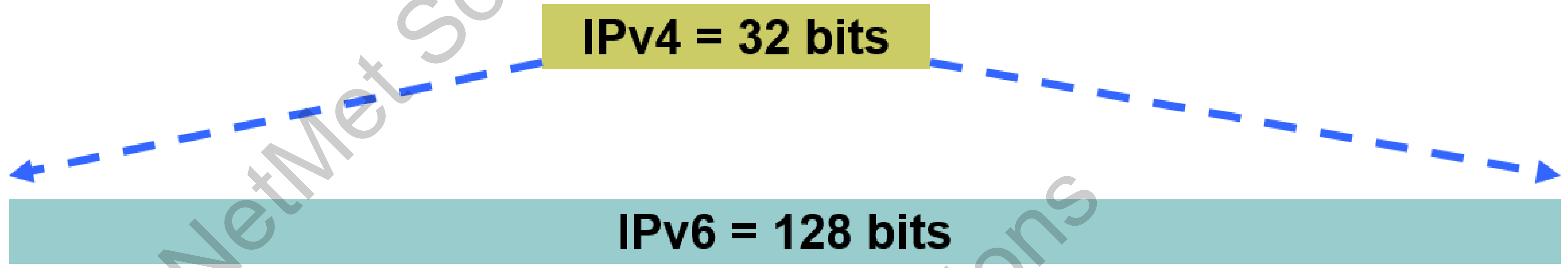
IPV6

PART 1

IPv6 Part 1

- **Larger address space:**
  - Global reach capability, flexibility, aggregation, multihoming, autoconfiguration, “plug-and-play,” renumbering
- **Simpler header:**
  - Streamlining of routing code
- **Security and mobility**
- **Transition richness**

IPv6 Part 1



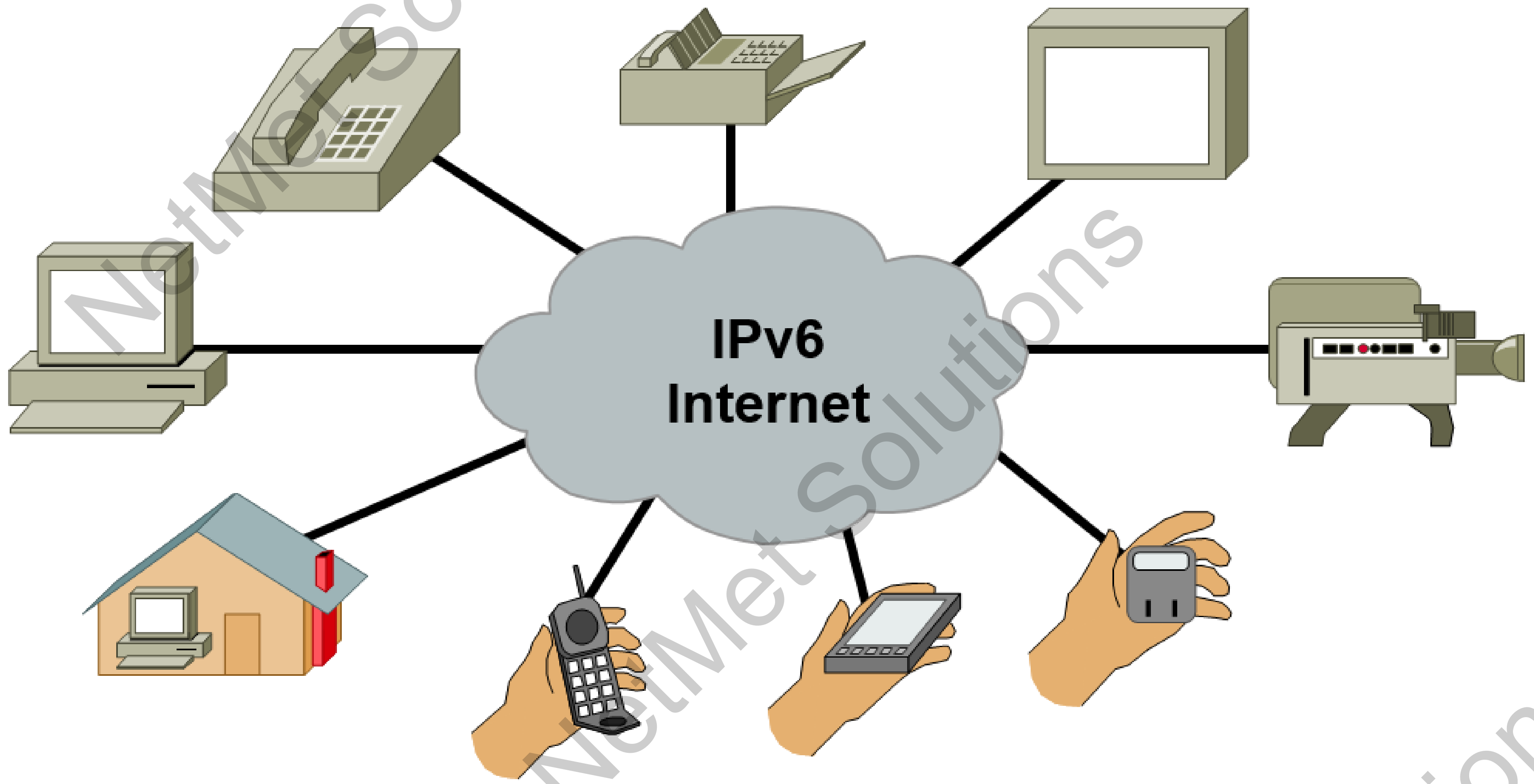
IPv4

- 32 bits
- = 4,294,967,296 possible addressable nodes

IPv6

- 128 bits: 4 times the size in bits
- =~ 3.4 * 10^{38} possible addressable nodes
- = 340,282,366,920,938,463,463,374,607,431,768,211,456
- =~ 53,730,194,312 * billion * billion addresses per person on the planet

IPv6 Part 1



Larger address space:

- **A globally reachable address for everything**
- **End-to-end reachability, full support of application protocols, end-to-end security**

