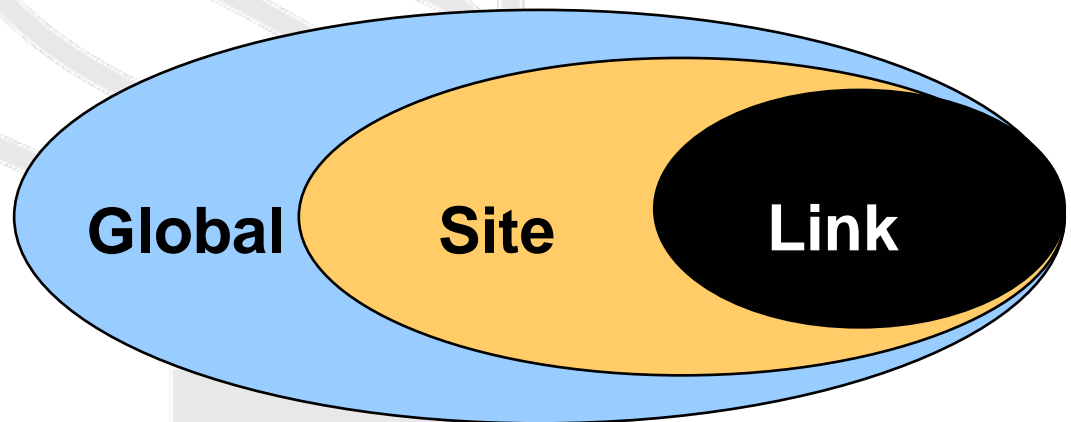
Interface 'expected' to have multiple addresses

