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Week7 Mac Sub-Layer and Network Layer

COMP90007 Internet Technology

Prepared by: Chenyang Lu (Luke)

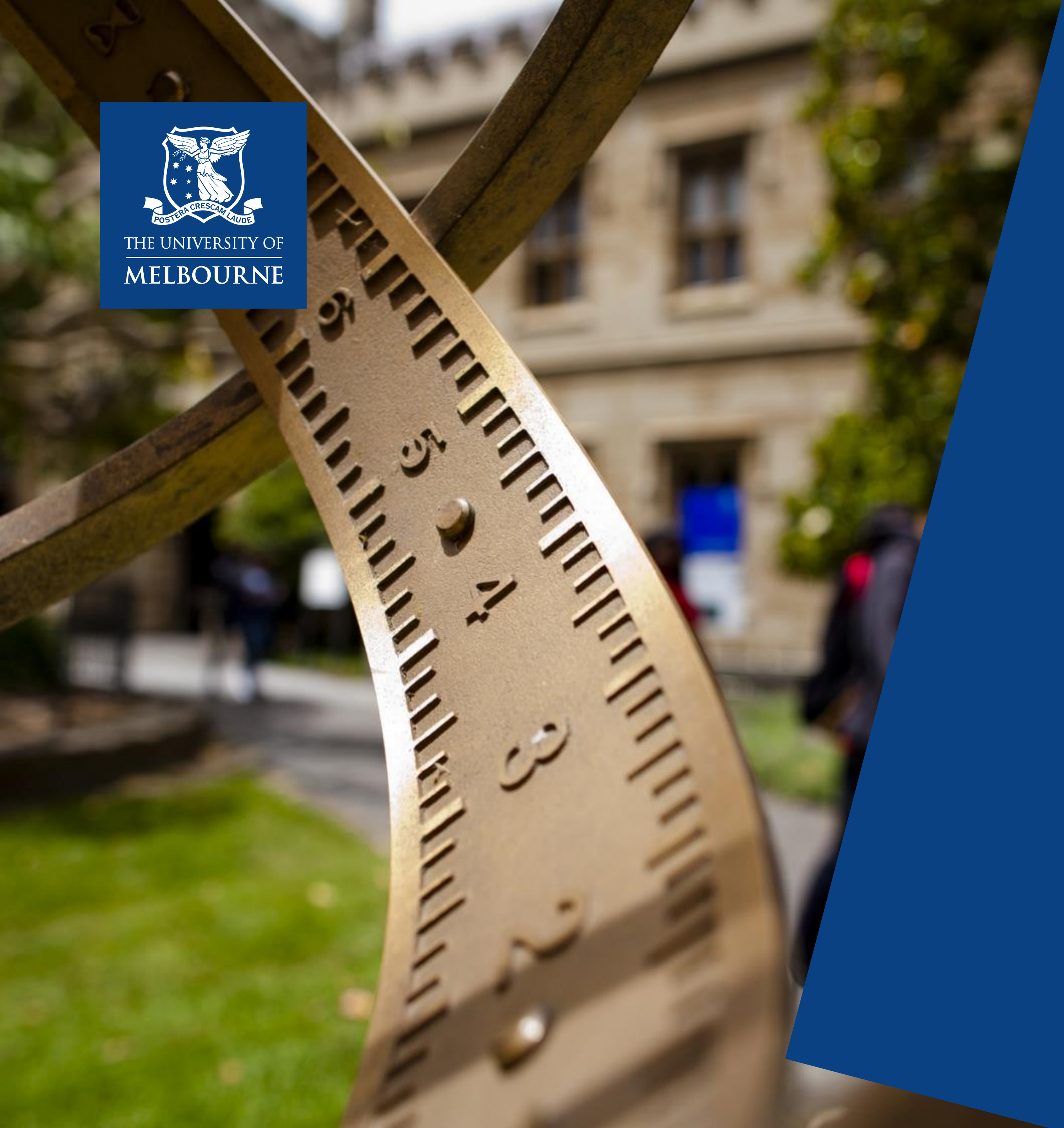
Your Tutor

Chenyang Lu (Luke)

- Email: chenyang.lu@unimelb.edu.au

- Workshop Slides: https://github.com/LuChenyang3842/Internet-technology-teaching-material

Day	Time	Location
Tue	18:15	Bouverie st –B114
Wed	10:00	Elec Engineering -122
Wed	17:15	Bouverie-sr 132



