NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

NTU IOT RESEARCH GROUP

WANDS wireless and networked distributed sensing group

CE3005 Computer Networks

Part 2 - Tutorial 1: Network Layer - IP Addressing and Fragmentation

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if you have questions

Q1

A university has been allocated the 155.69.0.0/16 address block. As the network administrator of the university, you have been asked to subnet the network. There are presently 10 schools in the university, and it may increase to 15 over the next few years. Currently, each school has a maximum number of host stations of 2000, but three schools are growing and may have 4000 hosts in a couple of years later. Determine the subnet address/subnet mask for each school.

Pre-Q1

How many hosts can a subnet support?

#IP addresses?

#hosts?

	#IP Addresses	#Hosts
/24		
/23		
/22		
/32		

Pre-Q1

How many hosts can a subnet support?

#IP addresses?

#hosts?

	#IP Addresses	#Hosts
/24	256	254
/23	512	510
/22	1024	1022
/32	1	1 (single host, no network/broadcast)

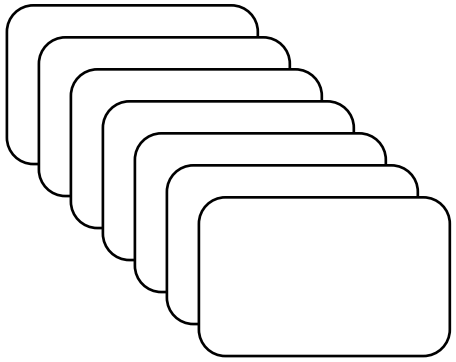
usable hosts: 2^(32-prefix) -2 , except for /31, /32

Bonus Question

Where is /32 useful?

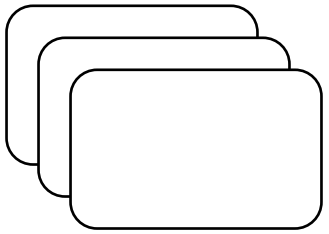
Q1: Assign suitable subnet address / subnet mask

12 schools



2000 hosts

3 schools



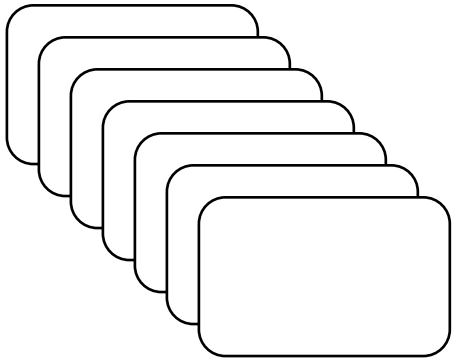
4000 hosts

IP block: 155.69.0.0/16

Q: Which subnet size fits 2000 respectively 4000 hosts?

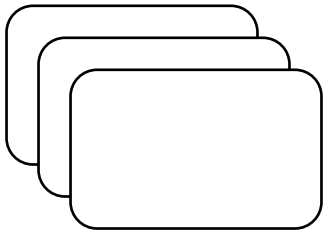
Q1: Assign suitable subnet address / subnet mask

12 schools



2000 hosts

3 schools



4000 hosts

IP block: 155.69.0.0/16

If using **/20** mask, # of hosts = 2^{12} - 2 = 4094
If using **/21** mask, # of hosts = 2^{11} - 2 = 2046

Q1: Assign suitable subnet address/subnet mask

IP block: 155.69.0.0/16

You can choose

- any 3 address blocks with /20, e.g.
  - 155.69.**0**.0/20 : 155.69.0.0 till 155.69.15.255
  - 155.69.**16**.0/20 :155.69.16.0 till 155.69.31.255
  - 155.69.**32**.0/20 :155.69.32.0. till 155.69.47.255

- any 12 address blocks with /21, e.g.
  - 155.69.**64**.0/21 : 155.69.64.0 till 155.69.71.255
  - 155.69.**72**.0/21 : 155.69.72.0 till 155.69.79.255
  - …
- Remember not to overlap the address block

Q2

An organization is assigned a /16 IP address block. The organization has created several subnets for its network. It is known that one of the subnets is 145.32.128.0/255.255.224.0. What is the broadcast address for this subnet?

Q: How do broadcast address look like?

Q2: Broadcast Address of a Subnet

-> broadcast address has all ‘1’ in host-id

Q2: Broadcast Address of a Subnet

IP/Subnet:	145.32.		128.0	/	255.255.		224.	0
Binary:	145.32.100	00000.0		/	255.255.111	00000.00000000		

-> broadcast address has all ‘1’ in host-id

Q2: Broadcast Address of a Subnet

IP/Subnet: 145.32. 128.0 / 255.255. 224. 0

Binary: 145.32.10000000.0 / 255.255.11100000.00000000

-> broadcast address has all ‘1’ in host-id

Binary: 145.32.10011111.11111111

BC IP: 145.32. 159. 255

Q3

Figure Q3 shows a network consisting of four subnets being interconnected by four routers. The integer on each link indicates the cost of that link. As a network engineer, you are allocated the IP address range 193.169.1.0/24 to support the network. Assign suitable IP address/subnet mask to each interface of the routers.

not really relevant here..