Addresses have scope

Link Local

Site Local

Global



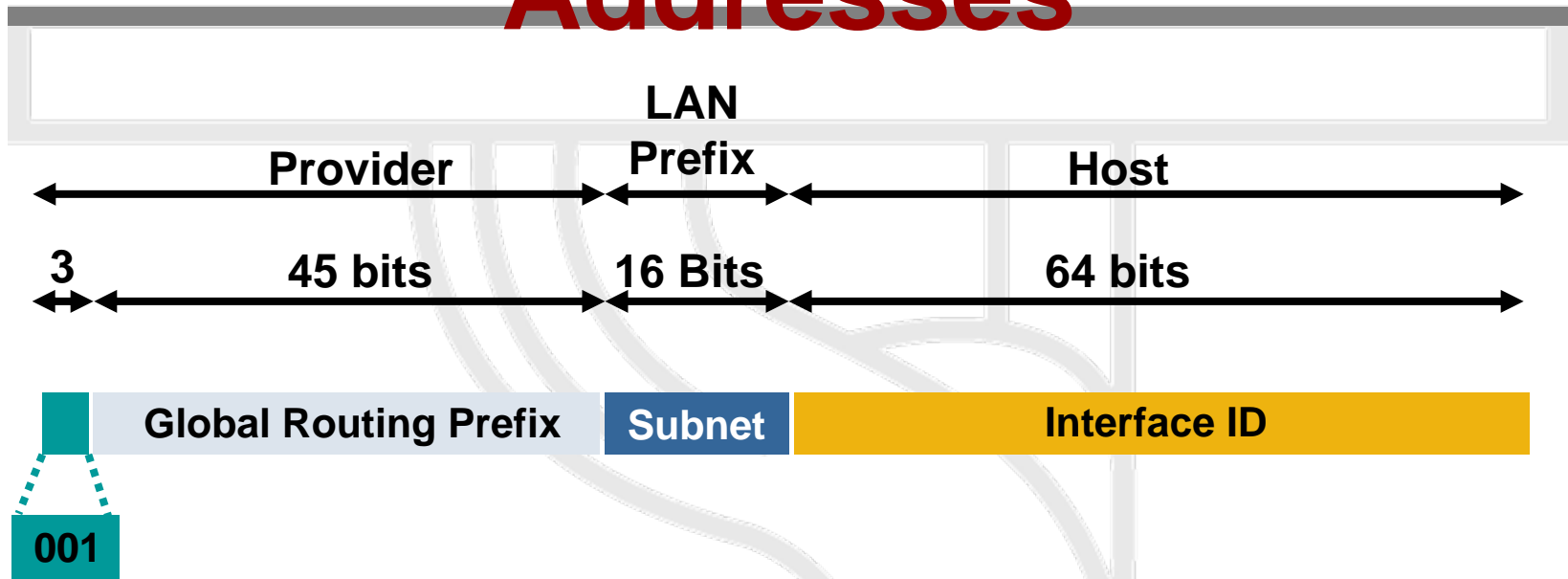
Addresses have lifetime

Valid and Preferred lifetime

