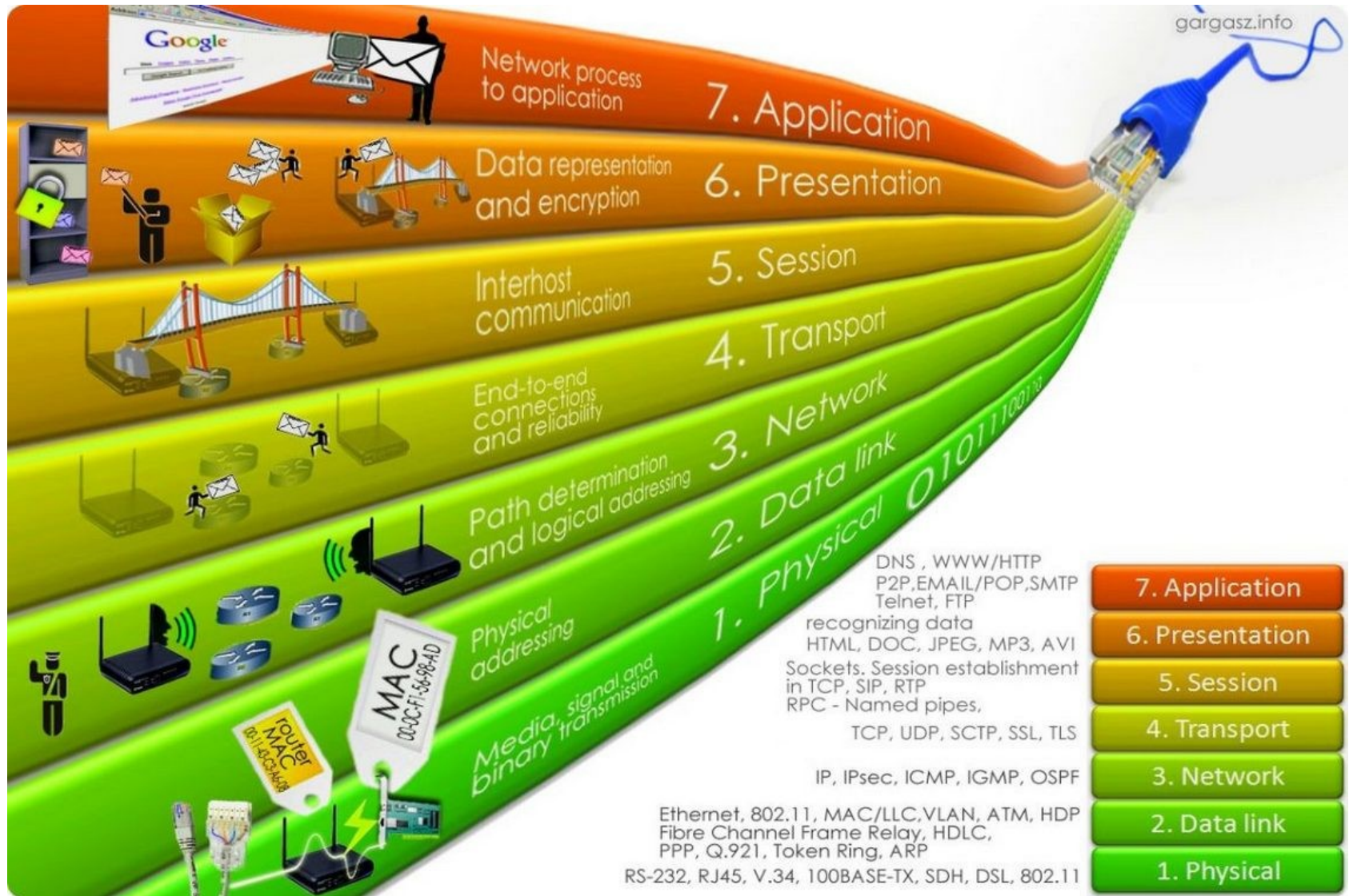


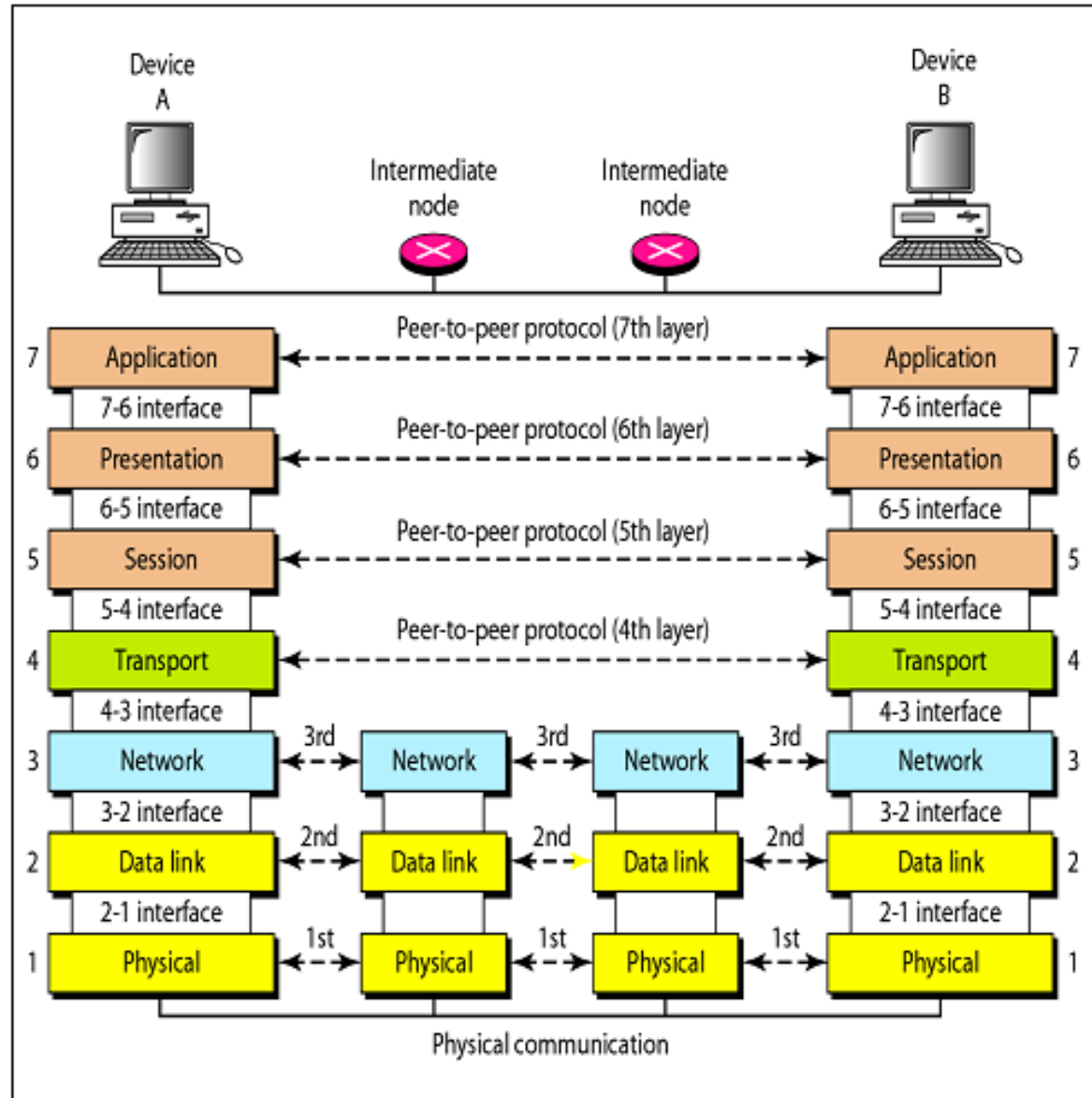
# **Mobile and Wireless Networks**

**IP over wireless**

# OSI Model

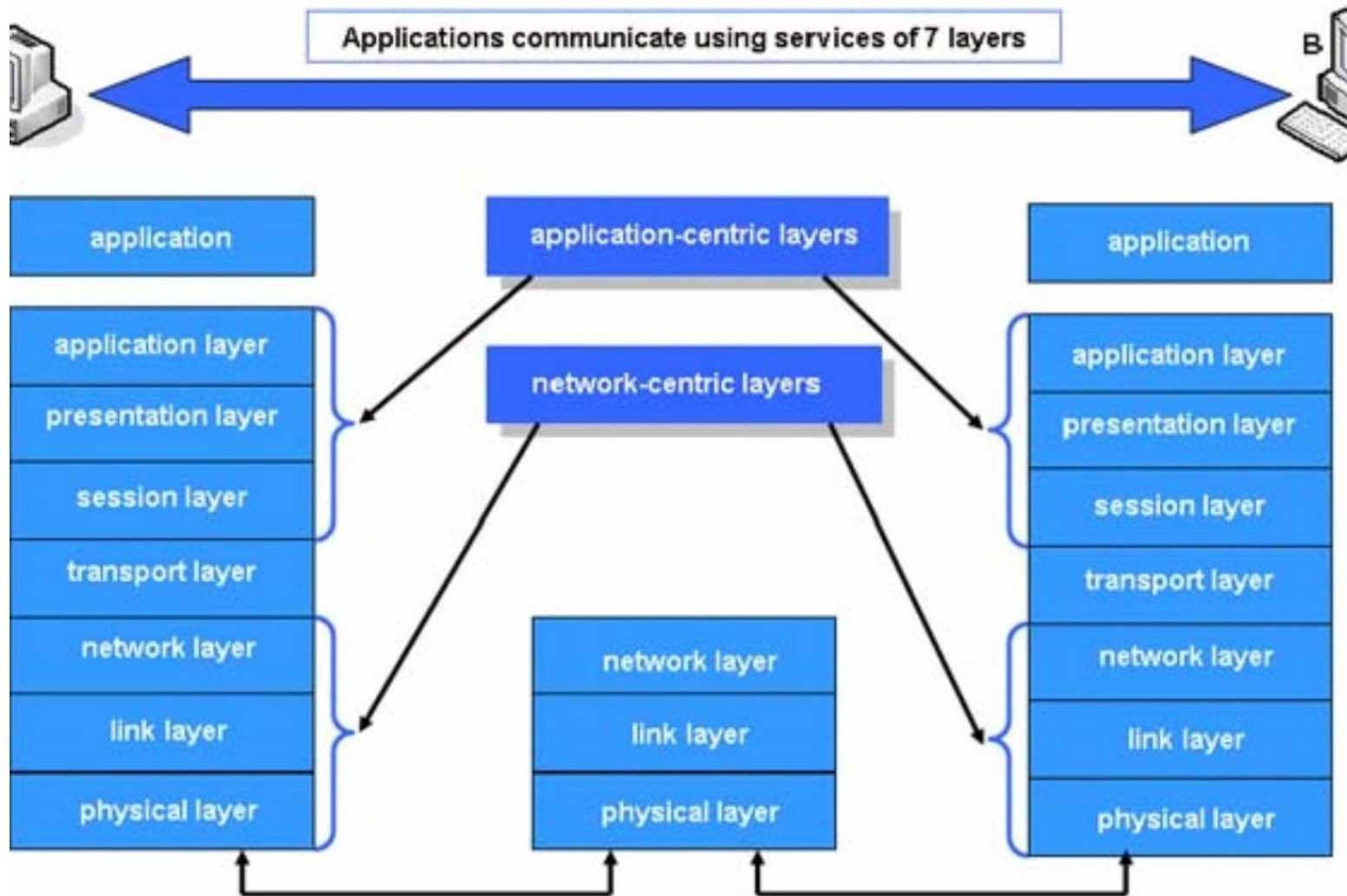


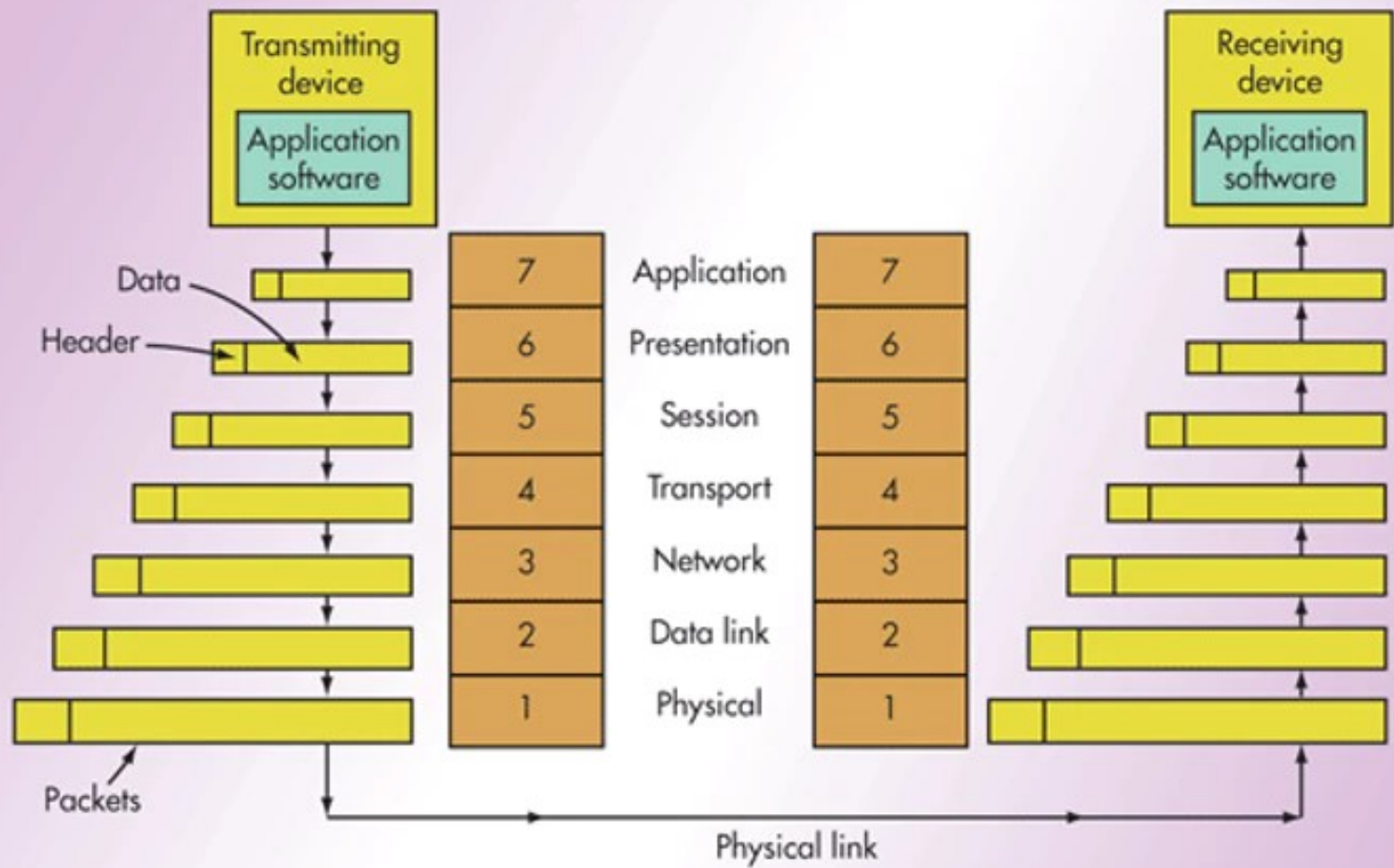
# OSI Model



**Fig: Communication & Interfaces in the OSI model**

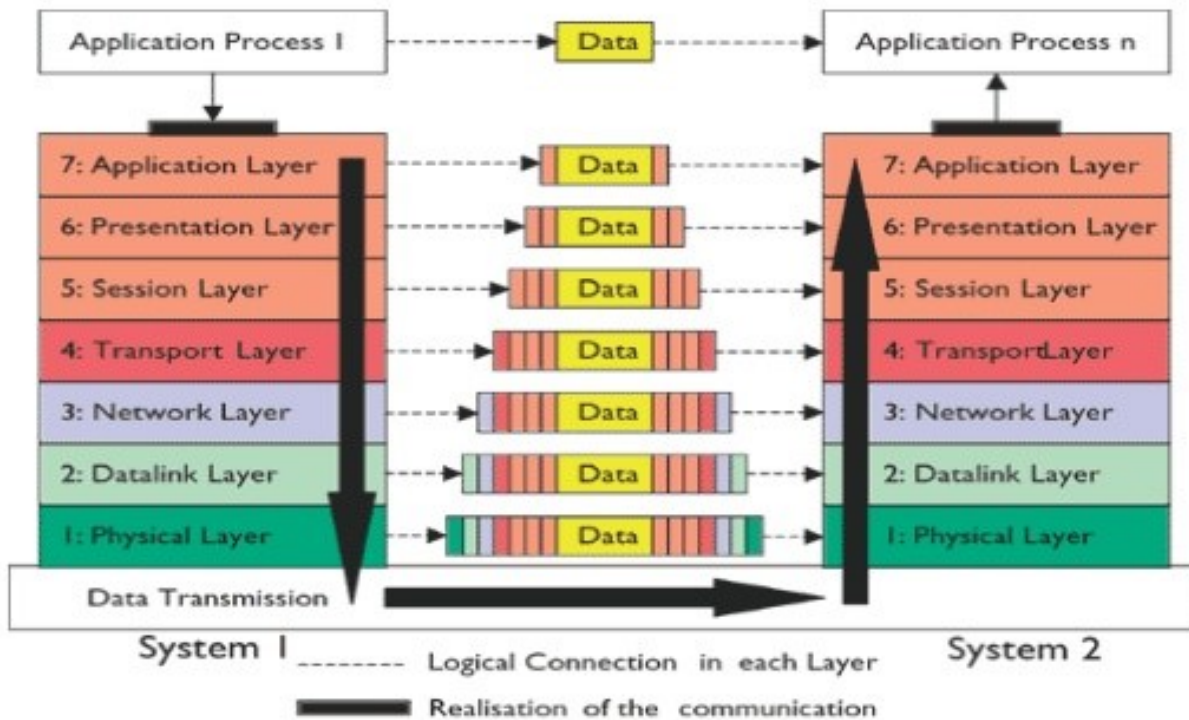
# ISO 7-Layer Model



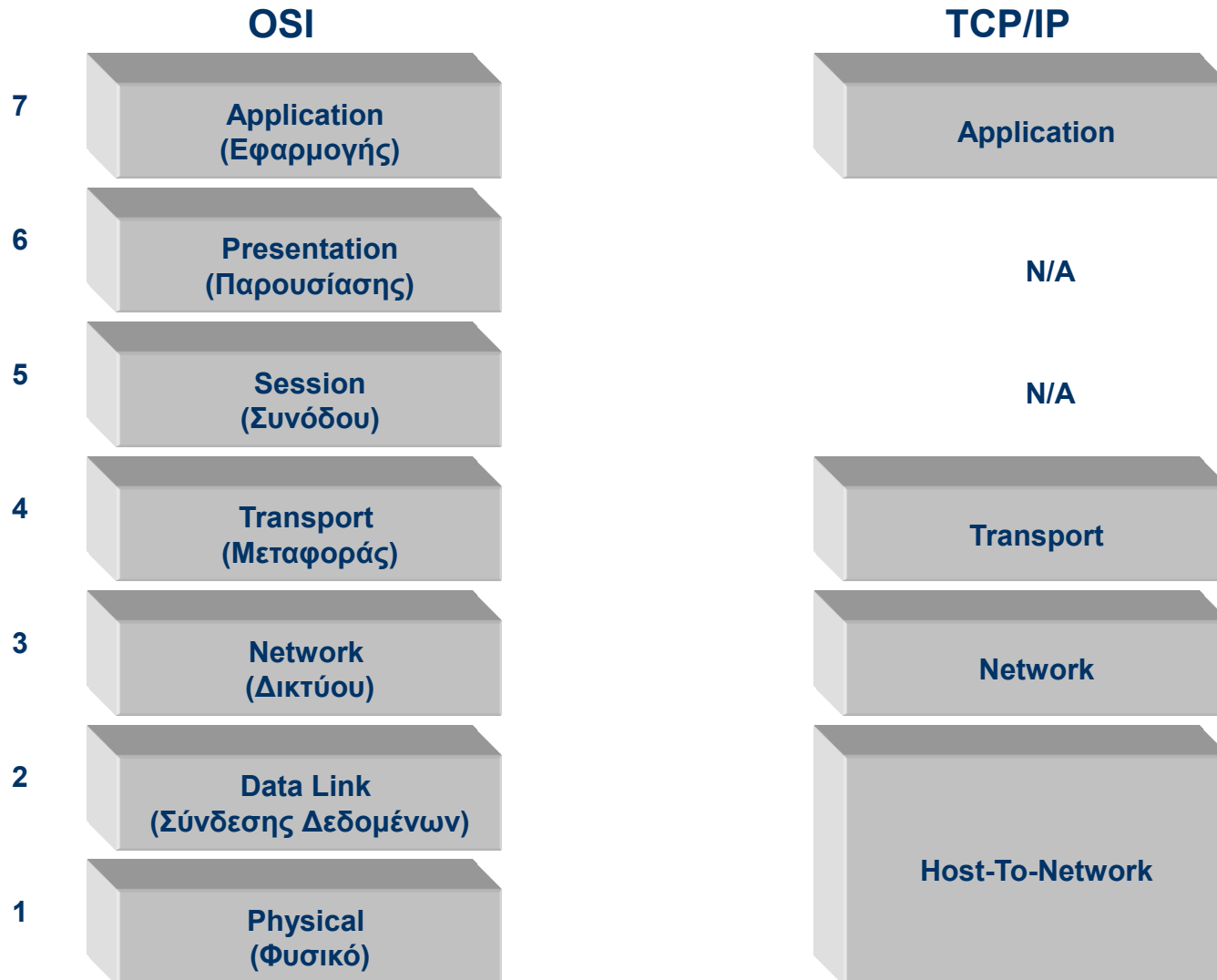