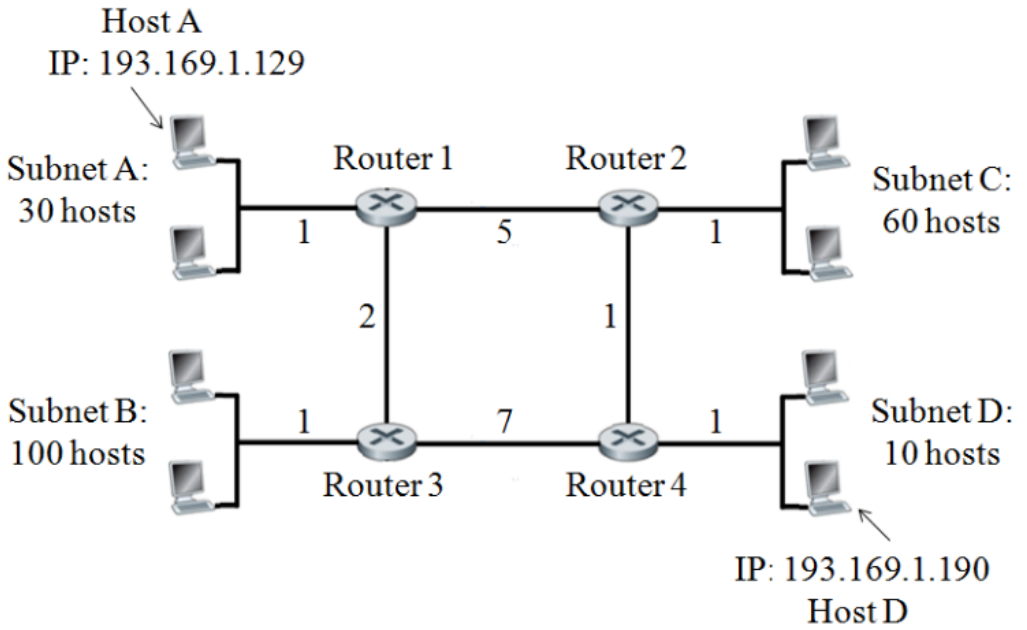


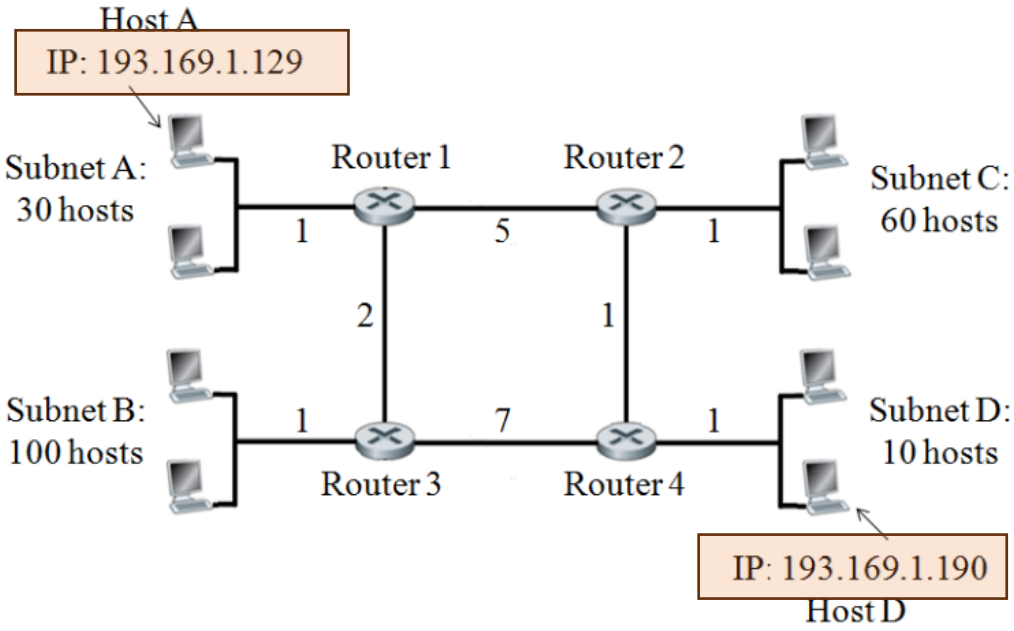
Figure Q3

Q3: Plan

Generally:

1. Sort by network size: B > C > A > D
2. Assign smallest possible subnet, go to next smaller network

BUT: we have given two addresses..



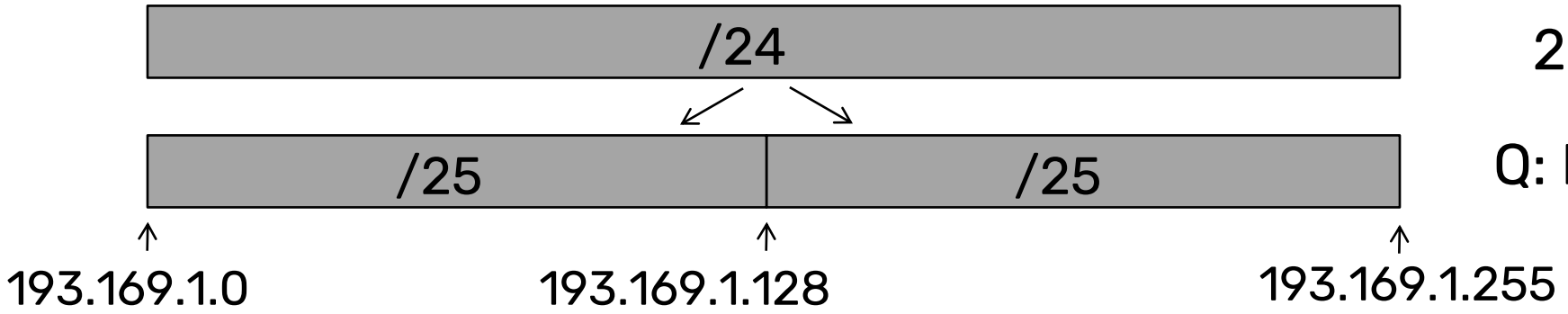
Q3

How many hosts can a subnet of /24 support?

#IP addresses?

#hosts?