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



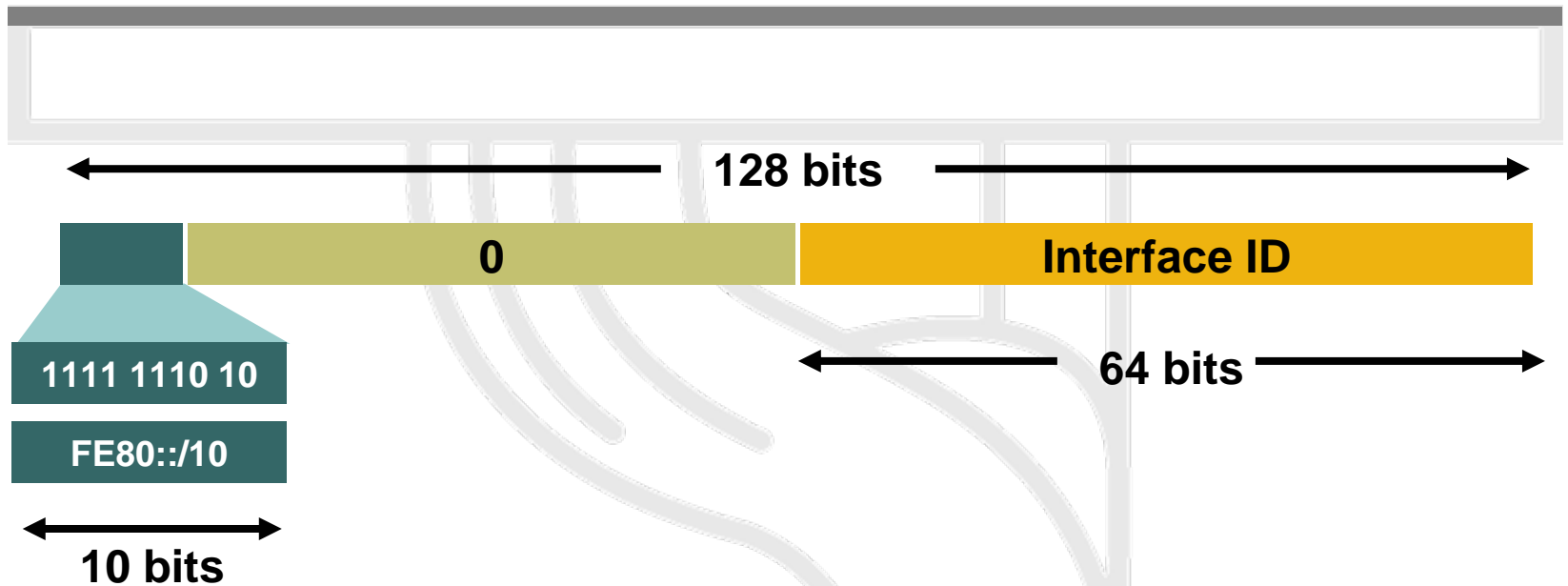
Aggregatable Global Unicast Addresses



- 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