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MAC Sub-Layer

Mac-sub Layer

TCP/IP Model

Application
Transport
Network
Data Link
MAC SUB-Layer
Physical

Question: What is MAC Sub-Layer and what is the function of MAC Sub-Layer

Mac-sub Layer

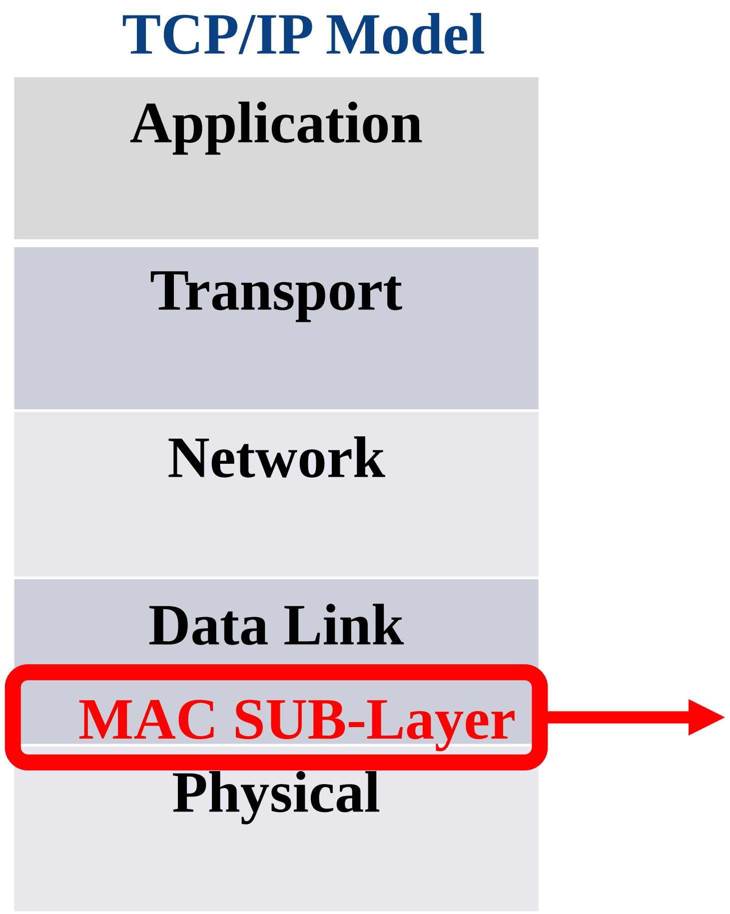
TCP/IP Model

Application
Transport
Network
Data Link
MAC SUB-Layer
Physical

Medium Access Control Sub-Layer:

- Lives near the bottom of data link layer
- Control how we can allocate multiple users over a single shared channel in a broadcast

Mac-sub Layer



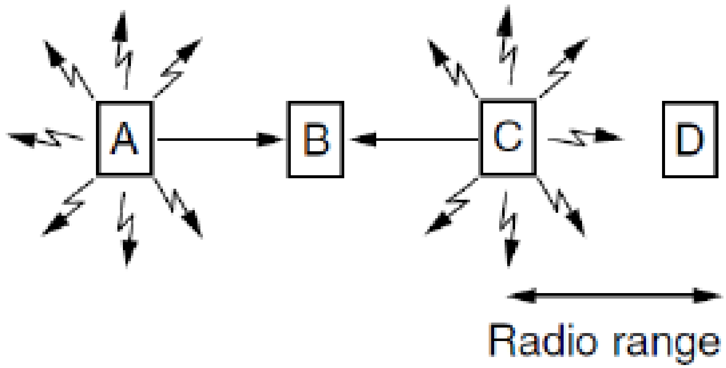
1. Contention
   - ALOHA
   - Carrier Sense Multiple Access (CSMA)
2. Collision Free
   - CSMA/CD – Binary Countdown
   - CSMA/CD - bit map
3. Limited Contention
   - CSMA/CD - Adaptive Tree Walk Protocol

4. MACA/MACAW (for Wireless LANs)

Wireless LAN protocol

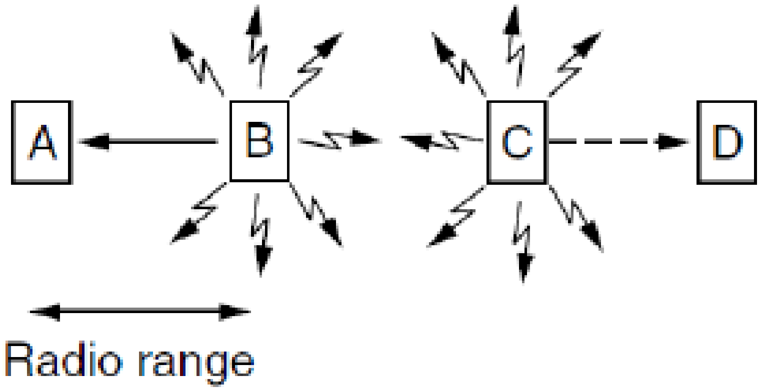
Hidden Terminal problem

- A sends data to B, C cannot hear A
- C wants to send data to B, C senses a "free" medium and starts transmitting
- Collision at B occurs
- A and C are hidden terminals, when both of them are sending data to B



Exposed Terminal problem

- B sends to A. C wants to send to another terminal D.
- C senses the carrier and detects that the carrier is busy.
- C postpones its transmission until B stops sending data
- <u>But A is outside radio range of C, waiting is not necessary</u>
- B and C are exposed terminals when B --> A, C--> D