Q3: Assign suitable IP addresses / subnet masks



# of host

254

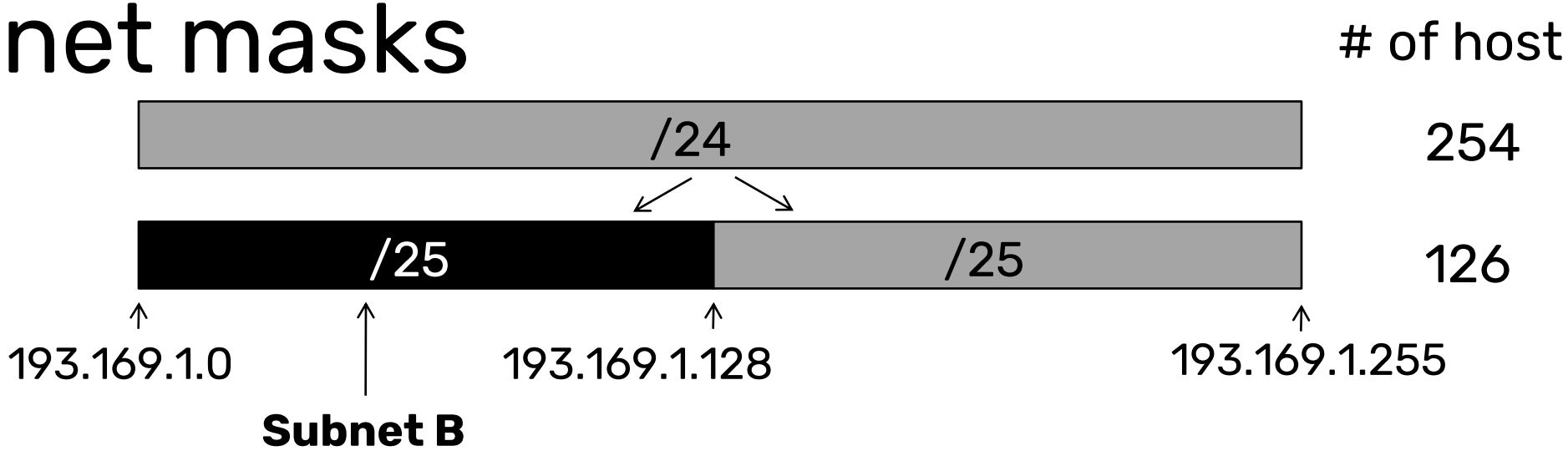
Q: How many?

Subnet B has 100 hosts..

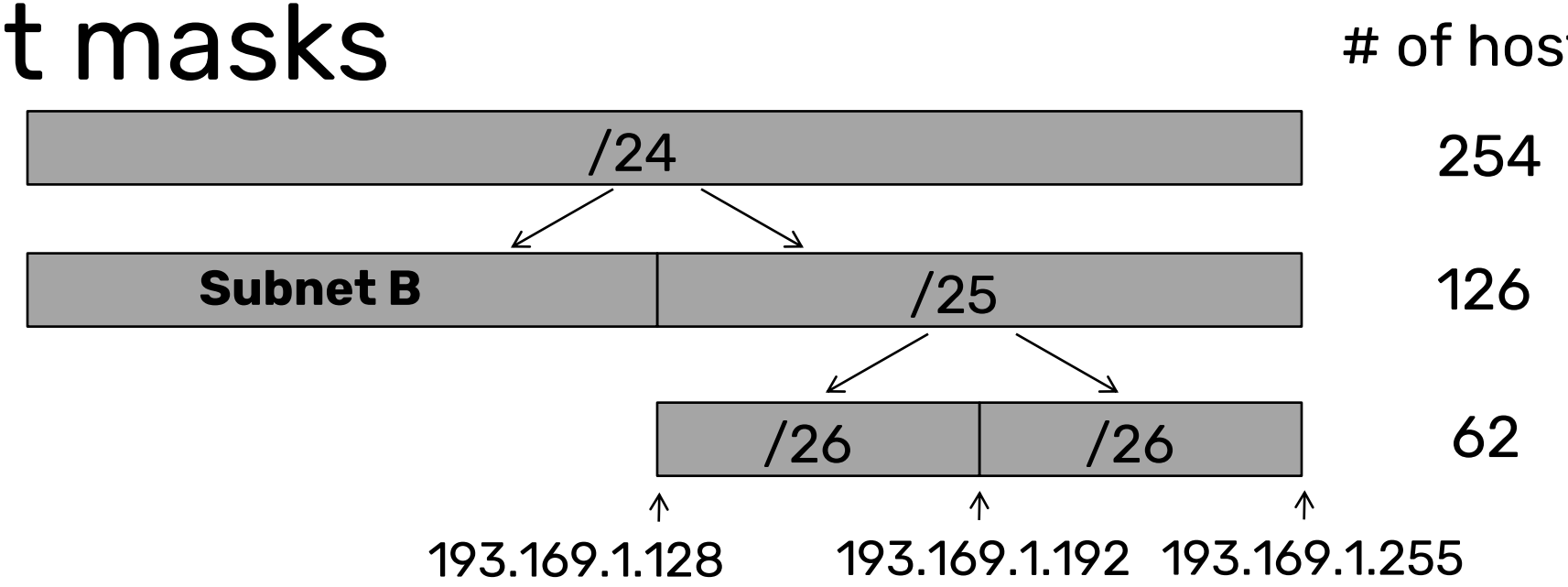
Host A: 193.169.1.129
Host D: 193.169.1.190

Q: In which of the two slices reside host A and host D?