# Data Transmission in the OSI Reference Model

## OSI LAYERS MODEL



# Reference model - TCP/IP



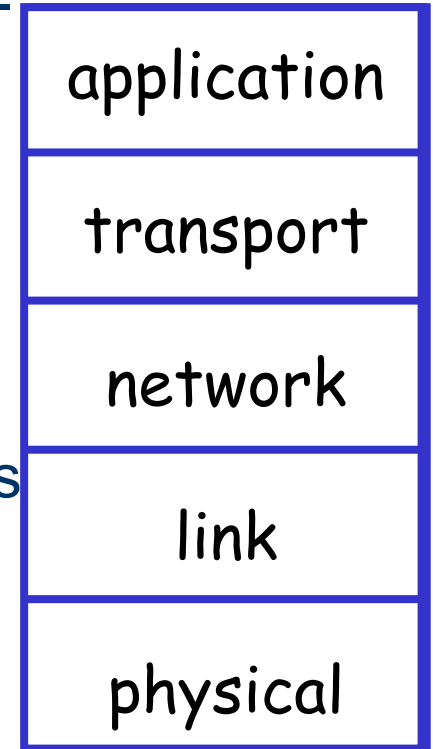
# Reference Model ISO/OSI

- **presentation**: cryptography, compression, description of application data
- **session**: synchronizing of data exchange, different flows per application
- Internet does not support these two layers
- If needed, they are supported at the application layers

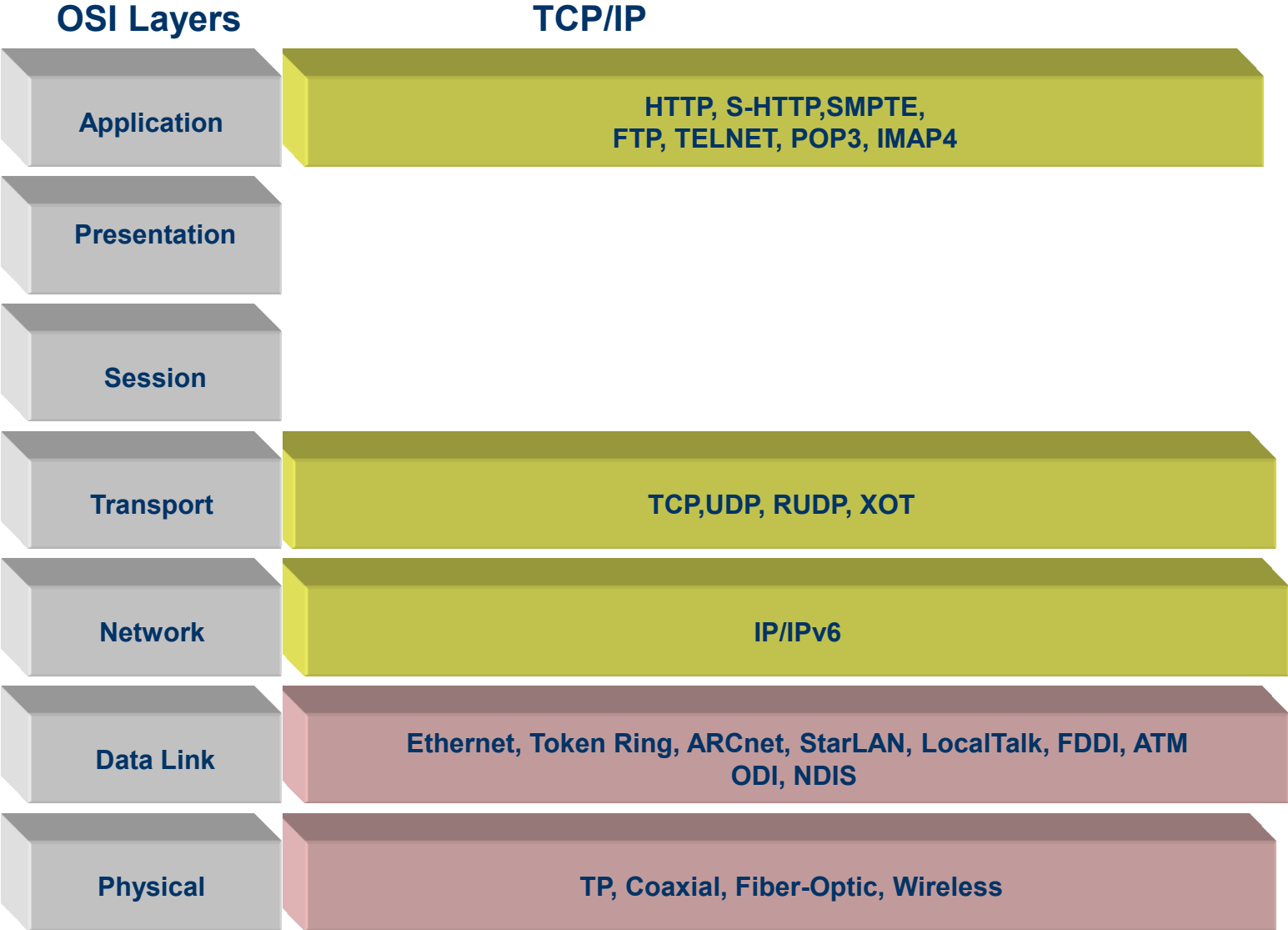


# Internet Protocol Stack

- **application:** support of network applications
  - **FTP, SMTP, HTTP**
- **transport:** transfer of application messages end-to-end
  - **TCP, UDP**
- **network:** routing of datagrams from source to destination
  - **IP, routing protocols**
- **link:** transfer of data between neighboring nodes in the network
  - **PPP, Ethernet, 802.11 (WiFi)**
- **physical:** bits “over the line”

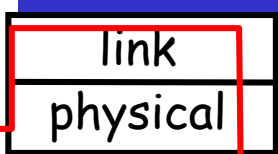
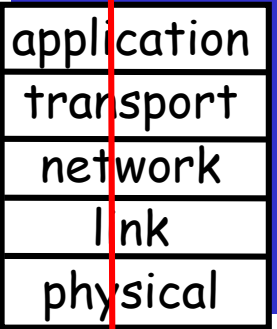
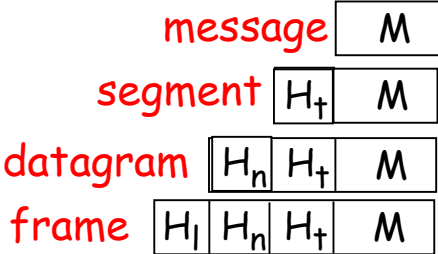


