National University of Computer & Emerging Sciences

Fall 2024
Lecture 03
BS(CS)
Protocols and Service Models

Protocol "layers"

Networks are complex, with many "pieces":

- hosts
- routers
- links of various media
- applications
- protocols
- hardware, software

Question:

is there any way of *organizing* structure of network?

…. or at least our discussion of networks?

TCP

MAC

FTP

applications

IPv4

HTTP

DHCP

DNS

UDP

SSH

ICMP

ARP

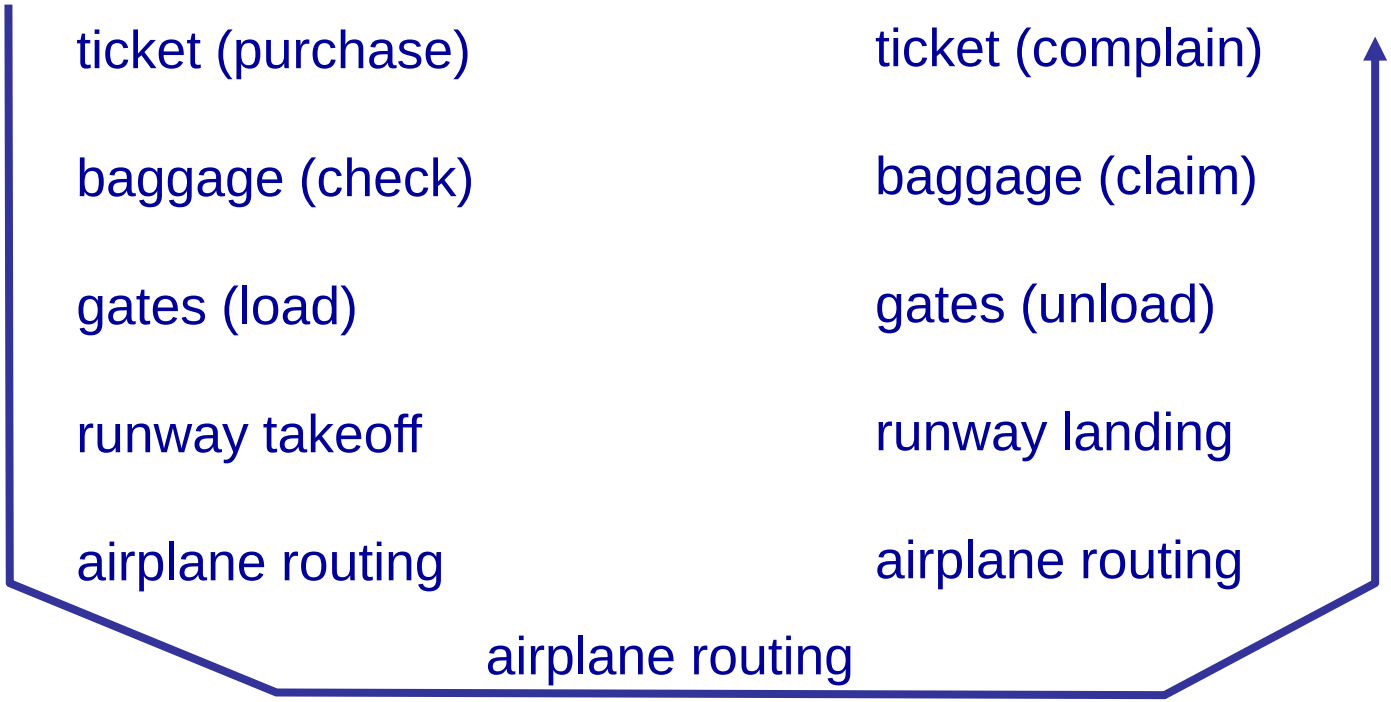
Routing protocols

hosts

RIP

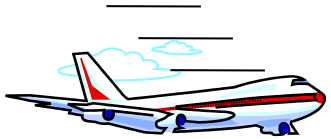
hardware, software

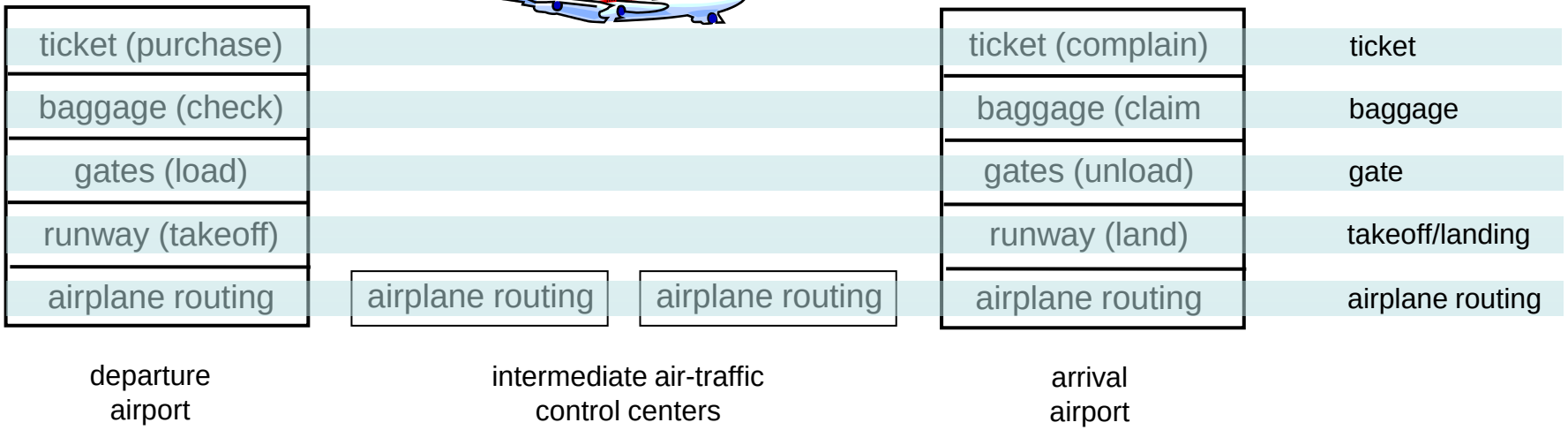