Q3: Assign suitable IP addresses / subnet masks



Q3: Assign suitable IP addresses / subnet masks

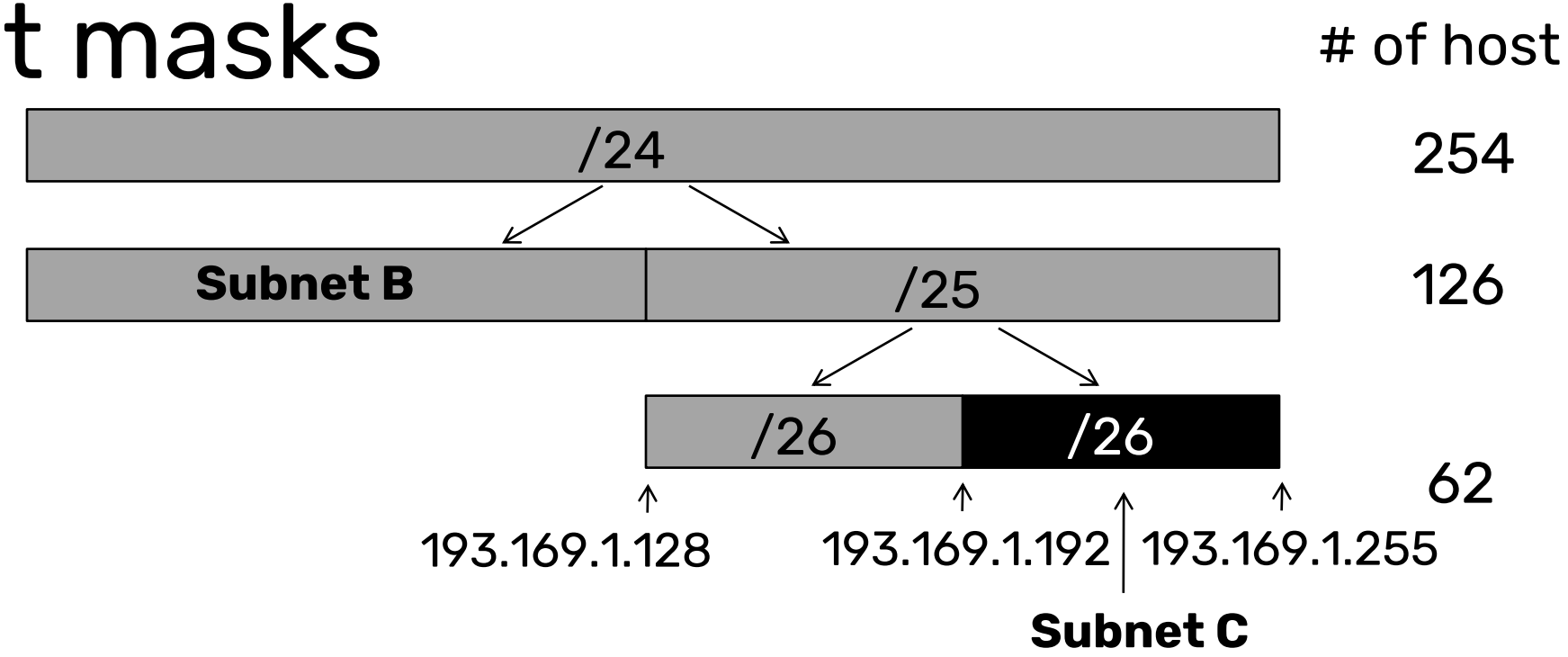


Subnet C has 60 hosts..

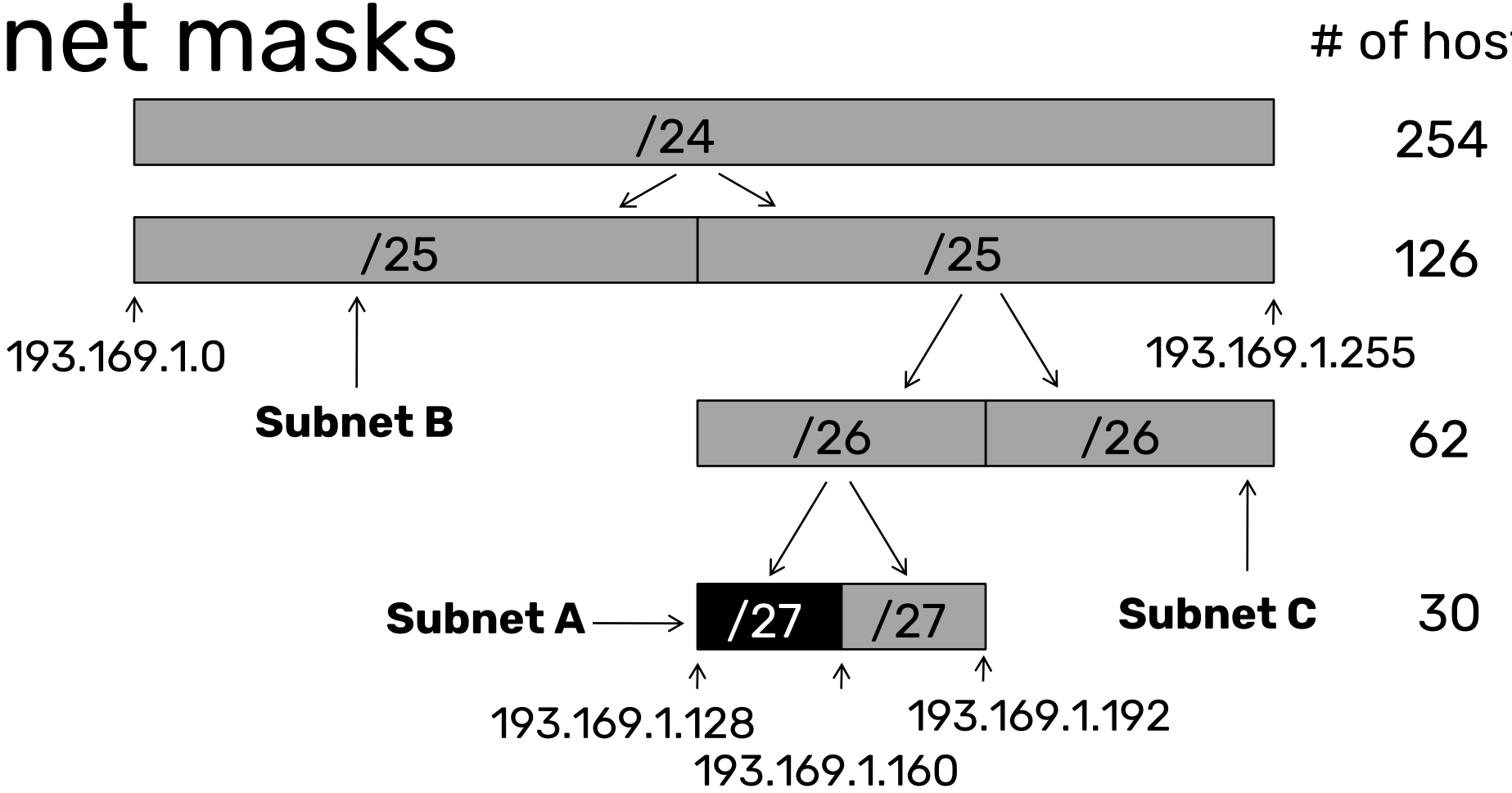
Host A: 193.169.1.129
Host D: 193.169.1.190

Q: In which of the two slices reside host A and host D?

