



IPv6 WORKSHOP

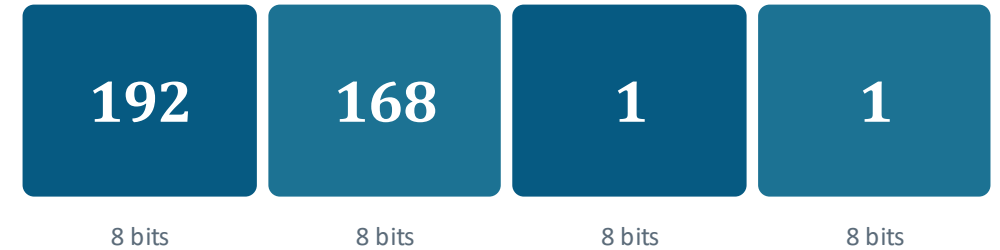
IPv6 Addressing Fundamentals

IPv6 101

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IPv4 Basics

- 32-bit address, written in dotted-decimal notation (e.g. 192.168.1.1)
- 4 octets, each ranging from 0 to 255
- Every address splits into a Network portion and a Host portion
- The subnet mask (or /n prefix) defines exactly where that split happens



192.168.1.1 = 32 bits total

Subnetting Recap

CIDR notation: /n = number of network bits

$$2^{(32-n)}$$

Total addresses

$$2^{(32-n)} - 2$$

Usable hosts

QUIZ 1



How many total IP addresses are in a /26 network?

QUIZ 1

How many total IP addresses are in a /26 network?

A 32

B 64

C 128

D 256

How many total IP addresses are in a /26 network?

A 32

✓ 64

C 128

D 256

QUIZ 2



How many usable host addresses are in that same /26 network?

QUIZ 2

How many usable host addresses are in that same /26 network?

A 64

B 62

C 30

D 126

How many usable host addresses are in that same /26 network?

A 64

✓ 62

C 30

D 126

QUIZ 3



How many /26 subnets can you create from a single /24 network?

QUIZ 3

How many /26 subnets can you create from a single /24 network?

A 2

B 4

C 8

D 16

QUIZ 3 · ANSWER

How many /26 subnets can you create from a single /24 network?

A 2

✓ 4

C 8

D 16

QUIZ 4



You have one /24 network and must create subnets for 4 departments, each needing up to 50 hosts. Which subnet mask should you use?

QUIZ 4

You have one /24 network and must create subnets for 4 departments, each needing up to 50 hosts. Which subnet mask should you use?

A /25

B /26

C /27

D /28

QUIZ 4 · ANSWER

You have one /24 network and must create subnets for 4 departments, each needing up to 50 hosts. Which subnet mask should you use?

A /25

✓ /26

C /27

D /28

IPv6 Fundamentals

1

1. IPv4 Exhaustion

Why the world had to move to IPv6

2

2. IPv6 Address Basics

Notation, format, and the two shortening rules

3

3. IPv6 Address Types

Unicast (GUA, LLA, ULA), multicast, anycast

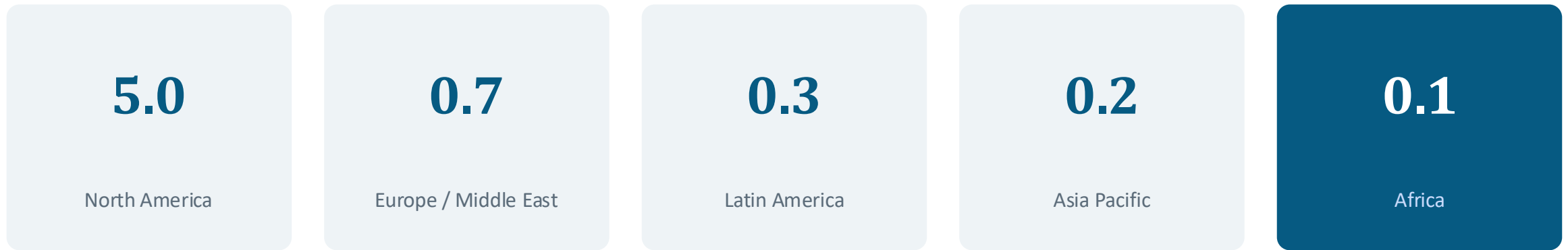
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TOPIC 1 OF 3