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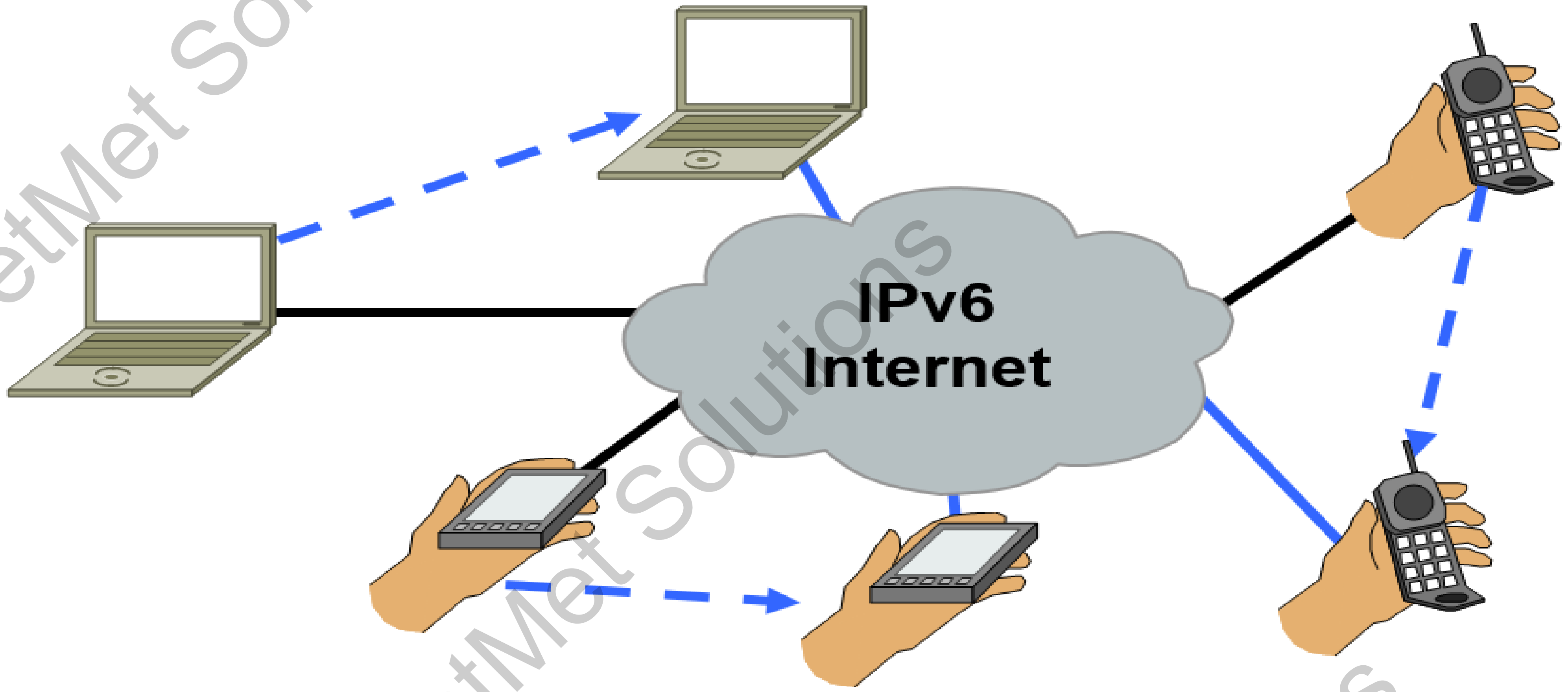
IPv6 Part 1

- Broadcasts in IPv4
  - Interrupt all computers on the LAN even if the destination was one or two computers
  - Can completely bring down a network ("broadcast storm")
- No broadcast in IPv6
  - Replaced by scoped multicast
- Multicast
  - Enables efficient use of the network
  - Has much larger address range

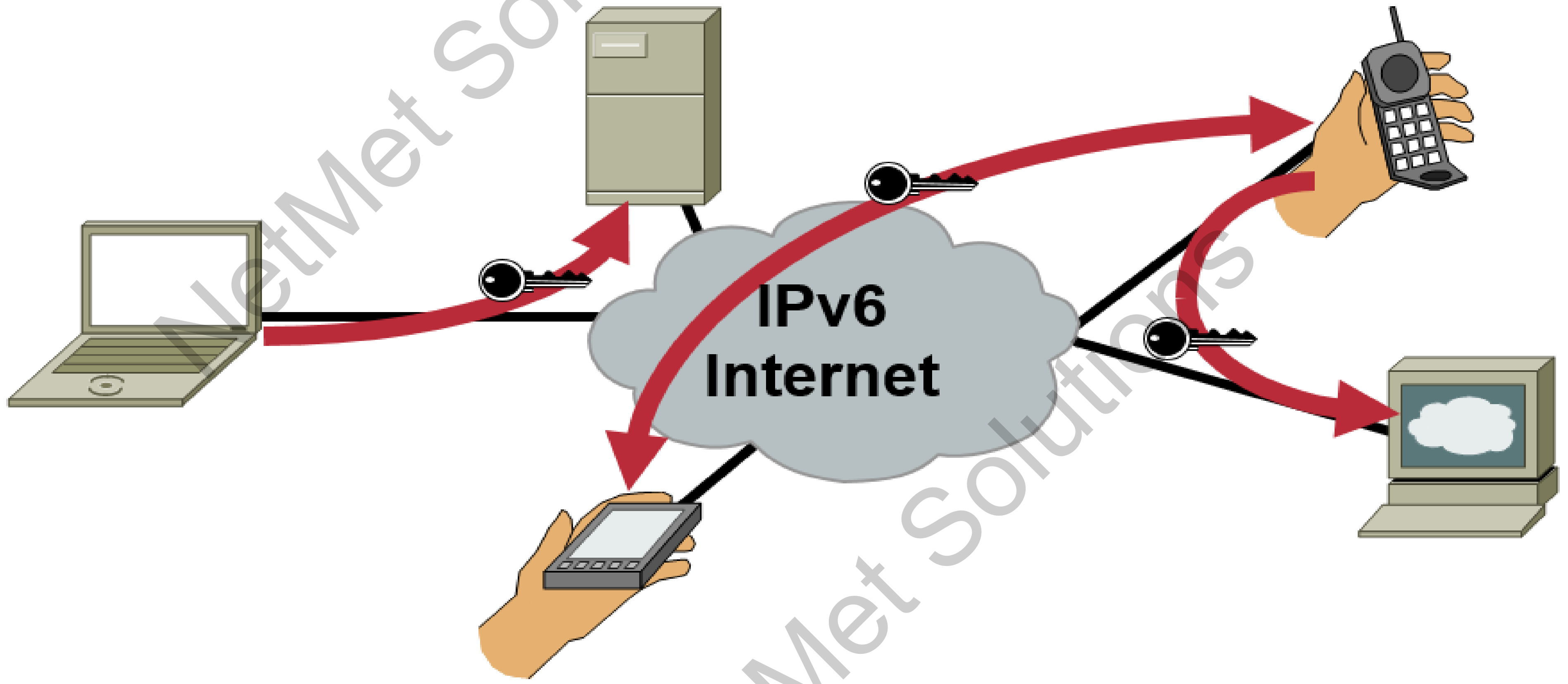
IPv6 Part 1



Mobility:

- Mobile devices are fully supported while moving.
- Mobility is built in on IPv6.
  - Any node can use it.
- Efficient routing means performance for end users.

