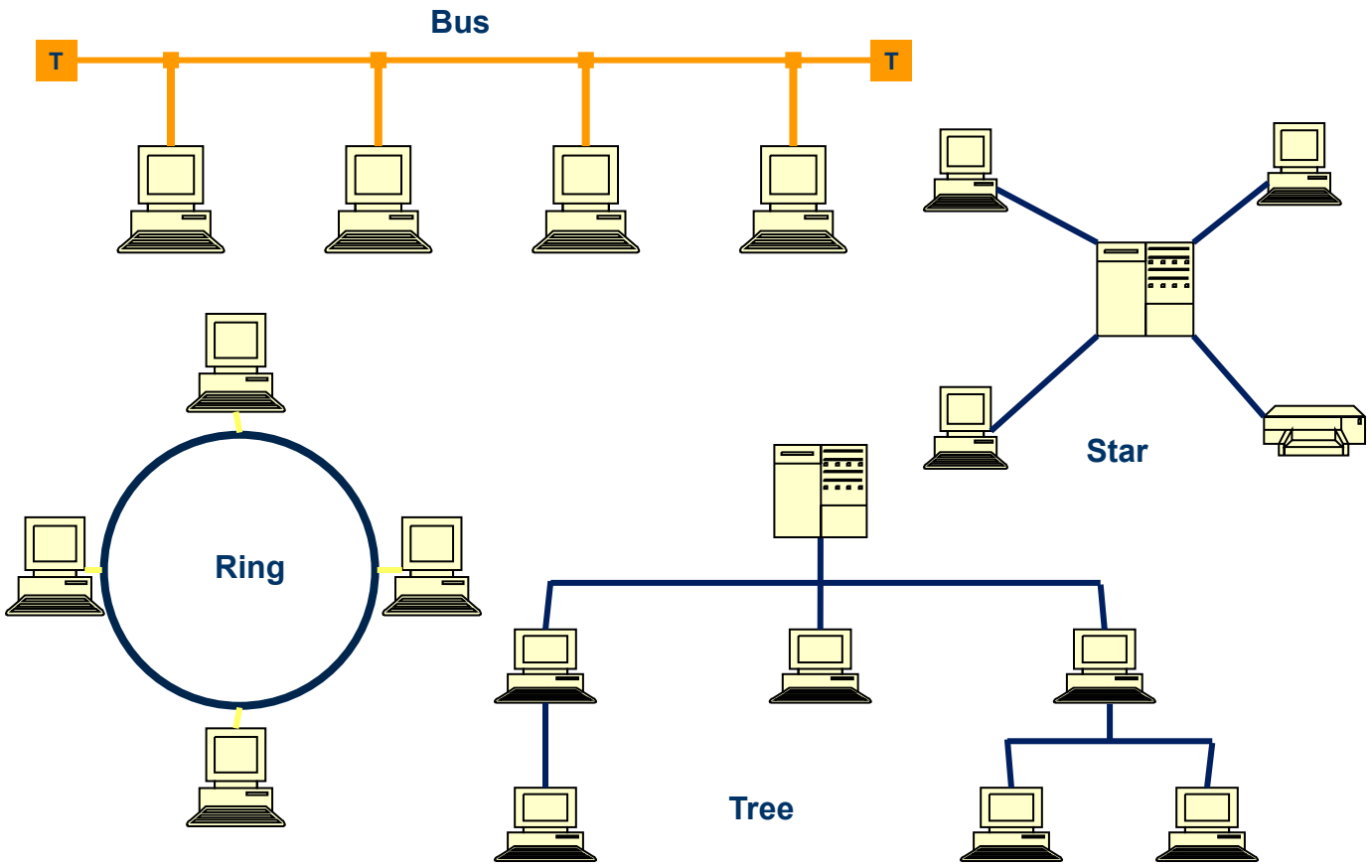
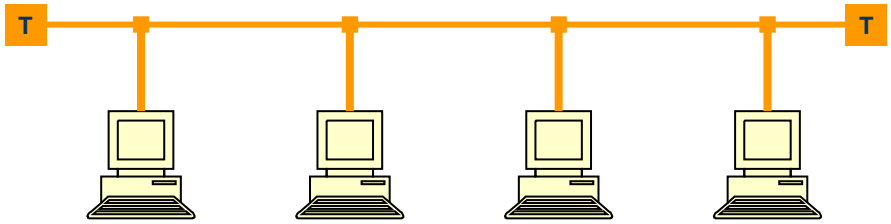
Mobile and Wireless Networks

