École Pour l'Informatique et les Techniques Avancées – EPITA

BSc L1 – 26 April 2024

Course: Introduction to Computer Networks

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Introduction to Computer Networks

Course schedule (tentative)

Date & Time	No.	Topics	Duration (hours)
Fri 19/04/24 – 10:00–13:00	1	Primer, Network protocols, types, topology, architecture	3
Fri 26/04/24 – 10:00–13:00	**2**	**Network models, TCP/IP model, Packet switching**	**3**
Sat 27/04/24 – 10:00–13:00	3	Physical Layer (Function, Signals, Modulation, Multiplexing, Transmission media & Hardware, Optical networks)	3
Sat 27/04/24 – 14:00–17:00	4	Data Link Layer (Function, Framing, Protocols, Flow control, Access control, Error correction, Hardware)	3
Fri 03/05/24 – 14:30–17:30	5	Network Layer (Function, IP addressing and subnets)	3
Sat 04/05/24 – 10:00–13:00	6	Network Layer (Routing algorithms and protocols), Internet Control Message Protocol	3
Fri 17/05/24 – 14:00–17:00	7	Network Layer (IGP & EGP), Autonomous System, Border Gateway Protocol	3
Fri 18/05/24 – 14:00–17:00	8	Transport Layer (Function, Flow and congestion controls, Protocols)	3
Fri 24/05/24 – 10:00–13:00	9	Application Layer (Function, Protocols)	3

Lecture 2 Outline

- Network Layers
  - OSI & TCP/IP (recap)
  - TCP/IP 5-layer model (Data transfer example)
  - TCP/IP 5-layer model (operations)
  - Class exercise 3
- Packet handling
  - Circuit switching vs packet switching
  - Packet switching approaches
  - Comparing switching types

Recap

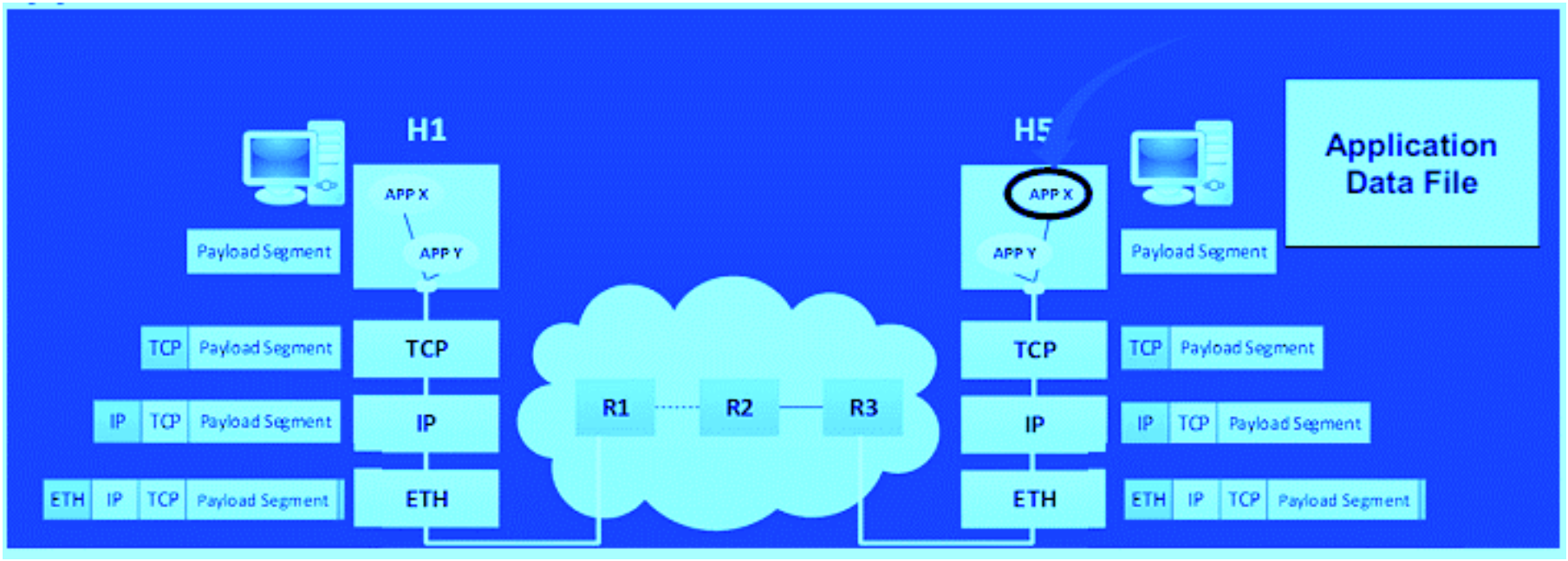
OSI 7 layer model	TCP/IP 5 layer model	Protocols	Protocol Data Unit (PDU)	Layer addressing
Application layer	Application layer	IMAP, FTP, SMTP, DNS, Telnet, SNMP, …	Data	Data
Presentation layer				
Session layer				
Transport layer	Transport layer	TCP, UDP, …	Segment (TCP), Datagram (UDP)	Port address
Network layer	Internet layer	IP, …	Packets	IP address (Source, Destination)
Data link layer	Network access layer	Ethernet, Wi-fi, Bluetooth, 3G, LTE, …	Frames	MAC address
Physical layer	Physical layer	Copper, Fiber optic cables, Wireless transmitters	Bits	n/a