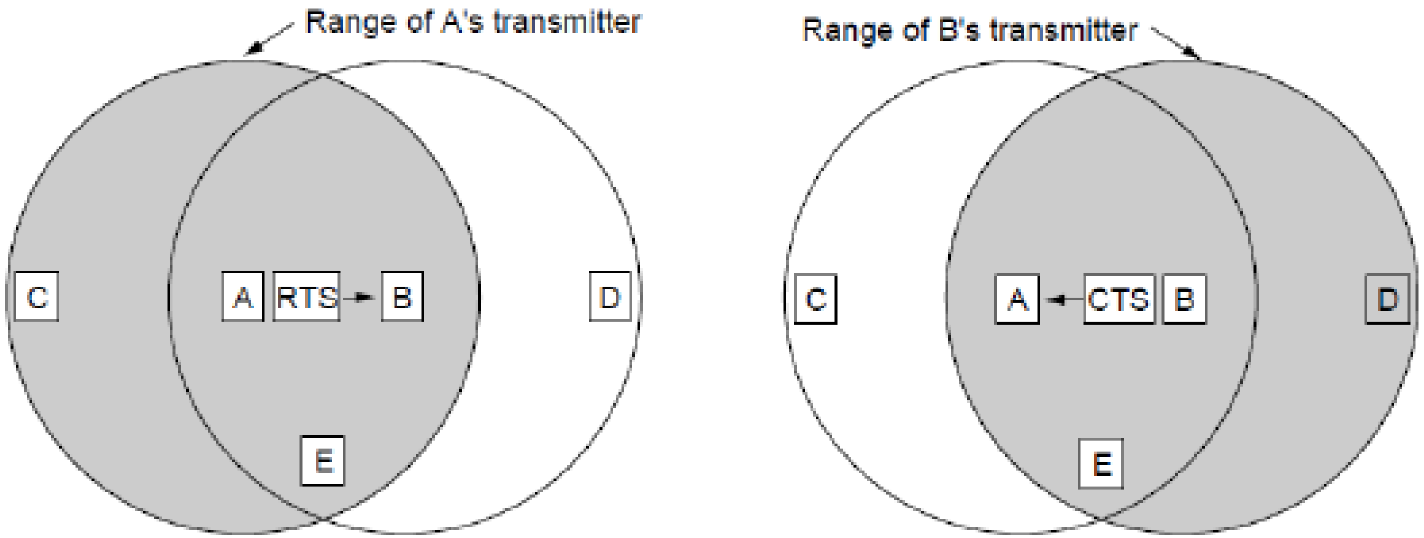


MACA(Multi Access with Collision Avoidance)

MACA used in wireless LAN

MACA protocol grants access for A (sender) to send to B (receiver):

- A sends RTS (Request to Send) to B [left]
- B replies with CTS (Clear To send) [right]
- A can send with exposed but no hidden terminals



A sends RTS to B; C and E hear and defer for CTS

B replies with CTS; D and E hear and defer for data

Question 1 MACA

Six stations, A through F, communicate using the MACA protocol. Is it possible that two transmissions take place simultaneously? Explain your answer.

Answer:
Yes. Imagine that they are in a straight line and that each station can reach only its nearest neighbours. Then A can send to B while E is sending to F.

