

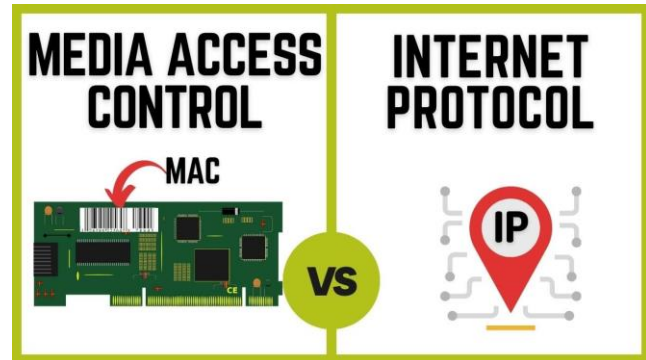


آموزش نتورک پلاس

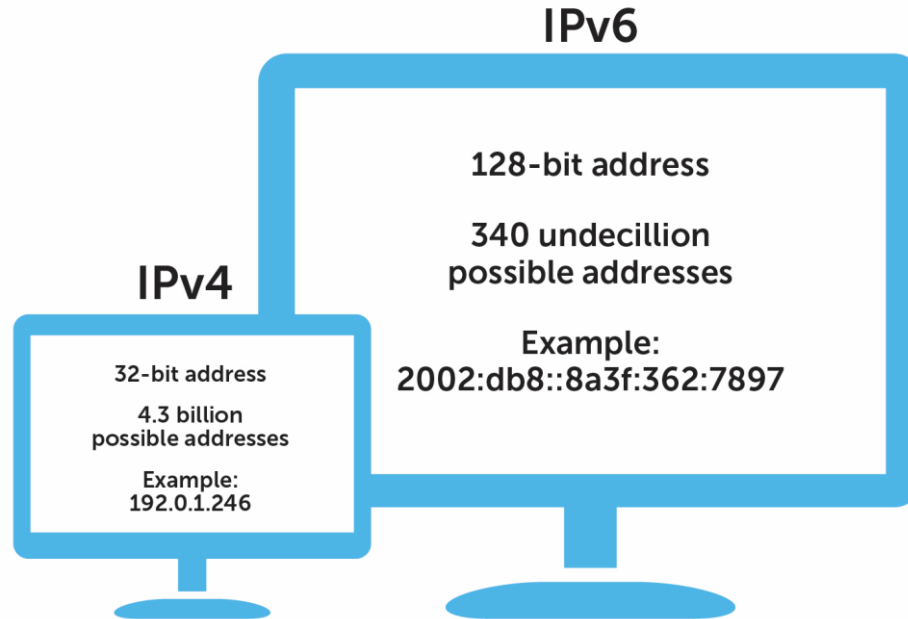
IP Addressing

MAC address vs. IP address

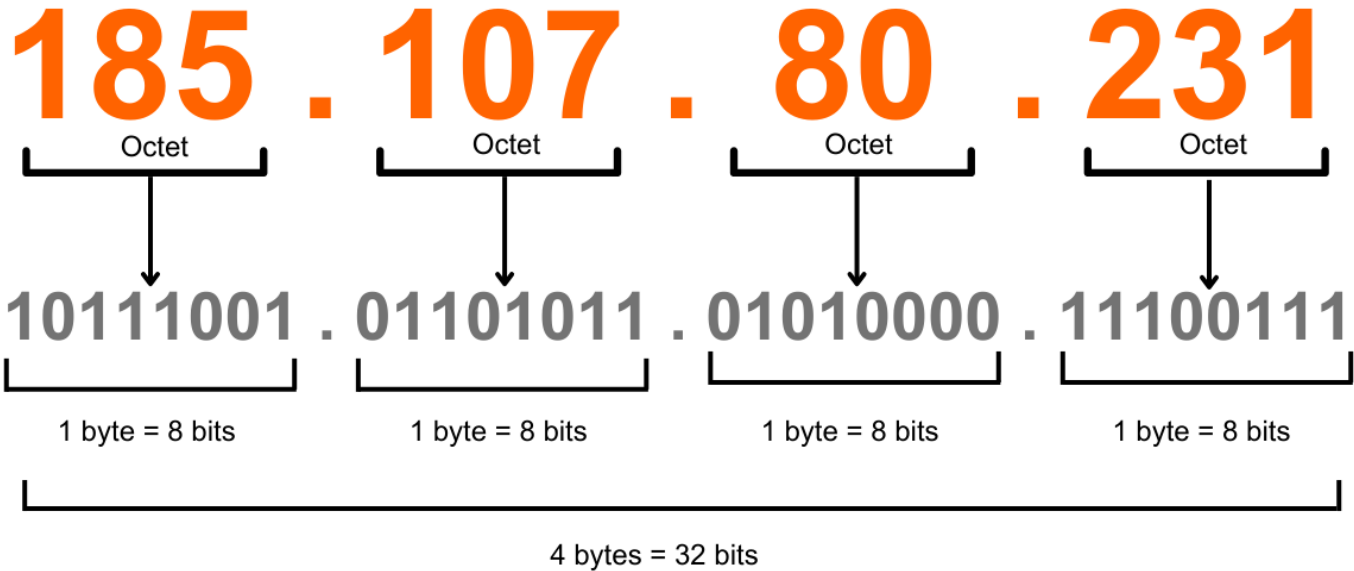
- Layer 2 vs. Layer 3 operation.
- Physical address vs. Logical address.
- Internal vs Internet Communications.
- MAC doesn't support routing.