IP over wireless

Network Topologies

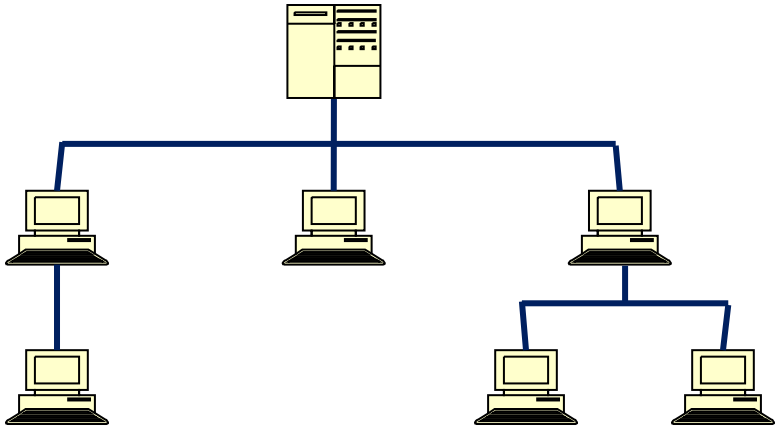


Bus



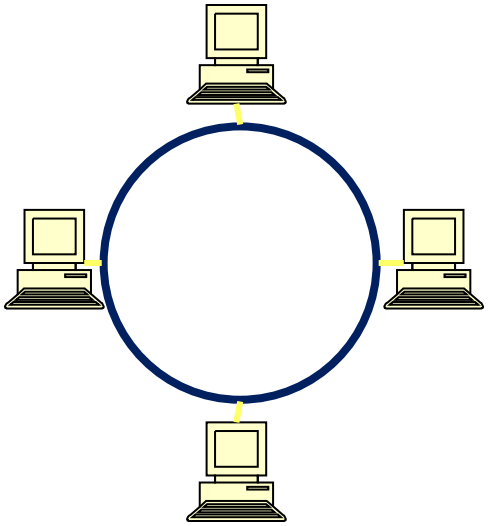
- All terminals on the bus
- Terminals can be connected/disconnected seamlessly
- End points
- Only one message at a time
- Low cable cost

Tree



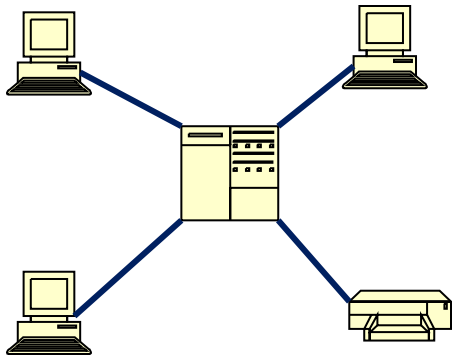
- Parent node can be a bottleneck
- Parent node out of order -> all tree out of order
- Add nodes at the lowest level

Ring



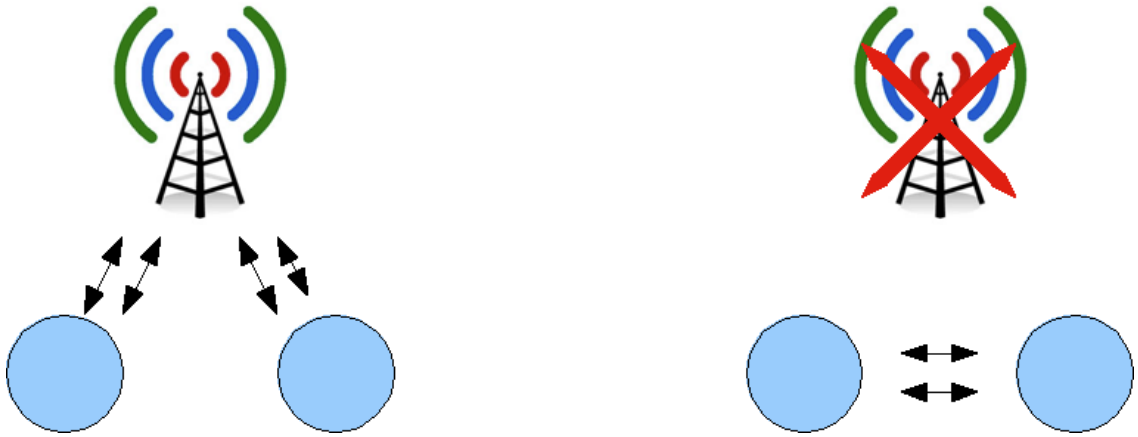
- Hop by hop transmissions
- Transmit/receive/check/forward
- Networks keep working on node errors

