IP Addresses and Host-to-host Communication part 1

Lecture 2

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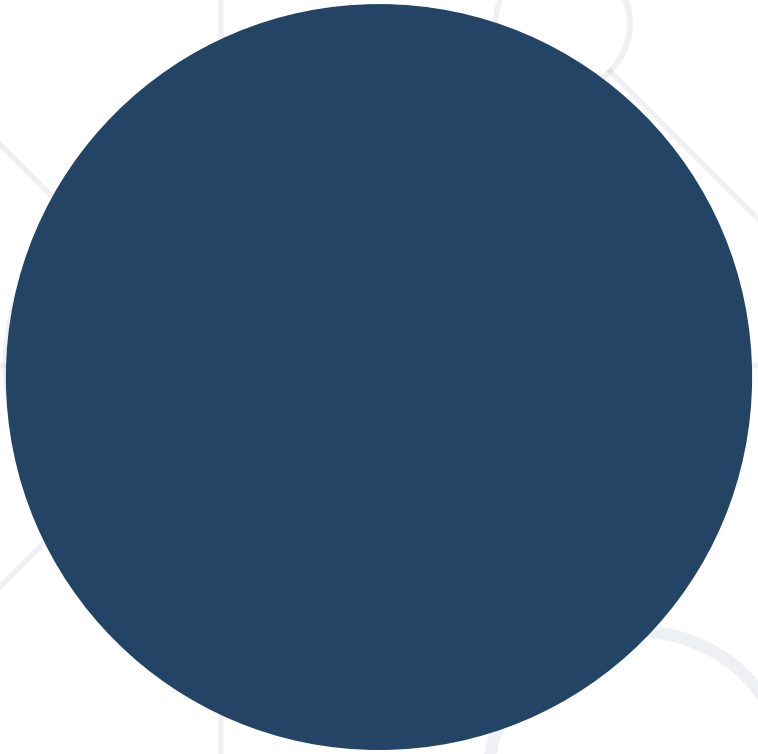


Binary, decimal and hexadecimal numbers

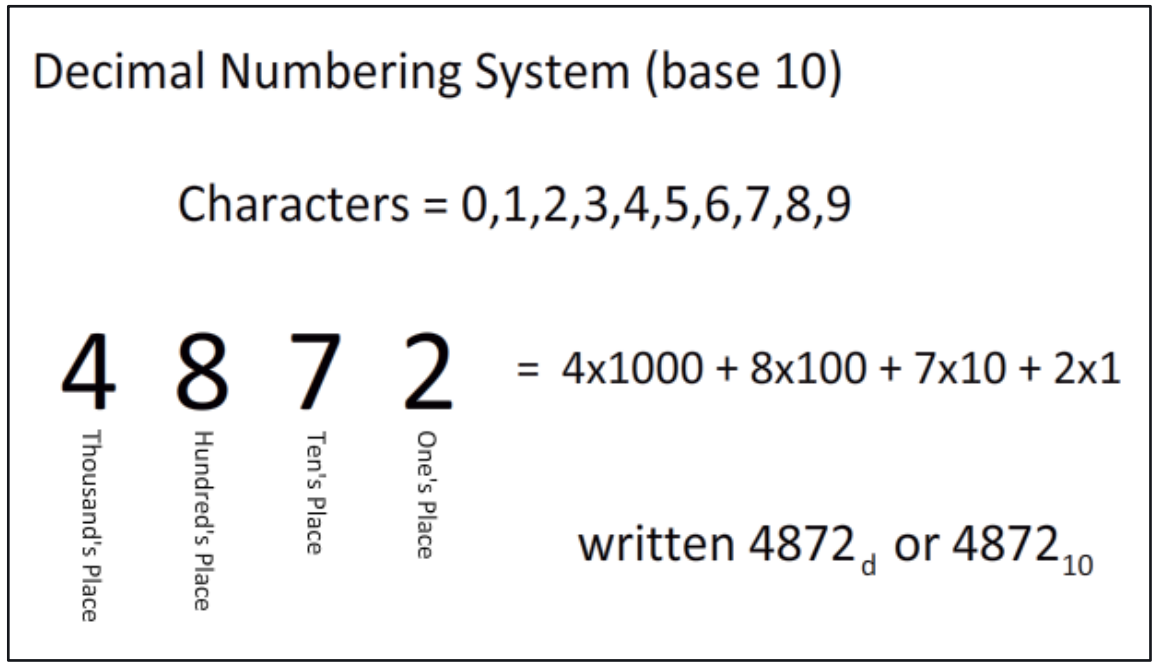
Different numeral systems

Hexadecimal	Binary	Decimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
A	1010	10
B	1011	11
C	1100	12
D	1101	13
E	1110	14
F	1111	15

Common Numeral Systems in Computer Networking:

- Decimal
- Binary
- Hexadecimal

Decimal Numeral System



- Base of 10
- Called decimal or denary
- A single digit can be:
  0 1 2 3 4 5 6 7 8 9

In this example:

$2x10^0 + 7x10^1 + 8x10^2 + 4x10^3 =$

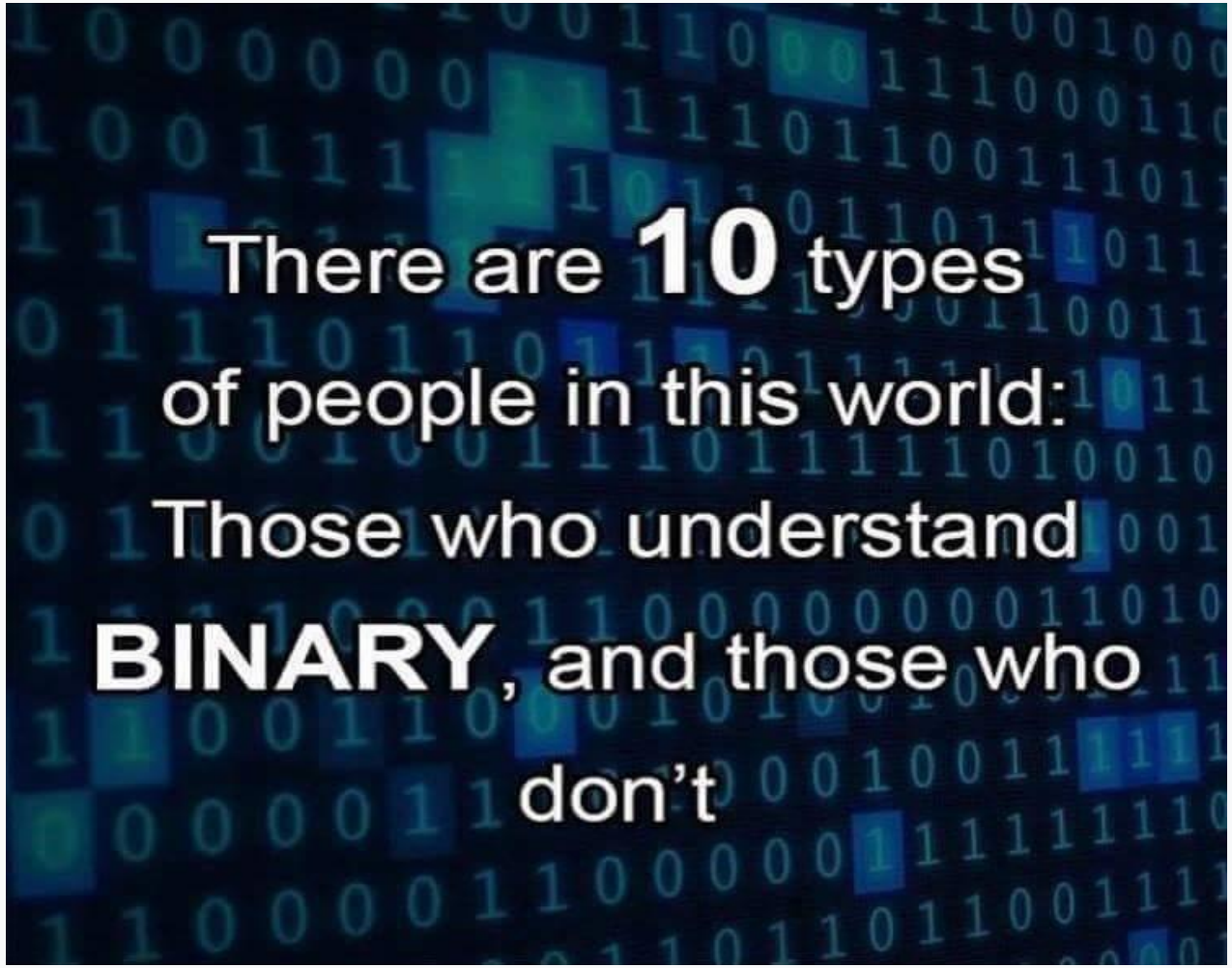
$2 + 70 + 800 + 4000 = 4872$

Binary Numeral System

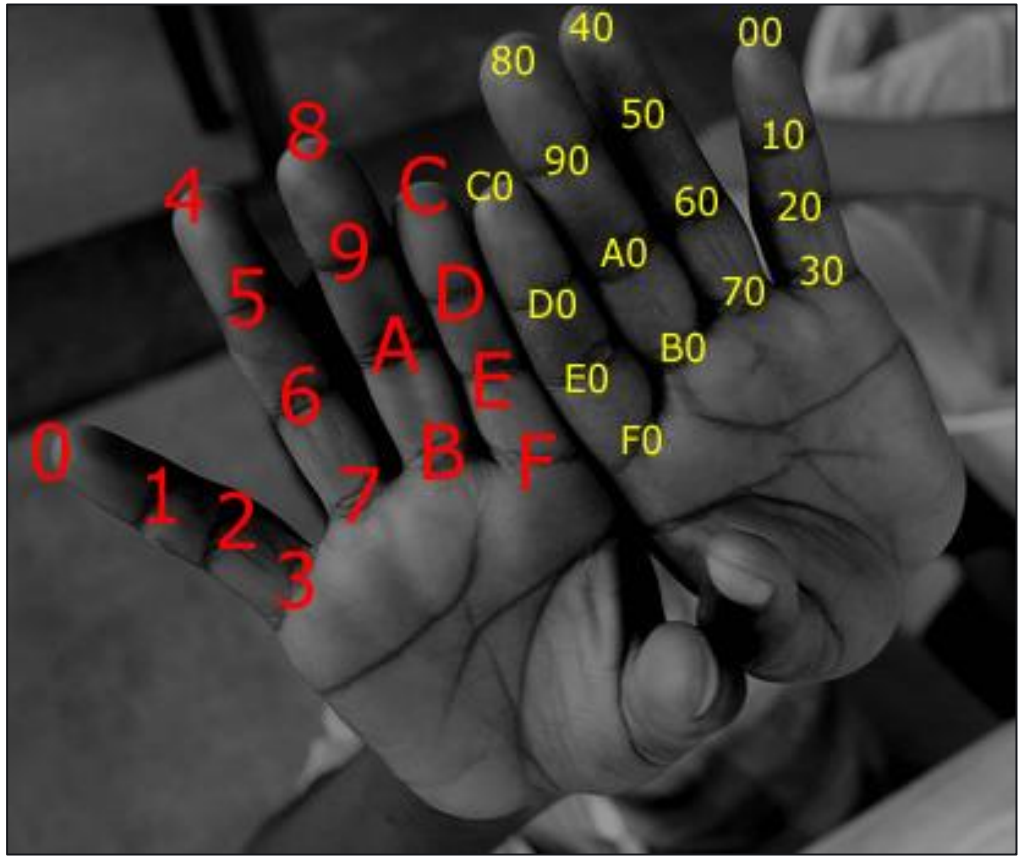
Decimal number	Binary number
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010

- Base of 2
- Used in computers and all computer-based devices
- Each digit is referred to as a bit
- A single digit (bit) can be either
  0 or 1

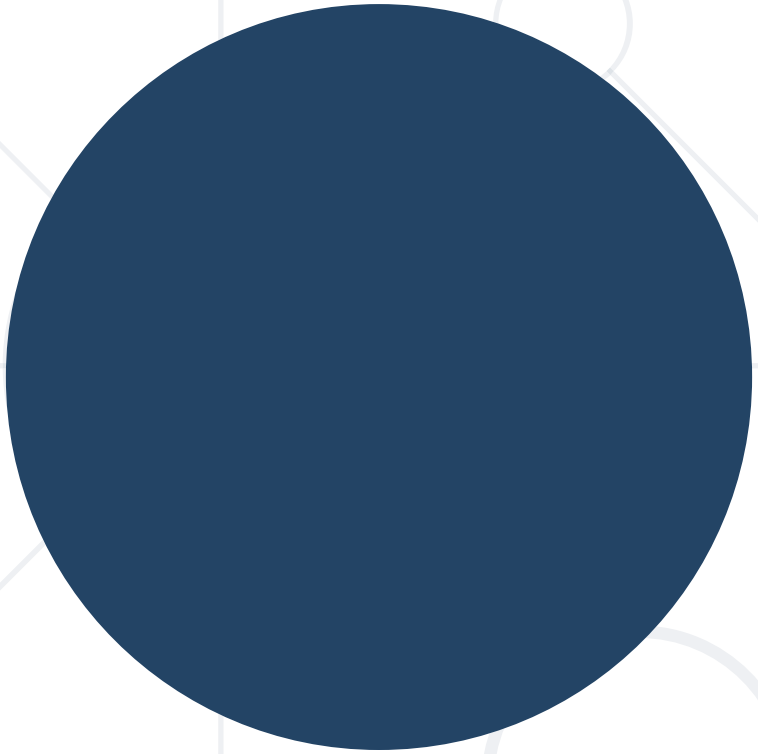
Binary joke


There are 10 types
of people in this world:
Those who understand
BINARY, and those who
don't

Hexadecimal numeral system

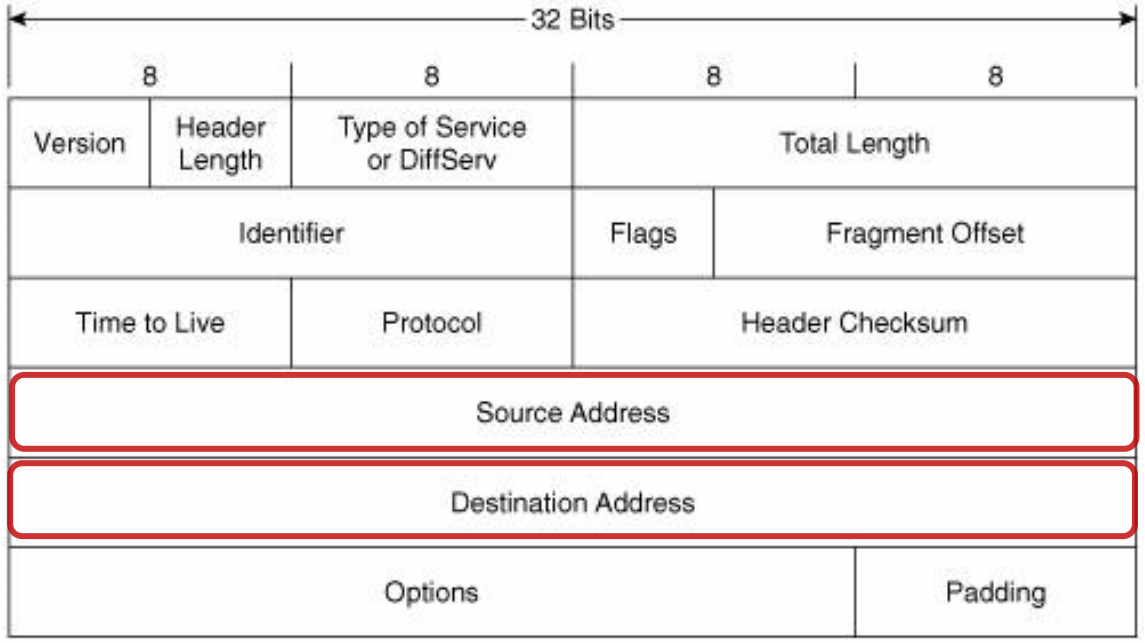


- Base of 16 (made of 16 symbols)
- Widely used by programmers and computer designers
- Used in MAC and IPv6 addresses
- A single digit can be:
  0 1 2 3 4 5 6 7 8 9 A B C D E F



IPv4

IPv4 address



- Plays important role for device connectivity
- It is a 32-bit address
- There are
  4 294 967 296
  IP addresses (2^{32})

Private IP addresses

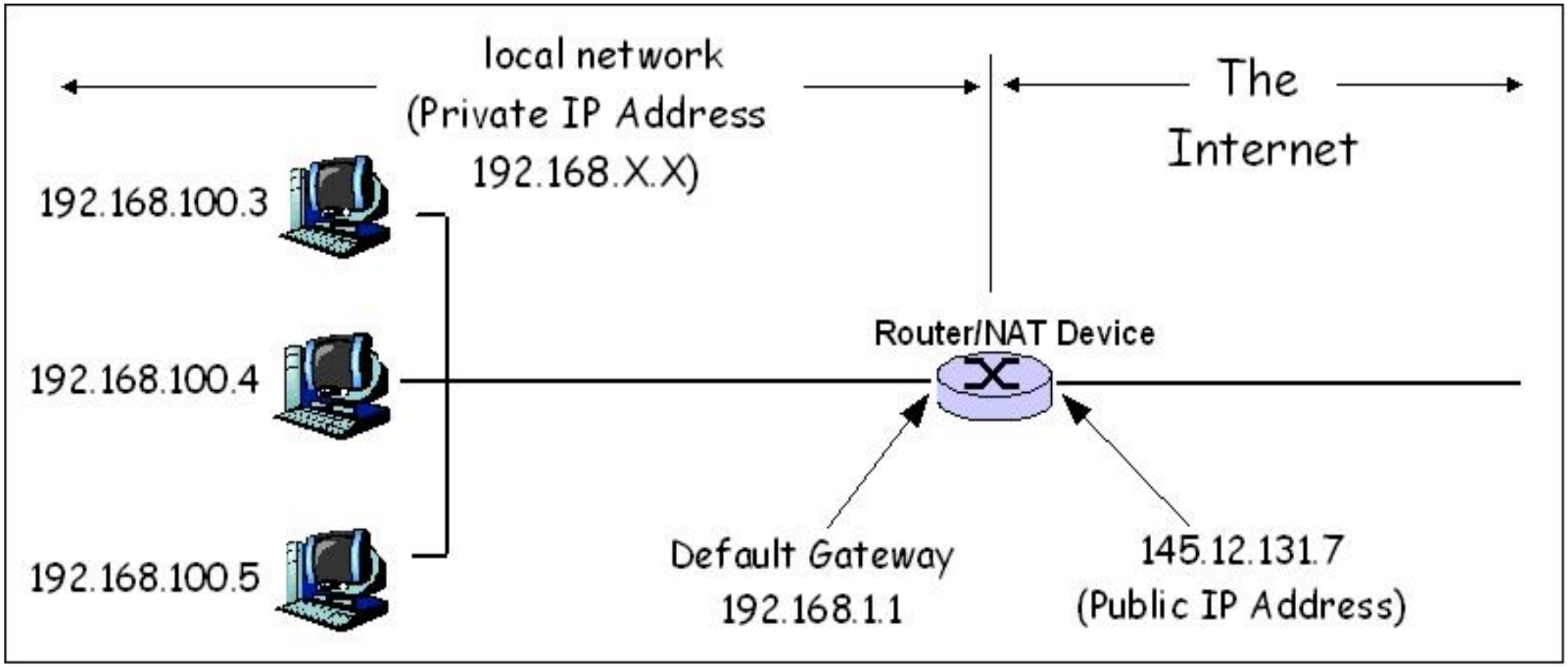
Class	Start of range	End of range
A	10.0.0.0	10.255.255.255
B	172.16.0.0	172.31.255.255
C	192.168.0.0	192.168.255.255