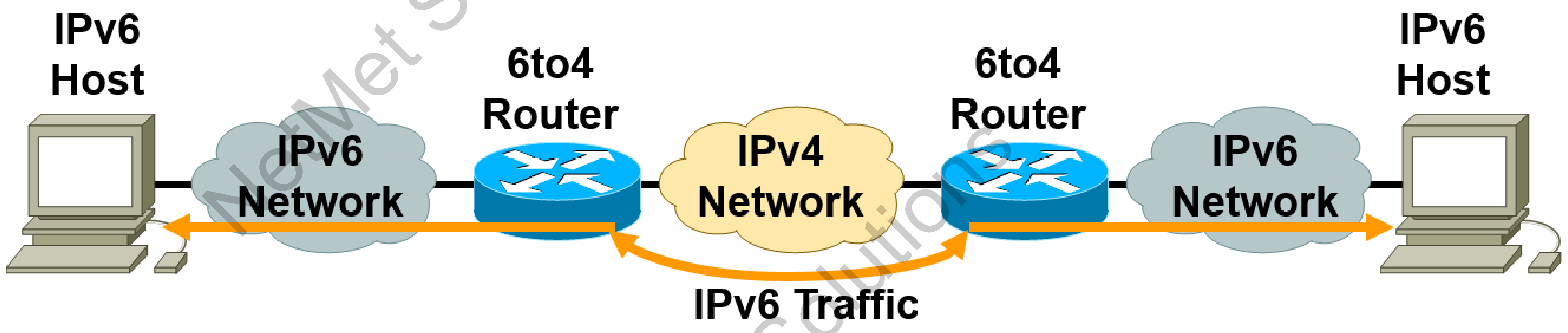
IPv6 Part 1



Security:

- End-to-end network security (integrity, authentication, confidentiality)
- Inherent (built in) on IPv6
  – Usable by any node

IPv6 Part 1



Transition richness:

- No fixed day to convert, no need to convert all at once
- Different transition mechanisms available
  – Smooth integration of IPv4 and IPv6
- Different compatibility mechanisms
  – Communication between IPv4 and IPv6 nodes

IPv6 Part 1

QoS

- QoS has been mentioned as an IPv6 feature—in fact IPv6 currently does QoS the same way as IPv4.
- IPv6 uses Traffic Class field in same manner as IPv4.
- There is no difference between QoS protocols and methods in IPv4 and IPv6.
- The IPv6 flow label can be used for QoS devices to identify specific flows.
- The flow label itself is not currently specified as a QoS feature.

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IPv6 Part 1

IP Service	IPv4 Solution	IPv6 Solution
Addressing Range	32-Bit, Network Address Translation	128-Bit, Multiple Scopes
Autoconfiguration	DHCP	Serverless, Reconfiguration, DHCPv6
Security	IPSec	IPSec Mandated, Works End-to-End
Mobility	Mobile IP	Mobile IP with Direct Routing
Quality of Service	Differentiated Service, Integrated Service	Differentiated Service, Integrated Service
IP Multicast	IGMP/PIM/Multicast BGP	MLD/PIM/Multicast BGP, Scope Identifier

IPv6 Part 1

- Address Representation
- Address Types
  - Unicast
  - Multicast
  - Anycast
- Addressing Architecture
- IPv6 over Data Link Layers
  - IPv6 over Ethernet
  - Multicast Mapping over Ethernet
  - Modified EUI-64 Format
- Privacy
- PPP Interface

IPv6 Part 1

Format:

- x:x:x:x:x:x:x:x, where *x* is a 16-bit hexadecimal field
  - 2001:0DB8:010F:0001:0000:0000:0000:0D0C
  - Case insensitive
- Leading zeros in a field are optional.
  - 2001:DB8:10F:1:0:0:0:D0C
- Successive fields of 0 are represented as :: but only once in an address.
  - 2001:DB8:10F:1::D0C

IPv6 Part 1

Example:

- **Address:**
  - 2001:0DB8:0000:0000:FFFF:0000:0000:0D0C
- **The following are good representations:**
  - 2001:db8::FFFF:0:0:D0C
  - 2001:db8:0:0:FFFF::D0C
- **The following is an incorrect representation:**
  - 2001:db8::FFFF::D0C

IPv6 Part 1

Further examples:

- FF02:0:0:0:0:0:0:1 => FF02::1
- FF15:0:0:0:0:0:1:c001 => FF15::1:c001
- 0:0:0:0:0:0:0:1 => ::1
- 0:0:0:0:0:0:0:0 => ::

IPv6 Part 1

Format:

- IPv4-compatible:
  - 0:0:0:0:0:0:192.0.2.100
  - = ::192.0.2.100
  - = ::C000:0246
- IPv4-mapped:
  - 0:0:0:0:0:FFFF:192.0.2.100
  - = ::FFFF:C000:0246

IPv6 Part 1

- **In a URL, the address is enclosed in brackets.**
  - **http://[2001:DF0:1003::f]:8080/index.html**
  - **Cumbersome for users**
  - **Mostly for diagnostic purposes**
  - **Use fully qualified domain names**