Open System Interconnection (OSI): ITU-T standard X.200 (ISO/IEC 7498-1)

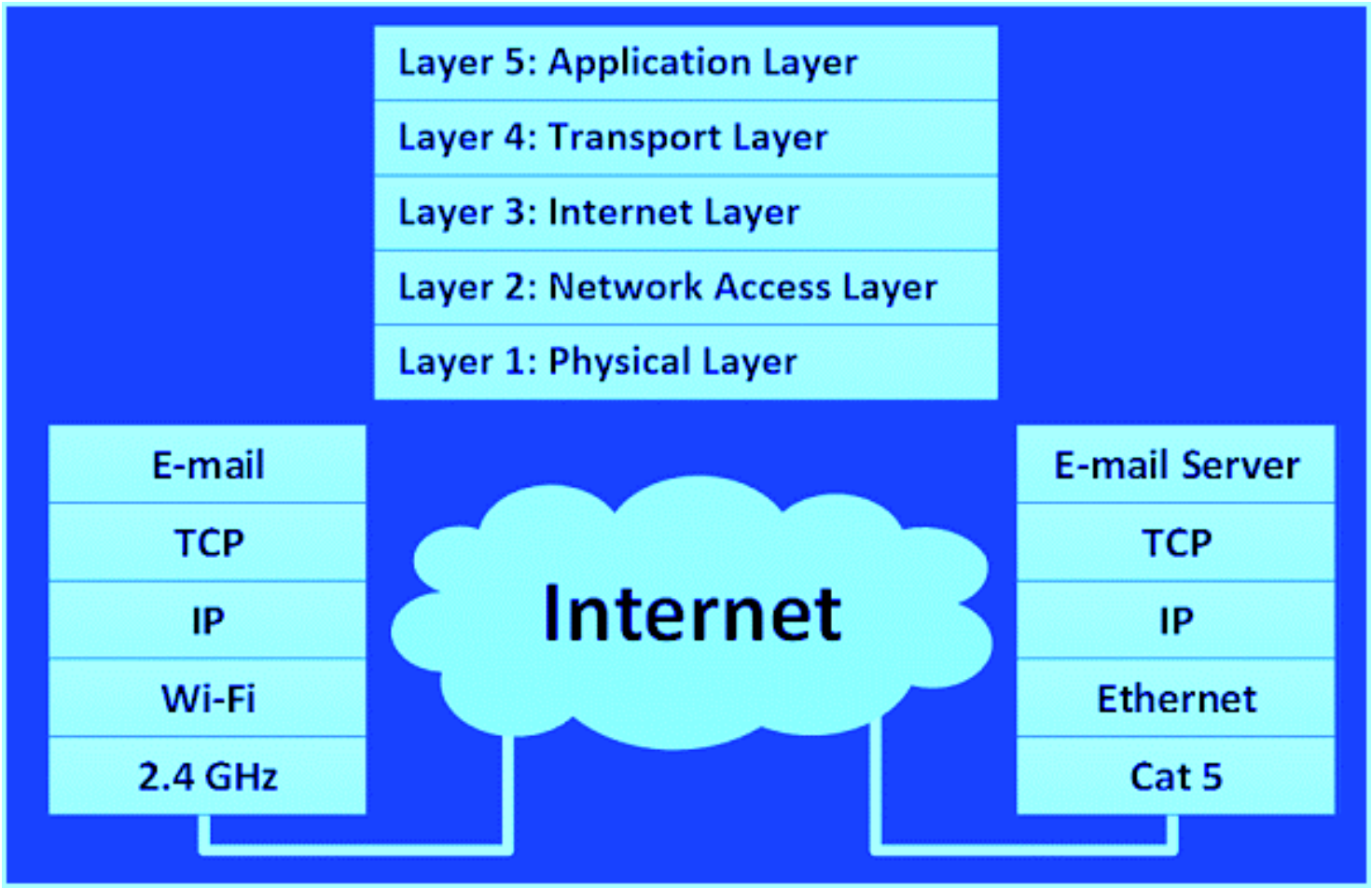
DoD Model: Currently Maintained by IETF

Application File Transfer Example

Sending ‘data file’ from H1 to H2…