- Used for addressing internal networks (offices, HQs etc.)
- Not routable on the Internet
- Can be reused in many networks
- Range of private addresses for each class

Public IP addresses

- Are not reserved for use in private networks
- Globally routed between ISP routers
- They are unique
- Example: 87.20.114.156

Network Address Translation – NAT



Network Address Translation – NAT (2)

- It is a method of translating one IP address into another

Example : 192.168.17.45 ---> 227.206.89.76

Private

Public

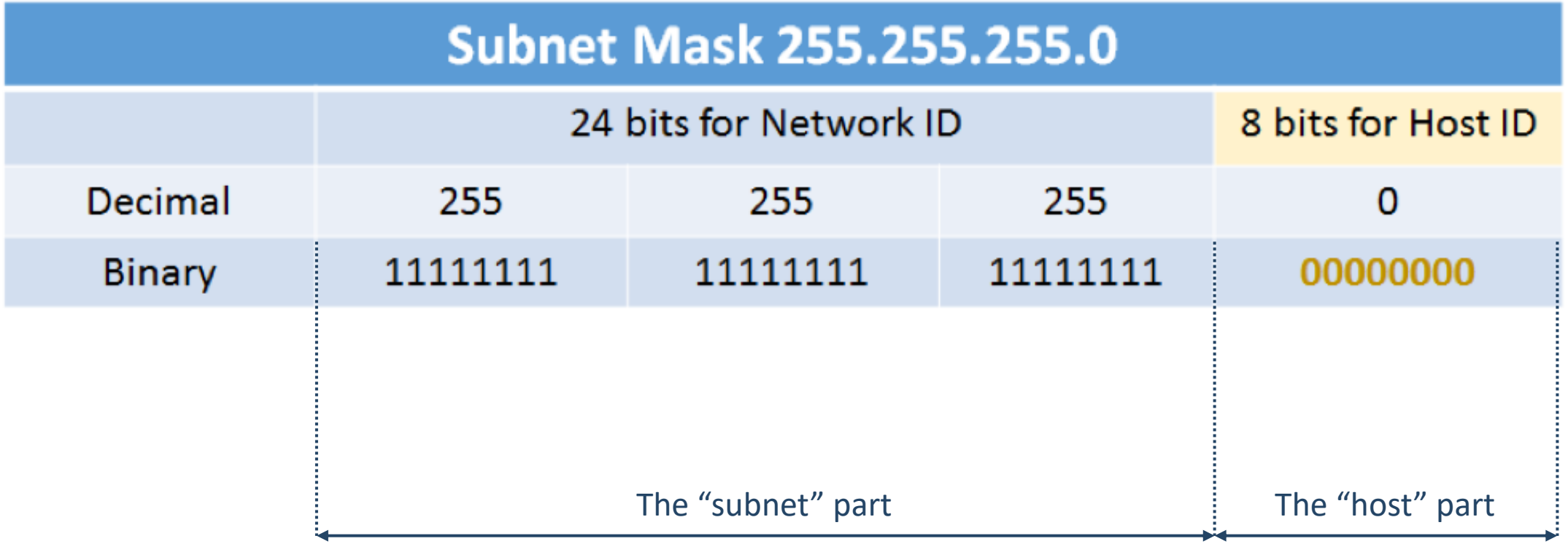
Network masks

IP address: 50.211.197.5
Subnet Mask: 255.0.0.0

	IP network	Host Addresses		
IP address	**50.**	211.	197.	5
Subnet Mask	**255.**	0.	0.	0

- Define the border between the network and the hosts part
- Segment the network

Network masks (24-bit mask)



Network masks (26-bit mask)

Subnet Mask 255.255.255.192				
	26 bits for Network ID			6 bits for Host ID
Decimal	255	255	255	192
Binary	11111111	11111111	11111111	11000000

Network masks – example 1

(Class A example)

- In decimal: 255.0.0.0
- Same mask written with prefix: /8
- Same mask written in binary:

11111111.00000000.00000000.00000000

One byte full of 1's.
No address space

Three more bytes full of 0's. This is 2^{24} - 2 or 16 million computers

Network masks – example 2

(Class B example)

- In decimal: 255.255.0.0
- Same mask written with prefix: /16
- Same mask written in binary:

11111111.11111111.00000000.00000000

Two bytes with 0's. This is 2^{16} - 2 or 65534 computers

Network masks – example 3

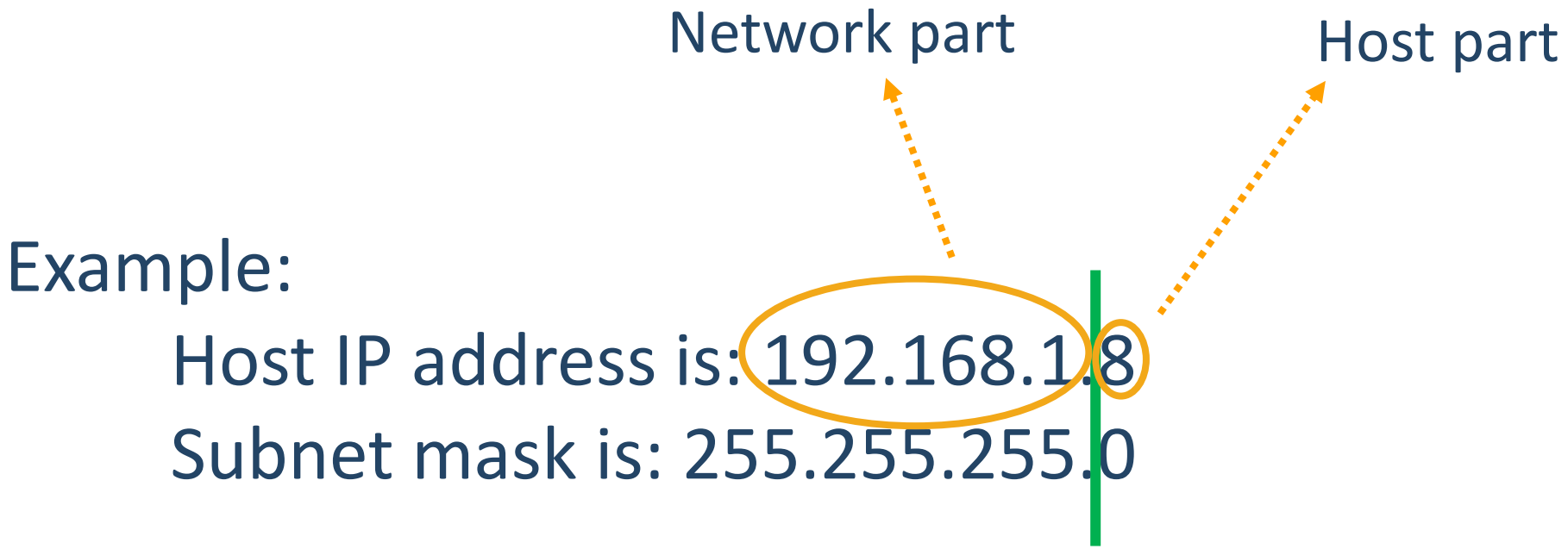
(Class C example)

- In decimal: 255.255.255.0
- Same mask written with prefix: /24
- Same mask written in binary:

11111111.11111111.11111111.00000000

One byte with 0's. This is $2^8 - 2$ or 254 computers

Network masks – IP/Mask example



How many IP addresses for the hosts?

To calculate the number of hosts, use the formula $2^n - 2$ where **n** is the number of bits in the host part

- Example: 192.168.1.0 /24 – how many host addresses?

Answer: We have 8 bits in the host part (n), so:

$2^8 - 2 = 254$

The Network and the Broadcast address

- Two important and special addresses:
  - The network address – first possible address
  - The broadcast address – last possible address

- These can NOT be assigned to hosts

The Network and the Broadcast address (2)

Example:

192.168.1.5 /24

192.168.1.0 is the network address

192.168.1.255 is the broadcast address

A quick challenge

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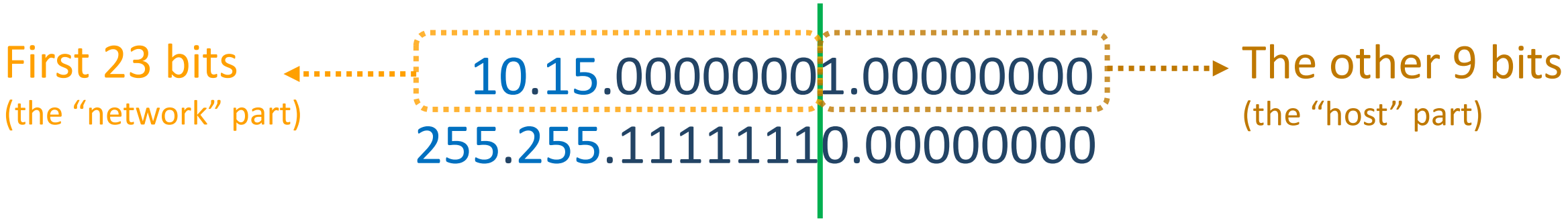
10.15.1.0

Is this a valid HOST IP Address?

A quick challenge (2)

It depends!

Let’s see it with /23 mask. 10.15.1.0 /23 can be presented as:



So, is it a valid host IP Address in this case?

A quick challenge (3)

In the example from the previous slide, which is the first and which is the last possible host address for the subnet to which this IP address belongs?