Organization of air travel



- a series of steps

Layering of airline functionality





layers: each layer implements a service

- via its own internal-layer actions
- relying on services provided by layer below

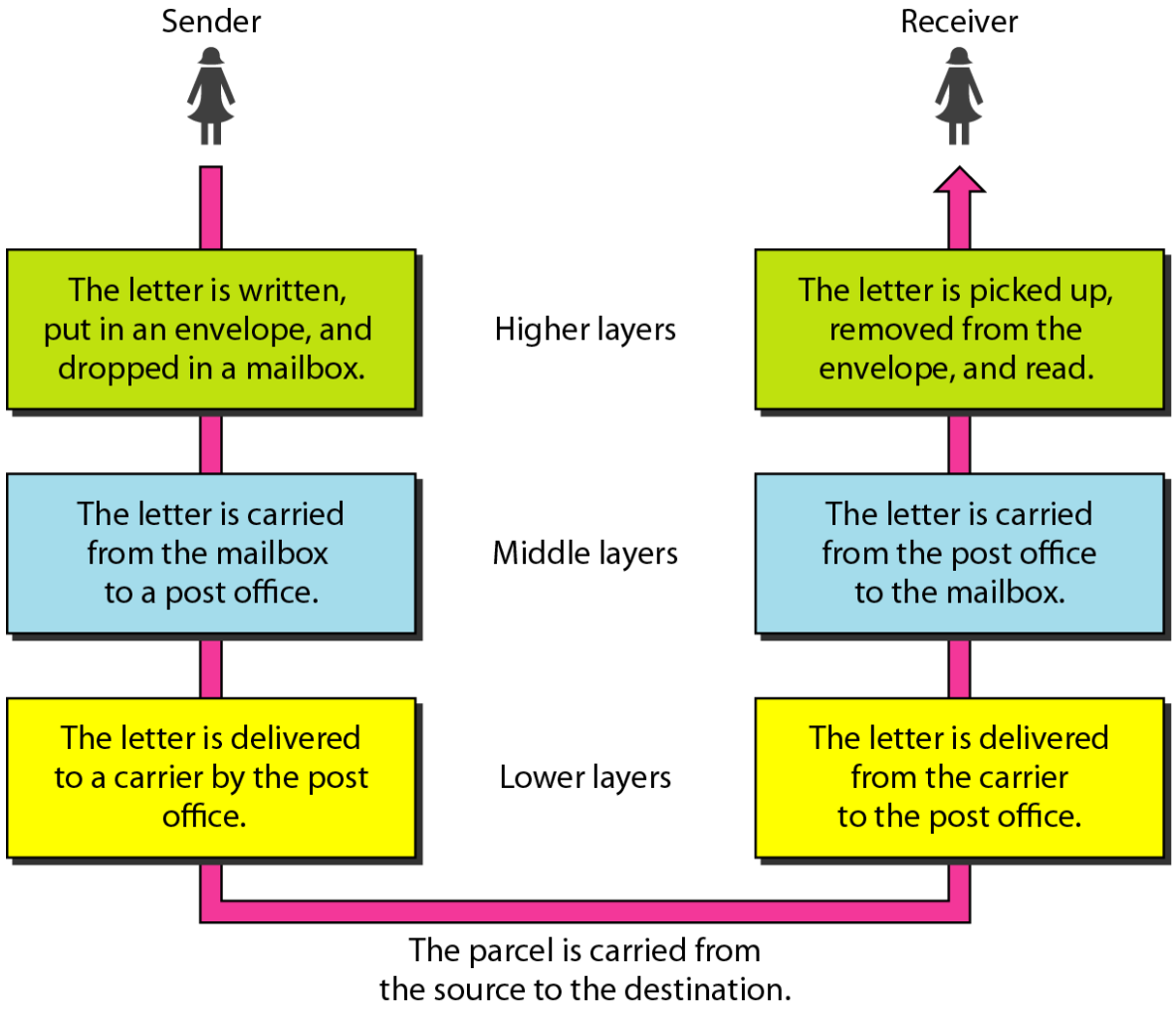
Why layering?

dealing with complex systems:

- modularization eases maintenance, updating of system
  - change of implementation of layer's service transparent to rest of system
  - e.g., change in gate procedure doesn't affect rest of system
- Led to flexibility in modifying and developing network architectures.
- Accommodates incremental changes.