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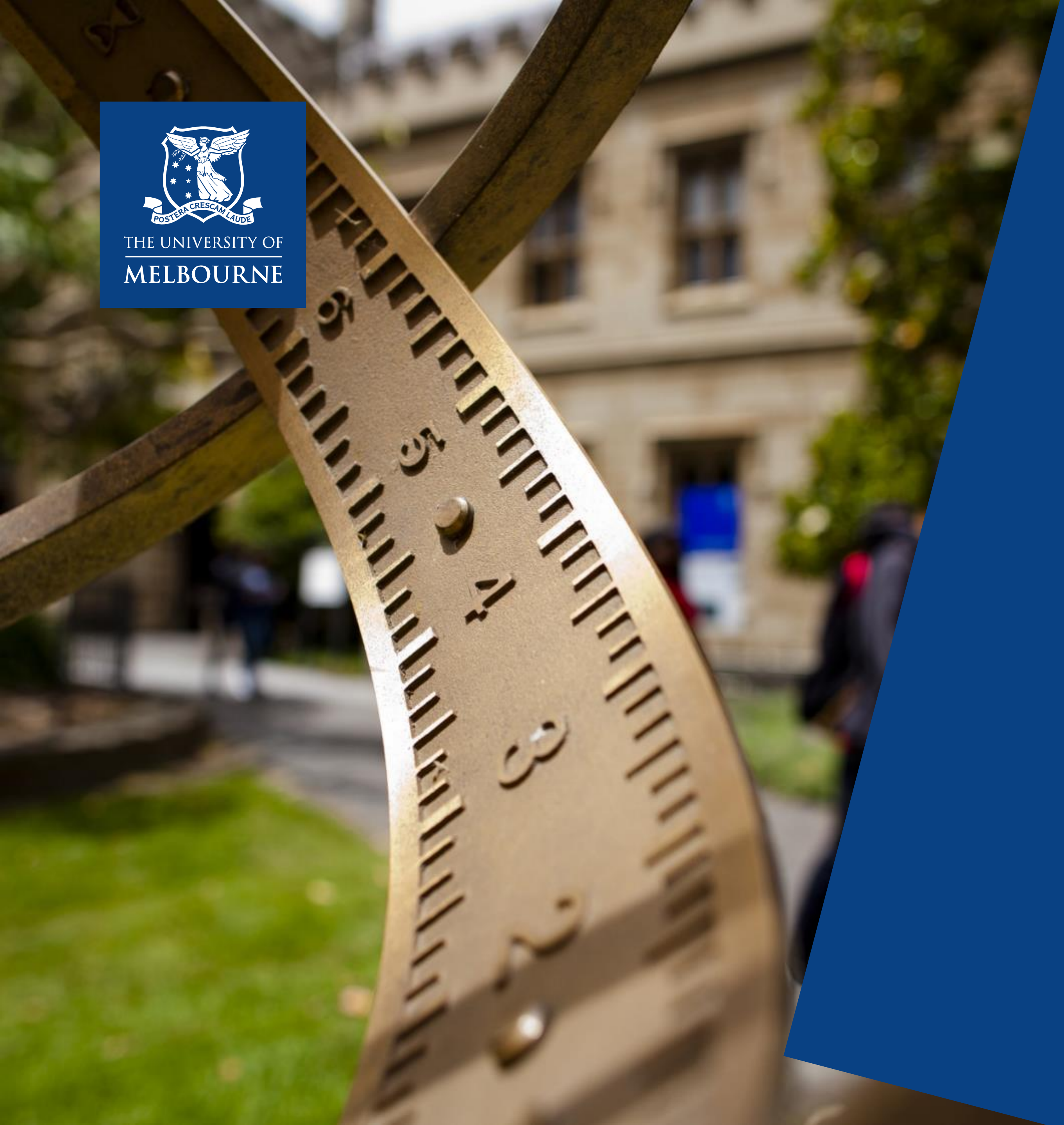


Network Layer

Network Layer

TCP/IP Model

- **Application**
- **Transport**
- **Network**
- **Data Link**
- **Physical**

Question:

1. *What is the protocol used in network layer*
2. *Function of that protocol?*

Network Layer

TCP/IP Model

Application
Transport
Network
Data Link
Physical

Internet protocol *is the most common protocol in network layer*

Internet protocol is the glue that ***holds the whole internet together***

Network Layer

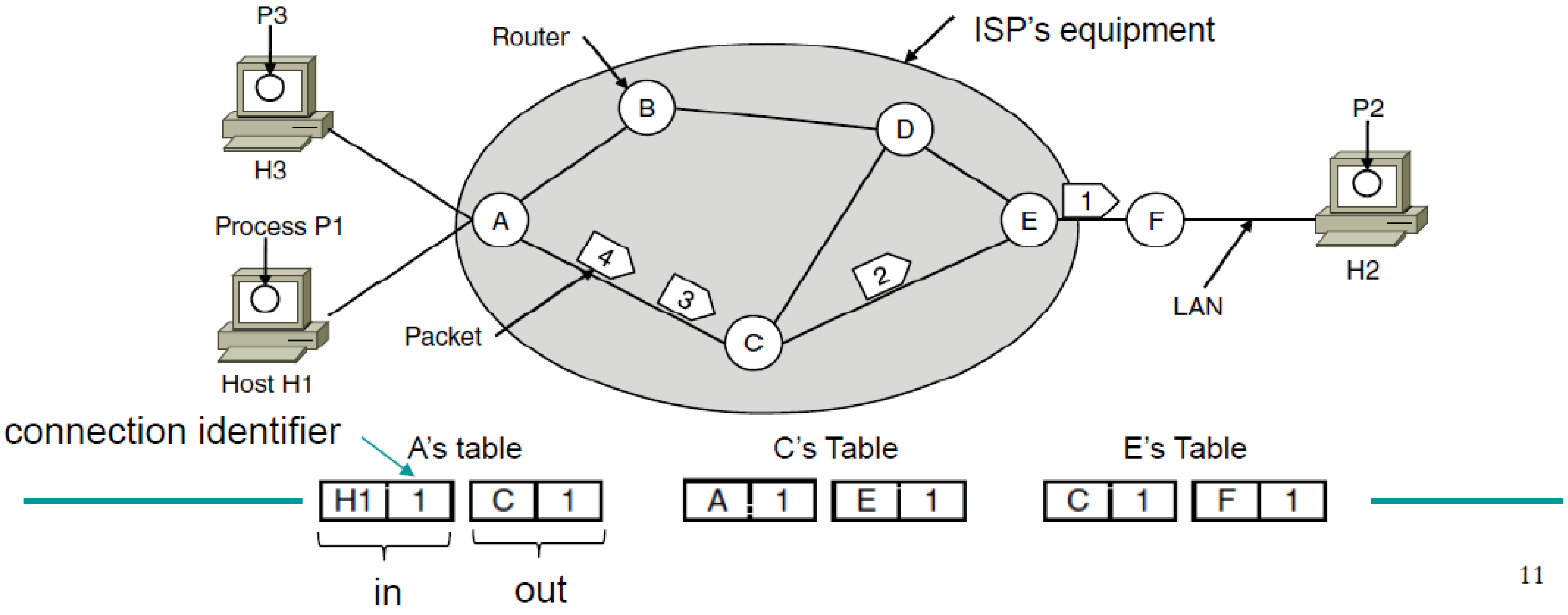
TCP/IP Model

Application
Transport
Network (Internet Protocol)
Data Link
Physical

1. Routing Method
   - Virtual-Circuit subnet (Connection Oriented)
   - Datagram subnet (Connectionless)
2. IPV4
   - Datagram
   - ★ IP address and subnetting (important!)
3. Fragmentation
4. Routing algorithm (Manage Routing Table)
   - Adaptive
   - Non-adaptive
   - Hierarchical Routing
   - Broadcasting Routing
   - Multicasting Routing

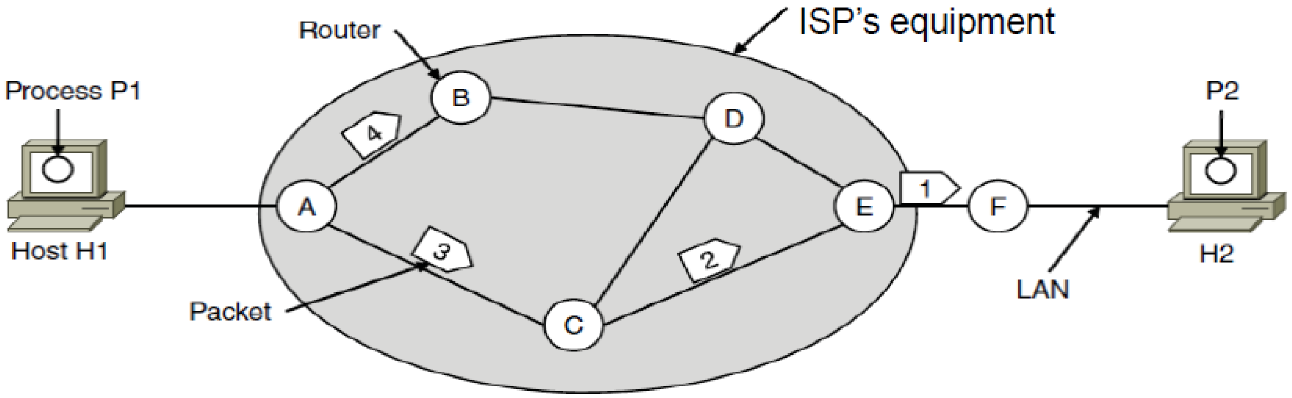
Routing with Virtual Circuit subnet

- **Telephone network model**
- Build a fixed channel before data transmission
- Routed through tag name (not a full address but unique at a given link)
- All packet take the same route
- Connection oriented



Routing with Datagram subnet

- **Post office model**
- Packet routed individually
- Packet can take different route
- Connectionless



A's table (initially)

Dest.	Line
A	⊠
B	B
C	C
D	B
E	C
F	C

A's table (later)

A	⊠
B	B
C	C
D	B
E	B
F	B

C's Table

A	A
B	A
C	⊠
D	E
E	E
F	E

E's Table

A	C
B	D
C	C
D	D
E	⊠
F	F

Routing table (can be fixed, can change over time)