10.15.1.0 /23

10.15.00000001.00000000

255.255.11111110.00000000

- ✓ 10.15.0.0 is the network address
- ✓ 10.15.0.1 is the first host address
- ✓ 10.15.1.254 is the last host address
- ✓ 10.15.1.255 is the broadcast address

IP address classes

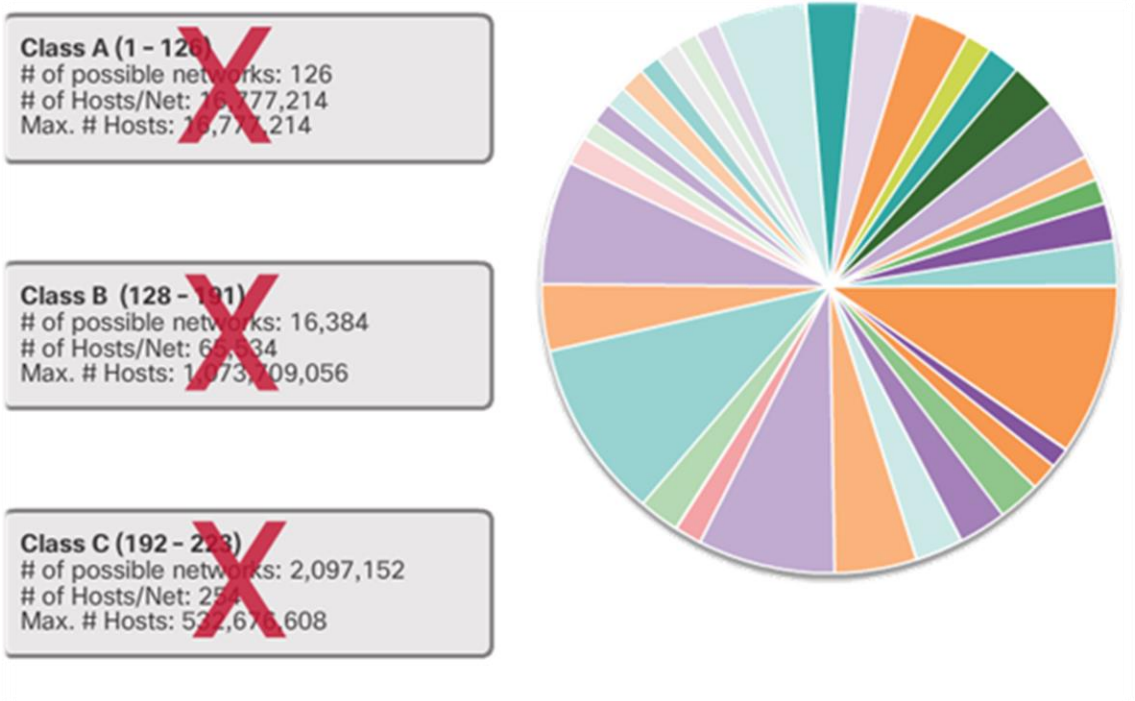
- IP Address class is determined by the first octet (byte)
- Three of them are used for addressing networks

Class A	0 - 127	For internetwork communication
Class B	128 - 191	For internetwork communication
Class C	192 - 223	For internetwork communication
Class D	224 - 239	Reserved for multicasting
Class E	240 - 254	Reserved for research and experiments

IP address classes (2)

- Examples of class **A** addresses
  - 10.0.0.1
  - 127.0.0.1
  - 0.0.0.1
- Examples of Class **B** addresses
  - 172.16.67.8
  - 169.254.x.x
- Examples of Class **C** addresses
  - 192.168.1.5
  - 198.51.100.0

Introduction to CIDR



- CIDR = Classless Inter-Domain Routing
- Ignores the concept Network Address Classes
- Reduces the amount of route advertisements

Without VLSM and CIDR:

10.1.1.0 /24 will be “seen” as 10.0.0.0 /8

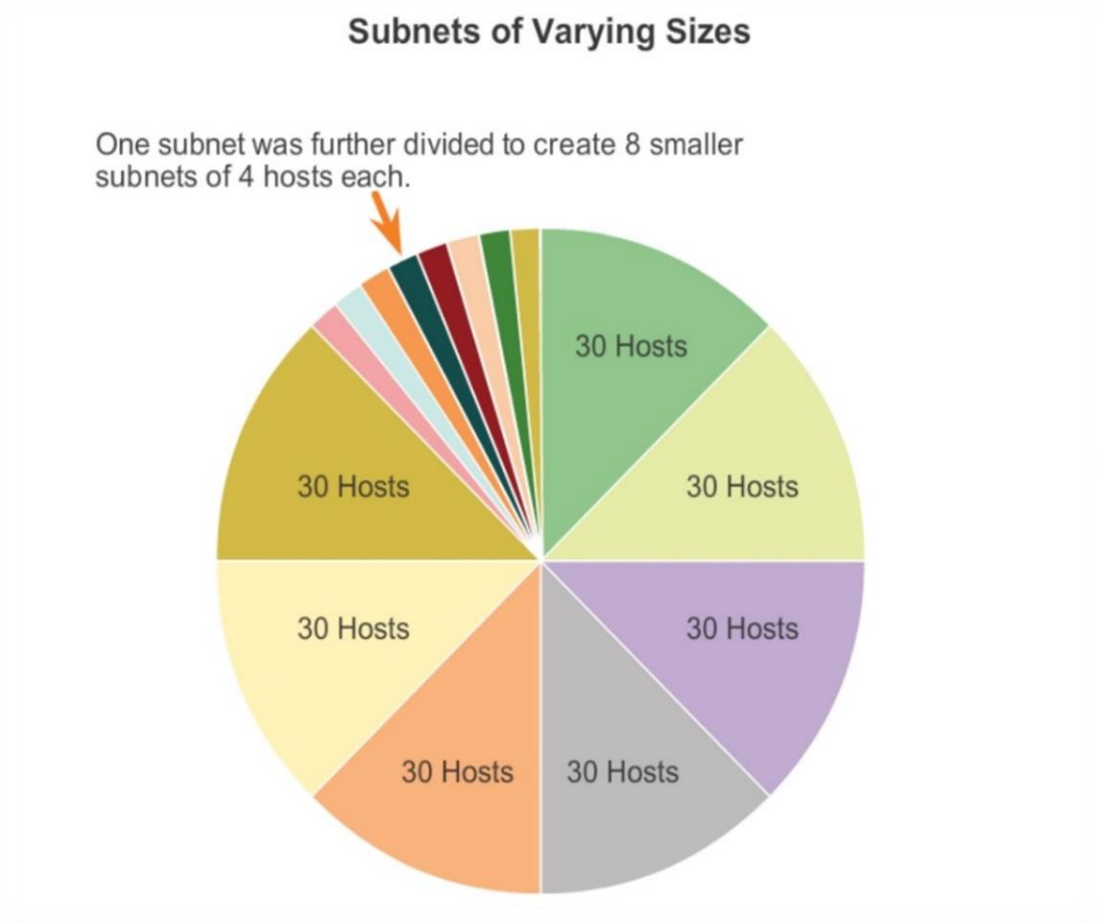
(because /8 is default for Class A)

With VLSM and CIDR:

10.1.1.0 /24 is “seen” as it is

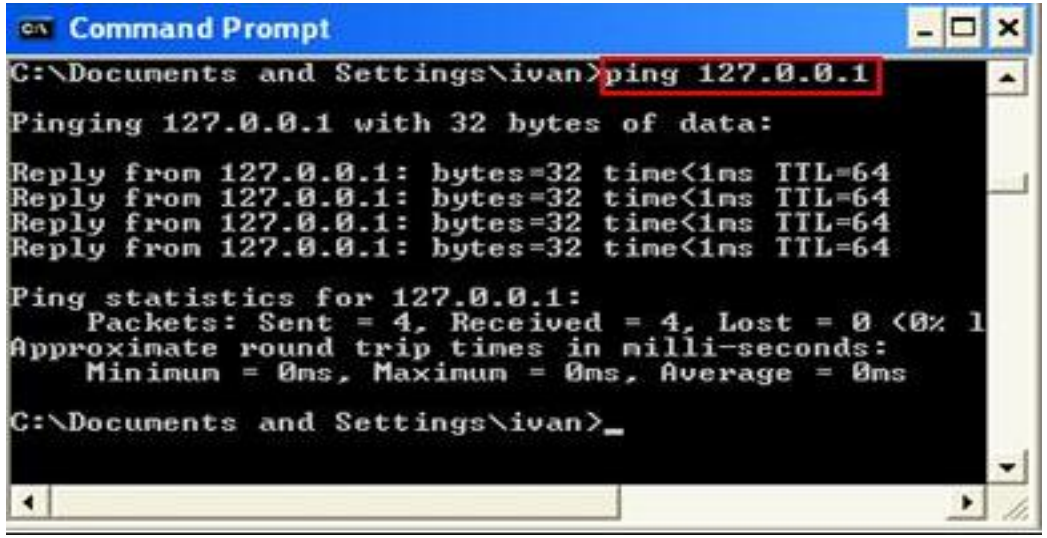
(although the mask is NOT the default)