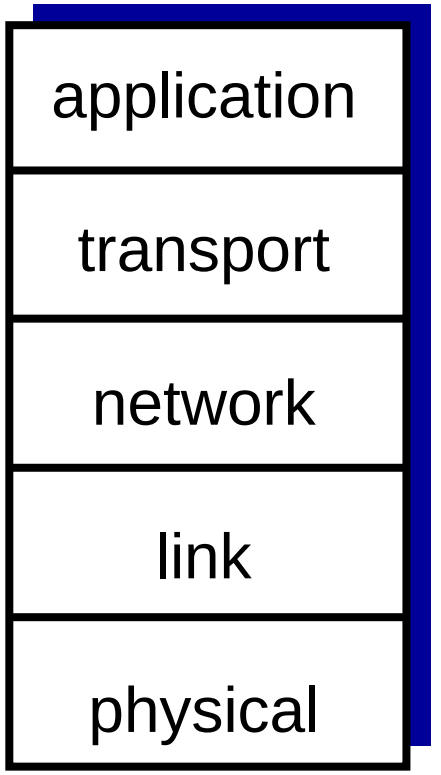
We use the concept of layers in our daily life. As an example, let us consider two friends who communicate through postal mail. The process of sending a letter to a friend would be complex if there were no services available from the post office.

Tasks involved in sending a letter



Internet protocol stack

- *application:* supporting network applications
  - FTP, SMTP, HTTP
- *transport:* process-process data transfer
  - TCP, UDP
- *network:* routing of datagrams from source to destination
  - IP, routing protocols
- *link:* data transfer between neighboring network elements
  - Ethernet, 802.111 (WiFi), PPP
- *physical:* bits "on the wire"



Note

the **application layer** provides services for an application program to ensure that effective communication with another application program in a network is possible

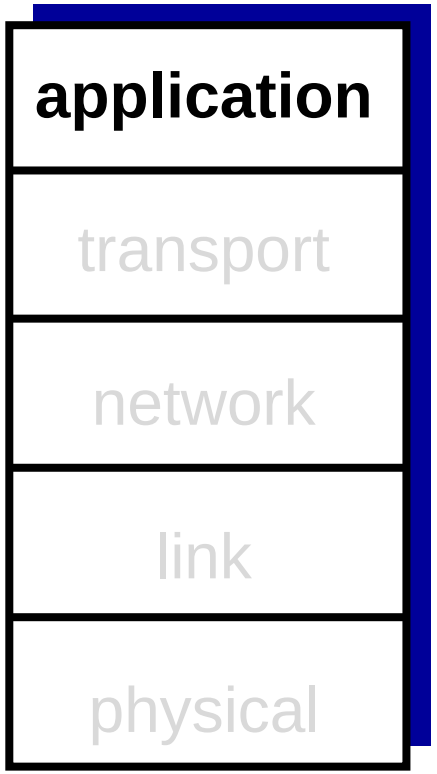
application: enable users/applications to access network resources

HTTP protocol (which provides for Web document request and transfer)

FTP protocol (transfer of files between two end systems)

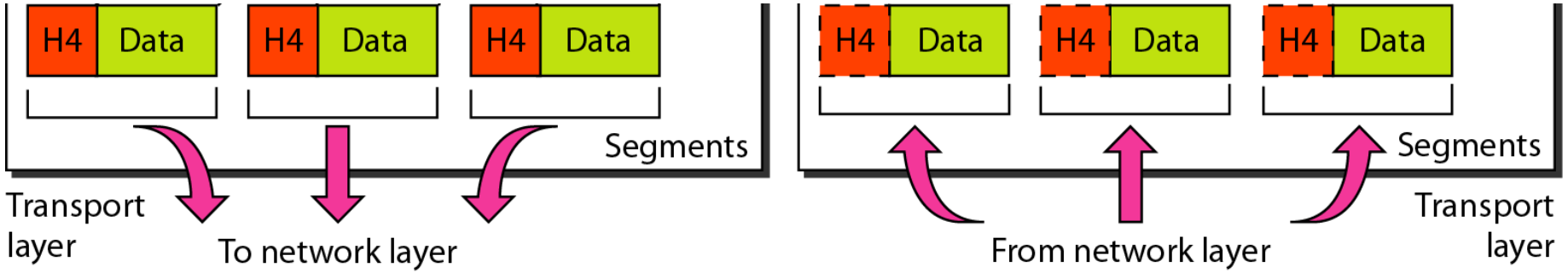
SMTP (transfer of e-mail messages)

DNS (Domain name system



Transport layer

- This layer divide the data into **segments.**
- Transport Layer is where the decision to use TCP/UDP is made. Among commonly used protocols in this layer, TCP is reliable, UDP isn't.
- Depending upon the choice made, the respective headers are attached to your packet.