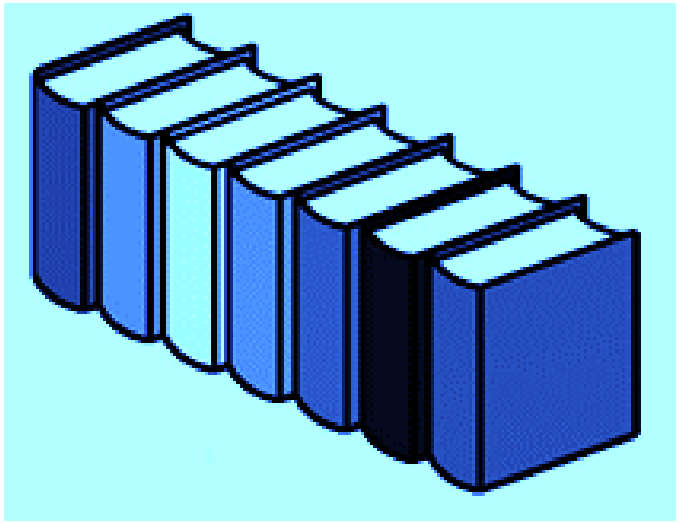


TCP/IP 5 layers operations



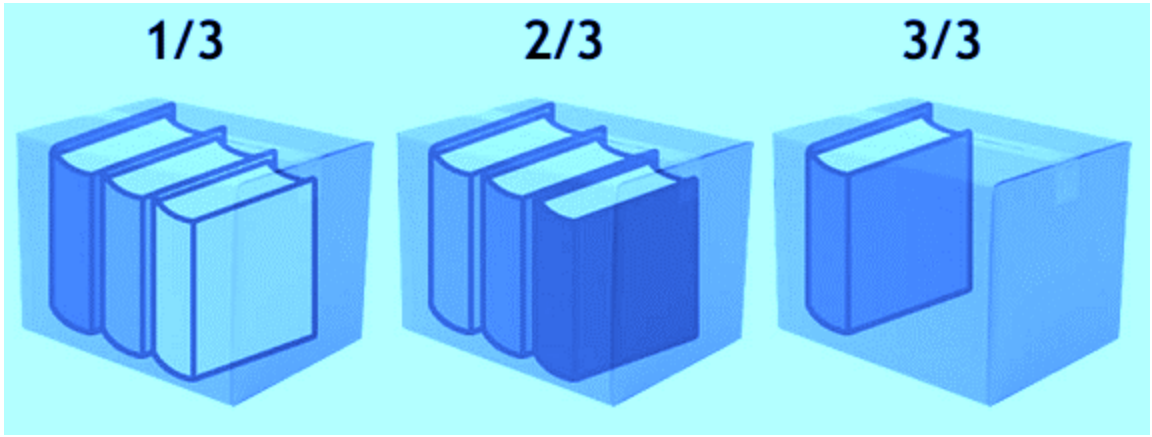
Another Example

- Layer 5: Application Layer (e.g., FTP)
  - I want to **send Books** to my friend by post