Star



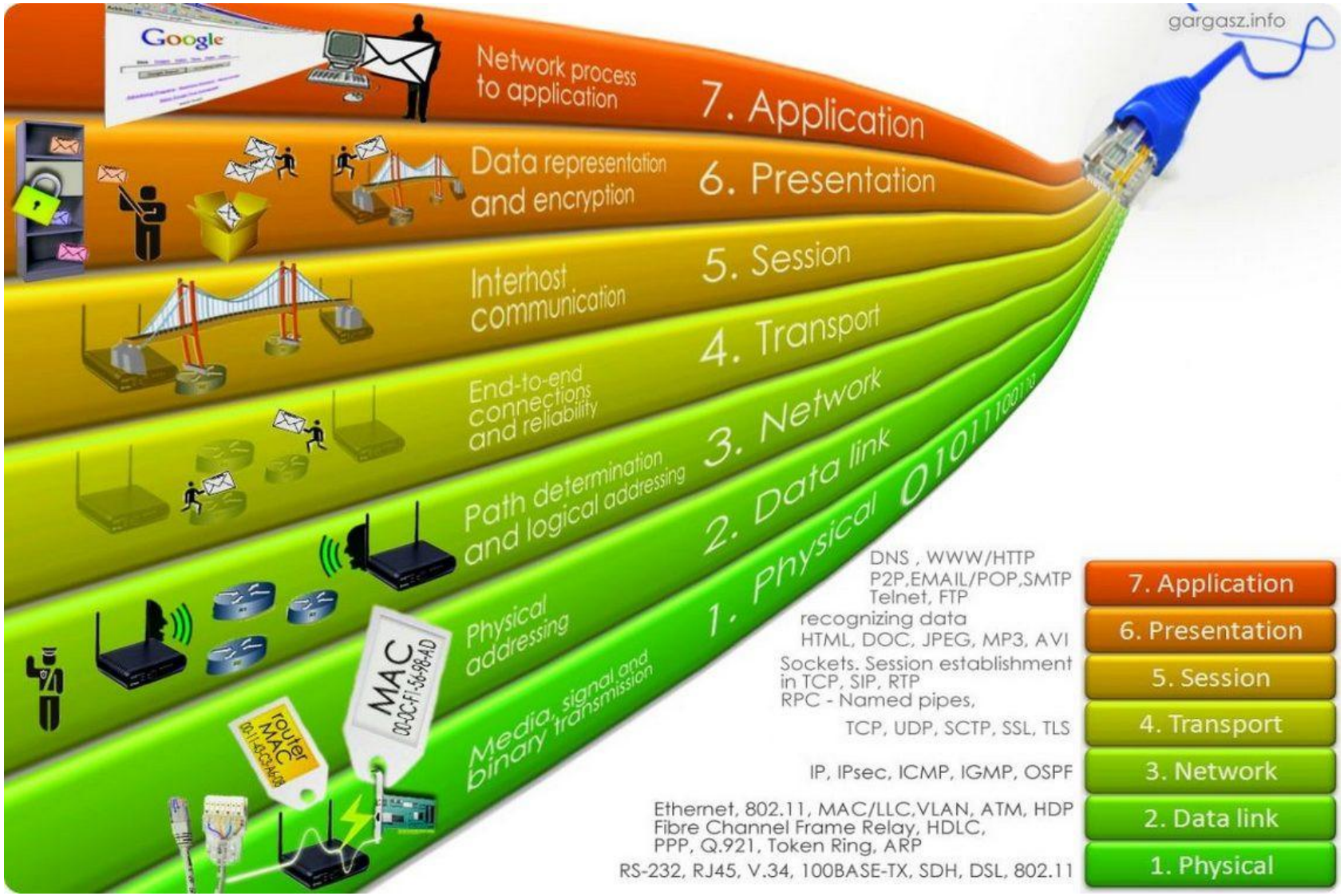
- All nodes connected in a central node
- Single point of failure

Mobile network topologies



- Cellular or Ad-hoc
- Common medium (bus)
- All traffic through a node (star)
- Hop-by-hop transmissions (ring)
- Multiple access control
- Error control
- Mobility