Internet Protocol address



IPv4



IPv4 and Subnet mask

	1 st Octet	2 nd Octet	3 rd Octet	4 th Octet
Dotted-decimal	192	168	1	4
Binary digits				
Subnet mask	255	255	255	0
Binary digits				

IPv4 and Subnet mask

	1 st Octet	2 nd Octet	3 rd Octet	4 th Octet
Dotted-decimal	192	168	1	4
Binary digits	11000000	10101000	00000001	00000100
Subnet mask	255	255	255	0
Binary digits	11111111	11111111	11111111	00000000

IP Calculator

Network: ?

The first IP add: ?

The last IP add: ?

Broadcast: ?

Hosts / Nodes: ?



Address: 192.168.0.15

Netmask: 255.255.255.0

Class	1 st Octet Value	Default Subnet Mask				Possible Hosts
A	1-127	255	0	0	0	16.7 million (256 x 256 x 256)
		N	H	H	H	
B	128-191	255	255	0	0	65,536 (256 x 256)
		N	N	H	H	
C	192-223	255	255	255	0	256
		N	N	N	H	
D	224-239	-				-
E	240-255	-				268 million (reserved)

XXXXXXXXX.XXXXXXXXXX.XXXXXXXXXX.XXXXXXXXXX

Types of IPv4 address

1. Public (Routable)
2. Private (Non-routable)

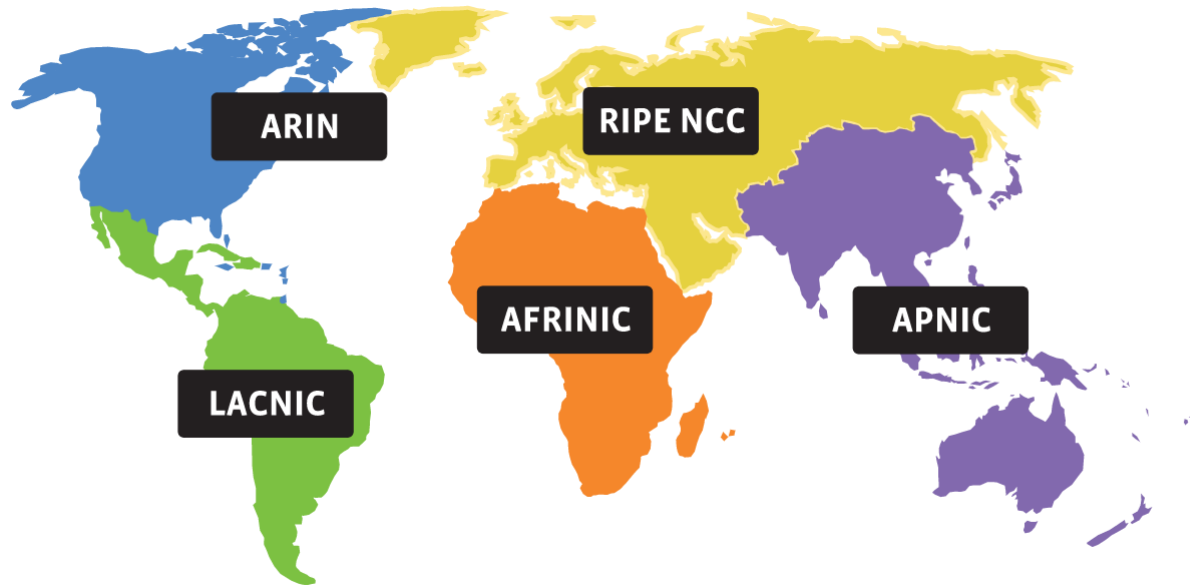
Internet Corporation for Assigned Names and Numbers