IPv6 Part 1

- Unicast
- Multicast
- Anycast

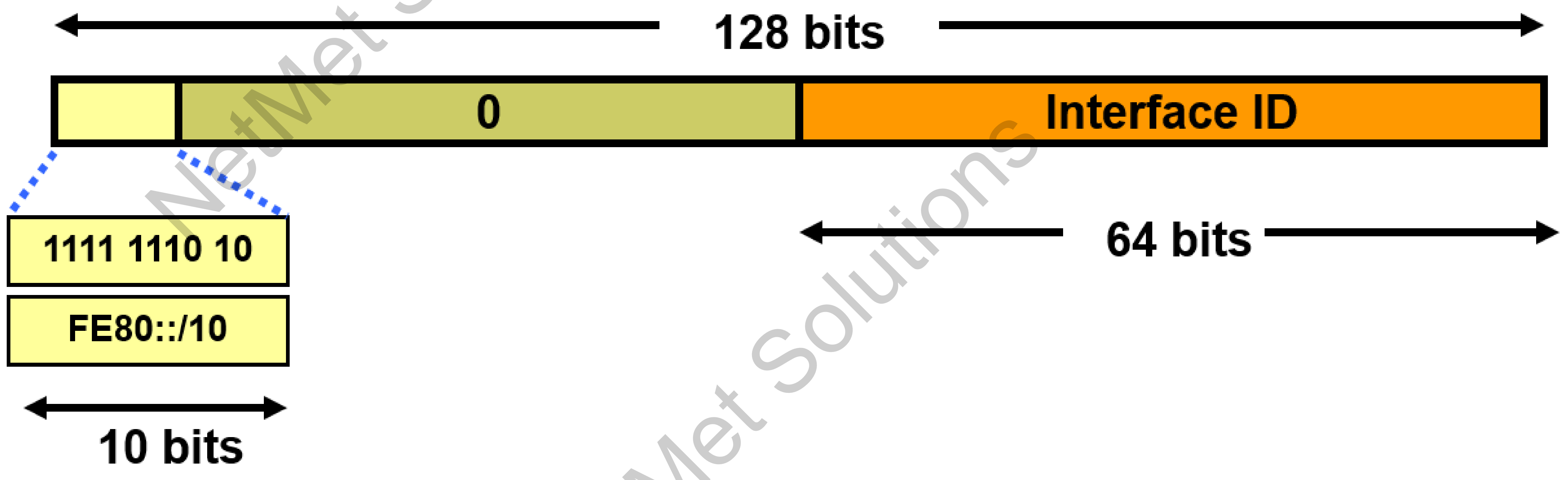
IPv6 Part 1

Unicast addresses are used in a one-to-one context.

IPv6 unicast addresses:

- **Global unicast addresses**
- **Link-local addresses**
- **Site-local addresses**
- **Special purpose unicast**
  - **Unspecified, loopback, IPv4-compatible, IPv4-mapped**

IPv6 Part 1



Link-local addresses:

- Have a scope limited to the link
- Are automatically configured with the interface ID

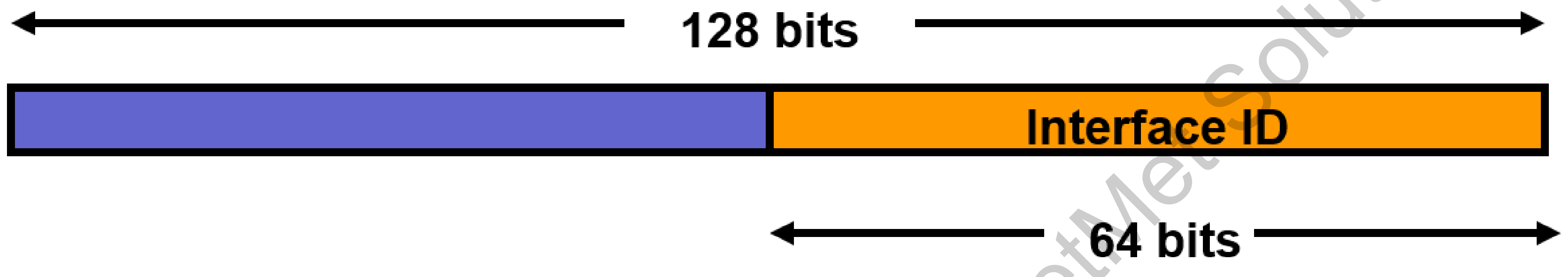
IPv6 Part 1

Used to identify interfaces on a link

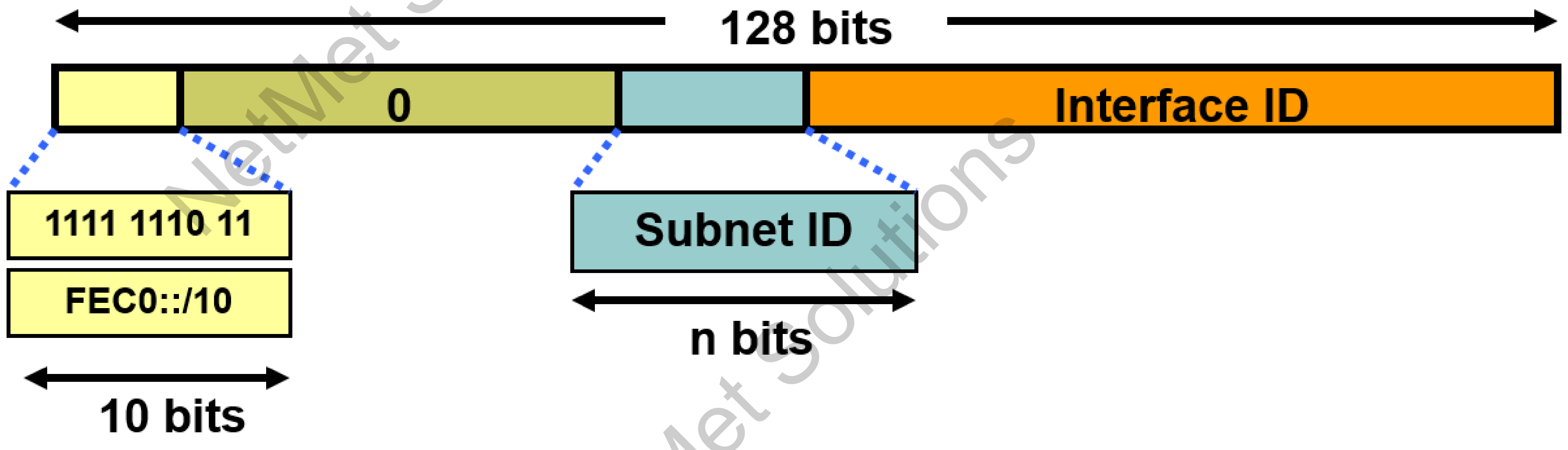
- Must be unique on that link
- Can be globally unique

Unicast addresses may have a 64-bit interface ID.