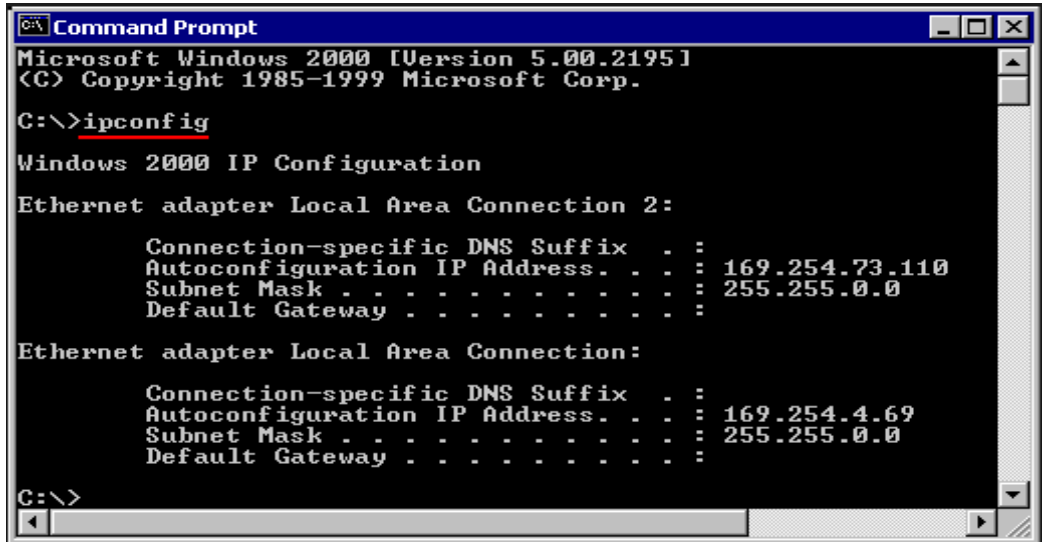
Introduction to VLSM



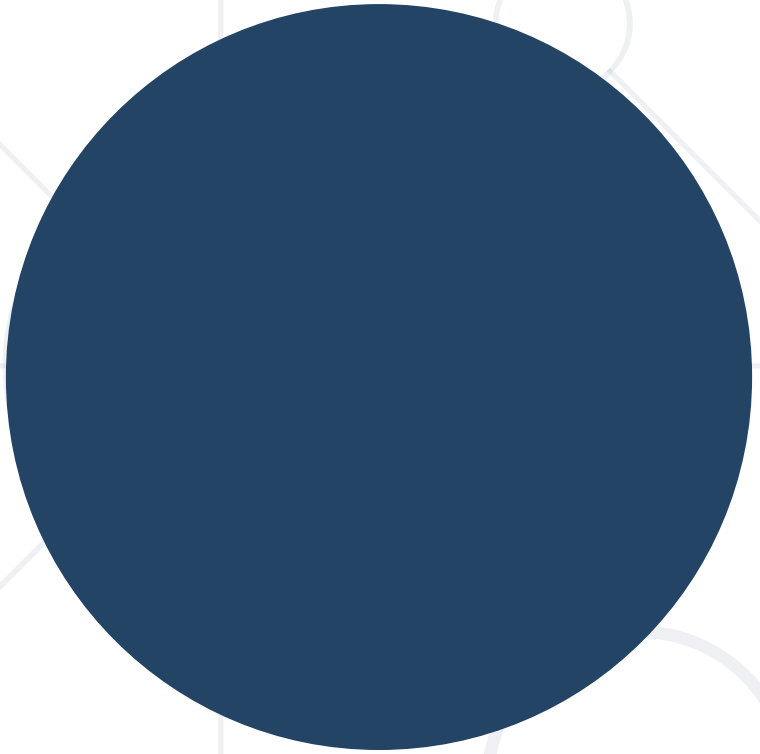
- VLSM: Variable-Length Subnet Masking
- Breaks the IP address classes idea
- “Subnetting of subnets”

Reserved/Special IP addresses





- There are some special IP addresses. For example:
  - 127.0.0.1 /8
    - Known as loopback address
    - On most computer systems, "localhost" resolves to the IP address 127.0.0.1
  - 169.254.X.X /16
    - When DHCP is not reachable
    - Known as APIPA (Microsoft)

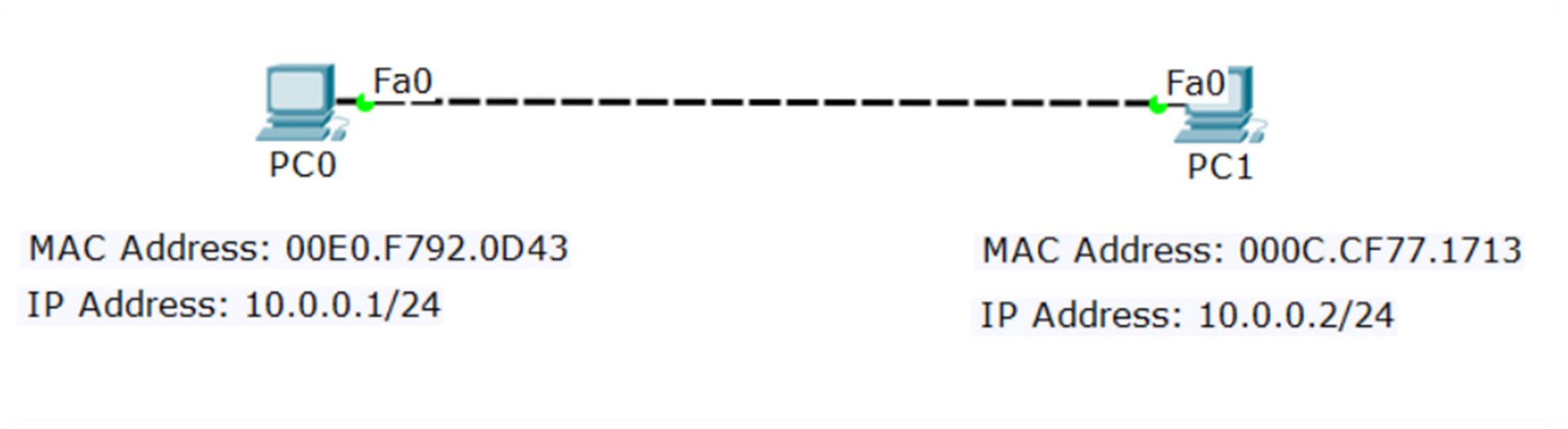


Host-to-host communication without routers

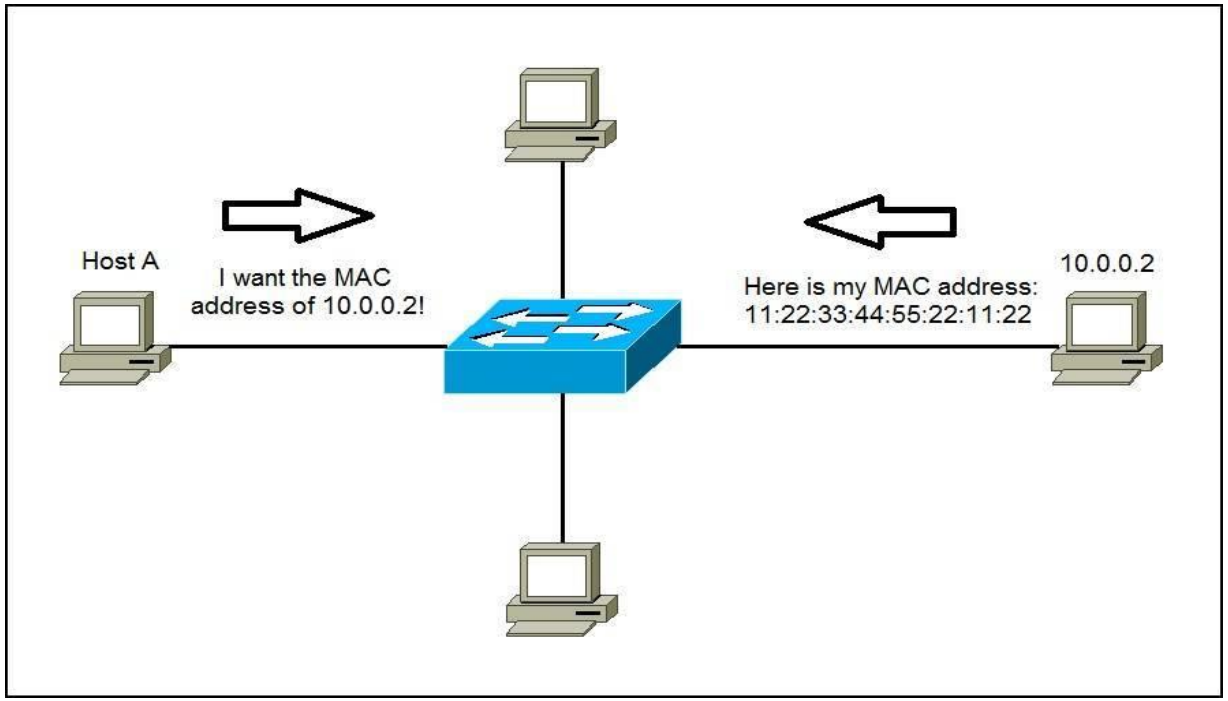
Four addresses required

- There are 4 addresses needed for Ethernet communication:

▪ Source IP	▪ Destination IP
▪ Source MAC	▪ Destination MAC



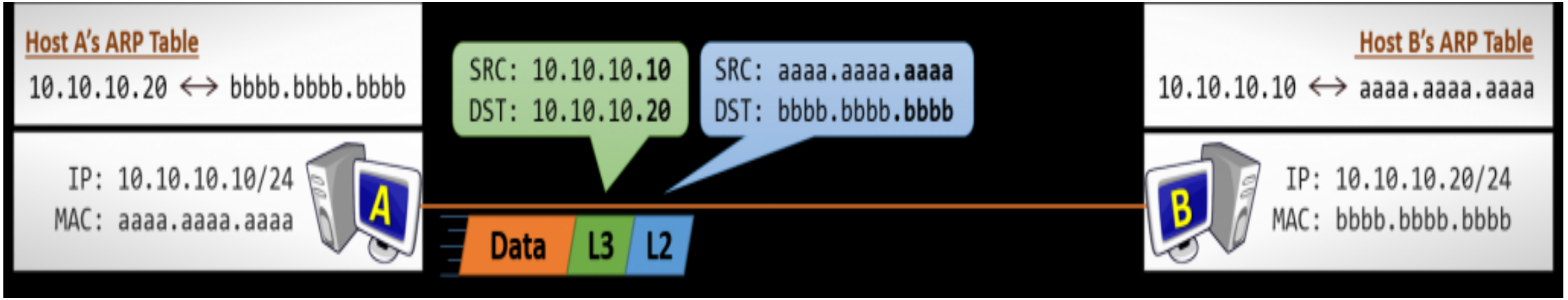
ARP: Address Resolution Protocol

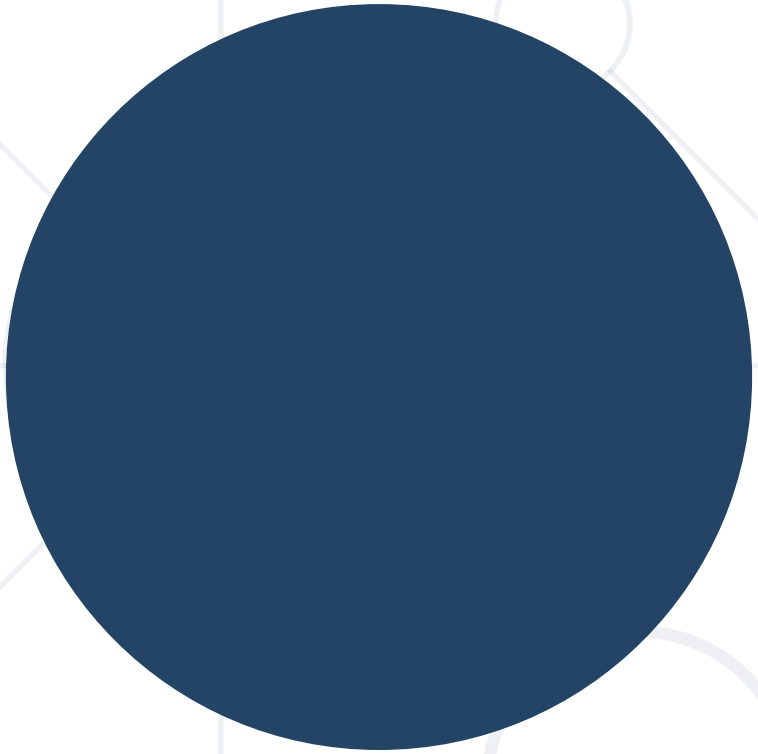


- Used to find the MAC address of the destination
- Uses Broadcast

Direct communication (without router)

- Source and destination MAC addresses are constant
- Source and destination IP addresses are constant





Basic connectivity checks

Basic Connectivity Checks

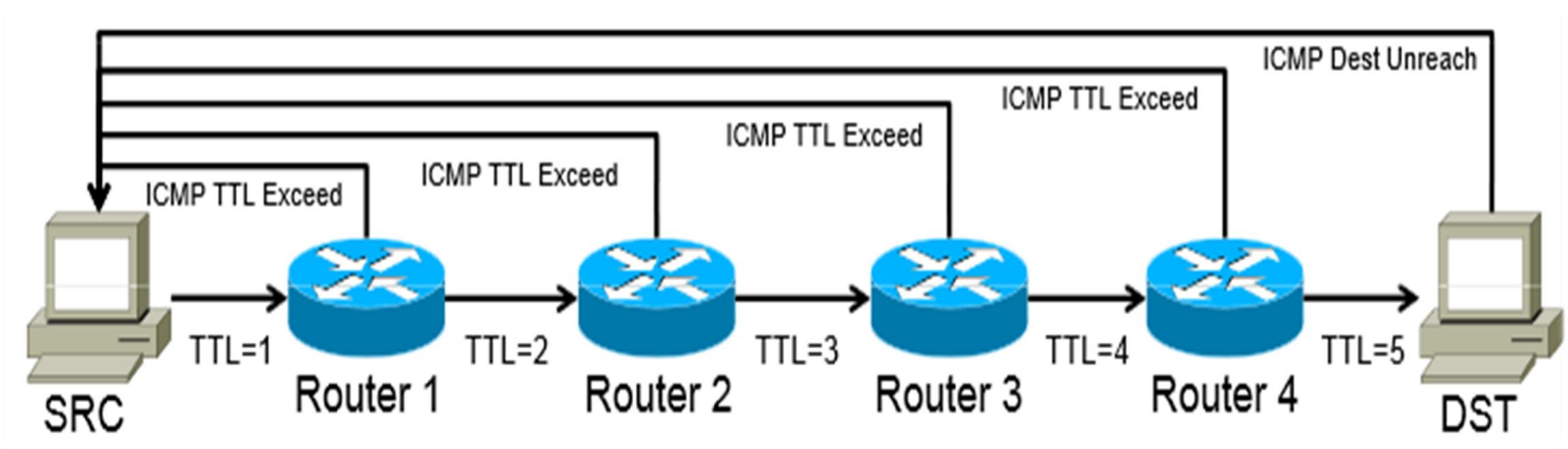
- Ping (Layer 3)
- Traceroute (Layer 3)
- LLDP (Layer 2)
- CDP (Layer 2)

Ping

- Important Layer 3 connectivity check
- Must have IP addresses
- ICMP echo request and ICMP echo reply

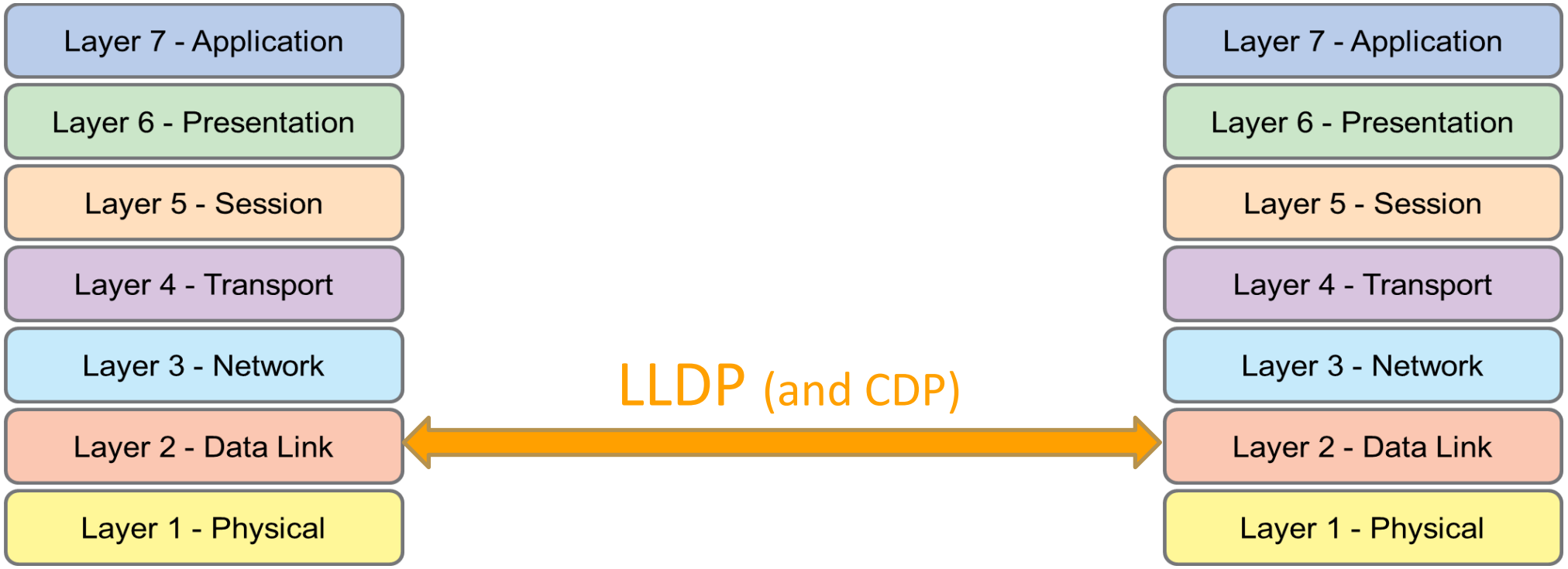
Traceroute

- Another L3 connectivity check
- Uses the TTL (Time to Live) value in the packet
- Can determine the number of hops (routers) in the path



LLDP: Link Layer Discovery Protocol

- Who is connected to me?
- Works at Layer 2
- Must be enabled on both sides
- Vendor-neutral