- The Internet Assigned Numbers Authority (IANA) is a department of ICANN that is responsible for maintaining the registries of the Internet's unique identifiers, which include **domain names, Protocol Parameters, and Internet numbers (IP Addresses and Autonomous System Numbers).**



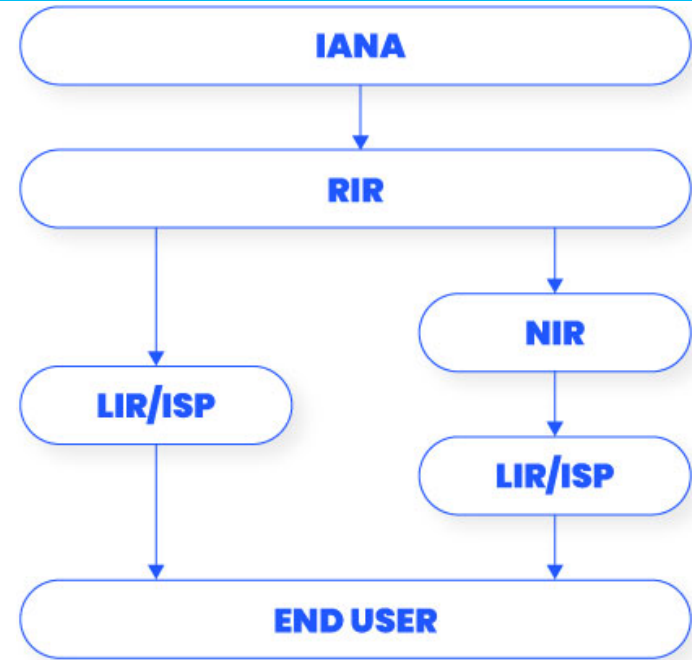
One World, One Internet

Both IPv4 and IPv6 addresses are generally assigned hierarchically



Both IPv4 and IPv6 addresses are generally assigned hierarchically

- Users are assigned IP addresses by Internet service providers (ISPs). ISPs obtain allocations of IP addresses from a local Internet registry (LIR) or National Internet Registry (NIR), or their appropriate Regional Internet Registry (RIR).



Private (Non-routable)

Class	Starting Value	IP Range	Possible Hosts
A	10	10.0.0.0-10.255.255.255	16.7 million (256 x 256 x 256)
B	172.16-172.31	172.16.0.0-172.31.255.255	1.05 million (16 x 256 x 256)
C	192.168	192.168.0.0-192.168.255.255	65,536 (256 x 256)

<https://www.rfc-editor.org/rfc/rfc1918.html>

Loopback Address

- 127.0.0.1 or Localhost



Assigning IPv4 Addresses

- Static
- Dynamic
 - BOOTP
 - DHCP
 - APIPA
 - ZEROCONF

Bootstrap Protocol (BOOTP)

- Dynamically assigns IP addresses and allows a workstation to load a copy of its boot image over the network.

Dynamic Host Configuration Protocol (DHCP)

- DHCP is the modern implementation of BOOTP.
- Each IP is leased for a while and returns to the pool when the lease expires.



Automatic Private IP Addressing (APIPA)

- Used when a device does not have a static IP address or cannot reach a DHCP server.
- **169.254.0.0 to 169.254.255.255**
- ipconfig (Windows)
ifconfig (Mac, Linux)

```
C:\>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet0:

    Connection-specific DNS Suffix  . : 
    Autoconfiguration IPv4 Address. . : 169.254.6.2
    Subnet Mask . . . . . : 255.255.0.0
    Default Gateway . . . . . : 
    Media State . . . . . : 
    Connection-specific DNS Suffix  . :
```

Zero Configuration (ZeroConf)

- A newer technology based on APIPA provides many of the same features and some new ones.
- Assign an IPv4 link-local address to a client.
- Resolve computer names to IP addresses without needing DNS by using mDNS (multicast domain name service).