IPv4 Exhaustion

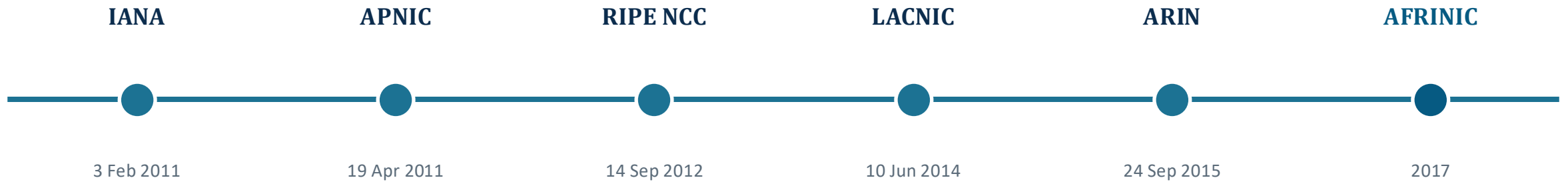
Why the world had to move to IPv6

Global IPv4 distribution is unbalanced



IPv4 addresses per person, by region

General IPv4 pool depletion timeline



Exhaustion drives up address costs & NAT



Implications for Africa: the ‘Scramble for Africa’

- 1 African networks are deprived of the critical IPv4 needed to facilitate a smooth transition to IPv6
- 2 We are largely forced to deploy greenfield IPv6, without the dual-stack runway richer regions had
- 3 As a direct result, the use of NAT increases across African networks

Discussion: how will you deal with IPv4 exhaustion?

Deploy IPv6

Address the root cause and future-proof the network

Deploy NAT on steroids

Squeeze more life from IPv4 with CGN and layered NAT

Wait and see

Delay the decision and hope the pressure eases

2

TOPIC 2 OF 3

IPv6 Address Basics

Notation, format, and the two shortening rules

TCP/IP model: IPv4 vs IPv6

IPv4 - 32 bits

ICMP
IGMP
IPSec
NAT
OSPF
IS-IS
mob. IP

IPv6 - 128 bits

ICMPv6
MLD
IPSec
ND
OSPFv3
IS-IS
mob. IP

How to write IPv6 addresses

- An IPv6 address is 128 bits long
- That's 32 nibbles (4 bits each)
- Written as 8 groups of 4 hex digits, separated by colons
- Followed by /n for the prefix length

`hhhh : hhhh : hhhh : hhhh : hhhh : hhhh : hhhh : hhhh /n`

- h = hexadecimal digit [0–9, a–f]
- n = prefix length (decimal value)

Full IPv6 address example



Each 4-hex group represents 16 bits - 8 groups × 16 bits = 128 bits total

Rules for shortening IPv6 addresses

1

The Zero Suppression rule

Strip off all LEADING zeroes within each group.

2

The Zero Compression rule

Replace ONE contiguous run of all-zero groups with '::' - usable only once per address.

Worked example: shortening an address

2001:0000:0000:0249:0000:0000:0000:ecfe



2001:0:0:249::ecfe

Zero suppression applied to "0249" → "249". Zero compression applied once to the trailing all-zero groups → "::"

QUIZ 5



What does the Zero Suppression rule do?

QUIZ 5

What does the Zero Suppression rule do?

A Replaces contiguous all-zero groups with ::

B Strips off leading zeroes within each group

C Removes trailing zeroes from an address

D Merges two IPv6 addresses together

What does the Zero Suppression rule do?

A

Replaces contiguous all-zero groups with ::

✓

Strips off leading zeroes within each group

C

Removes trailing zeroes from an address

D

Merges two IPv6 addresses together

QUIZ 6



What does the Zero Compression rule do, and how many times can it be used in one address?

QUIZ 6

What does the Zero Compression rule do, and how many times can it be used in one address?