# Reference model - TCP/IP



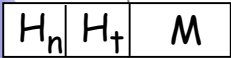
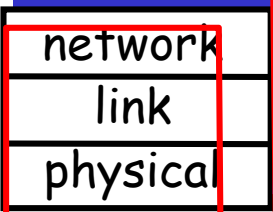
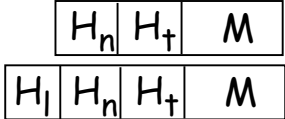
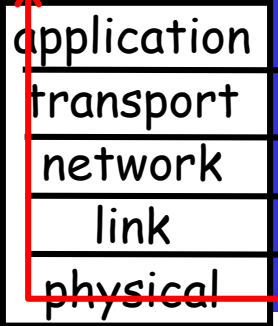
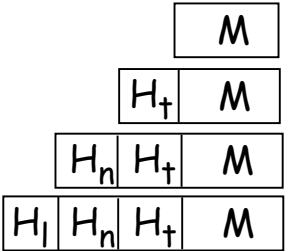
# Encapsulation

source

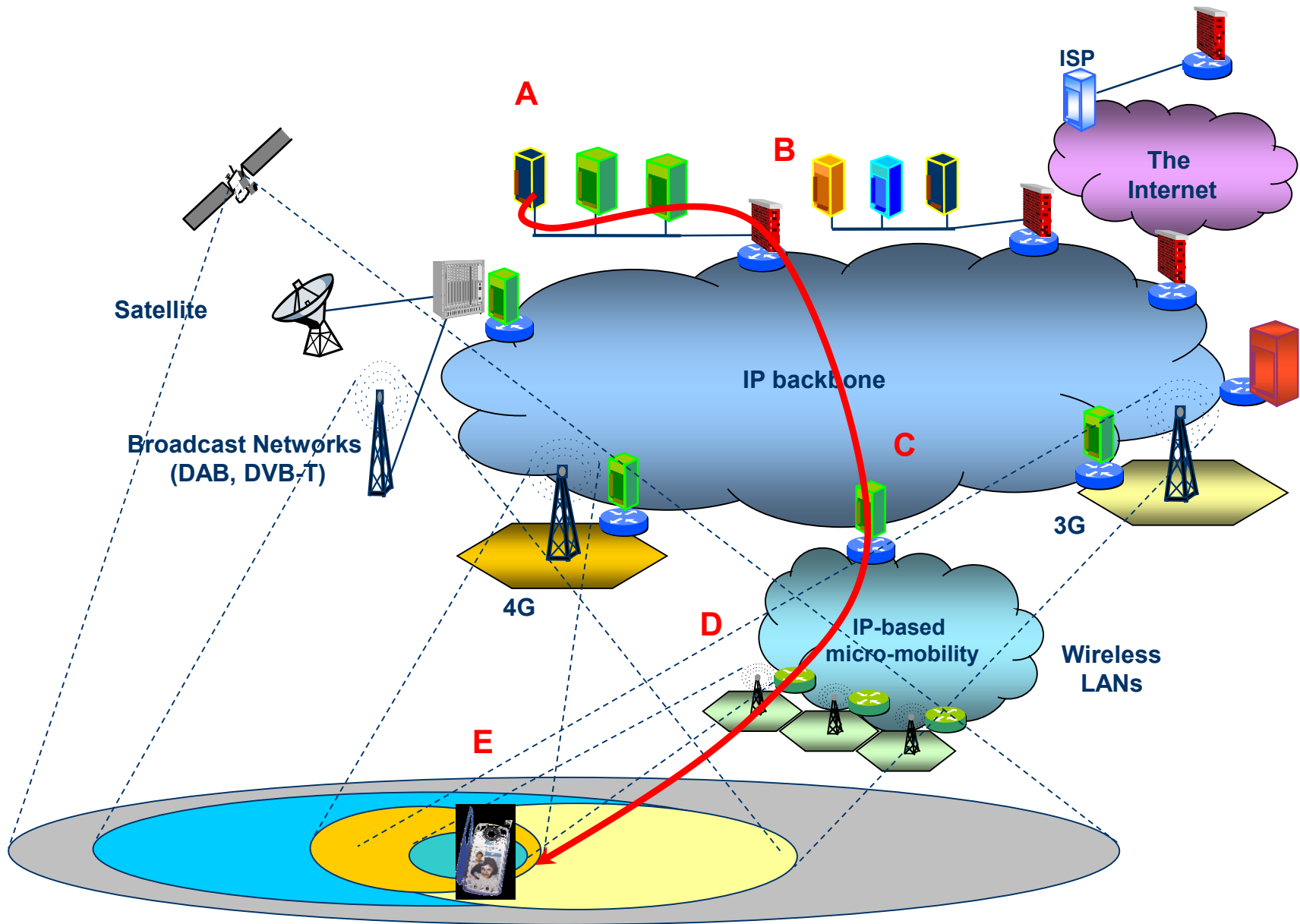


switch

destination



router

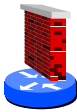




**A**



**E**



**B**



**C**



**D**

HTTP

HTTP

TCP

TCP

IP

IP

IP

IP

IP

Ethernet

Ethernet

ATM

ATM

Ethernet

Ethernet

802.11 MAC

802.11 MAC

Coaxial

Coaxial

Fiber-Optic

Fiber-Optic

Coaxial

Coaxial

802.11 PHY

802.11 PHY

# Protocol “Layers”

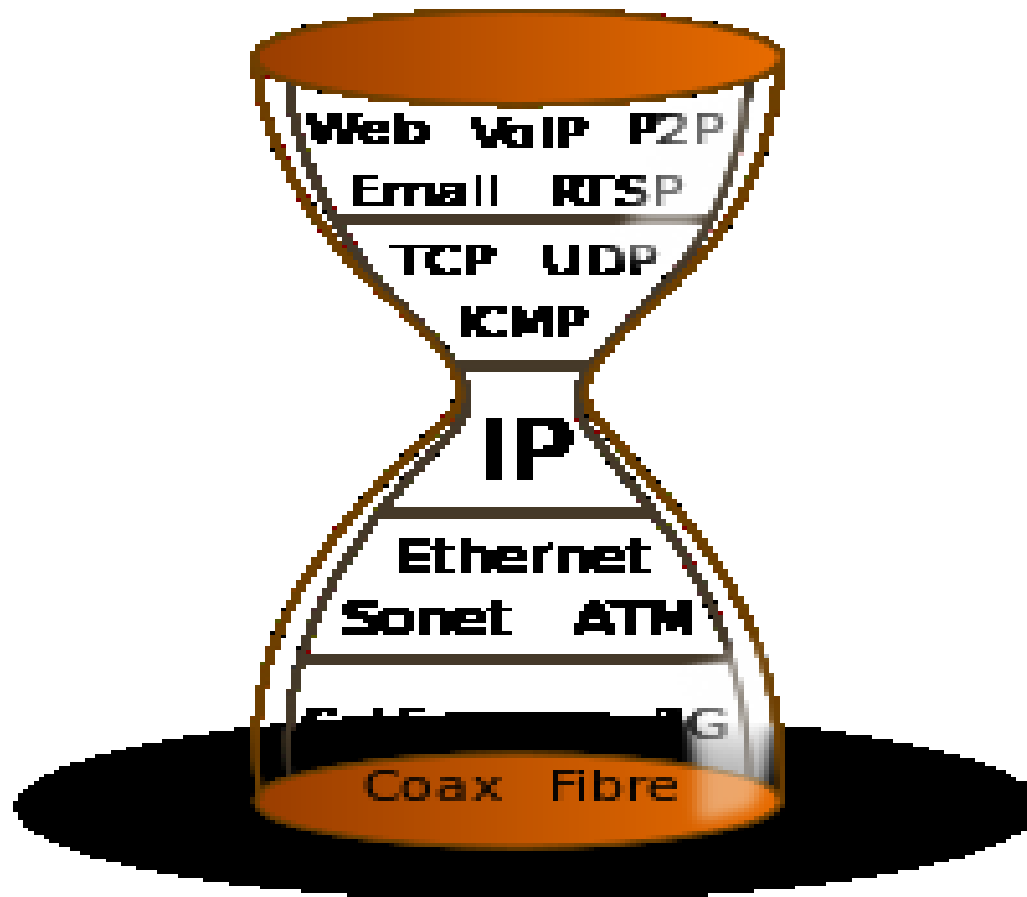
## Networks are complicated!