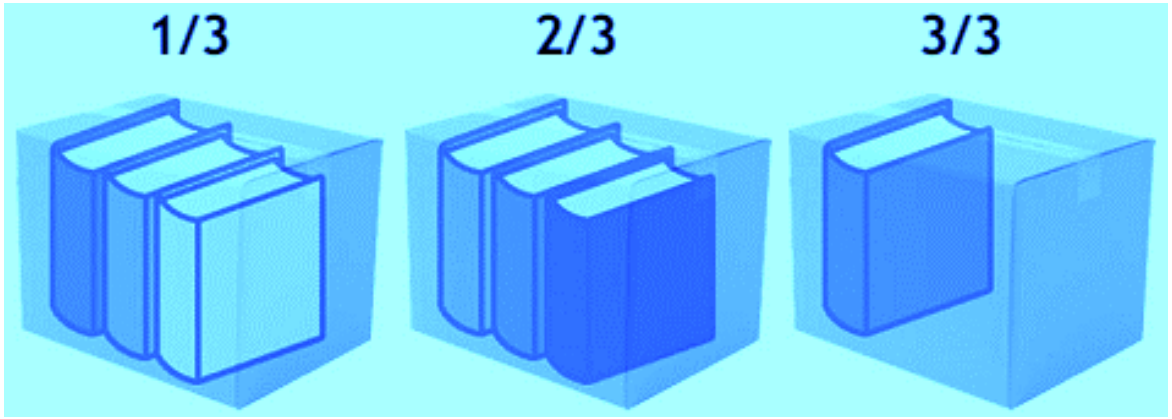


- Books → Application Data File

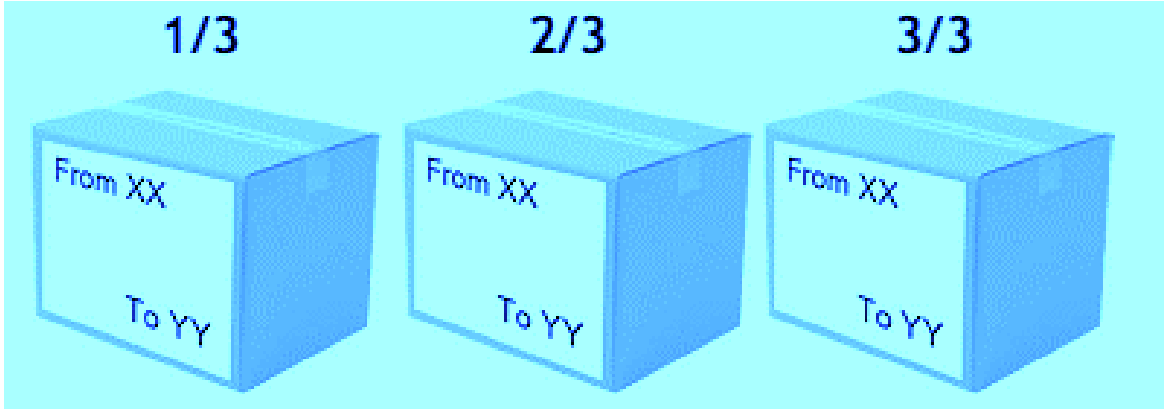
- Layer 4: Transport Layer (e.g., TCP)
  - Divide the books into Boxes and Number the boxes for mailing → 1, 2, 3 out of 3
    - Boxes → TCP Payload Segments
    - Box Numbering → TCP Sequence Numbers