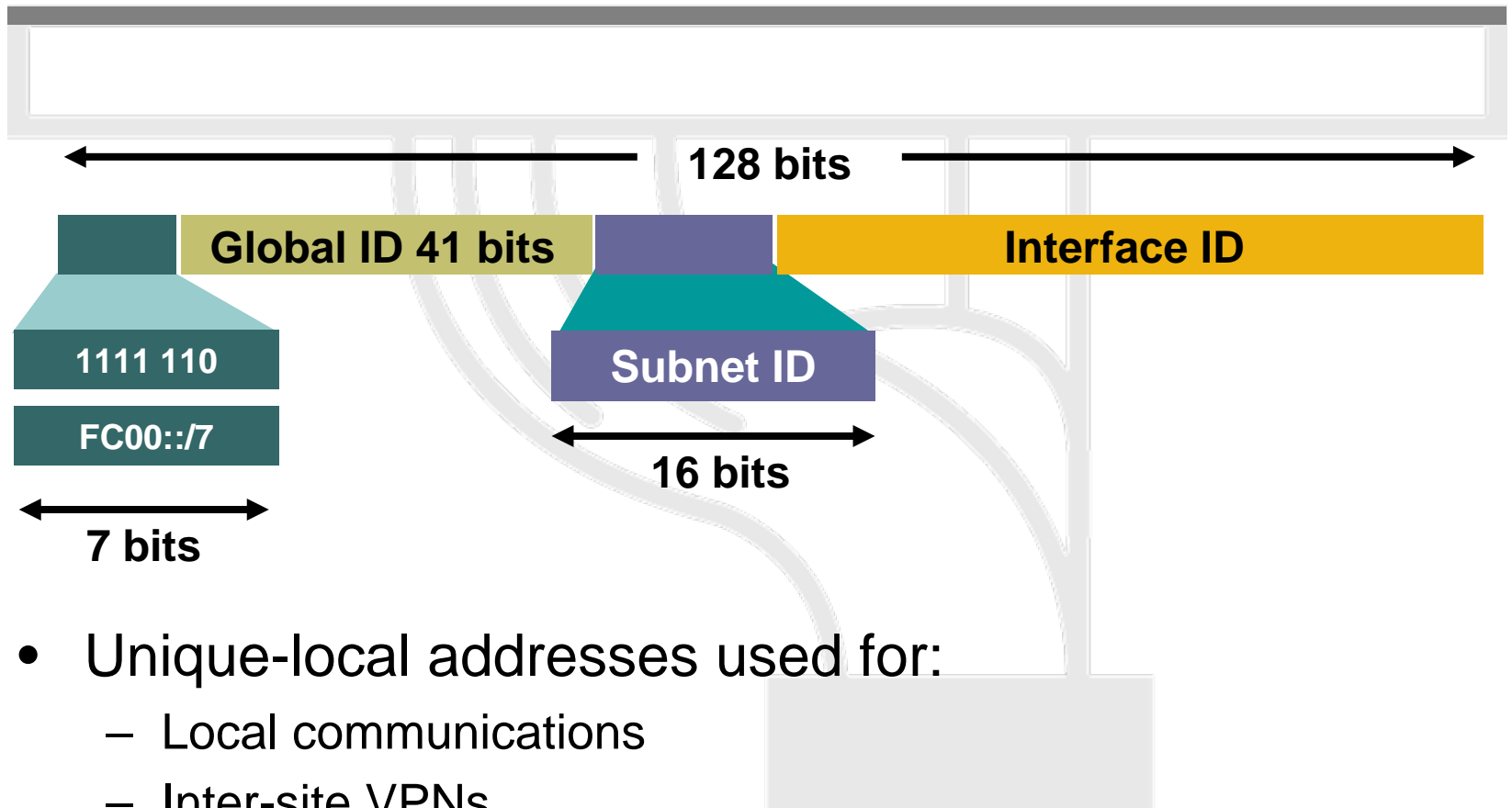
Link-Local Address

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

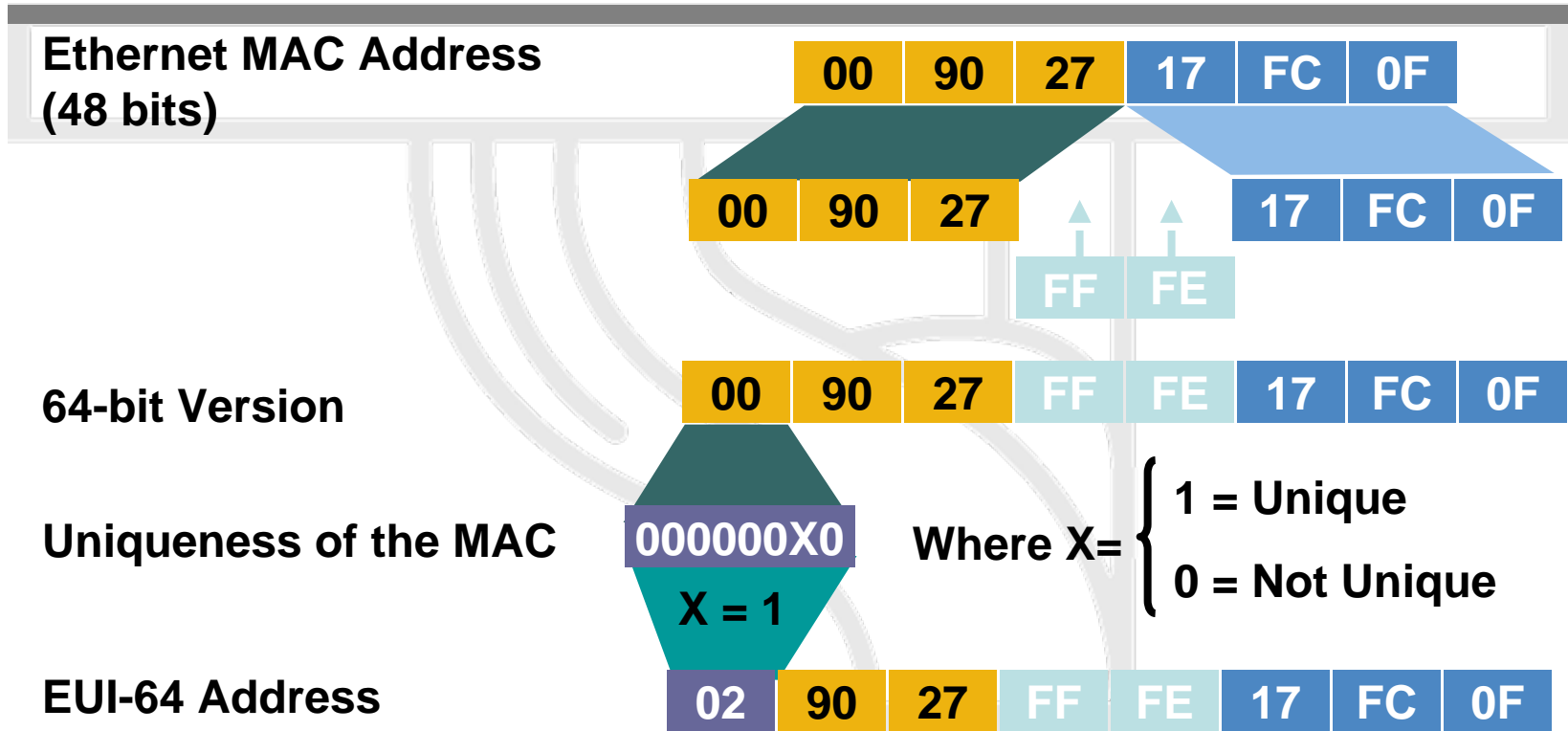


Aggregatable Global Unicast Addresses