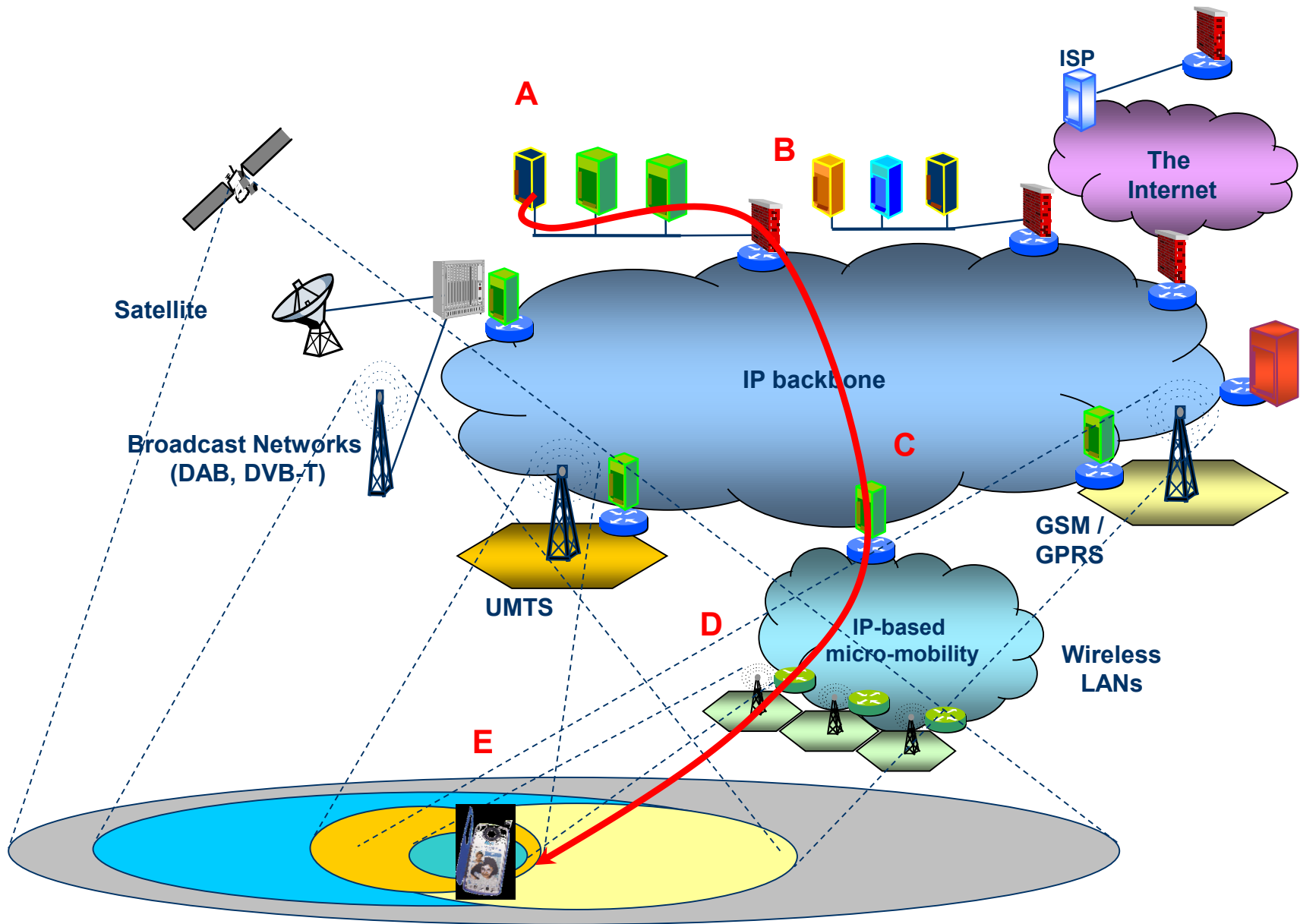
- Many “pieces”:
  - Hosts
  - Routers
  - Links of different types
  - Applications
  - Protocols
  - Hardware, software

## Question:

How to organize such a complicated system

# Why we call them IP networks?





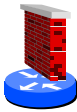




**A**



**E**



**B**



**C**



**D**

HTTP

HTTP

TCP

TCP

IP

IP

IP

IP

IP

Ethernet

Ethernet

ATM

ATM

Ethernet

Ethernet

802.11 MAC

802.11 MAC

Coaxial

Coaxial

Fiber-Optic

Fiber-Optic

Coaxial

Coaxial

802.11 PHY

802.11 PHY

# Problems of IP in wireless and mobile networks

## 1. Low performance in wireless environments

- No error avoidance, detection or correction

## 2. “Best Effort” (no QoS guarantees)

- No prioritization of traffic

## 3. No mobility support

- Routing based on the (static) IP address

# 1. Low performance in wireless environments

- No error correction in IP
- Based on anything provided by TCP/UDP or application

## TCP

- Designed for non-real-time applications
- Corrects errors through retransmissions
- TCP translates loss of packets as congestion to the route

## UDP

- Designed for real-time applications
- No error correction

# TCP operation

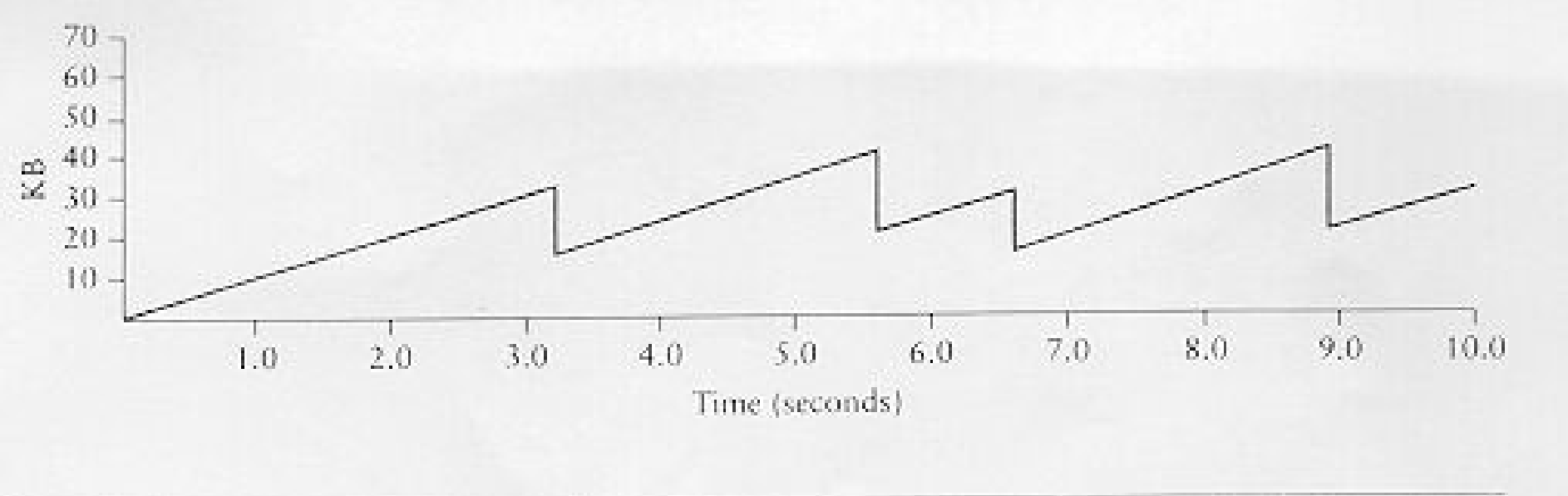
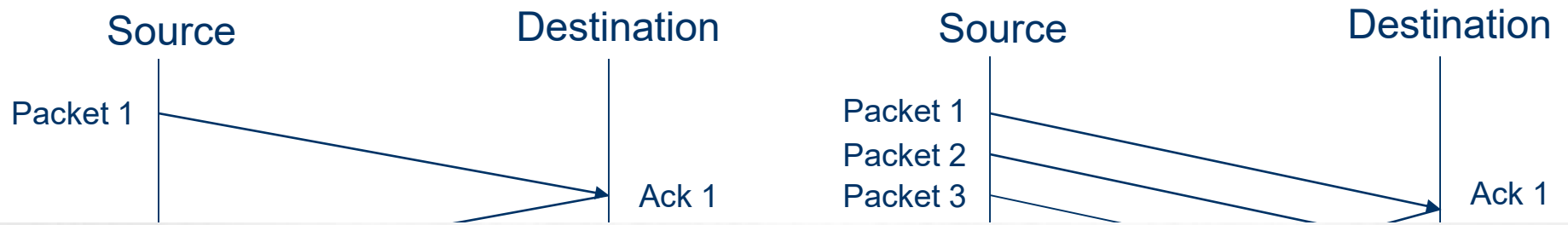
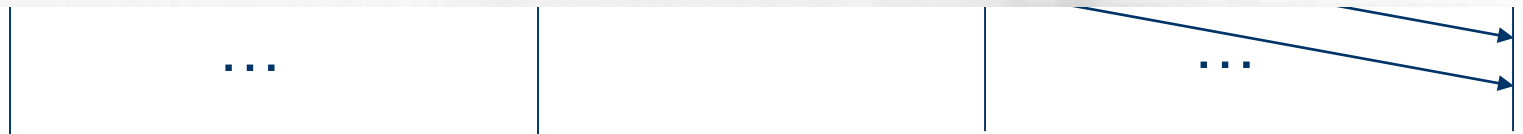
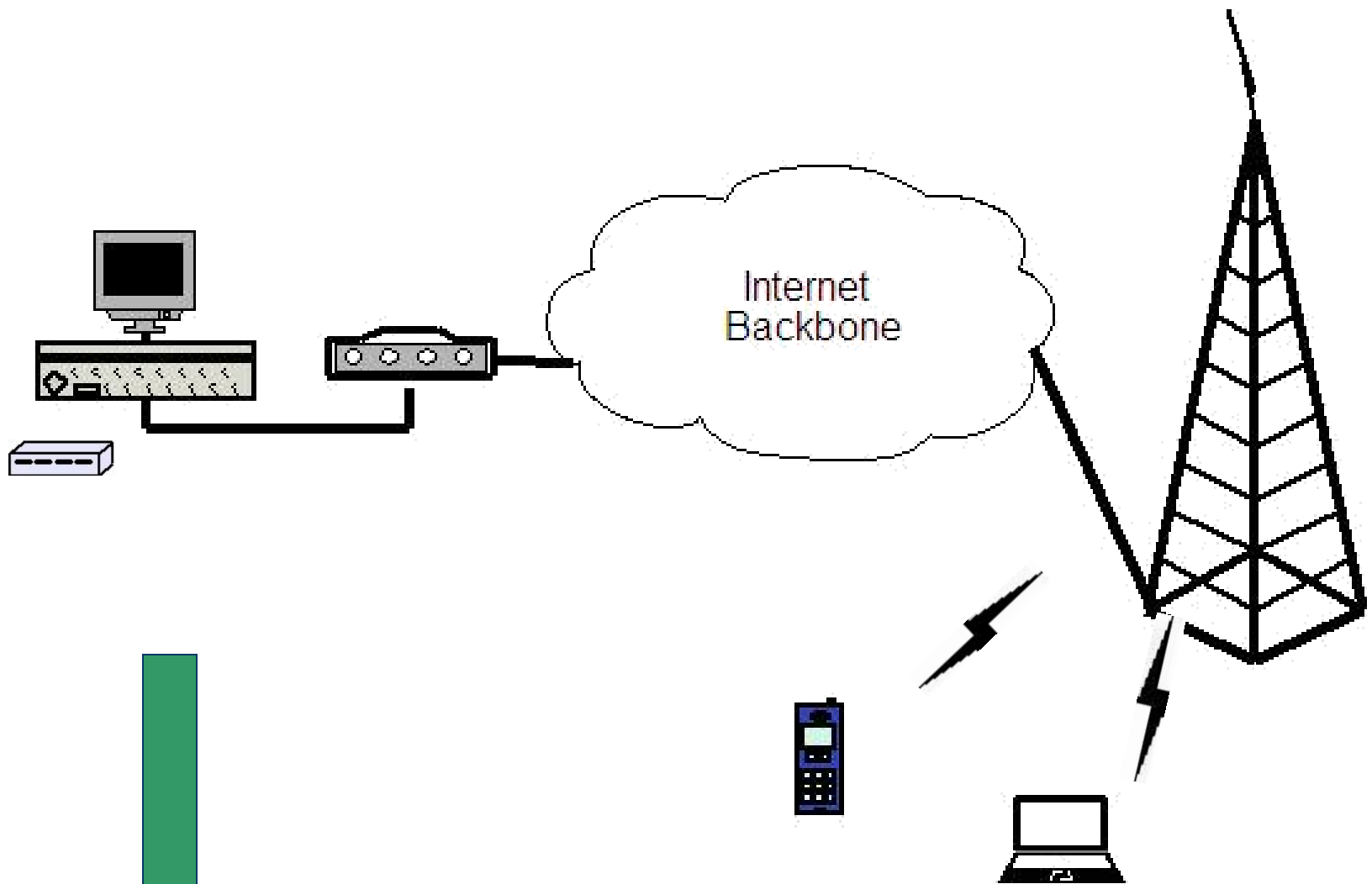