Zero Configuration (ZeroConf)

- Apple products
 - Bonjour
- Windows
 - Link-Local Multicast Name Resolution (LLMNR)
- Linux
 - SystemD

Binary \leftrightarrow Decimal

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)

Subnetting

Address Class	Default Subnet Mask	Assignable IP Calculation	Assignable IP Addresses
Class A	255.0.0.0	$2^{24} - 2 =$	16,777,214
Class B	255.255.0.0	$2^{16} - 2 =$	65,534
Class C	255.255.255.0	$2^8 - 2 =$	254



Subnetting

10.0.0.0 /8 (16.7 million)

10.0.0.0/24 (256 IPs)

10.0.1.0/24 (256 IPs)

10.0.2.0/24 (256 IPs)



Classless Interdomain Routing (CIDR)

- It allows routers to combine routes together.
- It utilizes the concept of supernetting.

192.168.0.0/24

192.168.1.0/24

192.168.2.0/24

192.168.3.0/24

192.168.0.0/?

Let's Practice!

172.16.0.0 /24

172.17.0.0 /24

172.18.0.0 /24

.

.

.

172.31.0.0/24

Let's Practice!

■ شبکه 192.168.1.0/24 را به 4 زیر شبکه مساوی تقسیم نمایید؟

■ شبکه 192.168.1.0/24 را به 4 زیر شبکه با تعداد 30 عدد IP قابل استفاده تقسیم نمایید؟

Variable–Length Subnet Mask (VLSM)

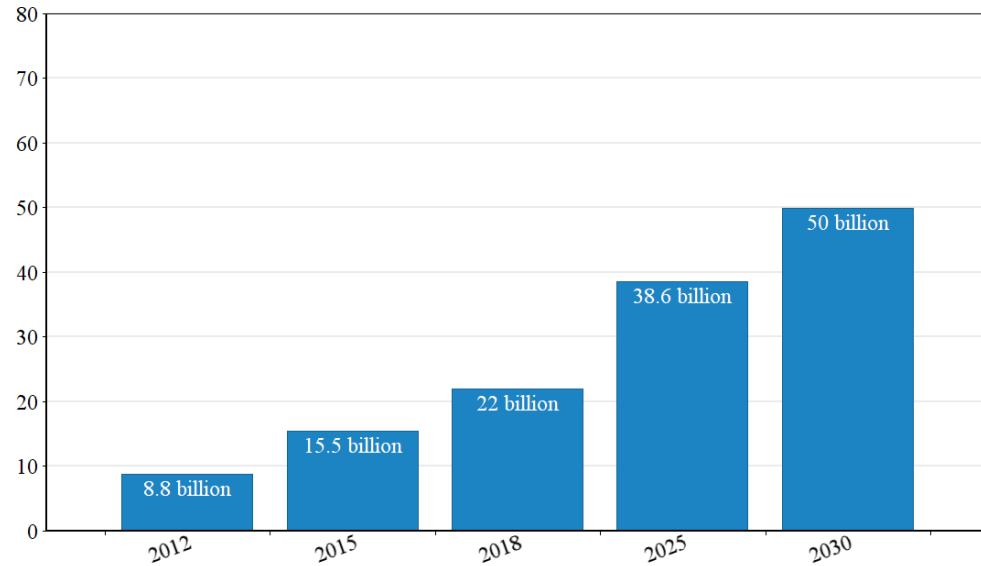
- It helps in the optimization of available address space.
- It utilizes the concept of subnetting.





There are 10 types of people in the world.
Those who understand binary and those who don't.

Expected number of connected devices on the Internet by 2030



Number of connected devices

Source: statista.com

Why IPv6 came after IPv4?

- IPv5 was created for experimental reasons, specifically for video and voice transmissions. Big companies such as Apple and Sun experimented with it but it never came to be. Later, the work done on IPv5 was used as a groundwork for today's VoIP protocols.