Routing algorithm – manages the routing table

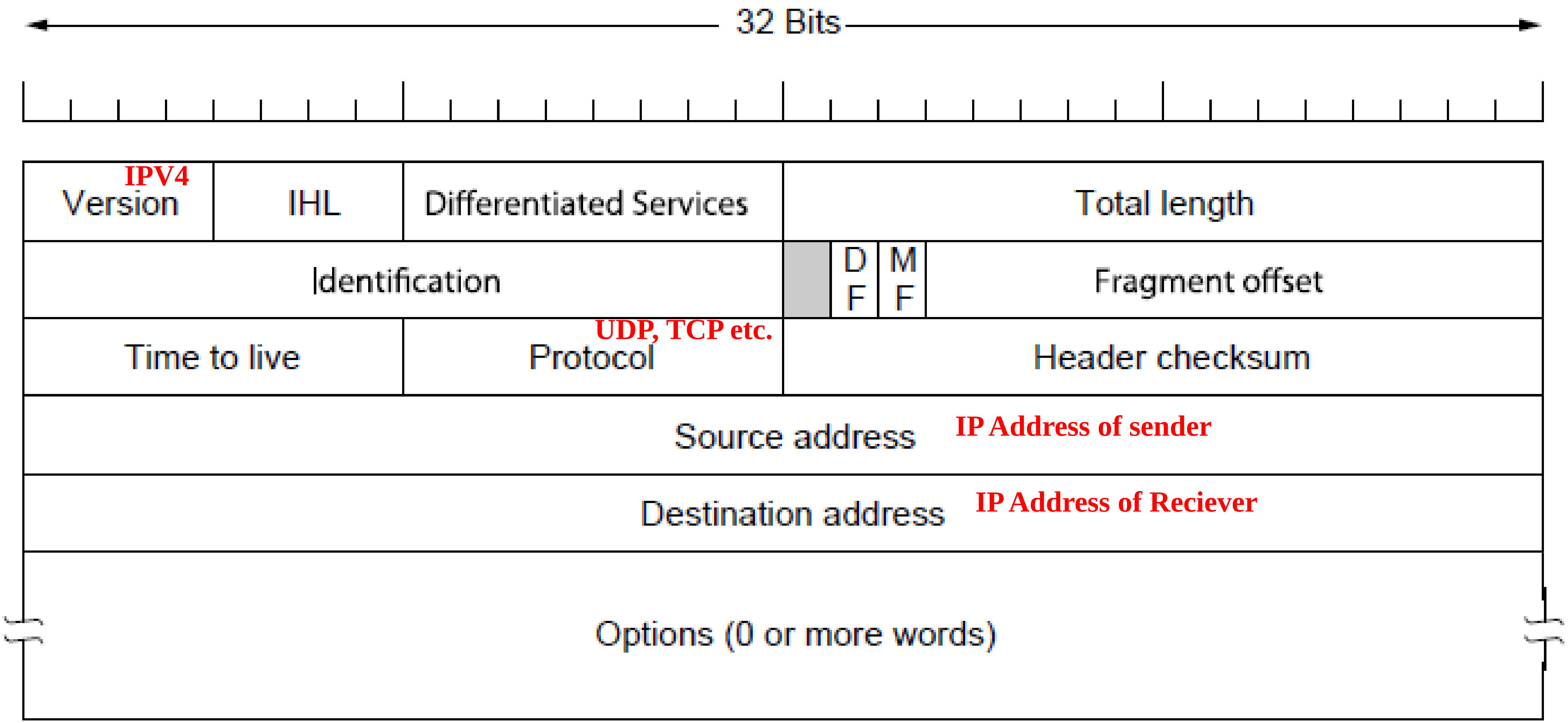
Question 2

If there are *n* independent paths between two nodes in a network, and the probability that an individual path is working is *p*, what is the probability of these two nodes being connected? Assume path failures are independent.
Hint: first try to calculate what is the probability that all paths have failed

Answer:

Pr(nodes connected)
= 1 − Pr(no connection)
= 1 − Pr(all paths failed)
= 1 − Pr(individual path failure)^n *(assuming independent events)*
= 1 − [1 − Pr(individual path working)]^n
= $1 - (1 - p)^n$

IP4 Datagram Structure



IP address

- **Can be represent in decimal or binary**

  - *Convert IP Address: 11000001.01010010.11010010.00001111 to dot-decimal notation*
    ans. 193.82.210.15
  - *Convert IP address: 240.68.10.10 to binary format?*
    ans. 1111 0000 . 0100 0100 . 0000 1010 . 0000 1010

IP address and subnetting

Major focus in this subject

- **IP address = Network portion + Host portion**
  - **Classful addressing (old Deign)**
    - Class A, B, C, D and E
  - **Classless inter-domain notation (CIDR)**

    The notation is constructed from an IP address, a slash ('/') character, and a decimal number.

    e.g. 192.168.5.130/24

	Binary Form	Dot-decimal
IP address	11000000.10101000.00000101.10000010	192.168.5.130/24
Subnet mask	11111111.11111111.11111111.00000000	255.255.255.0
Network prefix (Network Address)	11000000.10101000.00000101.00000000	192.168.5.0/24
Number of hosts	2^8 = 256 hosts	

IP address and subnetting

Subnet mask: *all 1s in the network portion.*

e.g. if the length of network portion is 8, the subnet mask is 111111111.00000000.00000000.00000000

Network prefix: *For network portion, keep them same as original IP address. For host portion, change them all to zero.*

Suffix of Ip address: *an integer represent the length of network portion*

Number of host: $2^{length\ of\ host\ portion}$

Question 3 subnet Mask

A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts that it can handle?

Answer:
255.255.240.0 in binary is 11111111 11111111 11111111 11110000 0000000

The mask is 20 bits long, so the network part is 20 bits. The remaining 12 bits are for the host, so 4096 host addresses exist.

Question 5 Subnet mask

A router an entry in its table that can be represented with mask as 135.46.56.0/21. What is the maximum number of hosts that this network can represent?