- Except for unicast addresses that start with binary 000
- Interface ID constructed in modified EUI-64 format



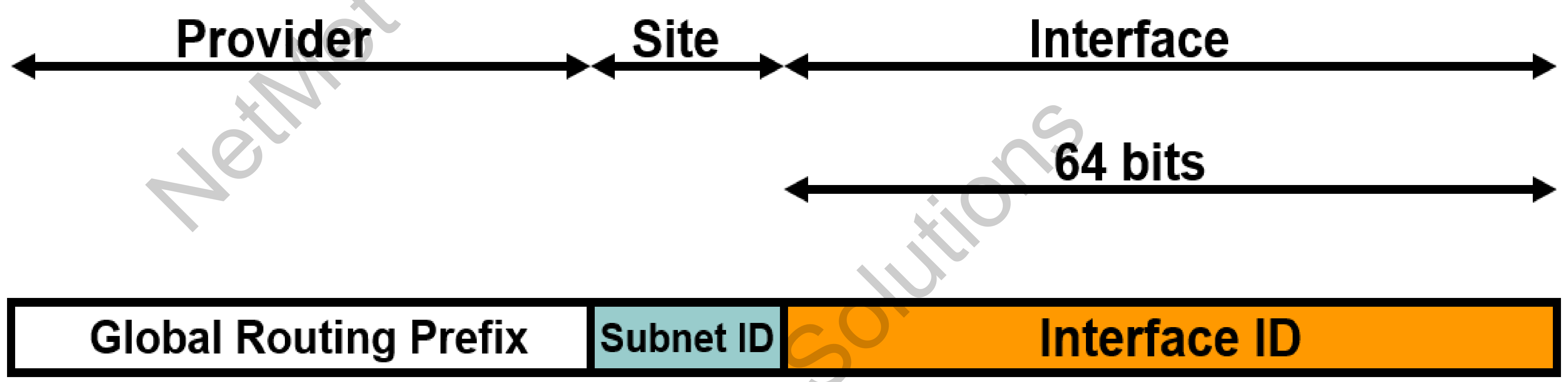
IPv6 Part 1



Site-local addresses:

- Have a scope limited to the site
- Contain inside topology of the site with the subnet ID

IPv6 Part 1



Global unicast addresses are addresses for generic use of IPv6.

IPv6 Part 1

Unspecified address:

- 0:0:0:0:0:0:0:0
- Used as a placeholder when no address is available (initial DHCP request, DAD)

Loopback address:

- 0:0:0:0:0:0:0:1
- Same as 127.0.0.1 in IPv4
- Identifies self

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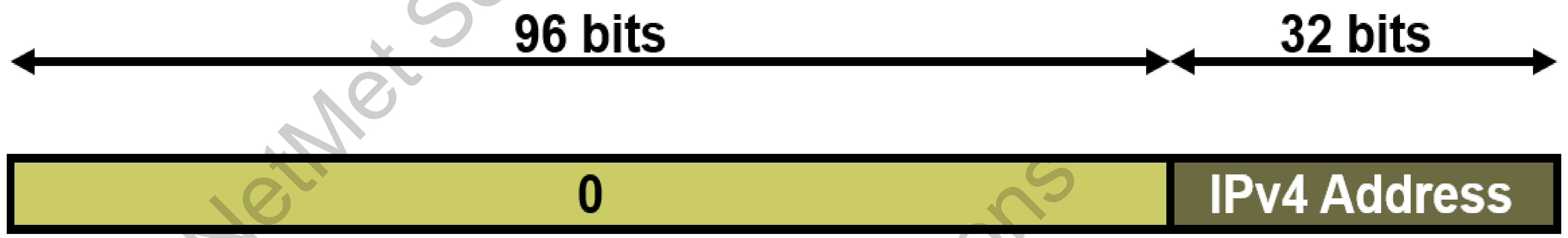
IPv6 Part 1



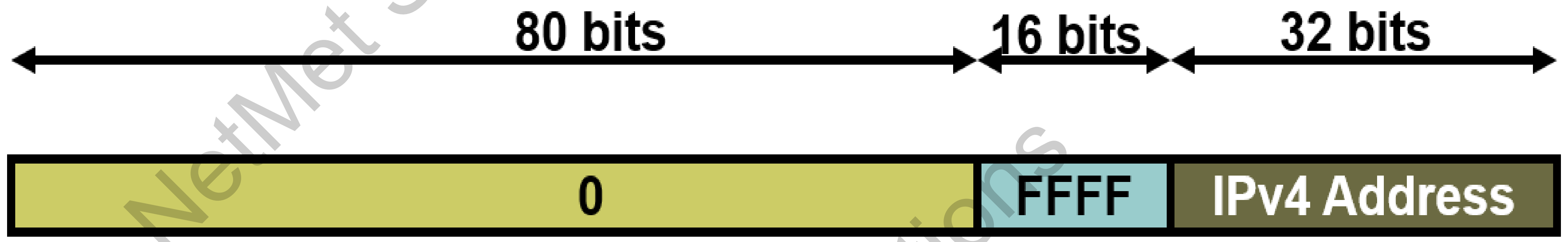
0:0:0:0:0:0:192.0.2.100

= ::192.0.2.100

= ::C000:0264

IPv4-compatible addresses refer to an IPv4/IPv6 node that supports automatic tunneling.