- A** Strips leading zeroes; unlimited uses
- B** Replaces one contiguous run of all-zero groups with ::, only once per address
- C** Replaces every zero group with :: wherever it appears
- D** It doesn't apply to IPv6 addresses

What does the Zero Compression rule do, and how many times can it be used in one address?

A

Strips leading zeroes; unlimited uses

✓

Replaces one contiguous run of all-zero groups with ::, only once per address

C

Replaces every zero group with :: wherever it appears

D

It doesn't apply to IPv6 addresses

QUIZ 7



Shorten this address:
2001:0DB8:0000:0000:0000:0000:1428:57ab

QUIZ 7

Shorten this address: 2001:0DB8:0000:0000:0000:0000:1428:57ab

A

2001:DB8::1428:57ab

B

2001:0DB8::1428:57ab

C

2001:DB8:0:0:0:0:1428:57ab

D

2001::DB8::1428:57ab

Shorten this address: 2001:0DB8:0000:0000:0000:0000:1428:57ab



2001:DB8::1428:57ab



2001:0DB8::1428:57ab



2001:DB8:0:0:0:0:1428:57ab



2001::DB8::1428:57ab

QUIZ 8



Which of these is an INVALID shortened IPv6 address?

QUIZ 8

Which of these is an INVALID shortened IPv6 address?

A 2001:db8::1

B fe80::1

C 2001::db8::1

D ::1

Which of these is an INVALID shortened IPv6 address?

A

2001:db8::1

B

fe80::1

✓

2001::db8::1

D

::1

3

TOPIC 3 OF 3

IPv6 Address Types

Unicast (GUA, LLA, ULA), multicast, and anycast

There are 3 types of IPv6 addresses



Unicast

1 : 1 - delivered to exactly one interface



Multicast

1 : n - delivered to every member of a group



Anycast

1 : closest - delivered to the nearest interface

Note: there is no broadcast address (or broadcast communication) in IPv6

An address has scope = extent of uniqueness



Global scope

Unique across the entire internet

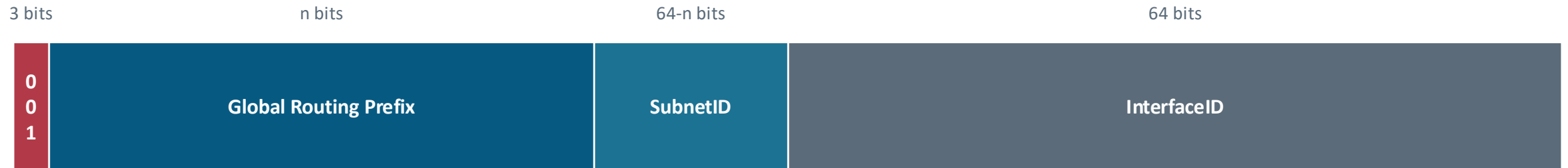


Link-local scope

Unique only within the local link/segment

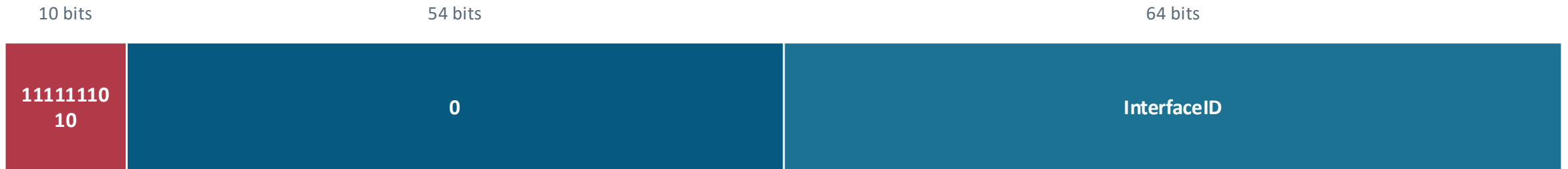
Within a scope, an address can be used as a unique ID for an interface

Global Unicast Addresses (GUA)



`2001:4290:10:249:bae8:56ff:fe4a:ecfe` (prefix range 2000::/3)

Link-Local Addresses (LLA)