Differences between IPv4 and IPv6

IPv4

Address Size:

32-bit number

Address Format:

Dotted Decimal Notation:

192.168.1.1

Prefix Notation:

255.255.255.0

/24

Number of addresses:

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

IPv6

Address Size:

128-bit number

Address Format:

Hexadecimal Notation:

fe80::94db:946e:8d4e:129e

Prefix Notation:

/64

Number of addresses:

$2^{128} =$

340,282,366,920,938,463,374,607,
431,768,211,456

IPv4 Header vs IPv6 Header





IPv6 Header

Version	Traffic Class	Flow Label	
Payload Length		Next Header	Hop Limit
Source Address			
Destination Address			

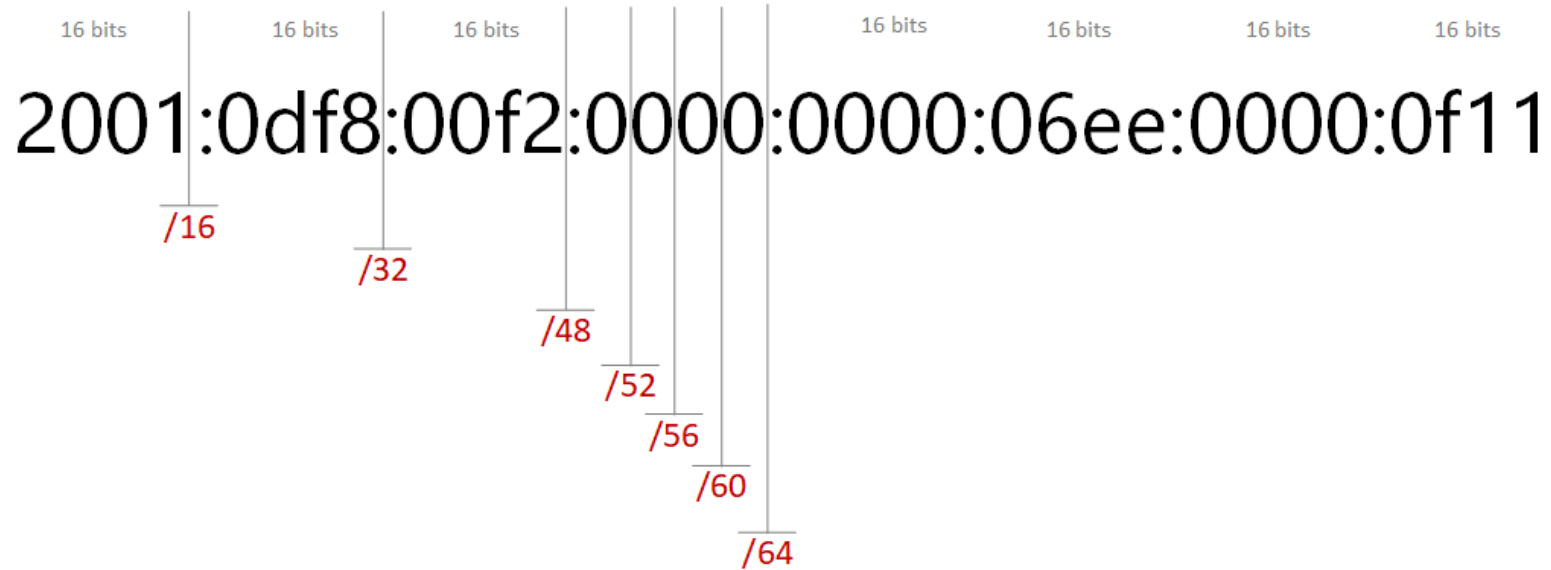
IPv4 Header

Version	IHL	Type of Service	Total Length			
Identification			Flags	Fragment Offset		
TTL	Protocol		Header Checksum			
Source Address						
Destination Address						
Options			Padding			

Legend

-  Fields **kept** in IPv6
-  Fields **kept** in IPv6, but name and position changed
-  Fields **not kept** in IPv6
-  Fields that are **new** in IPv6

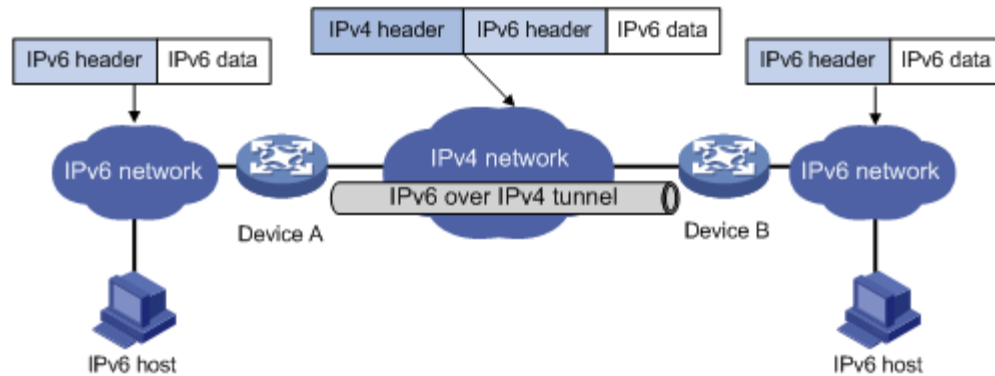
IPv6 Prefix Notation



IPv6 can coexist with IPv4 (Dual Stack)