IPv6 Part 1



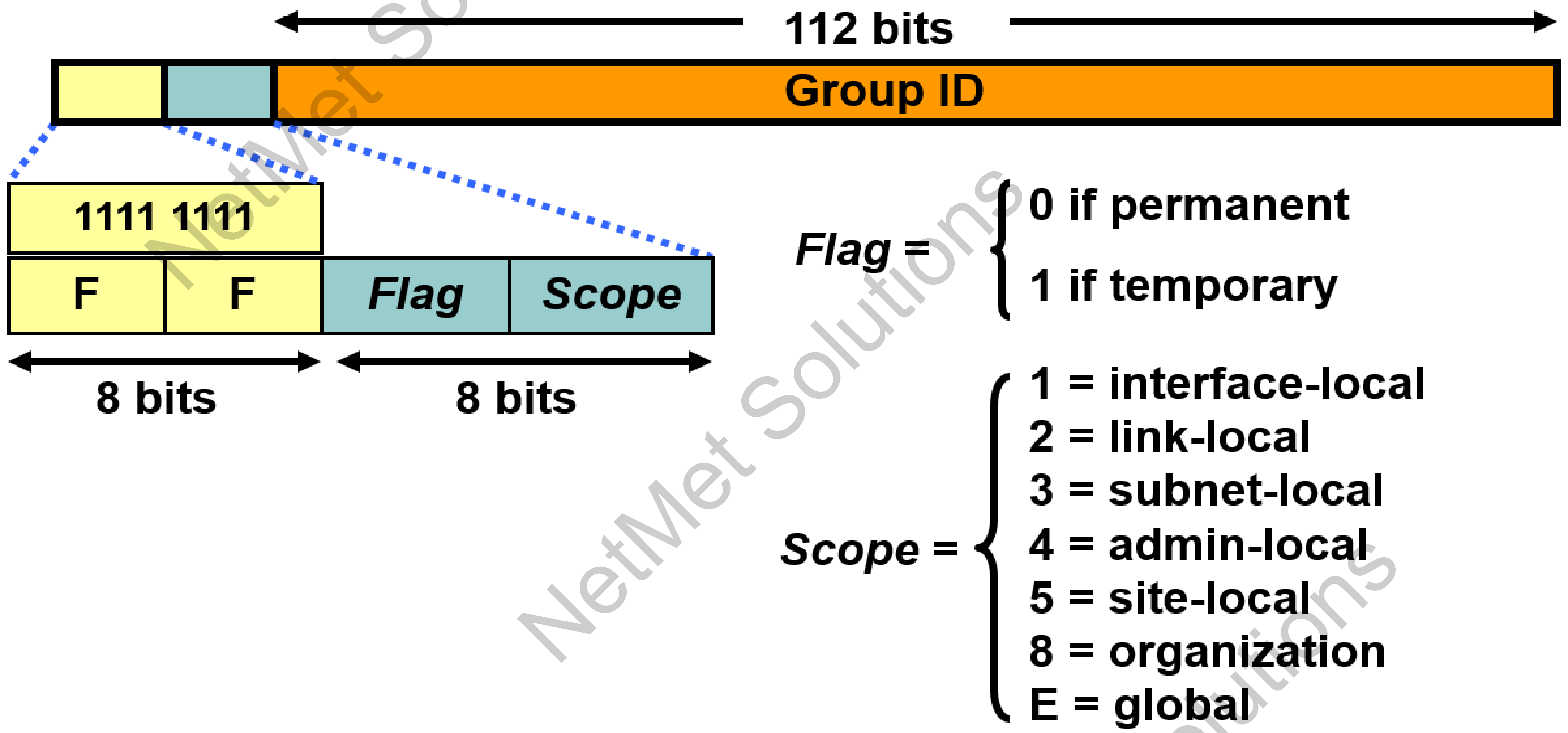
0:0:0:0:0:FFFF:192.0.2.100

= ::FFFF:192.0.2.100

= ::FFFF:C000:0246

IPv4-mapped addresses are used to represent the addresses of IPv4 nodes as IPv6 addresses.

IPv6 Part 1



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

IPv6 Part 1

- FF0X:: is reserved (X=0..F).
- Inside this range, the following are assigned:

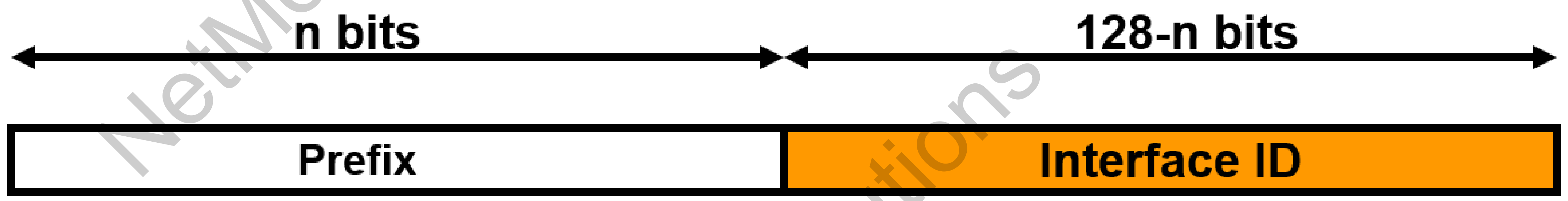
	Meaning	Scope
FF02::1	All nodes	Link-local
FF02::2	All routers	Link-local
FF02::9	All RIP routers	Link-local
FF02::1:FFXX:XXXX	Solicited-node	Link-local
FF05::101	All NTP servers	Site-local

IPv6 Part 1

- FF0X:: is reserved (X=0..F).
- Inside this range, the following are assigned:

	Meaning	Scope
FF0X::103	Rwhod	Any scope
FF0X::102	SGI-Dogfight	Any scope
FF0X::127	Cisco-rp-announce	Any scope
FF0X::128	Cisco-rp-discovery	Any scope
FF05::1:3	All-DHCP servers	Site-local