- 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



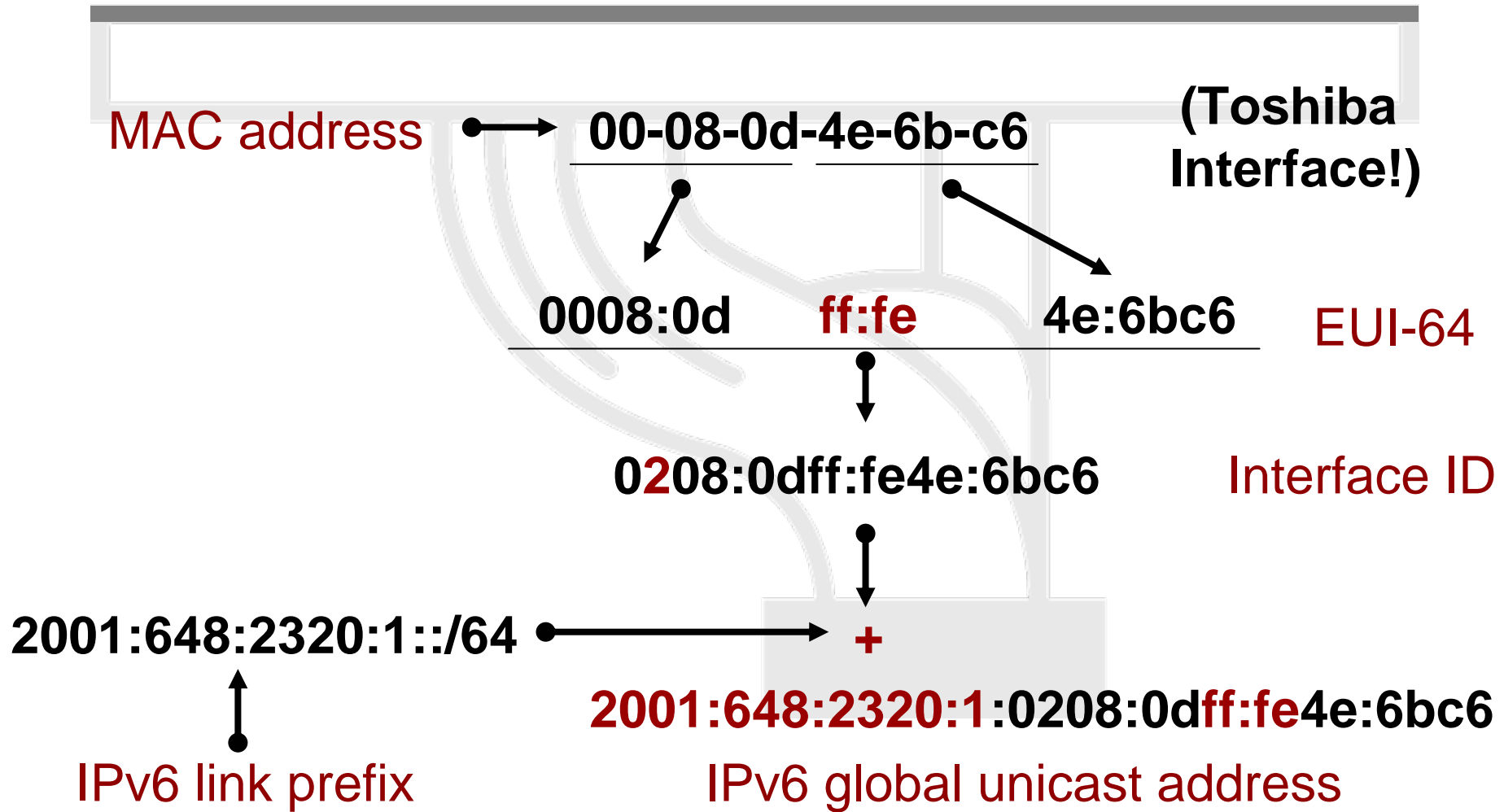
EUI-64



- 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 »