Transport layer (TCP/UDP)

Application	Application-Layer Protocol	Underlying Transport Protocol
Electronic mail	SMTP	TCP
Remote terminal access	Telnet	TCP
Web	HTTP	TCP
File transfer	FTP	TCP
Remote file server	NFS	Typically UDP
Streaming multimedia	typically proprietory	UDP or TCP
Internet telephony	typically proprietory	UDP or TCP
Network Management	SNMP	Typically UDP
Routing Protocol	RIP	Typically UDP
Name translation	DNS	Typically UDP

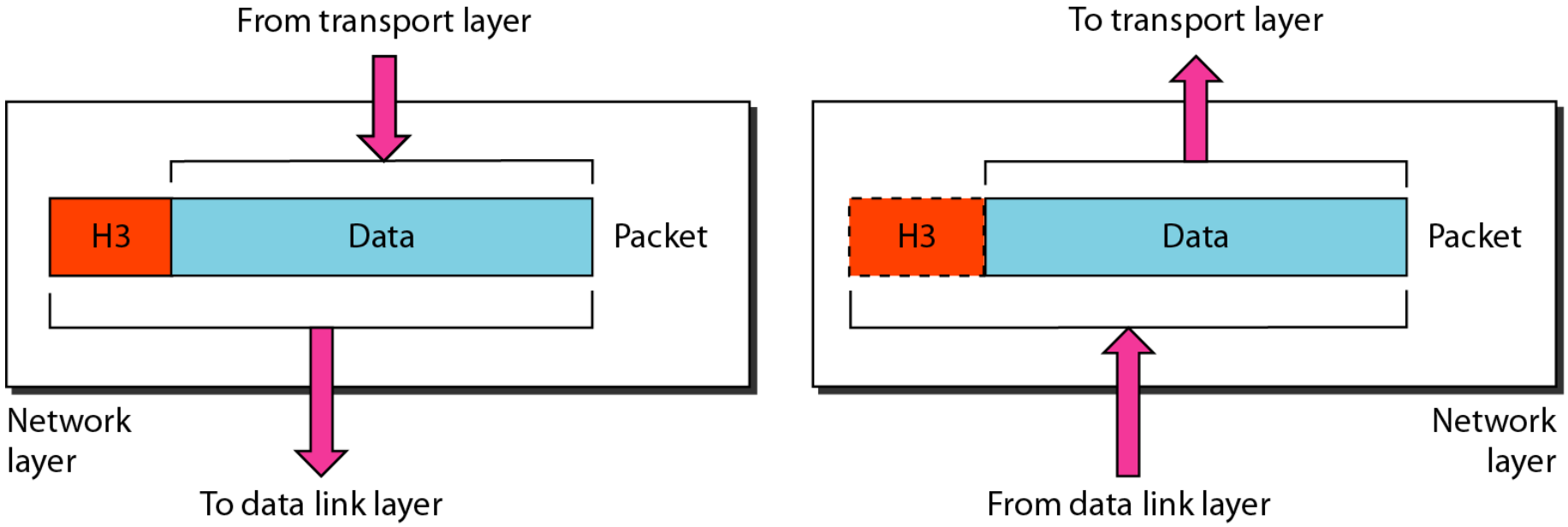
Figure 1. Popular Internet applications and their underlying transport protocols

Note

- Now, after TCP/UDP header being appended, it moves on to the Network Layer. Till this step, the remote end-point's IP address wasn't a part of the packet at all.

Network layer

- The Internet transport-layer protocol (TCP or UDP) in a source host passes a transport-layer segment and a destination address to the network layer.



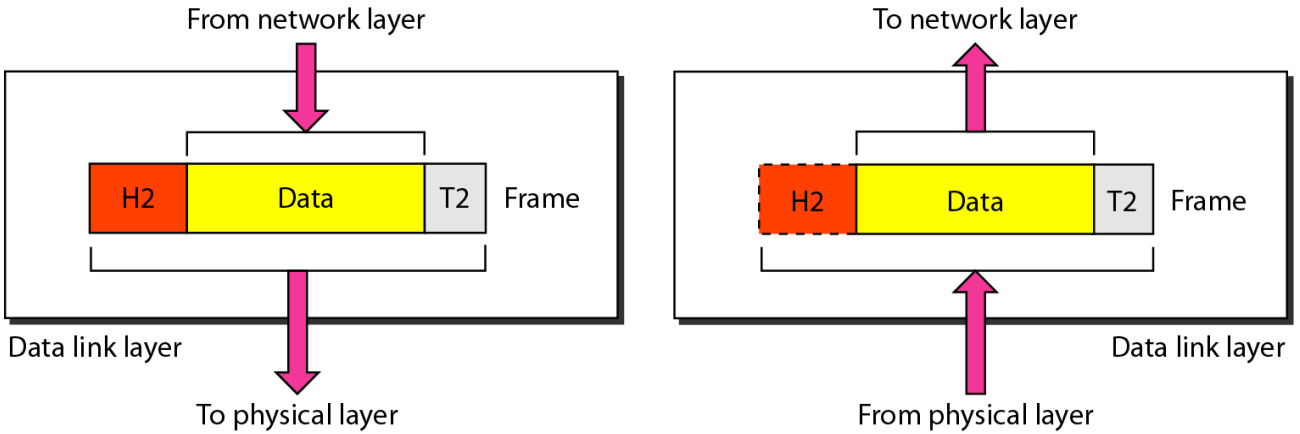
Network layer

- The first physical equipment at the Network Layer would be Routers
- It receives SEGMENTS from the upper layer and convert it into PACKETS.
- **Logical addressing**: The network layer adds a header to the packet coming from the upper layer, includes the logical addresses (IP) of the sender and receiver.
- Makes "**Best Path Determination**" decision based on logical addressing.