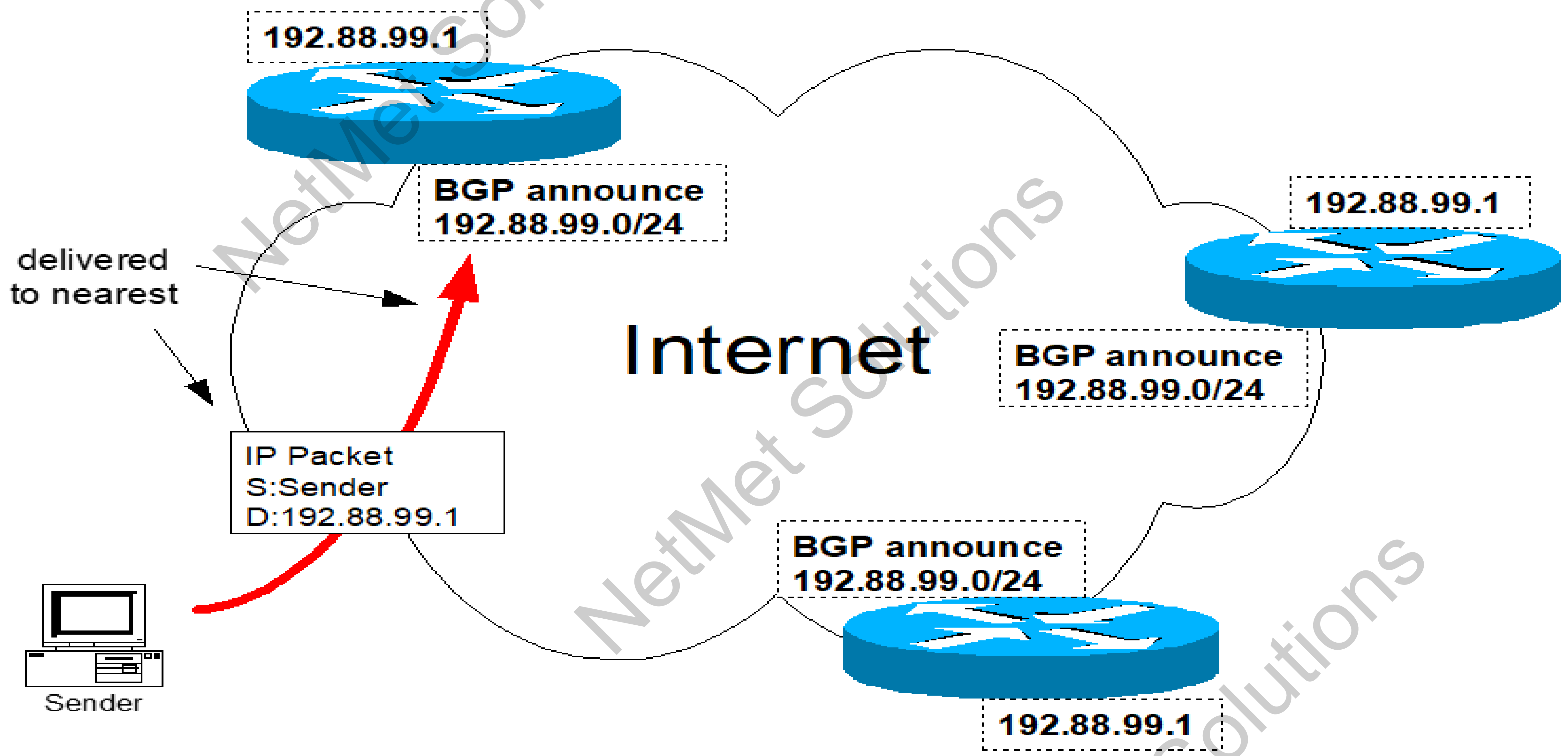
IPv6 Part 1



Anycast:

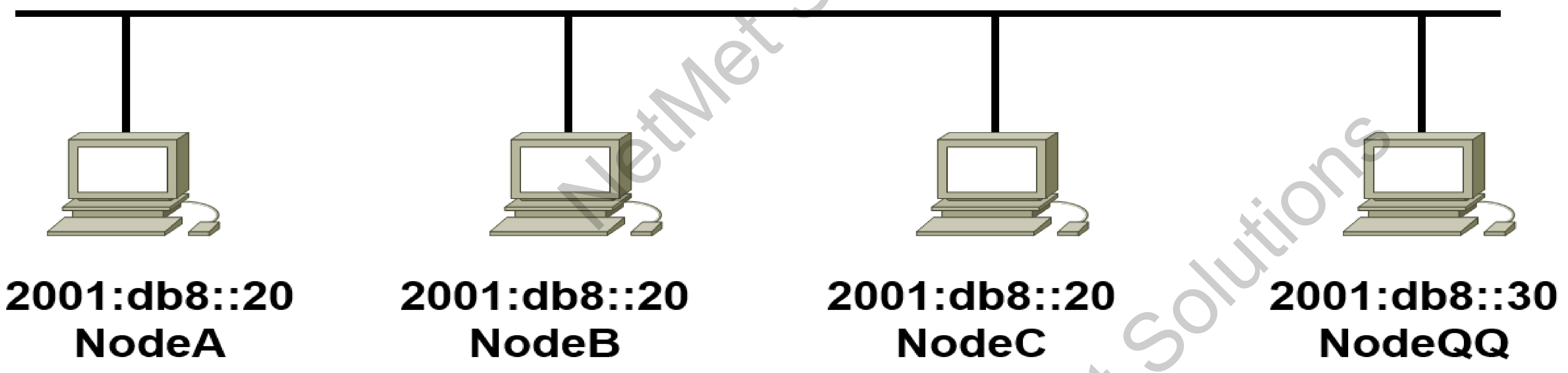
- Used in the context of one-to-nearest
- Assigned to more than one interface
- Allocated from the unicast address space

IPv6 Part 1


192.88.99.1
BGP announce
192.88.99.0/24
delivered
to nearest
Internet
192.88.99.1
BGP announce
192.88.99.0/24
IP Packet
S:Sender
D:192.88.99.1
BGP announce
192.88.99.0/24
192.88.99.1
Sender

IPv6 Part 1

Nearest anycast address is whichever host is put into NodeQQ neighbor cache first.



IPv6 Part 1

An IPv6 host interface requires the following IPv6 addresses for proper operation:

- **A link-local address**
- **Loopback address**
- **All-nodes multicast address**
- **Any additional unicast and anycast addresses configured (automatically or manually)**
- **Solicited-node multicast address for each of its unicast and anycast addresses**
- **Multicast address of all other groups to which the host belongs**

IPv6 Part 1

An IPv6 router interface requires the following IPv6 addresses for proper operation:

- **All the required host addresses**
- **All-routers multicast addresses**
- **Subnet-router anycast addresses for all interfaces for which it is configured to act as a router**
- **Other anycast configured addresses**

IPv6 Part 1

	Binary Prefix	IPv6 Notation
Unspecified	00 … 0 (128 bits)	::/128
Loopback	00 … 1 (128 bits)	::1/128
Multicast	1111 1111	FF00::/8
Link-local unicast	1111 1110 10	FE80::/10
Site-local unicast	1111 1110 11	FEC0::/10
Global unicast	Everything else	

IPv6 Part 1

IPv6 is defined for most data link layers:

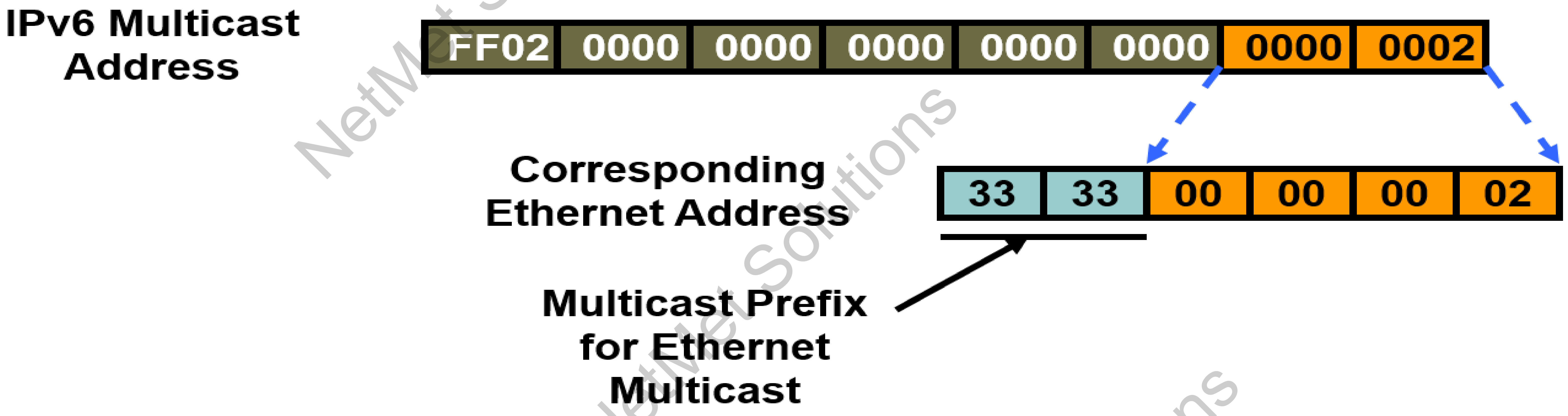
- Ethernet
- PPP
- FDDI
- Token Ring
- HDLC
- Nonbroadcast multiaccess
- ATM
- Frame Relay
- IEEE 1394

IPv6 Part 1

Destination Ethernet Address	Source Ethernet Address	0x86DD	IPv6 Header and Payload

IPv6 has a specific Ethernet protocol ID that is different from the one in IPv4.

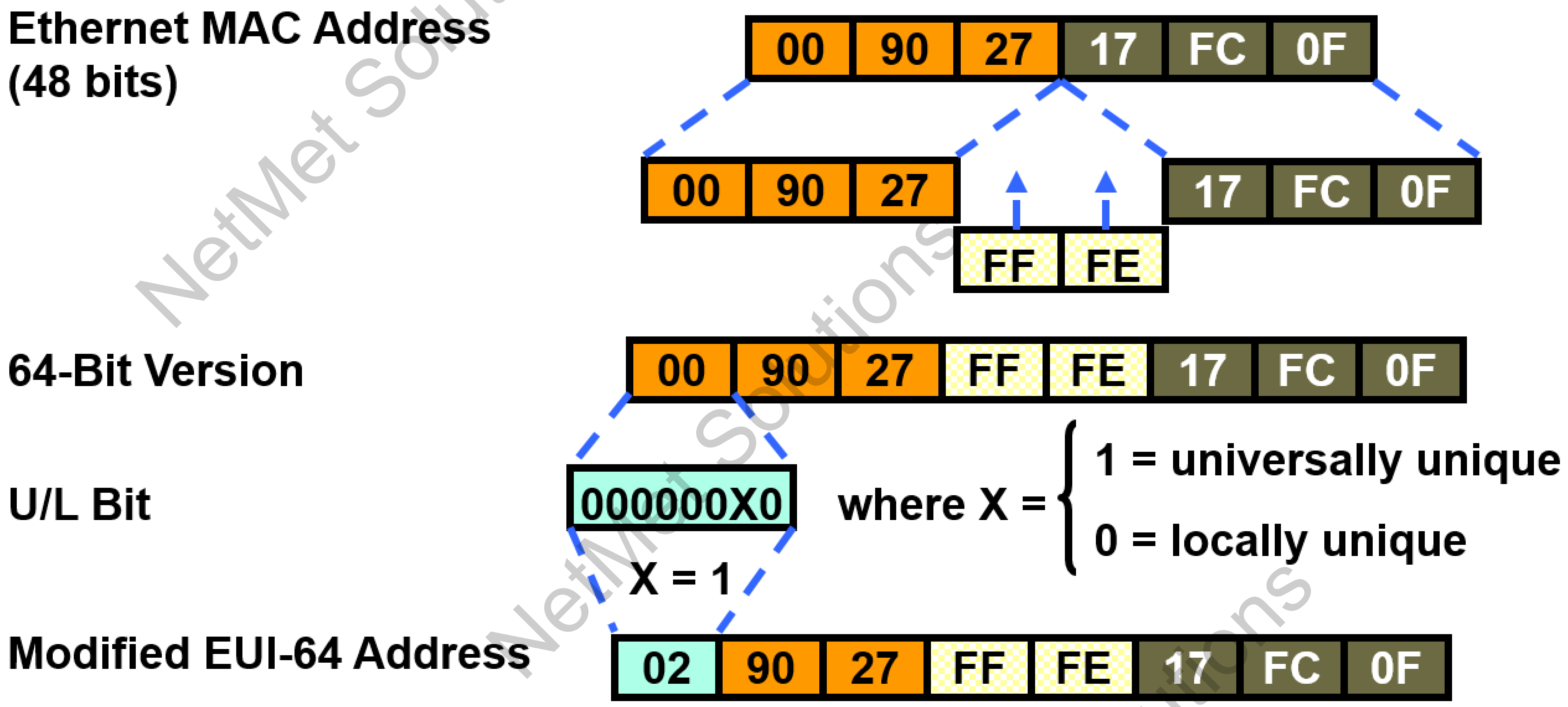
IPv6 Part 1



Mapping of IPv6 multicast address to Ethernet address:

- **33:33:<last 32 bits of the IPv6 multicast address>**

IPv6 Part 1



Modified EUI-64 address is formed by inserting "FFFE" and “complimenting” a bit identifying the uniqueness of the MAC address.

IPv6 Part 1

PPP interface construction process:

- Use an EUI-64 or EUI-48 from another interface on the node, if available.
- Construct a unique 64-bit identifier using other node-unique information (e.g., machine serial number).
- Create a random identifier.

These values are confirmed on-link during initialization by IPv6 CP.