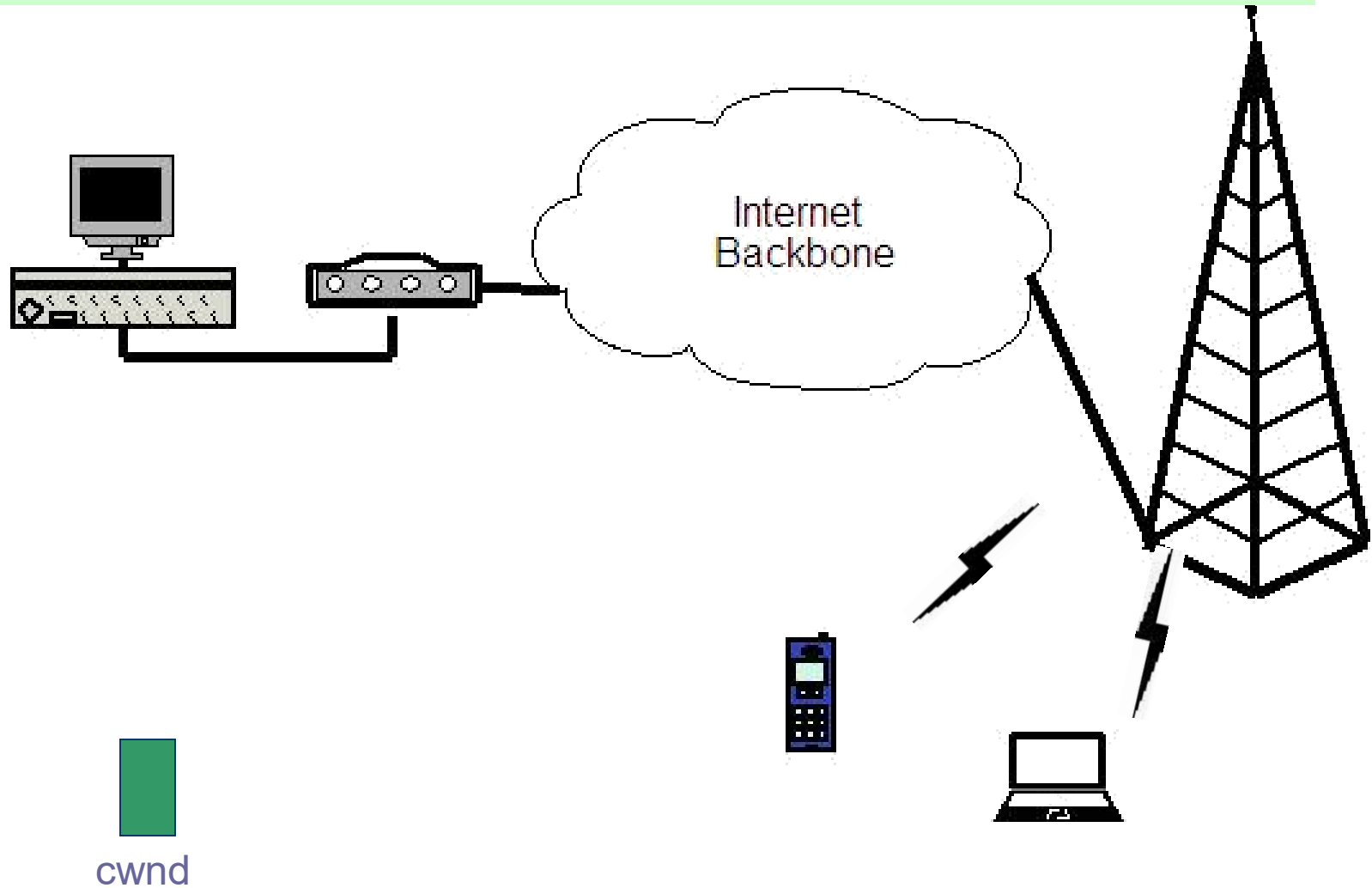
Figure 6.9 Typical TCP sawtooth pattern.