CDP: Cisco Discovery Protocol

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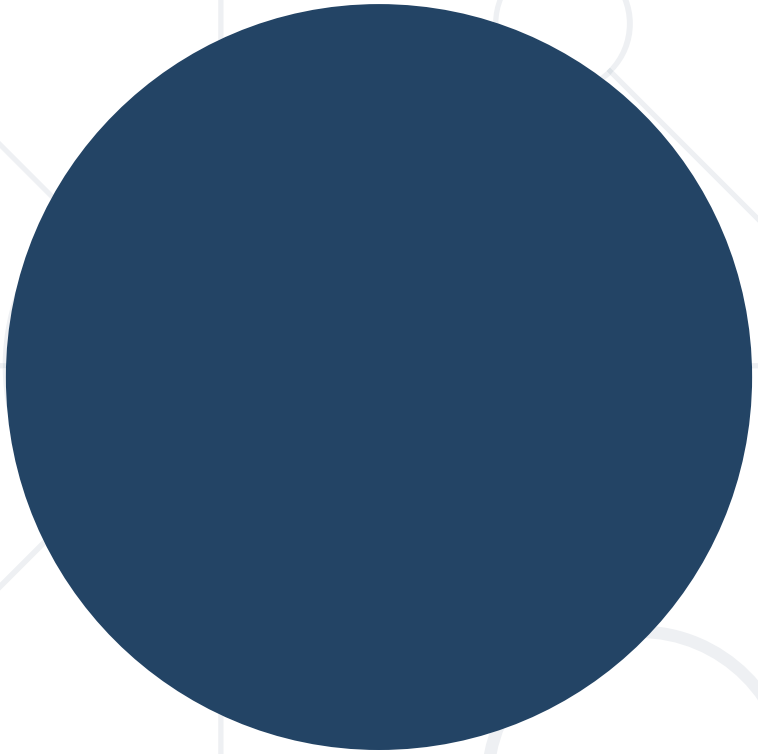
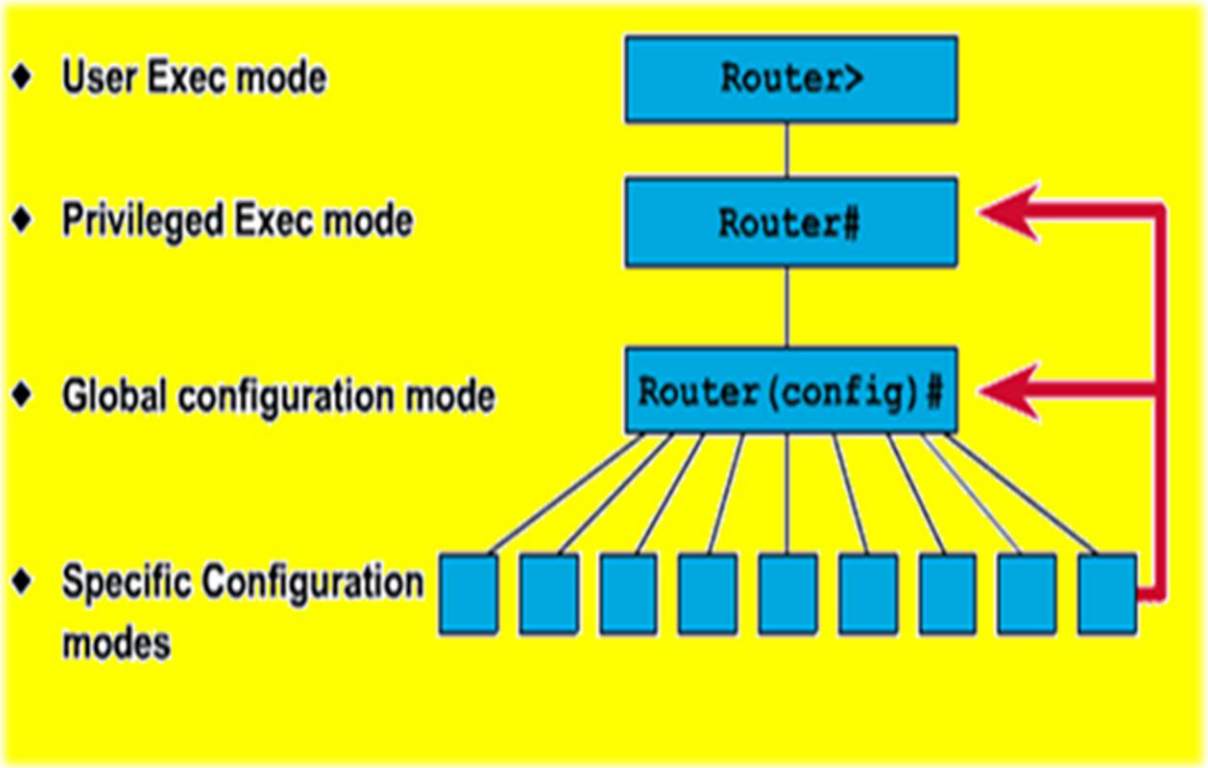
- Cisco proprietary
- Gathers info about other Cisco (CDP) neighbor devices
- Operates at L2
- Turned on default by all Cisco switches and routers



The command line

Command line introduction



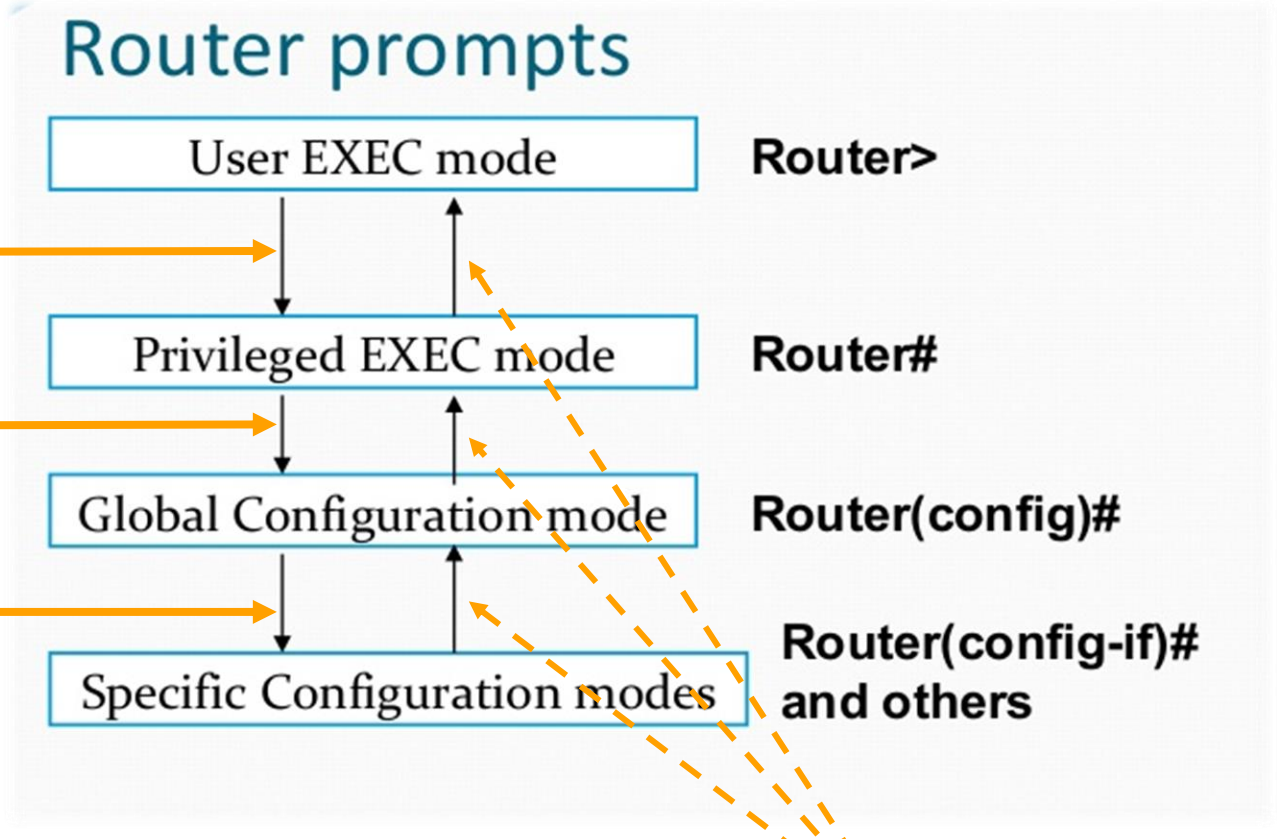
- Different vendors use different names but the logic is similar
- Typical CLI modes:
  - Read-only (User)
  - Read-write (Privilege)
  - Configuration (Global config)
  - Sub-configuration

Command line

type “enable”

type “configure terminal”

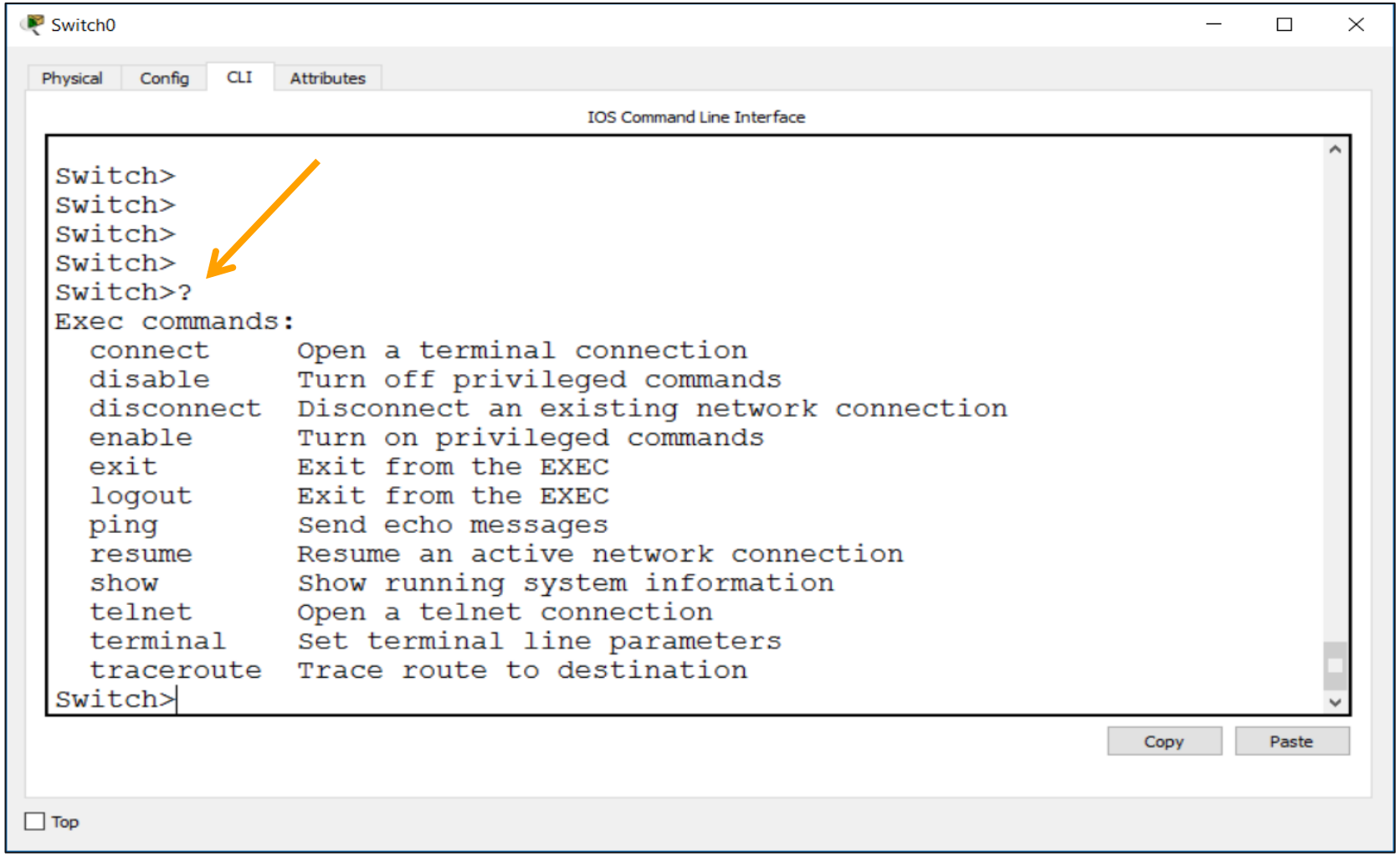
Interface, VLAN, routing, etc.