Q3: Assign suitable IP addresses / subnet masks



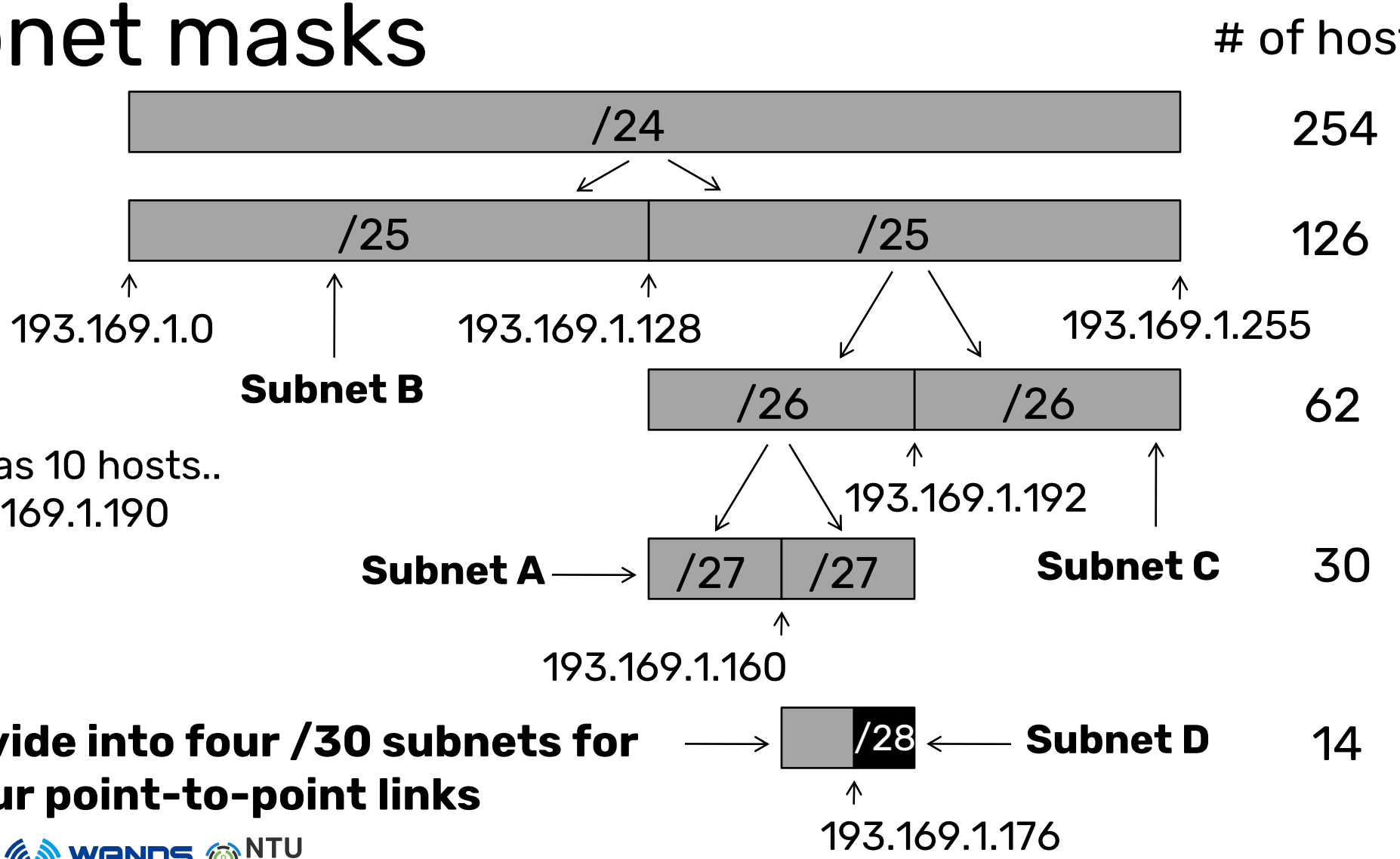
Q3: Assign suitable IP addresses / subnet masks



Subnet A has 30 hosts..

Host A: 193.169.1.129
Host D: 193.169.1.190

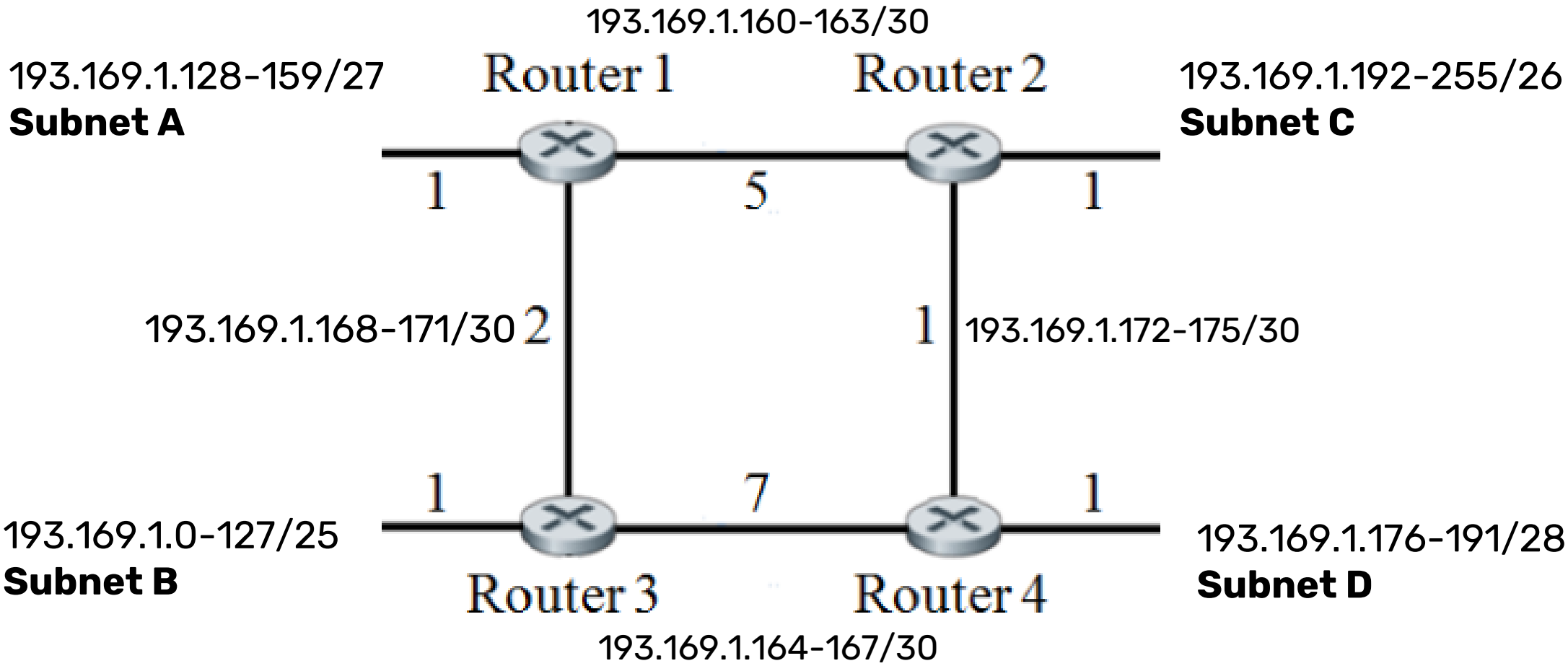
Q3: Assign suitable IP addresses / subnet masks