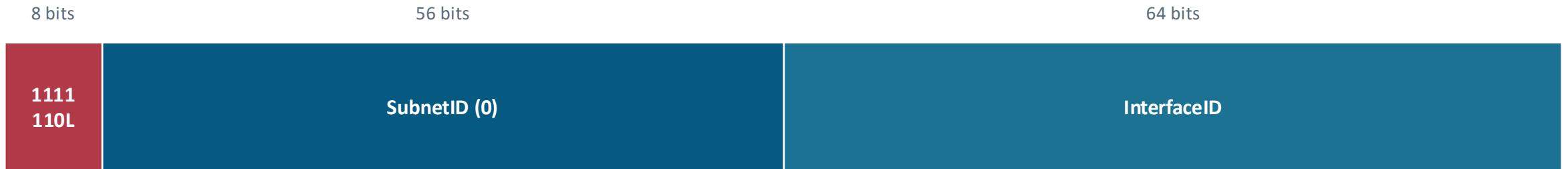
`fe80:0000:0000:0000:bae8:56ff:fe4a:ecfe` (prefix `fe80::/10`)

Link-local reachability and ScopeID

- Every interface can have the same fe80:: prefix - it's only unique per link
- A router with multiple links doesn't know which interface to send a link-local packet out of
- You must additionally specify the egress interface

```
ping fe80::1 → which interface does the router send it out of?
```

Unique Local Addresses (ULA)



`fc00::/7` - L=0 unassigned, L=1 → `fd00::/8` (free-use self-assignment)

Generating the InterfaceID (IID)

1

Static

Manually configured

Servers, router interfaces

2

EUI-64

Derived from the MAC address

Automatically configured hosts

3

Cryptographic

Derived using cryptographic functions

Automatically configured hosts

4

Pseudo-random

Randomly generated, changes over time

Automatically configured hosts

How EUI-64 InterfaceIDs are generated

1

MAC address (48 bits)

00:90:27:17:FC:0F

2

Insert FFFE at the midpoint (→ 64 bits)

00:90:27:FF:FE:17:FC:0F

3

Flip the U/L bit (unique MAC → 0→1 in 7th bit)

02:90:27:FF:FE:17:FC:0F

Important well-known addresses

::

Unspecified address - host has no IPv6 address; never used as a destination

::/0

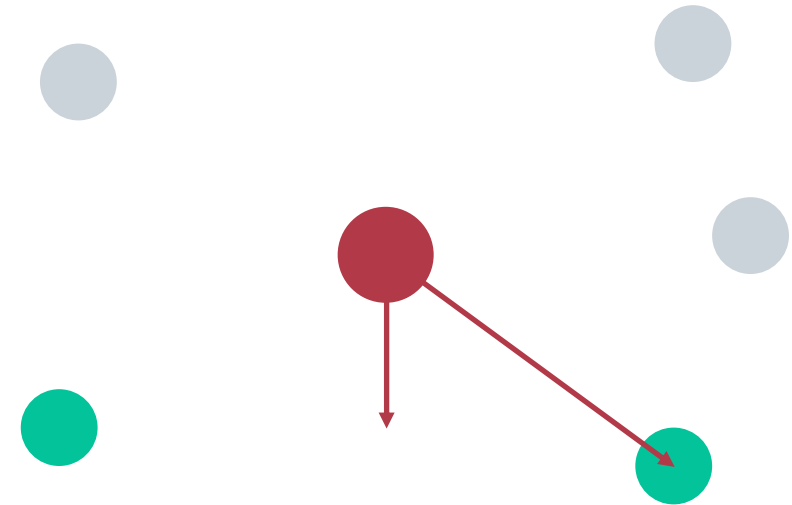
Represents all IPv6 addresses (default route)