Ans. 21 bits means network has 21 bits reserved and remaining 11 bits are for hosts.
Hence maximum number of hosts is 2^11 = 2048

Question 4 IPV6

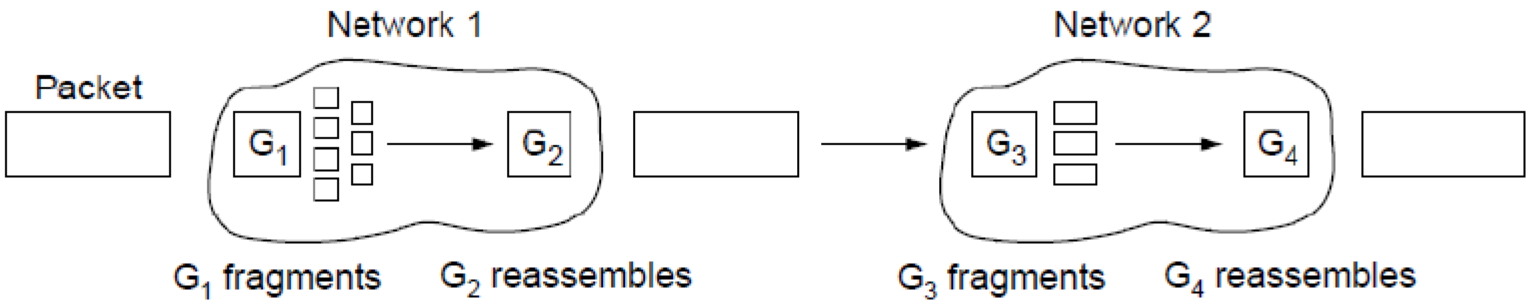
IPv6 uses 16 bytes addresses. If a block of 1 million addresses is allocated every picosecond, how long will the addresses last? (1 picosecond = 10^{-12} second)

Answer:
*Total number of bits: 16 *8 = 128 bits*
Total number of address: 2^{128}
Allocating rate: $10^{6}/10^{-12} = 10^{18}$ addresses per second.
Times it takes to run out the IP addresses: $2^{128} / 10^{18} = 3.4\times10^{20}$ seconds = 10^{13} years.

This number is 1000 times the age of the universe.

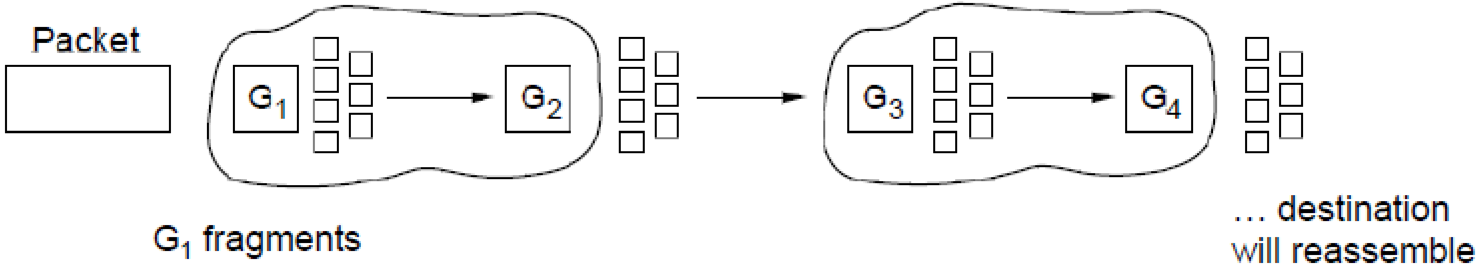
Fragmentation

- All networks have a maximum size for packets
- Fragmentation (division of packets into fragments) allows network gateways to meet size constraints



Type of fragmentation

1. **Transparent** – packets fragmented / reassembled in each network. Route constrained, more work



2. **Non-transparent** – fragments are reassembled at destination. Less work (IP works this way) –packet number, byte offset, end of packet flag