Subnet D has 10 hosts..
Host D: 193.169.1.190

Divide into four /30 subnets for four point-to-point links

Q3: Assign suitable IP addresses/subnet masks



Q4

Q: Which layer in
the TCP/IP model?

Consider sending a 3000 byte datagram into a link that has an MTU of 500 bytes. Suppose the original datagram is stamped with the identification number 422. How many fragments are generated? What are their characteristics?

Q4

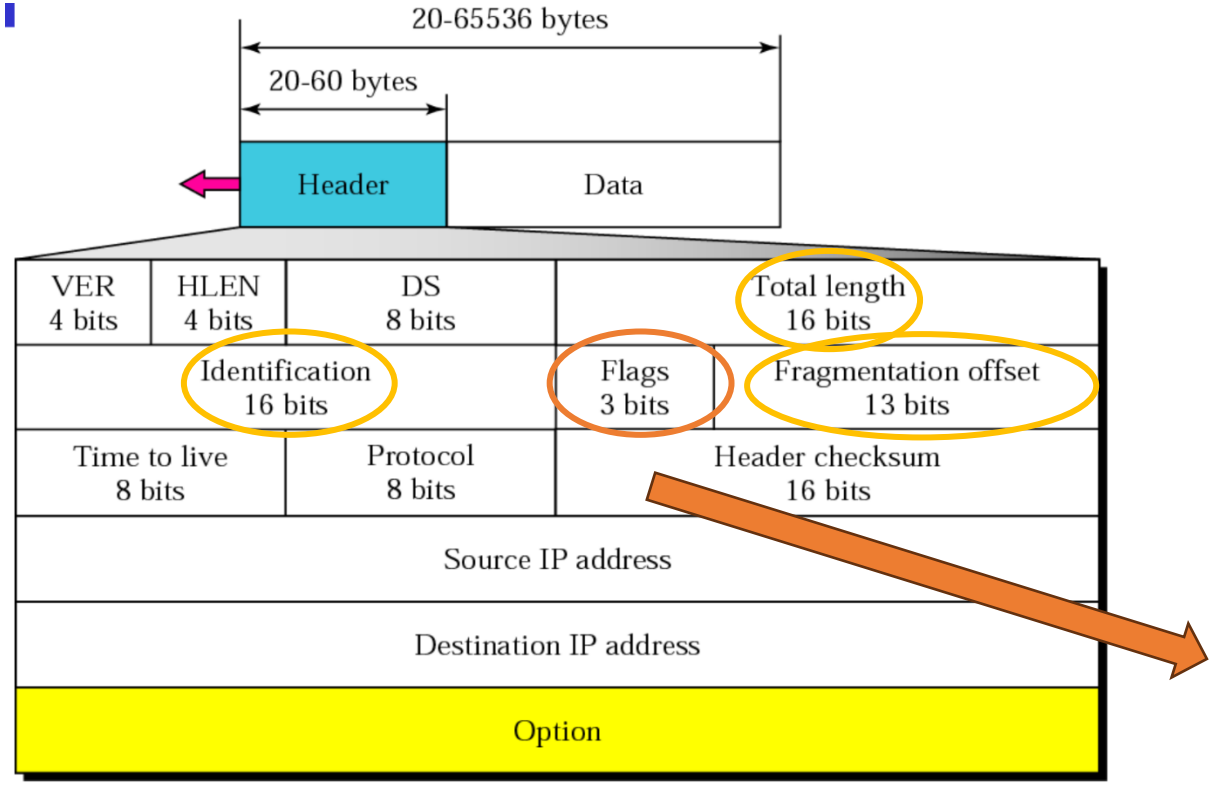
Layer	Unit of data
Layer 4 - TCP	Segment
Layer 4 - UDP	Datagram
Layer 3 - IP	Datagram / Packet

MTU would have revealed it too..

->in TCP, it is MSS (Maximum Segment Size)