Link layer services

framing, link access:

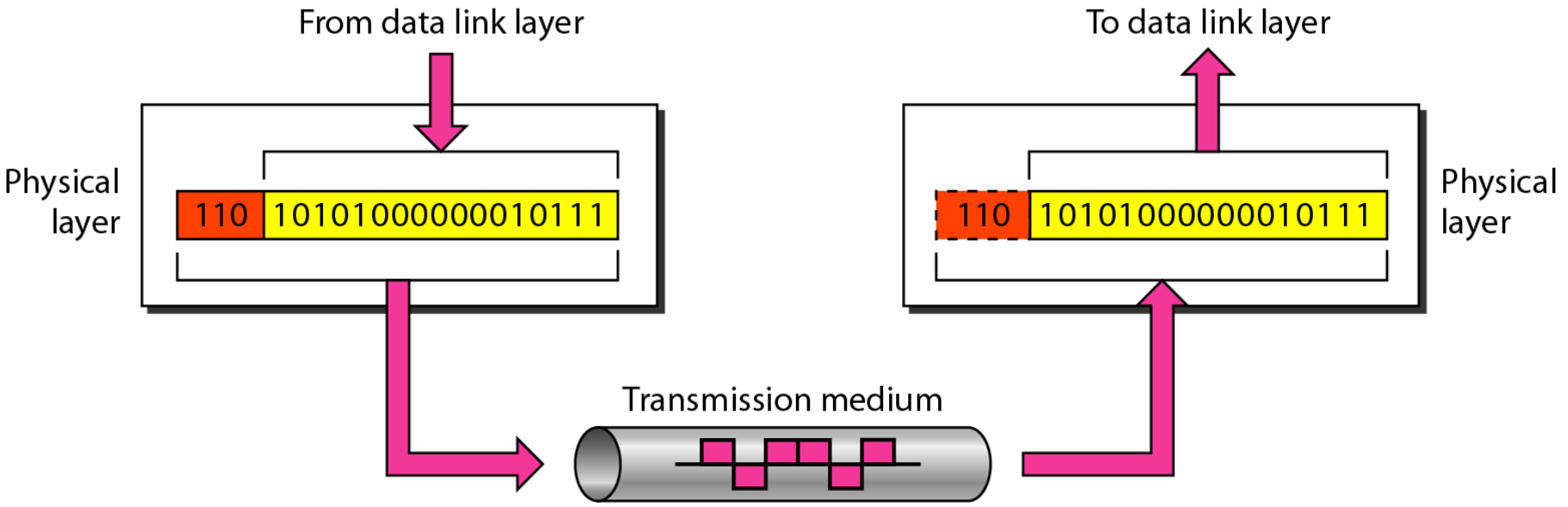
- specify the **encapsulation** of a packet into a frame and the techniques for getting the encapsulated packet on and off each medium.
- **channel access if shared medium**
  - "MAC" addresses used in frame headers to identify source, dest (different from IP address!
- **Error checking**