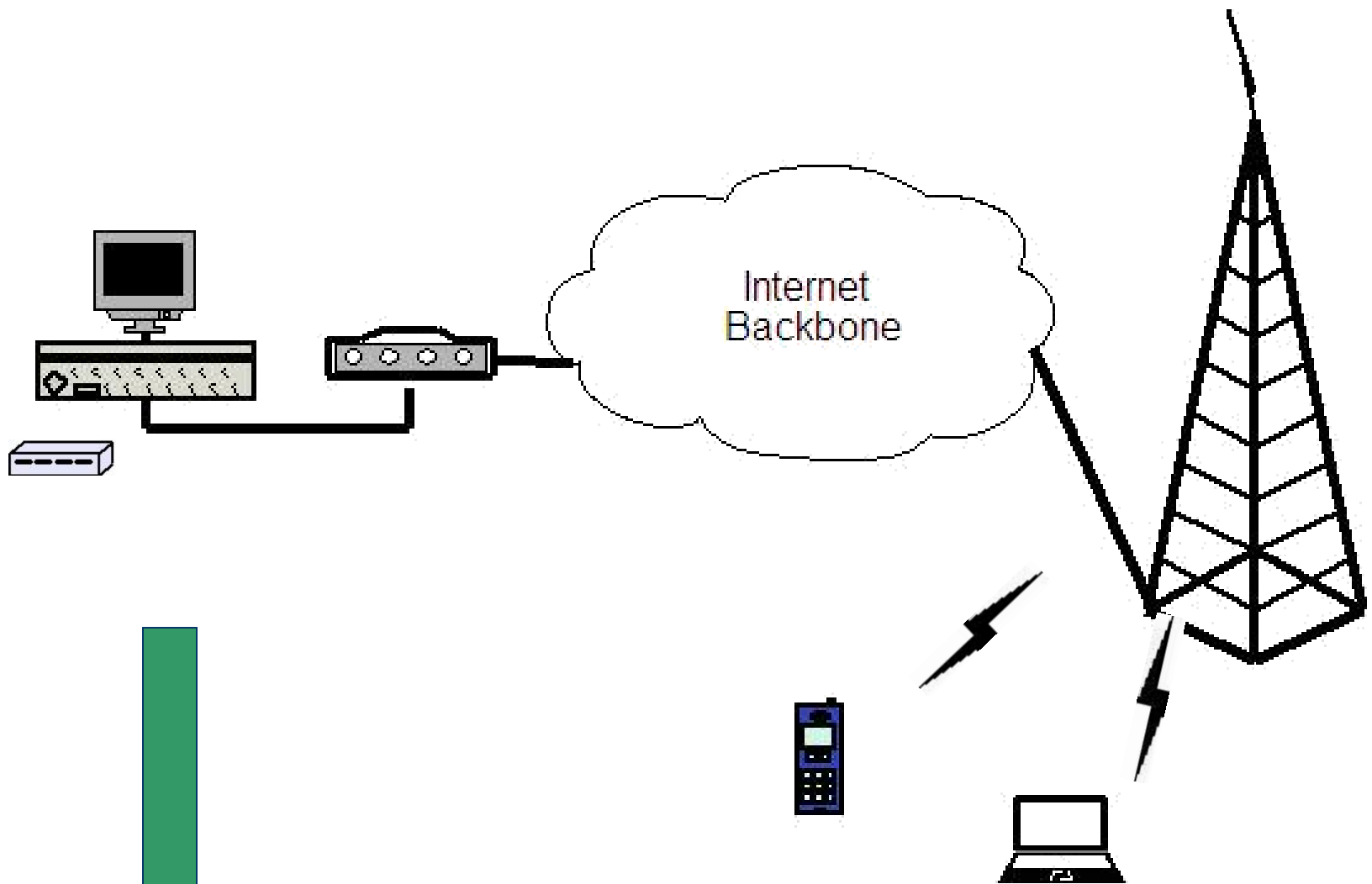





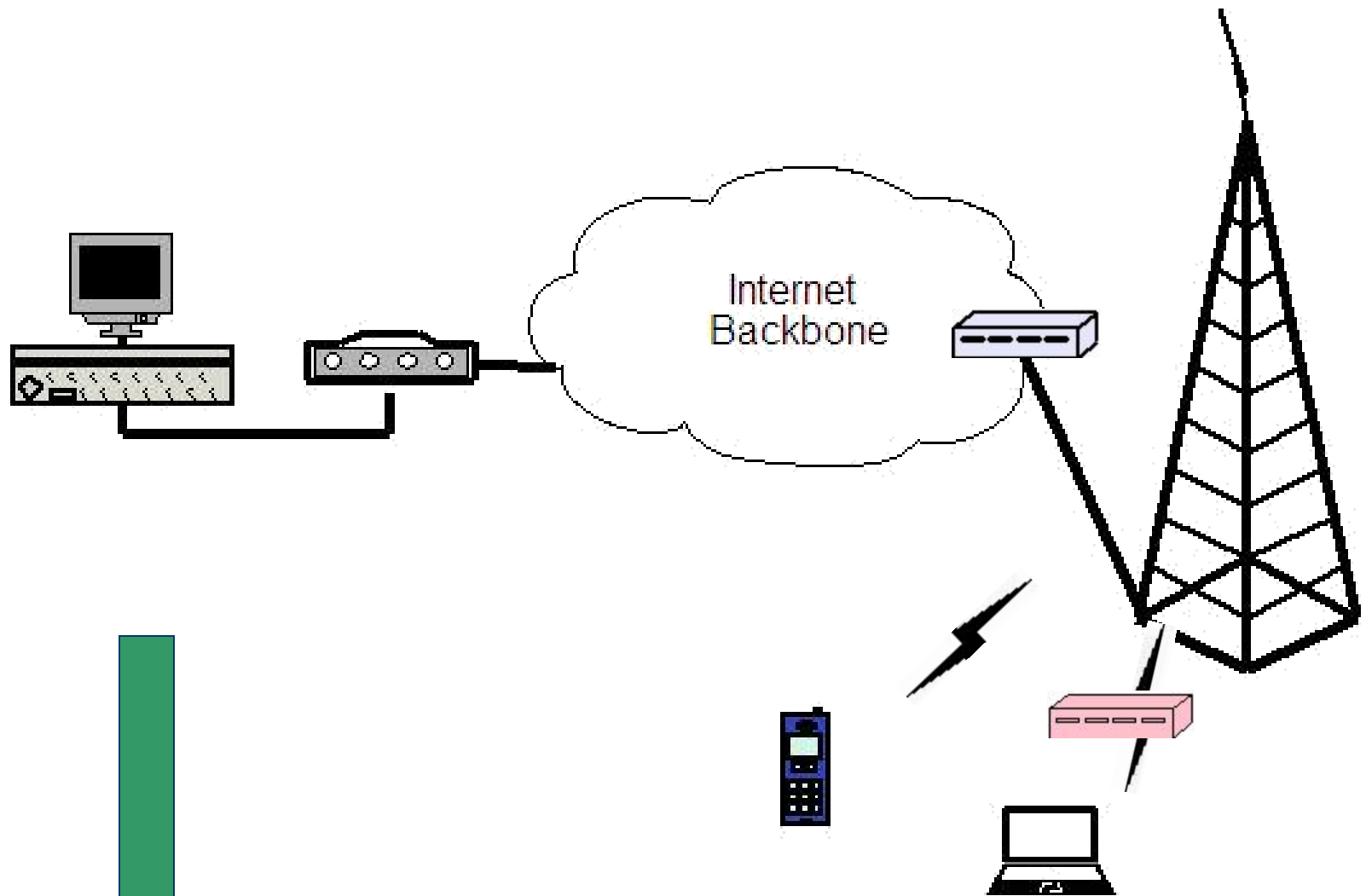
  
cwnd

Loss of packet due to congestion  
Reduction of cwnd  
Reduction of data traffic





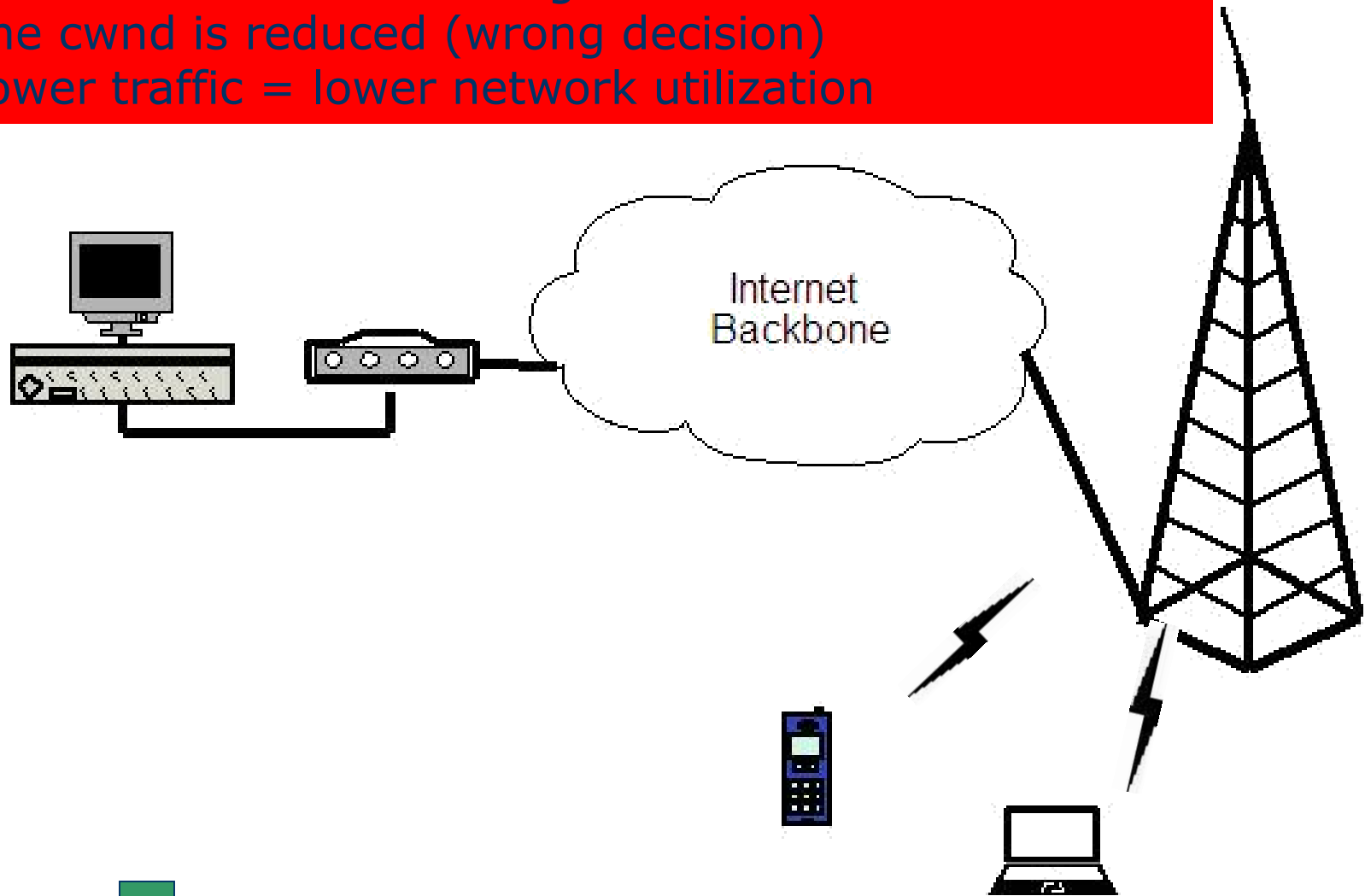
  
cwnd



cwnd



Loss of packet due to the wireless channel  
TCP translates this as congestion  
The cwnd is reduced (wrong decision)  
Lower traffic = lower network utilization



  
cwnd

## 2. «Best Effort»

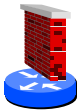
- All types of information are formed as IP packets and sent to the network
- IP does not have mechanism to guarantee quality characteristics for each traffic flow (delay, packet loss, etc.)
- Only UDP or TCP traffic is not enough
- The need for QoS guarantees is much bigger due to the low capacity and high error rate
- Conclusion: Traditional protocols like Ethernet is insufficient.