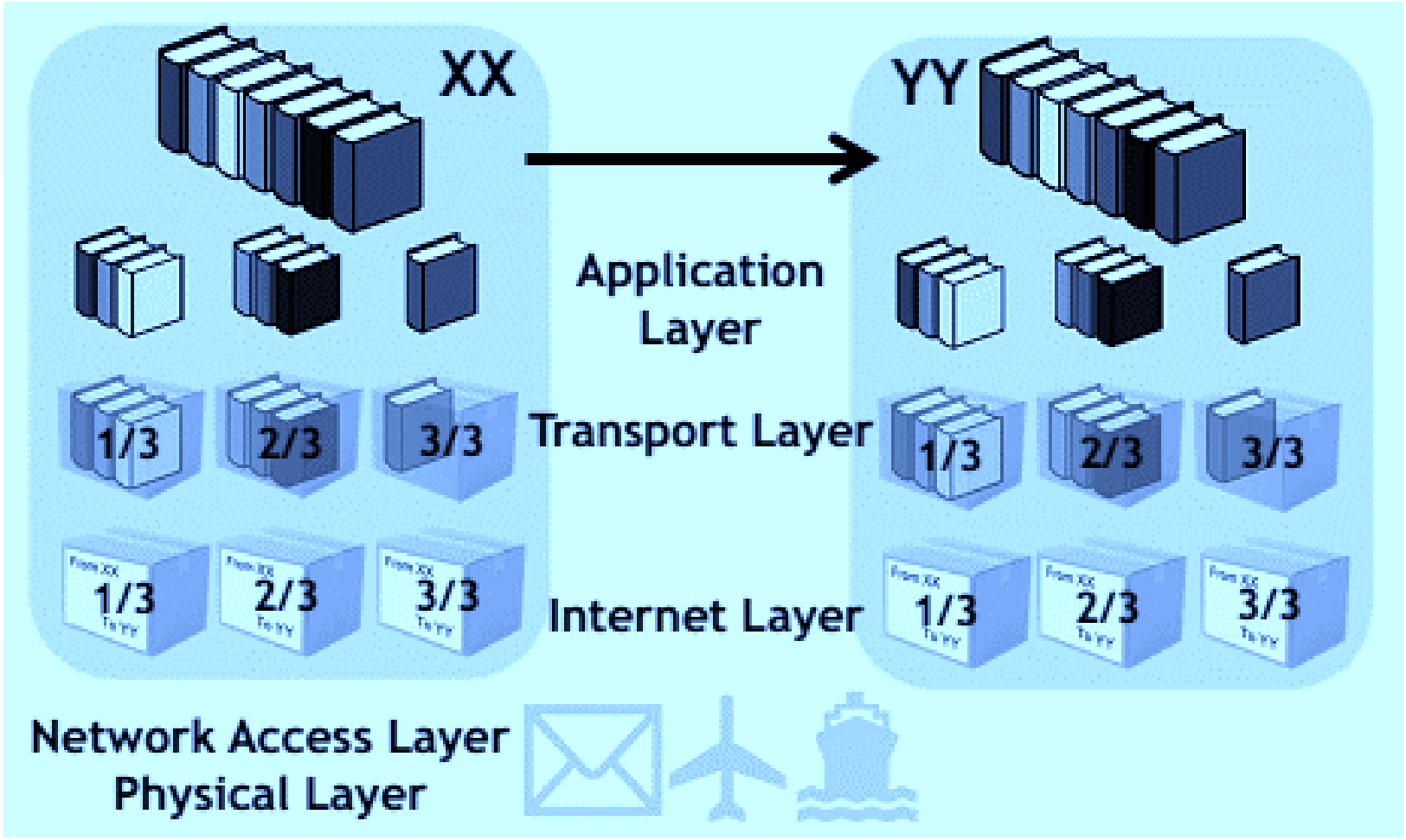
- Layer 4: Transport Layer (e.g., TCP)
  - When received at the destination, the box numbers will be used to
    - Find any Missing Box (payload segment)
    - Reorder books in to the proper sequence



- Layer 3: Internet Layer (i.e., IP)
  - Add Sender and Receiver addresses on each box
    - Sender address → Source IP address
    - Receiver address → Destination IP address
    - IP addresses are used to deliver (route) the packet to the receiver (destination) address



- Layer 2: Network Access Layer (e.g., WiFi)
  - Air mail, Surface mail, Priority mail, etc.
    - Satellite Communications
    - Mobile Communications: 3G, 4G (LTE), 5G
    - Optical Fiber Network Communications
    - Ethernet, Wi-Fi, Bluetooth, etc
- Layer 1: Physical Layer (e.g., Fiber Optic)
  - Airplane, ship, truck, bicycle, motor cycle, walking, etc
    - Wired Electrical Signal & Cable
    - Wireless RF Signal & Antenna
    - Optical Laser Signal & Optical Fiber


XX
YY
Application Layer
1/3
2/3
3/3
Transport Layer
1/3
2/3
3/3
1/3
2/3
3/3
Internet Layer
1/3
2/3
3/3
Network Access Layer
Physical Layer

Exercise 3: Practical work

- Use any FTP client to connect to FTP server of your choice e.g., ftp.gnu.org (or use network simulator) and perform a transfer/read operation on a file:
  1. List down the actions (in step-wise fashion) e.g., by documenting logs
  2. Visualize/Map each connection with the respective TCP/IP Layer (e.g., see slide no. 25 & 24)

  -> Use network simulator e.g. Cisco Packet Tracer (direct link)