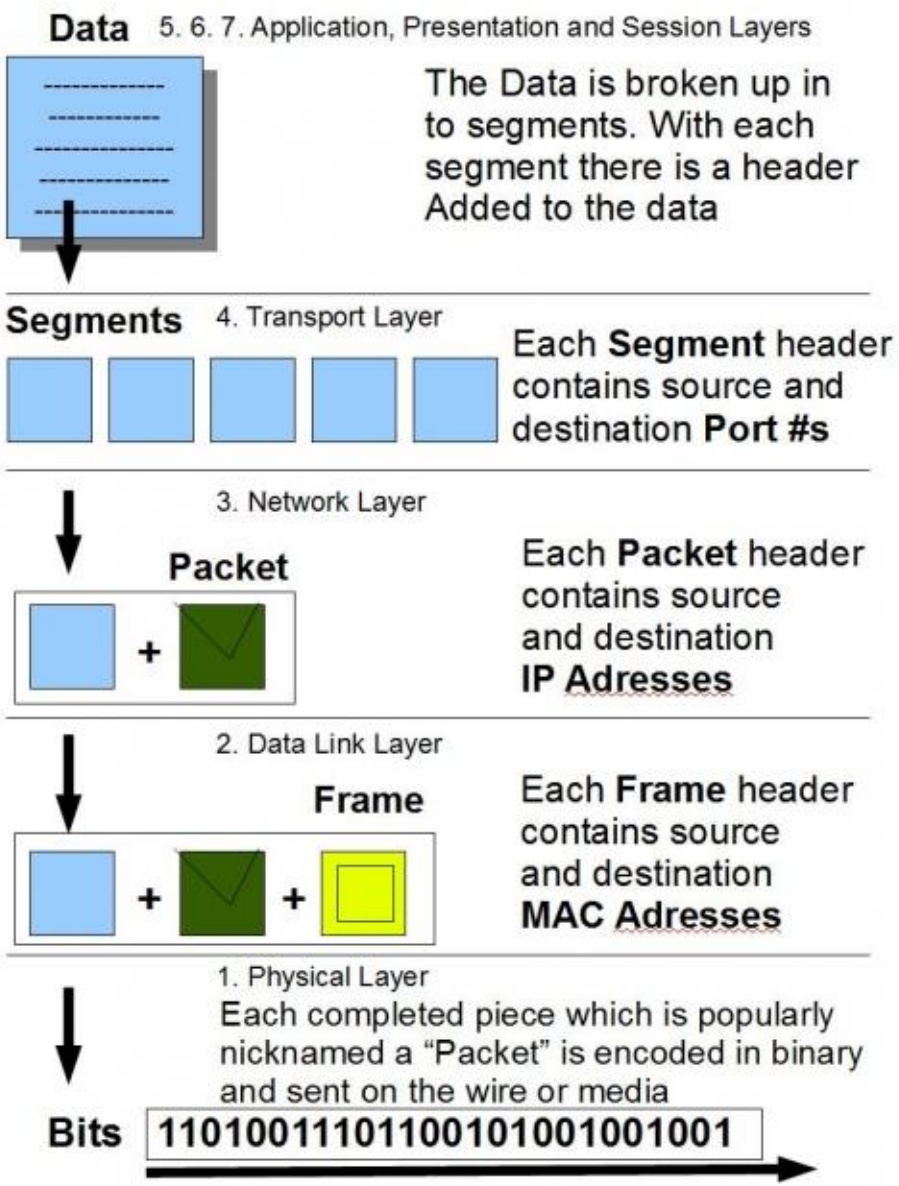


Physical layer

- Defines the physical and electrical medium for data transfer.
- Physical layer components: cables, jacks, punch blocks, hubs.

Physical layer




Data
5. 6. 7. Application, Presentation and Session Layers
The Data is broken up in to segments. With each segment there is a header Added to the data
Segments
4. Transport Layer
Each Segment header contains source and destination Port #s
3. Network Layer
Packet
Each Packet header contains source and destination IP Adresses
2. Data Link Layer
Frame
Each Frame header contains source and destination MAC Adresses
1. Physical Layer
Each completed piece which is popularly nicknamed a "Packet" is encoded in binary and sent on the wire or media
Bits
11010011101100101001001001