::1

IPv6 loopback address - must never be forwarded outside the node

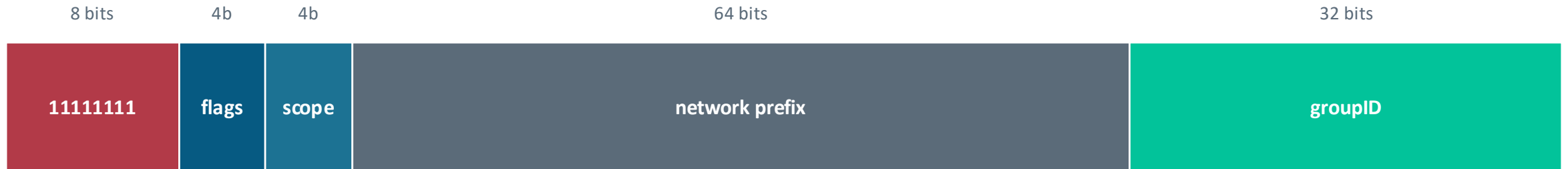
Anycast addresses

- The same unicast address is assigned to multiple interfaces
- Anycast packets are delivered to the topologically closest interface holding that address



Anycast packets reach the nearest green node, not all of them

Multicast addresses



All multicast addresses fall in the range ff00::/8

Well-known multicast scopes

Bits	Hex	Scope
0001	1	Interface-local
0010	2	Link-local
0100	4	Admin-local
0101	5	Site-local
1000	8	Organization-local
1110	e	Global

QUIZ 9



How many types of IPv6 addresses are there?

QUIZ 9

How many types of IPv6 addresses are there?

- A** 2 - Unicast, Multicast
- B** 3 - Unicast, Multicast, Anycast
- C** 4 - including Broadcast
- D** 5

How many types of IPv6 addresses are there?

A

2 - Unicast, Multicast



3 - Unicast, Multicast, Anycast

C

4 - including Broadcast

D

5

QUIZ 10



True or False: IPv6 still supports broadcast addresses like IPv4.

QUIZ 10

True or False: IPv6 still supports broadcast addresses like IPv4.

A

True

B

False

True or False: IPv6 still supports broadcast addresses like IPv4.



True



False

QUIZ 11



What is the prefix range for Global Unicast Addresses (GUA)?

QUIZ 11

What is the prefix range for Global Unicast Addresses (GUA)?

A fe80::/10

B fc00::/7

C 2000::/3

D ff00::/8

What is the prefix range for Global Unicast Addresses (GUA)?

A fe80::/10

B fc00::/7

✓ 2000::/3

D ff00::/8

QUIZ 12



What is the prefix for Link-Local Addresses (LLA)?

QUIZ 12

What is the prefix for Link-Local Addresses (LLA)?

A

2000::/3

B

fe80::/10

C

fc00::/7

D

::1/128

What is the prefix for Link-Local Addresses (LLA)?

A

2000::/3

✓

fe80::/10

C

fc00::/7

D

::1/128

QUIZ 13



What is the prefix range for Unique Local Addresses (ULA)?

QUIZ 13

What is the prefix range for Unique Local Addresses (ULA)?

A fe80::/10

B fc00::/7

C 2000::/3

D ff00::/8

What is the prefix range for Unique Local Addresses (ULA)?

A fe80::/10

✓ fc00::/7

C 2000::/3

D ff00::/8

QUIZ 14



Which prefix range is used for IPv6 multicast traffic?

QUIZ 14

Which prefix range is used for IPv6 multicast traffic?

A

2000::/3

B

fe80::/10

C

ff00::/8

D

fc00::/7

Which prefix range is used for IPv6 multicast traffic?

A

2000::/3

B

fe80::/10

✓

ff00::/8

D

fc00::/7

QUIZ 15



What does the address ::1 represent?

What does the address ::1 represent?

- A** All IPv6 addresses
- B** A host with no address
- C** The loopback interface (like 127.0.0.1 in IPv4)
- D** The global unicast prefix

What does the address ::1 represent?

- A** All IPv6 addresses
- B** A host with no address
- ✓** The loopback interface (like 127.0.0.1 in IPv4)
- D** The global unicast prefix

QUIZ 16



Which of the following is a valid method for generating an Interface ID (IID)?

QUIZ 16

Which of the following is a valid method for generating an Interface ID (IID)?

A

EUI-64

B

Static / manual

C

Pseudo-random

D

All of the above

Which of the following is a valid method for generating an Interface ID (IID)?



EUI-64



Static / manual



Pseudo-random



All of the above

Questions?

Thank you - IPv6 Workshop · SomNOG-ISOC Somalia