Question 6 fragmentation

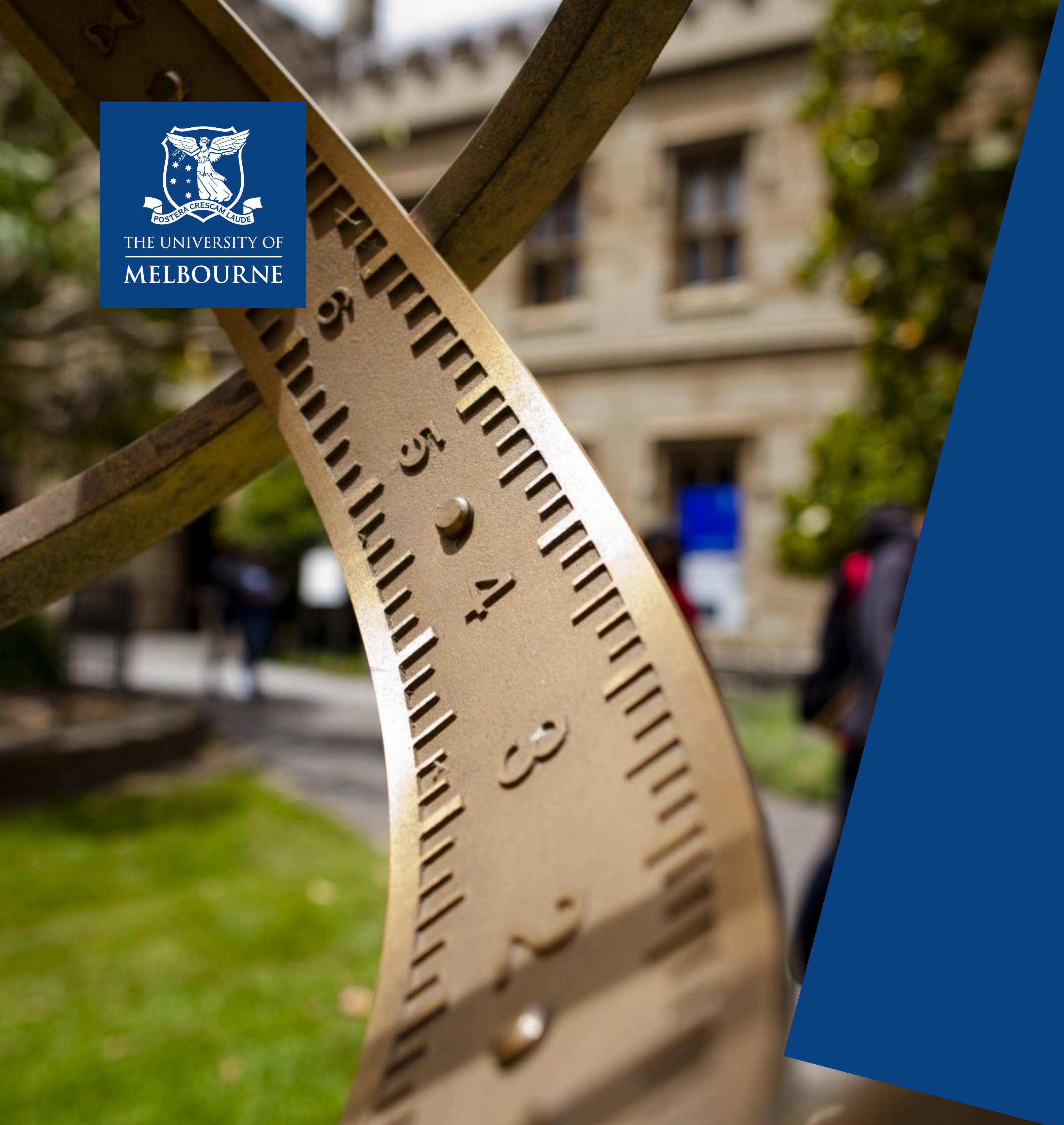
What are the benefits and disadvantages of Transparent fragmentation in Network Layer?

Benefits

- Good design paradigm and encapsulation of fragmentation within each network
- Easy to implement and use

Disadvantage

- Router must know when it has received all packets, so either a count or “end of packet” bit must be provided
- All fragments must exit via the same router so they can be reassembled.
- Router need to buffer all the fragments as they arrive, and decide when to throw them away if not all fragments arrive
- Some of this work may be wasteful. The packet may pass through a series of small packet network and repeatedly fragmented and reassembled.



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Some extra questions for IP Address and subnetting

	Binary Form	Dot-decimal
IP address	?	118.217.110.149/10
Subnet mask	?	?
Network prefix	?	?
Number of hosts	?	

Q1

	Binary Form	Dot-decimal
IP address	?	?
Subnet mask	?	?
Network prefix	?	192.0.2.0/23
Number of hosts	?	

Q2

	Binary Form	Dot-decimal
IP address	?	?
Subnet mask	11111111.11111111.11111111.00000000	?
Network prefix	?	?
Number of hosts	?	

Q3

If the network portion of Ip address is 15, what is the subnet mask? What is the number of host?

Q4

	Binary Form	Dot-decimal
IP address	01110110.11011001.01101110.10010101	118.217.110.149/10
Subnet mask	11111111.11000000.00000000.00000000	255.192.0.0
Network prefix	01110110.11000000.00000000.00000000	118.192.0.0/10
Number of hosts	2^22	

Q1

	Binary Form	Dot-decimal
IP address	N/A	N/A
Subnet mask	11111111.11111111.11111110.00000000	255.255.254.0
Network prefix	11000000.00000000.00000010.00000000	192.0.2.0/23
Number of hosts	2^9	

Q2

	Binary Form	Dot-decimal
IP address	N/A	N/A
Subnet mask	11111111.11111111.11111111.00000000	255.255.255.0
Network prefix	N/A	N/A
Number of hosts	2^8	

Q3

Q4

If the network portion of Ip address is 15, subnet mask: 255.254.0.0, number of host: 2^17