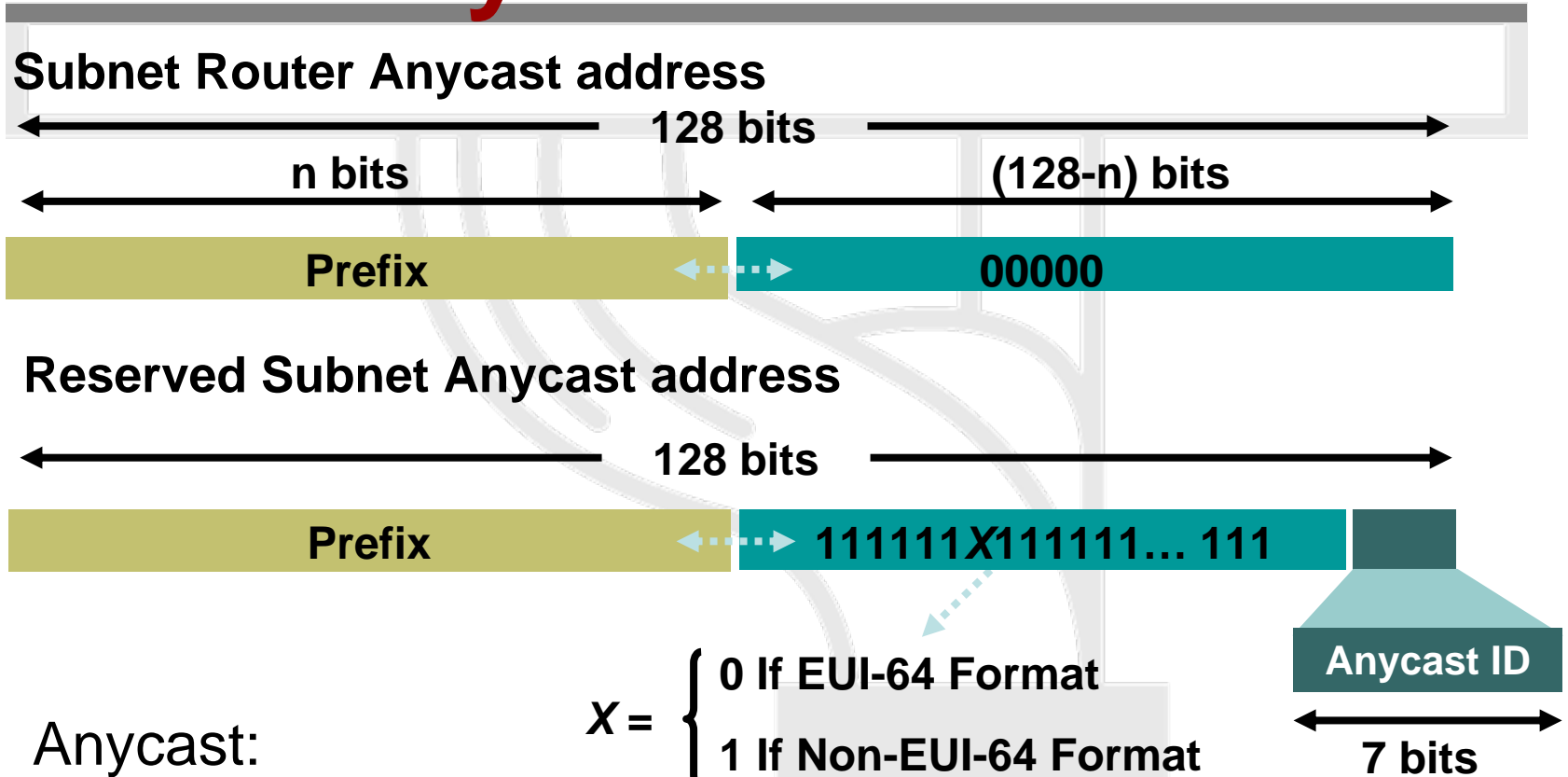


Anycast Addresses (RFC 3513)