Q4: IP Header

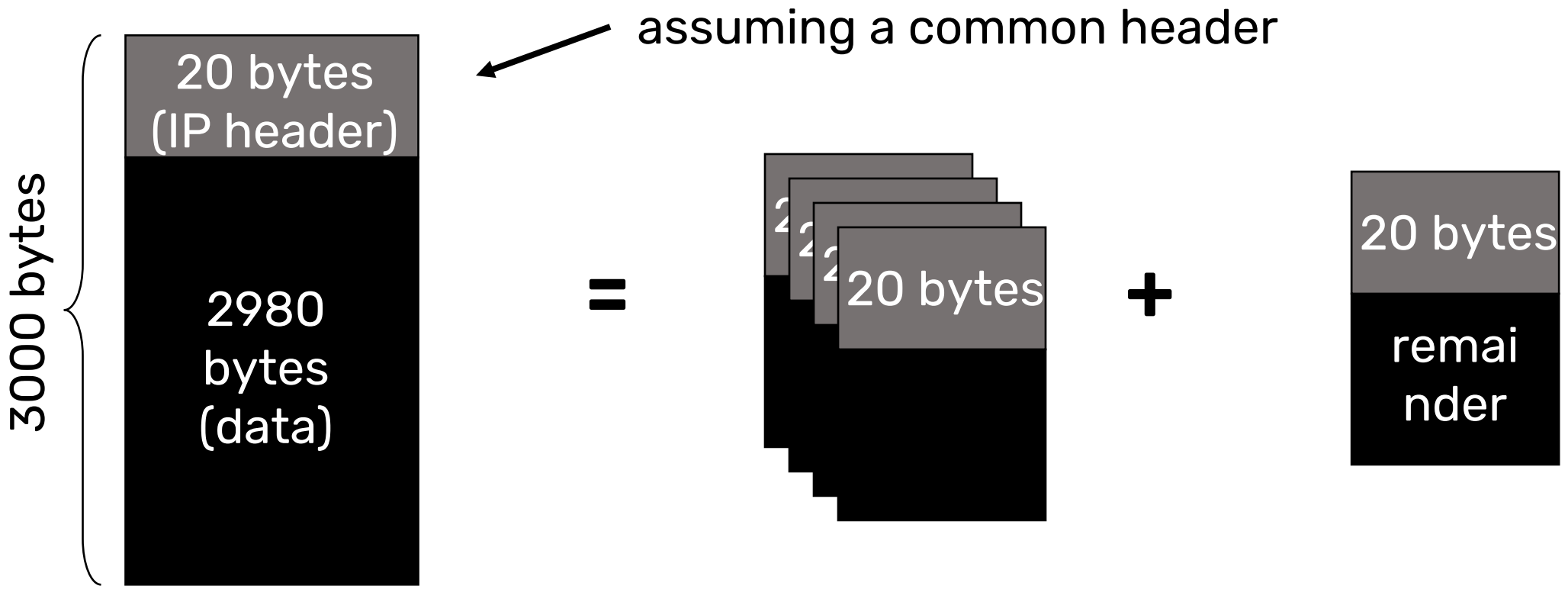
Q: Size of the header (w/o optional fields)?