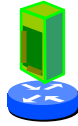
A



E



B



C



D

HTTP

HTTP

TCP

TCP

IP

IP

IP

IP

IP

Ethernet

Ethernet

ATM

ATM

Ethernet

Ethernet

802.11 MAC

QoS support

802.11 MAC

Coaxial

Coaxial

Fiber-Optic

Fiber-Optic

Coaxial

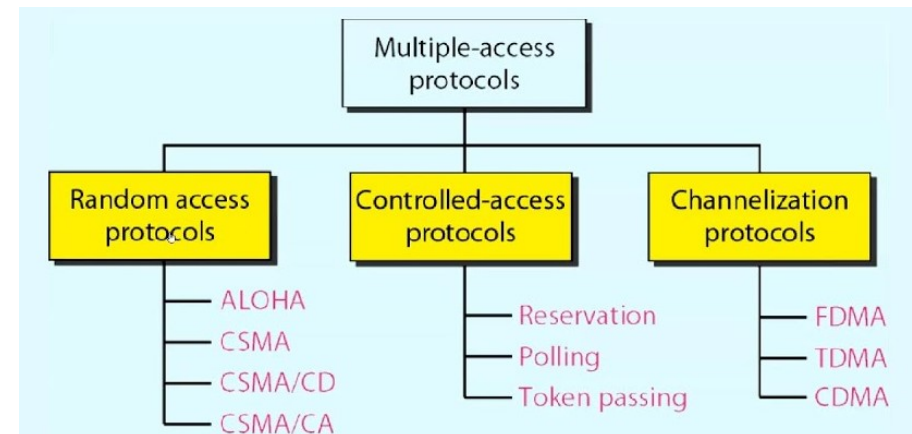
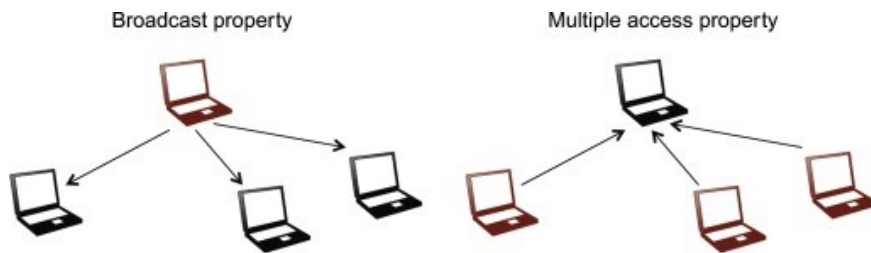
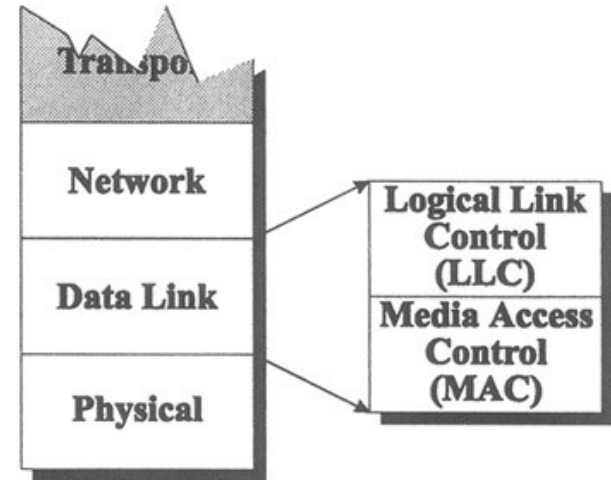
Coaxial

802.11 PHY

802.11 PHY

# Radio Resource Management

- Multiple Access Control protocols
- Used mainly for uplink
- Trade-off between complexity and efficiency



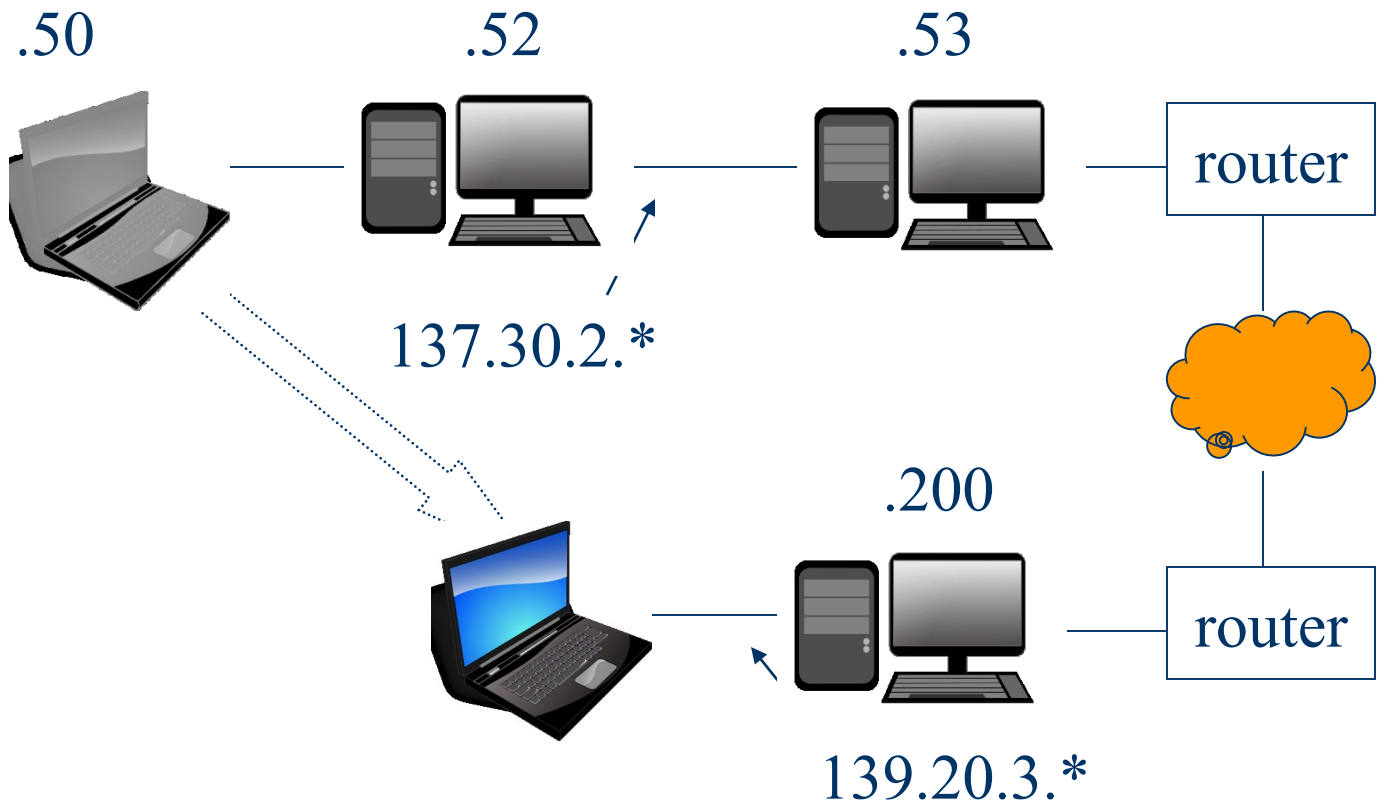
# 3. IP does not support mobility

- Packet routing is based on a static scheme of IP addresses
- A static address depends on the static connection point of the terminal to the network
- If the connection point changes without change of address the packets are routed to the old connection point
- But if the address changes how this can be communicated to the rest of the world?
- Impossible to inform the network each time a terminal changes its connection point

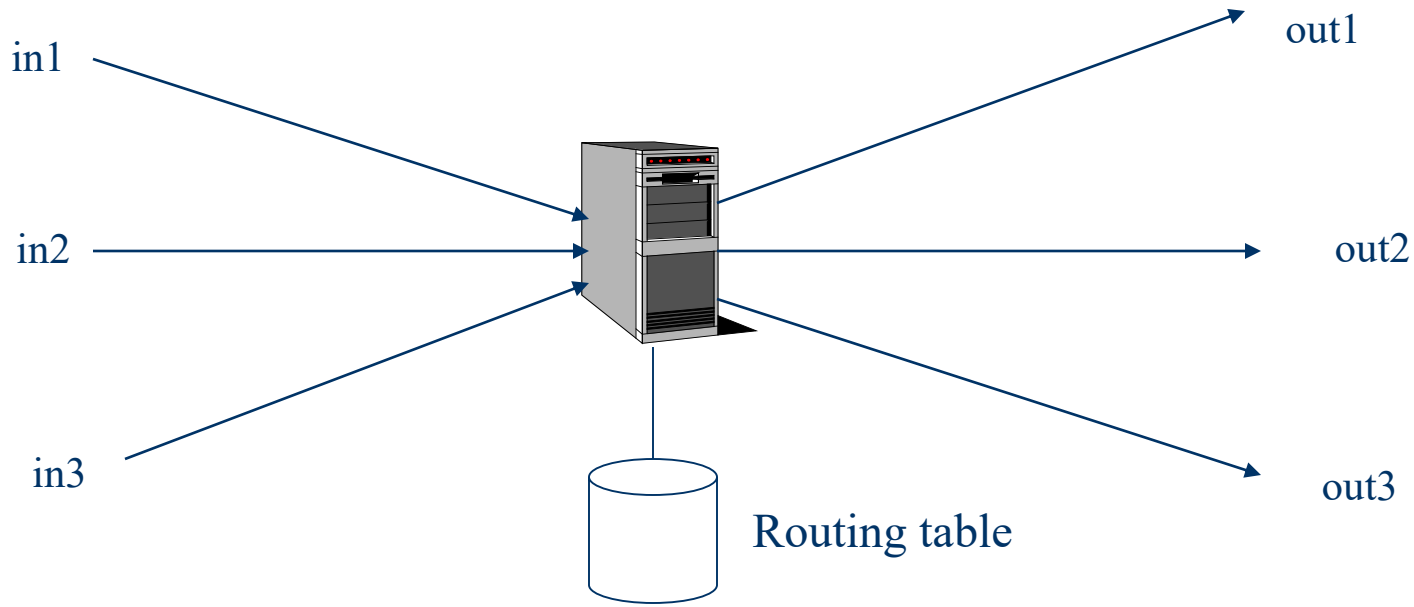
# IP Header

ver.		TOS	total length			
IP ID					offset	
TTL	protocol		checksum			
32 bit Source IP address						
32 bit Destination IP address						
Options						
Source Port			Destination Port			TCP/UDP

IP



# IP routing



137.30.2.x	out1
137.30.3.x	out2
default	out3