Tunneling



IPv6

- 2001:0000:0000:0000:00ab:0000:0000:0c45
- 2001:0000:0000:0000:00ab:0000:0000:0c45
- 2001:0:0:0:ab:0:0:c45
- 2001:0:0:0:ab:0:0:c45
- 2001::ab:0:0:c45 or 2001:0:0:0:ab::c45

Which of the following is an IPV6 address?

1. 12:34:56:78:90:ab
2. 1234::5678:90ab

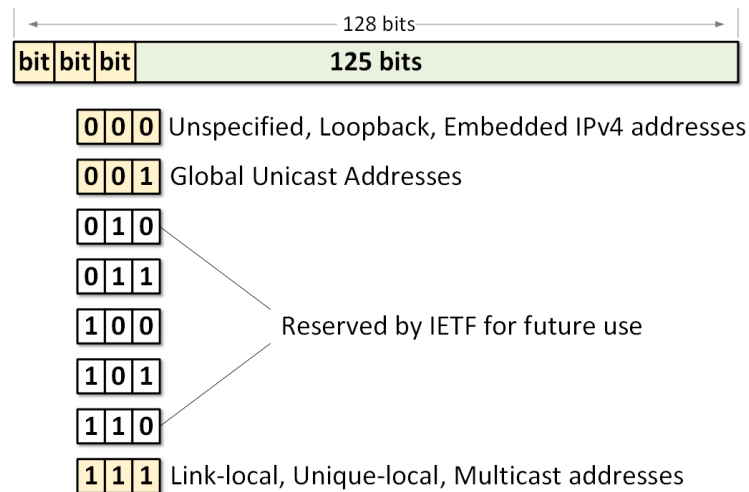
IPv6 address communication

- Unicast
- Multicast
 - FF02::1 All Nodes Address
 - FF02::2 All Routers Address
- Anycast



Types of IPv6 Addresses

- Unicast
 - Global Unicast (2000::/3)
 - Unique Local (FC00::/7)
 - Link-Local (FE80::/10)
- Multicast Address (ff00::/8)



Loopback

- ::1/128

There are three methods to configure a host with an IPv6 address:

1. Configure the host manually.
2. Using SLAAC and a Stateless DHCPv6 server.
3. Using a Stateful DHCPv6 server.

Stateless Address Autoconfiguration (SLAAC)

1. Take the interface's MAC address (for this example 7007.1234.5678):

70 07 . 12 34 . 56 78

2. Insert 0xFFFE in the middle of the MAC address:

70 07 . 12 FF FE 34 . 56 78

3. Flip the 7th bit of the MAC address. (Note that the MAC is written in HEX, to flip the 7th bit we must convert the first two HEX digits to BINARY):

70 07 12 FF FE 34 56 78

To binary

01110000

Flip the 7th bit

01110010

To HEX

72 07 12 FF FE 34 56 78

Stateless Address Autoconfiguration (SLAAC)

4. Combine the link-local prefix with the EUI-64 identifier:

FE80::	72	07	12	FF	FE	34	56	78
--------	----	----	----	----	----	----	----	----



The resulting IPv6 link-local address for this interface is:

FE80::7207:12FF:FE34:5678/64

Windows and EUI-64



Randomize Identifiers
Disabled

Link-local address created from:

FE80::/64	EUI-64
-----------	--------



Randomize Identifiers
Enabled by default

Link-local address created from:

FE80::/64	Random 64-bits
-----------	-------------------

We can check this using the

PowerShell command **get-netipv6protocol** or using

netsh interface ipv6 show global in the Windows Command Prompt

Windows and EUI-64

We can use the following command in PowerShell to change the default behavior of a Windows host and disable the Randomize Identifiers. Disabling this feature forces Windows to use EUI-64 for Interface ID.

set-netipv6protocol -RandomizeIdentifiers Disabled

DHCPv6

- Stateless DHCPv6
- Stateful DHCPv6



عباس ولی زاده

مدرس دوره های شبکه و امنیت