bit 0: reserved/unused
bit 1: don't fragment
bit 2: more fragments

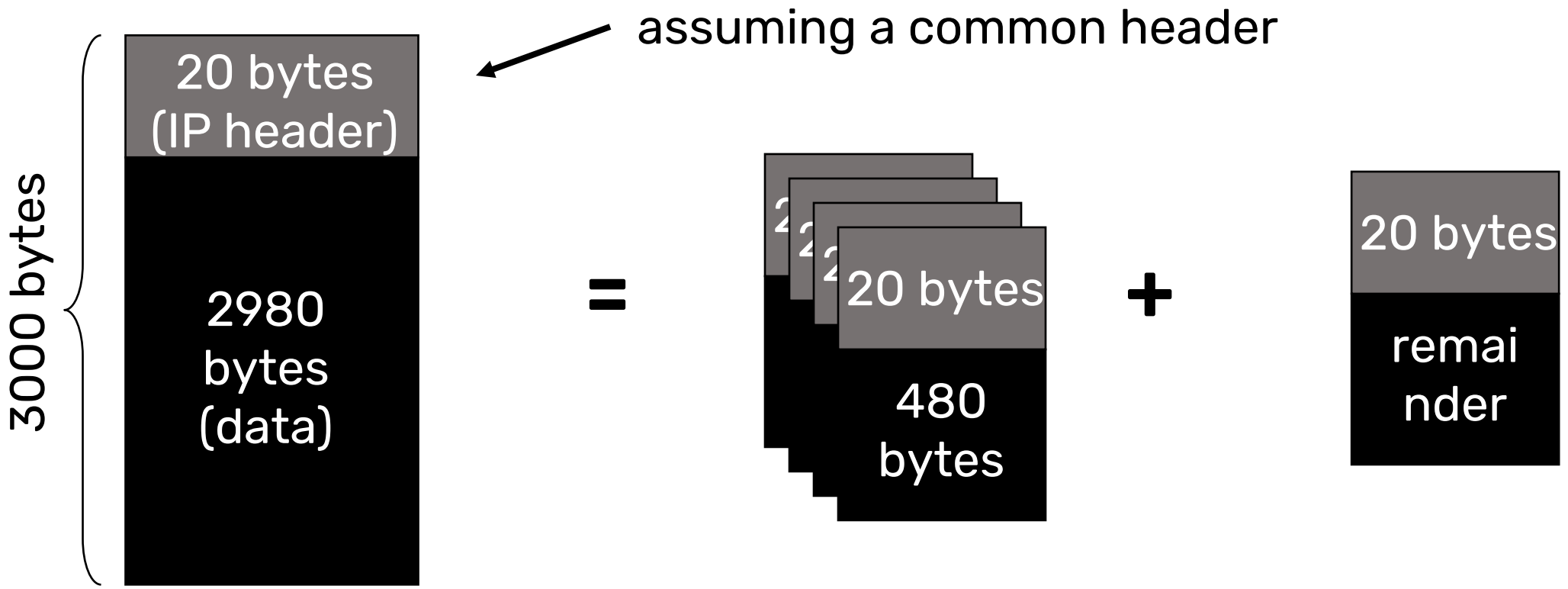
https://gsephrioth.github.io

Q4: IP Fragmentation



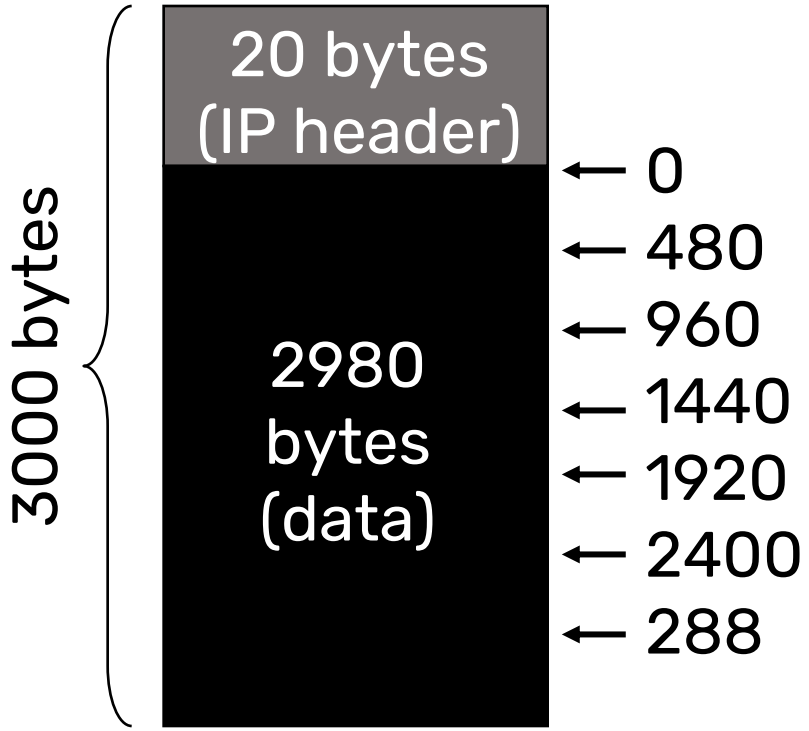
Size of the datagram = **3000 bytes**
Total data in the datagram = **2980 bytes**
Max. data in each fragment = ?
Number of fragments = ?

Q4: IP Fragmentation



Size of the datagram = **3000 bytes**
Total data in the datagram = **2980 bytes**
Max. data in each fragment = **500 - 20 = 480 bytes**
Number of fragments = 2980 / 480 = 6.21 = **7 fragments**

Q4: IP Fragmentation



Fragment	length	ID	MF	offset
1	500	422	1	0
2	500	422	1	60
3	500	422	1	120
4	500	422	1	180
5	500	422	1	240
6	500	422	1	300
7	120	422	0	360

‘offset’ is in 8-byte units
(for efficiency reasons)

Bonus Question

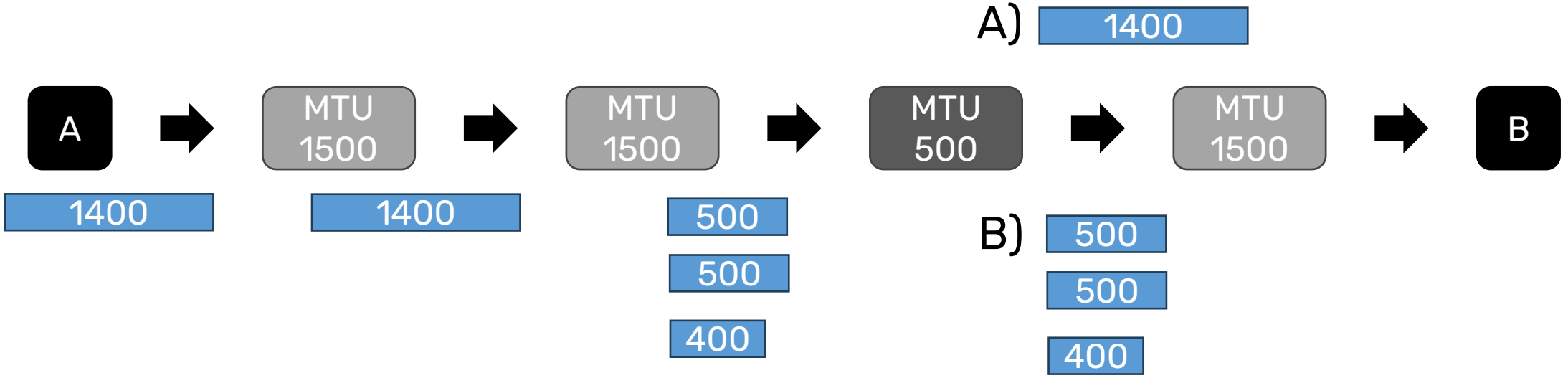
Why would you want large MTU?

Why not?

Discuss in your group.

Bonus Question

Get fragmented packets re-assembled on the path?
if yes: why?
if no: why?



Questions?

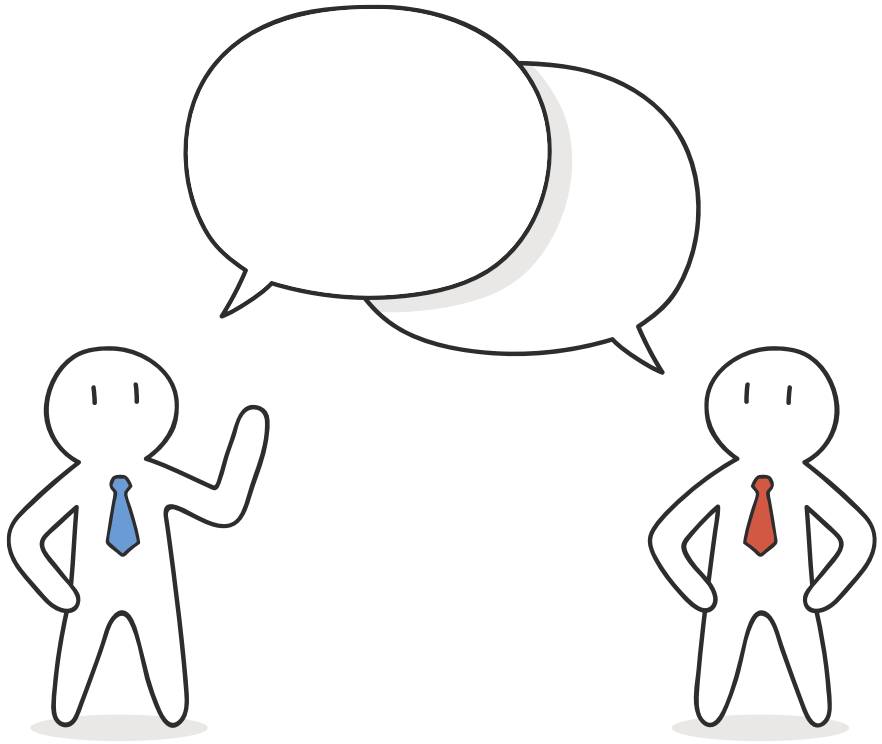


Image by dooder on Freepik