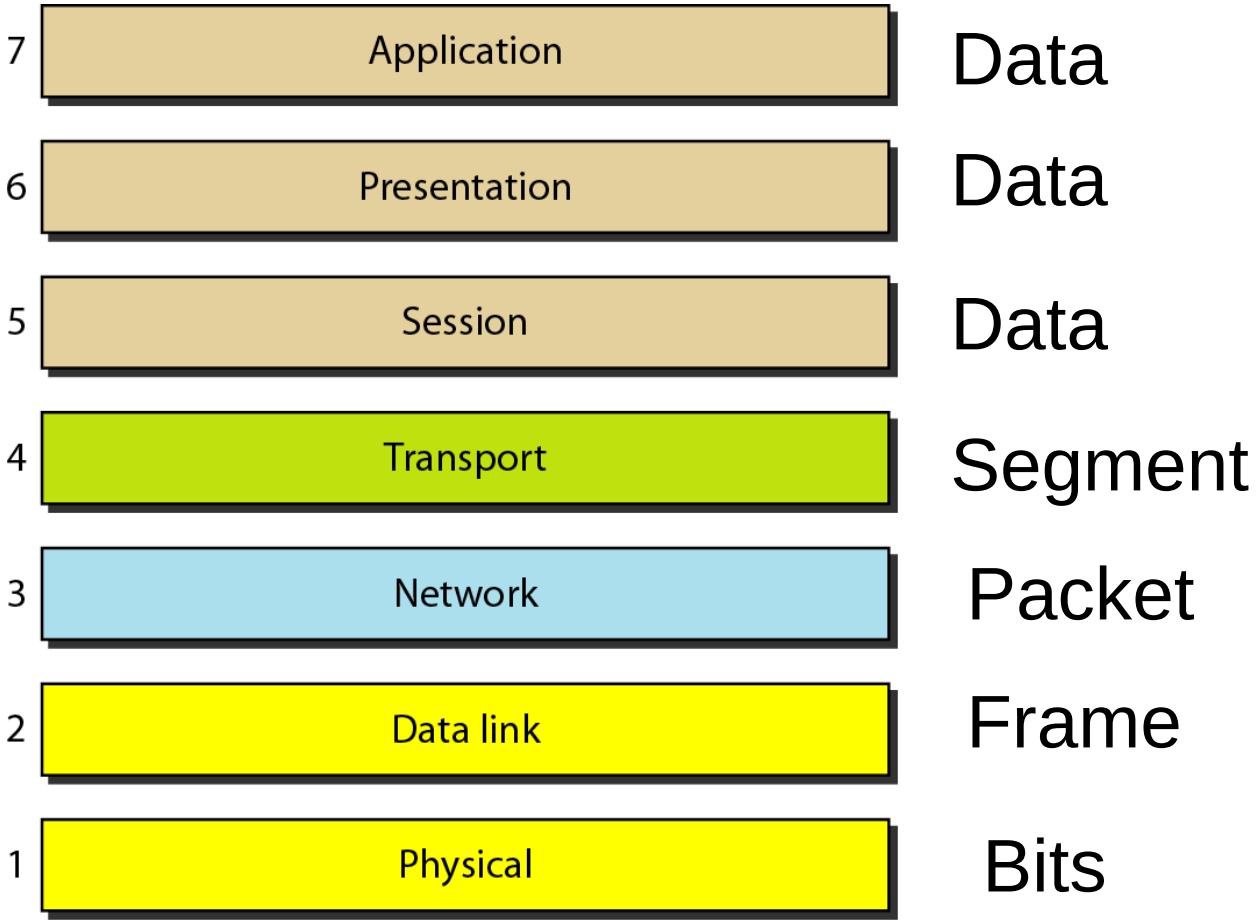
The OSI Model

Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards. An ISO standard that covers all aspects of network communications is the Open Systems Interconnection (OSI) model. It was first introduced in the late 1970s.

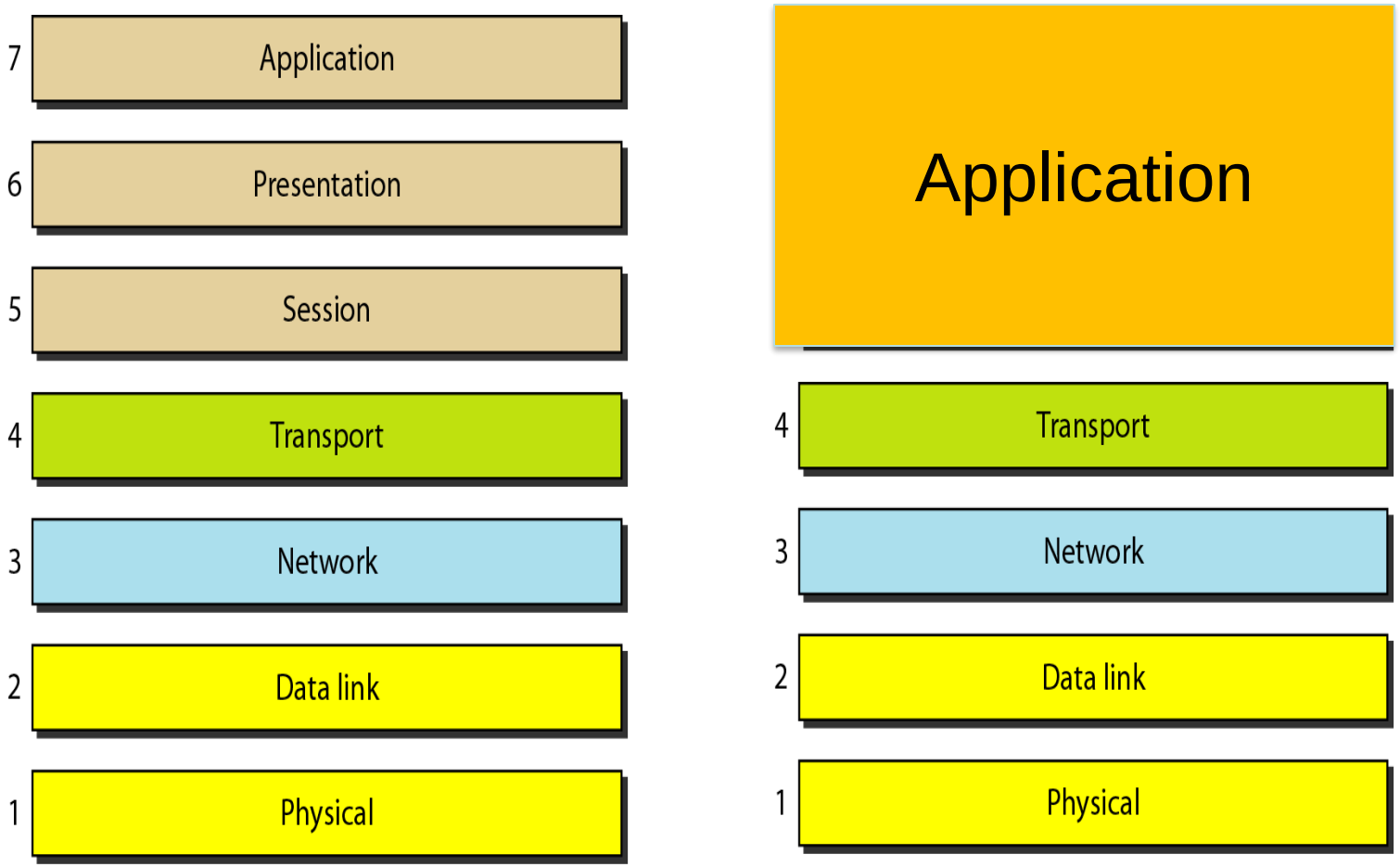
Note

ISO is the organization.
OSI is the model.