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



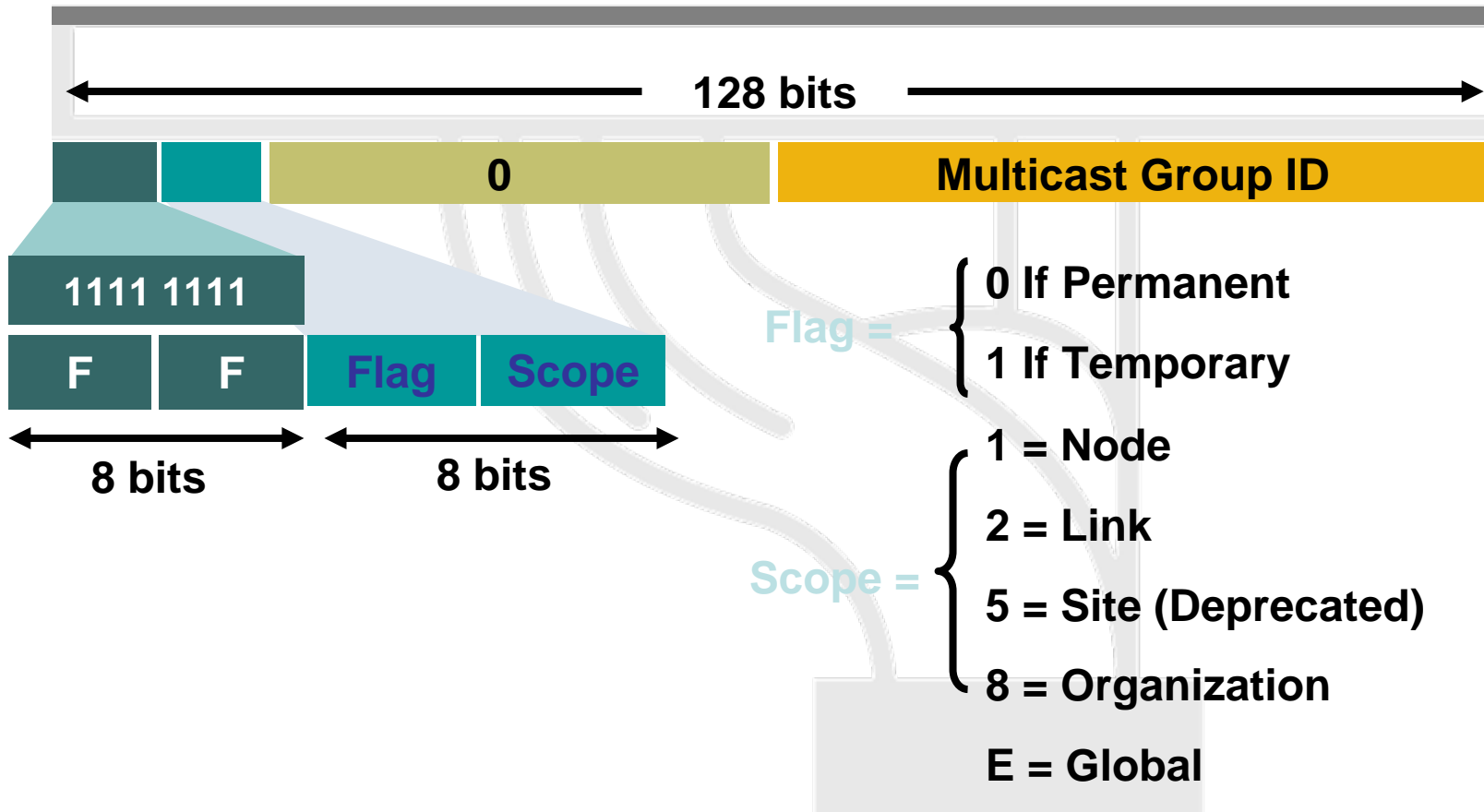
Anycast Address



- 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