to go back, type “exit”

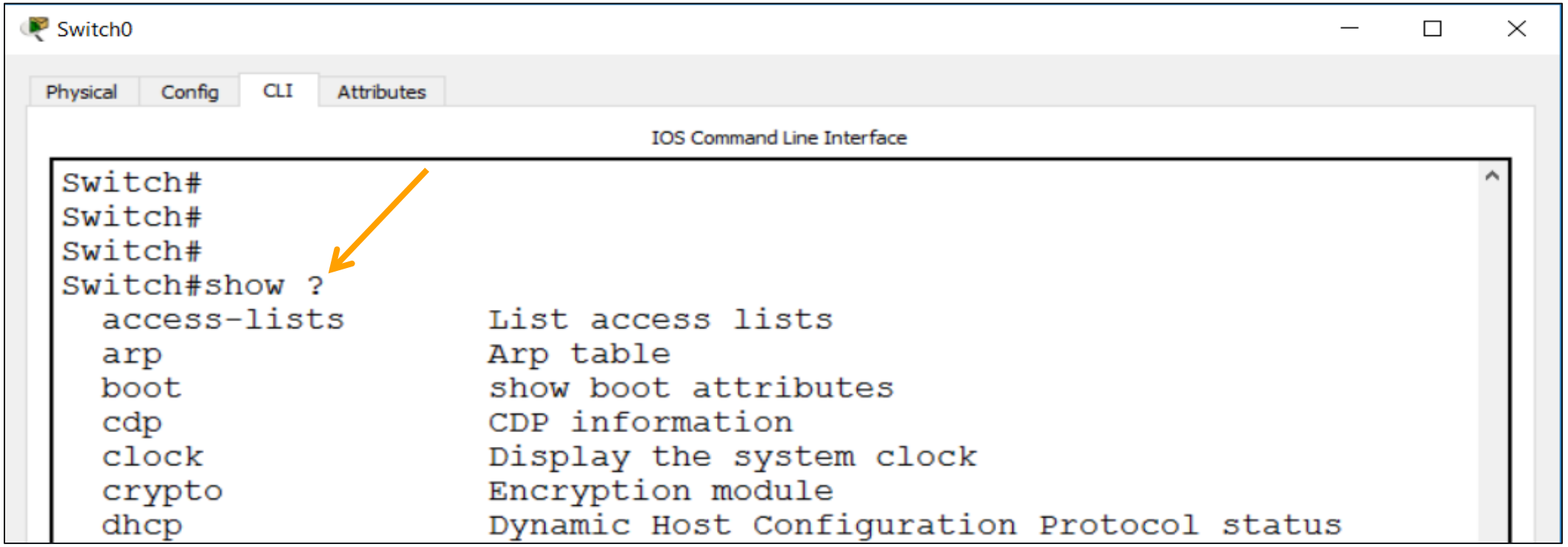
Using the help – "?"

- Use the "?" at each level to see the available commands

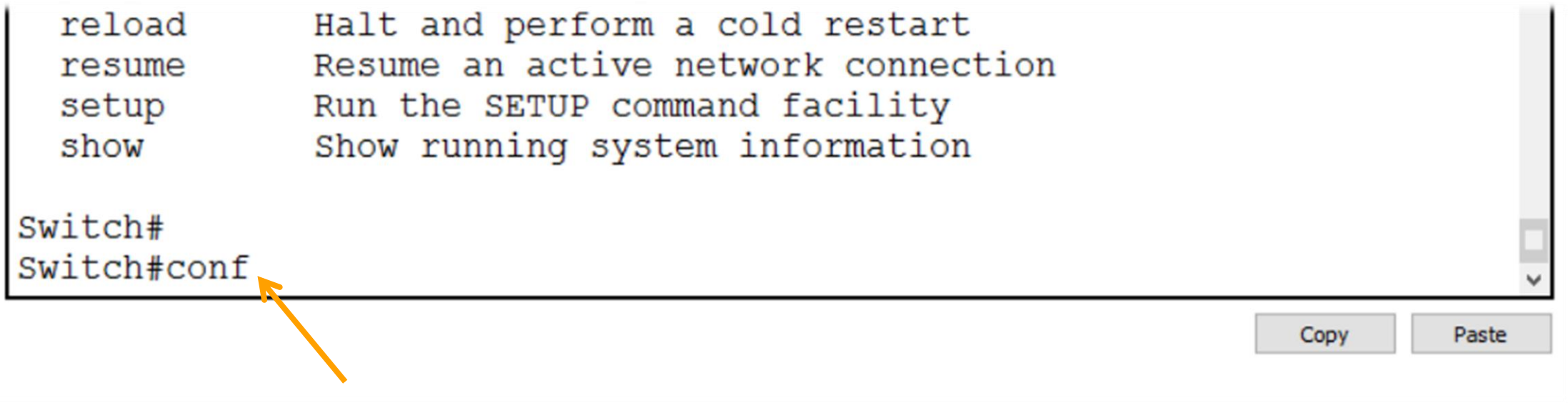


Using the help – "?" (2)

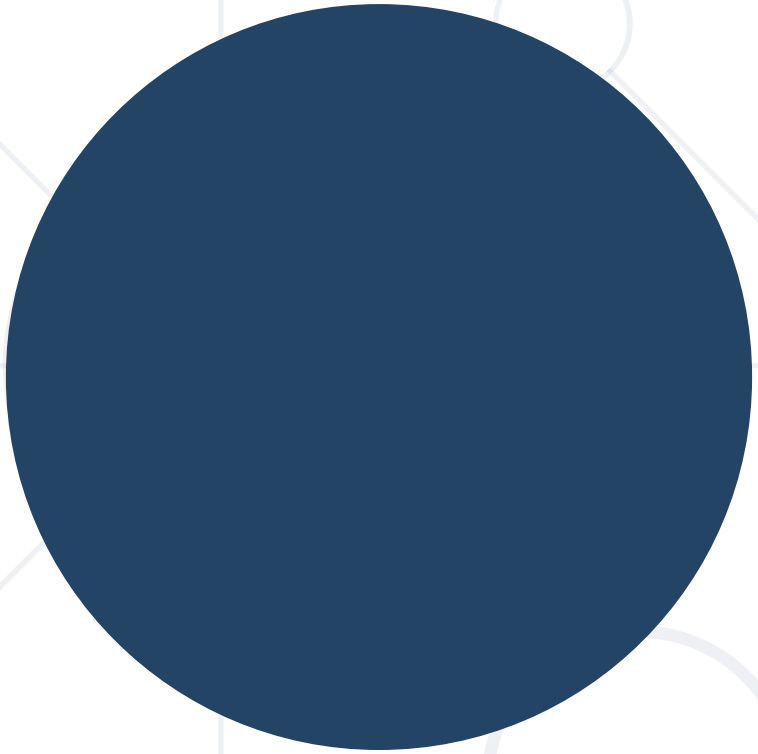
- Use the "?" as you type to see:
  - how to finish a command
  - what is/are the next word in the command



Using the help – TAB



Hit the TAB key here to autocomplete “configure”



Demonstration

Summary

1. Binary, decimal and hexadecimal numbers
2. IPv4 - details
3. Host-to-Host communication without routers
4. The ARP table
5. Basic connectivity checks
6. The command line
7. Demo

Questions?

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AMBITIONED

DRAFT KINGS

SOFTWARE GROUP

BOSCH

Postbank
Решения за твоето утре

PHAR VISION

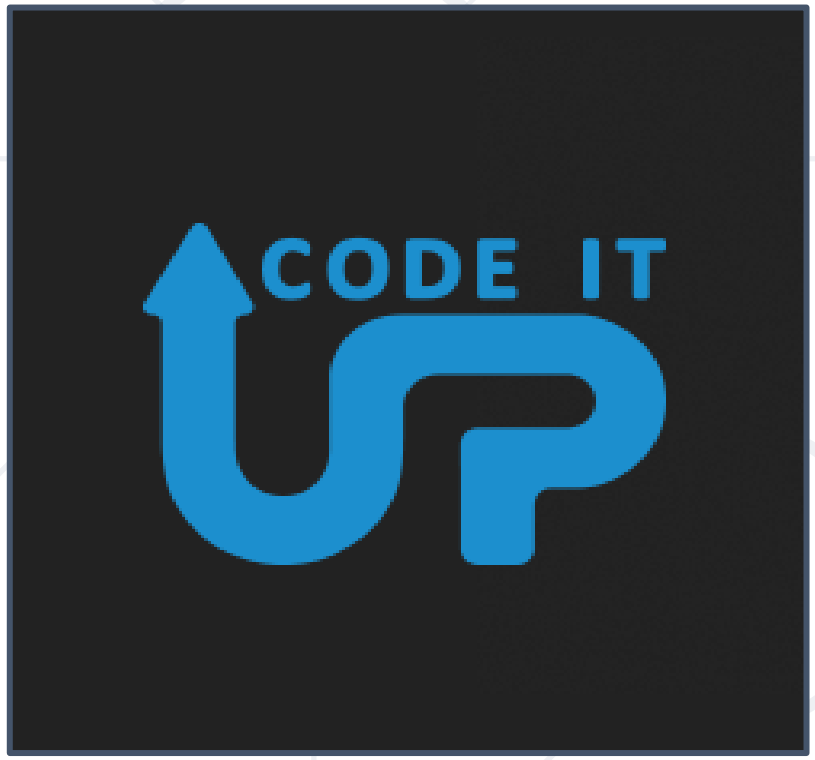
SmartIT

DXC TECHNOLOGY

createX

Educational Partners

Software University



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