Seven layers of the OSI model



Seven layers of the OSI model



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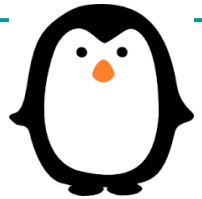
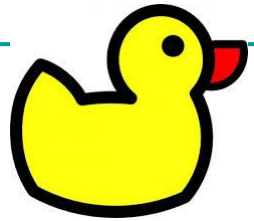
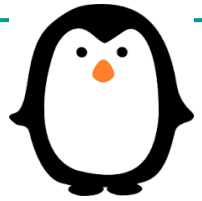
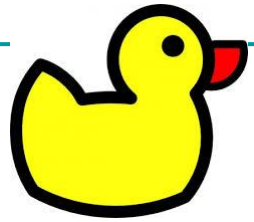




7	Application		Application
6	Presentation	Data	Presentation
5	Session		Session
4	Transport		Transport
3	Network		Network
2	Data link		Data link
1	Physical		Physical

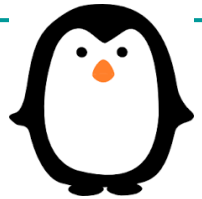
Seven layers of the OSI model

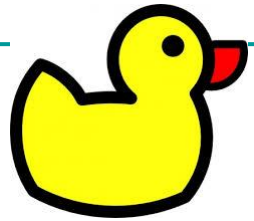




7	Application			7 Application
6	Presentation			6 Presentation
5	Session			5 Session
4	Transport	TH | Seg1	TH | Seg2	4 Transport
3	Network			3 Network
2	Data link			2 Data link
1	Physical			1 Physical

Seven layers of the OSI model





7	Application		Application
6	Presentation		Presentation
5	Session		Session
4	Transport	TH | Seg2	Transport
3	Network	NH|TH | Seg1	Network
2	Data link		Data link
1	Physical		Physical

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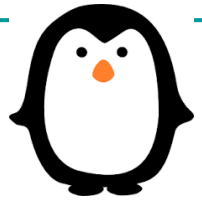

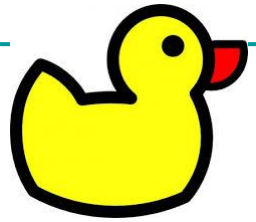

7	Application		Application
6	Presentation		Presentation
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4	Transport		Transport
3	Network	NH|TH | Seg2	Network
2	Data link	DH|NH|TH | Seg1	Data link
1	Physical		Physical

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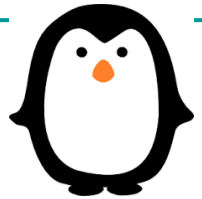

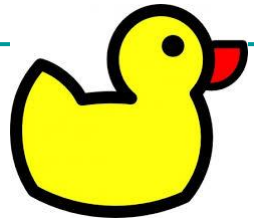

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5	Session		Session
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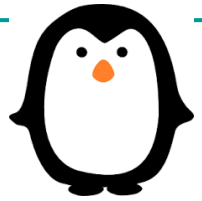
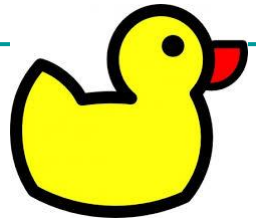
2	Data link	DH|NH|TH | Seg2	Data link
1	Physical	01001010001010	Physical

Seven layers of the OSI model





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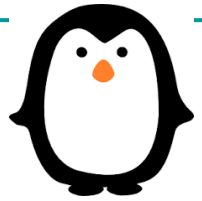

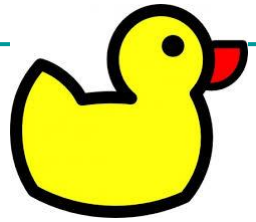

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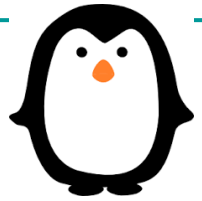

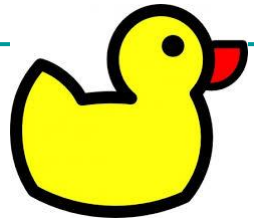

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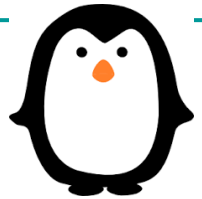

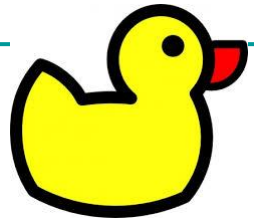

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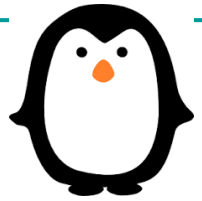

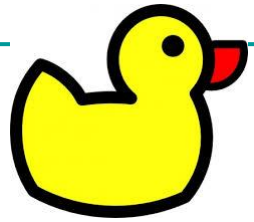

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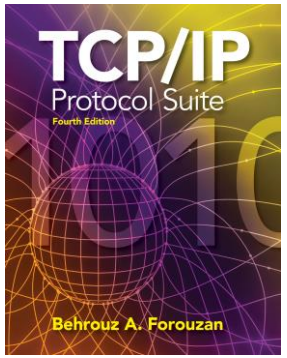
Computer Networking: A Top Down Approach
8th edition
Jim Kurose, Keith Ross
Addison-Wesley

A note on the origin of these ppt slides:

These slides are freely provided by the book authors and it represents a *lot* of work on their part. We would like to thank J.F Kurose and K.W. Ross.

Some slides adapted from the ones accompanying the book “The TCP/IP Protocol Suite”