  Others: https://nil.uniza.sk/network-simulation-virtualization-software-list

Deadline: See 'Teams' Assignment section

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  - Packet switching approaches
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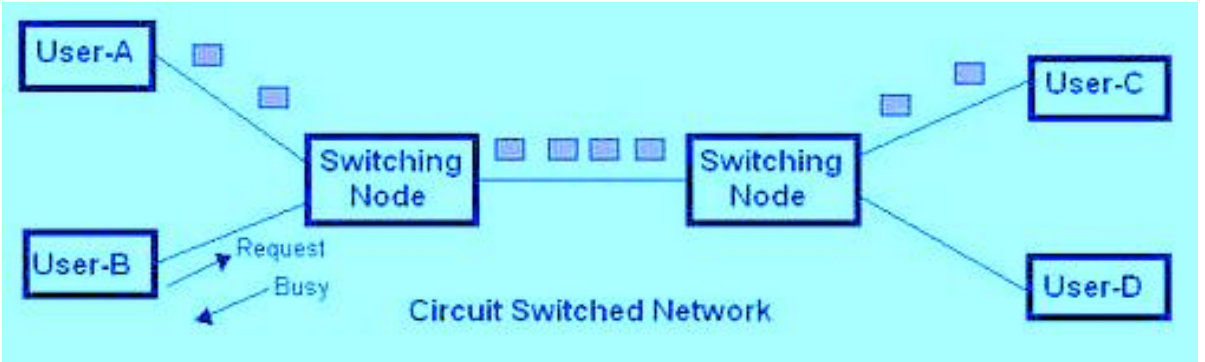
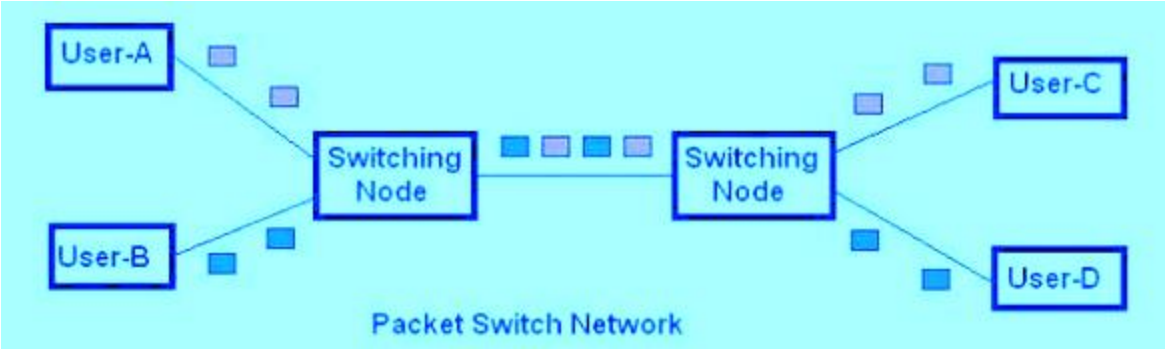
Circuit Switching

- In Circuit Switching (CS), network dedicated channel must be established before the call is made between users
  - The channel is then reserved (with dedicated transmission rate) till the connection is active e.g., phone call over PSTN (Public switched telephone network), POTS (plain old telephone service)
  - Any idle resource that is part of the reserved channel, then cannot be used by other ongoing communications



Packet Switching

- In packet switching network, unlike CS network, it is not required to establish the connection initially
  - The connection/channel is available to use by many users and allocates variable transmission rate based on demand
  - Message is broken into series of small packets (that contains their routing information)



Packet switching approaches

- Packet switching can be viewed under two **approaches**:
  - **Datagram type (connection-less)**: e.g., IP, UDP,
    - Each packet (containing source/destination IP, Port, sequence) is treated independently
    - Every intermediate node must take routing decisions
  - **Virtual circuit type (connection-oriented)**: e.g., TCP
    - A preplanned route is established before any packets are sent
    - Route is fixed for the duration of logical connection for all packets
    - For route termination, a clear request must be sent

Virtual circuit can be regarded as 'mixed' (i.e., share some properties of circuit switching)

Comparing switching types

Circuit Switching	Packet Switching(Datagram type)	Packet Switching(Virtual Circuit type)
Dedicated path	No Dedicated path	No Dedicated path
Path is established for entire conversation	Route is established for each packet	Route is established for entire conversation
Call setup delay	packet transmission delay	call setup delay as well as packet transmission delay
Overload may block call setup	Overload increases packet delay	Overload may block call setup and increases packet delay
Fixed bandwidth	Dynamic bandwidth	Dynamic bandwidth
No overhead bits after call setup	overhead bits in each packet	overhead bits in each packet

Lecture 2 ends here

- Course Slides: Go to MS Teams:
  'Introduction to Computer Networks - Spring 2024 | BSc'
  -> Files section

- Send your questions by email:
  mohammad-salman.nadeem@epita.fr
  OR via direct message using MS Teams

- Thank You!