OSI Model


gargasz.info
Google
Network process to application
7. Application
Data representation and encryption
6. Presentation
Interhost communication
5. Session
End-to-end connections and reliability
4. Transport
Path determination and logical addressing
3. Network
Physical addressing
2. Data link
Media, signal and binary transmission
1. Physical
MAC
router MAC
DNS , WWW/HTTP
P2P,EMAIL/POP,SMTP
Telnet, FTP
recognizing data
HTML, DOC, JPEG, MP3, AVI
Sockets. Session establishment
in TCP, SIP, RTP
RPC - Named pipes,
TCP, UDP, SCTP, SSL, TLS
IP, IPsec, ICMP, IGMP, OSPF
Ethernet, 802.11, MAC/LLC,VLAN, ATM, HDP
Fibre Channel Frame Relay, HDLC,
PPP, Q.921, Token Ring, ARP
RS-232, RJ45, V.34, 100BASE-TX, SDH, DSL, 802.11
7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data link
1. Physical

OSI Model

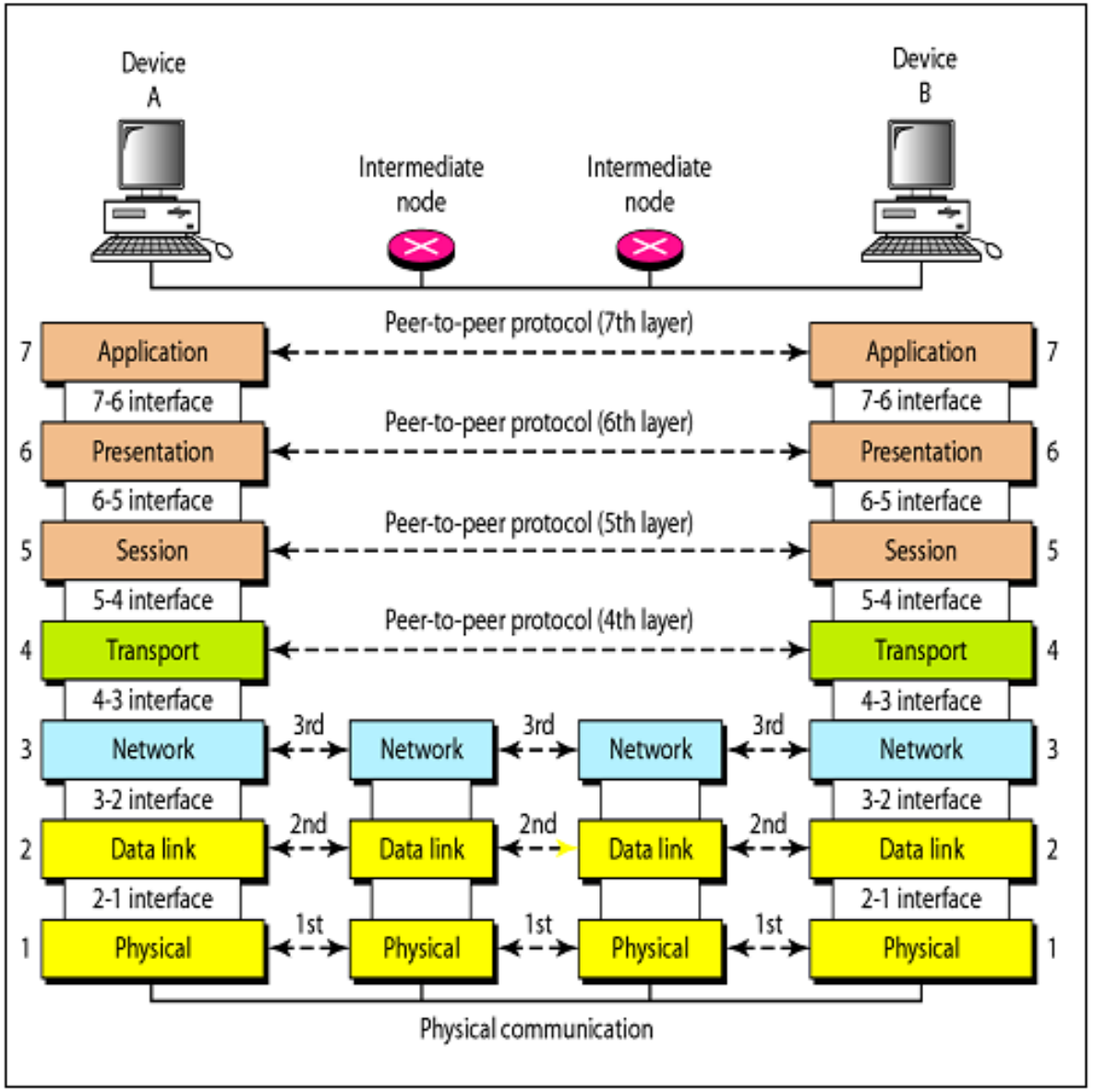
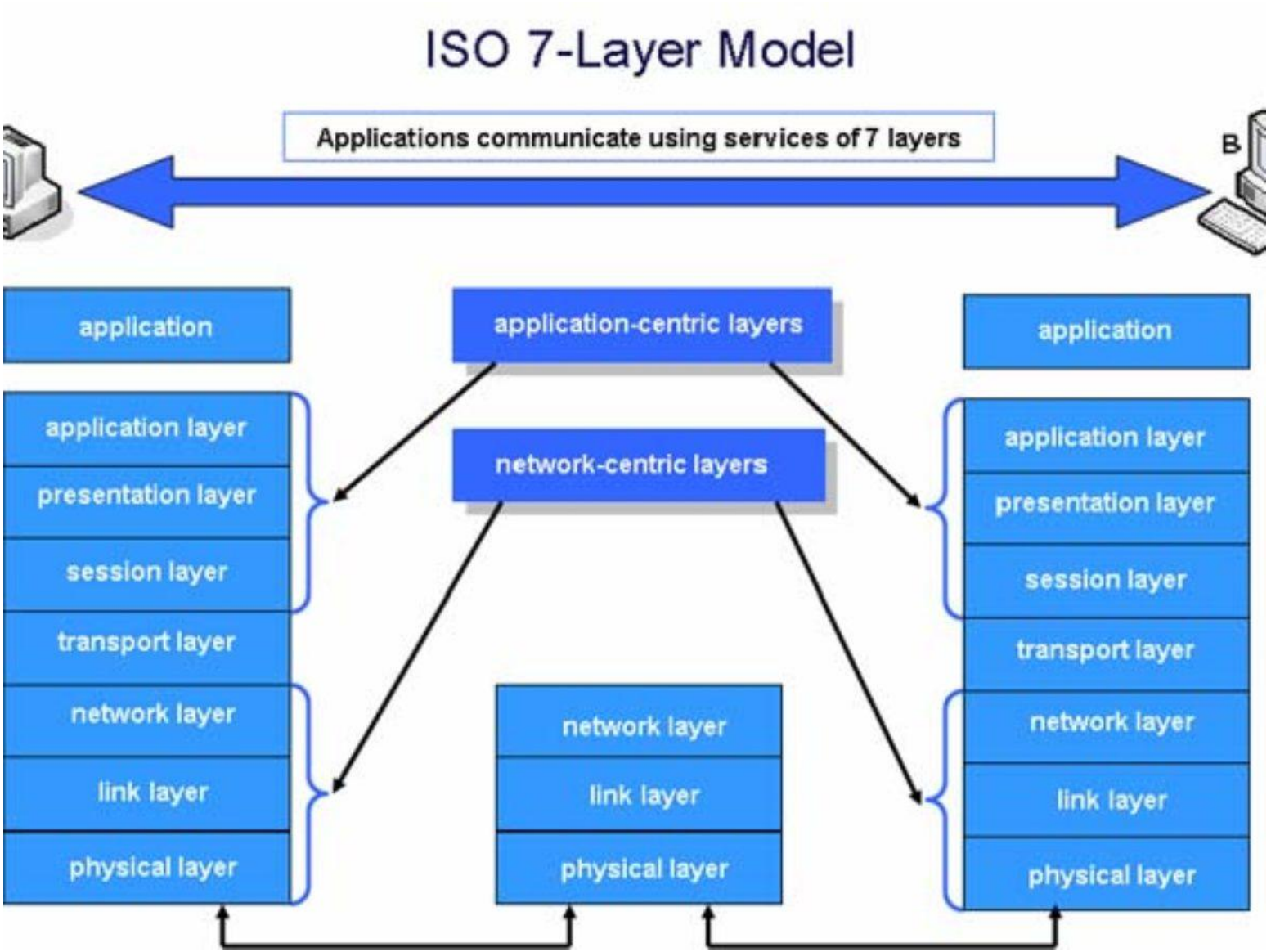
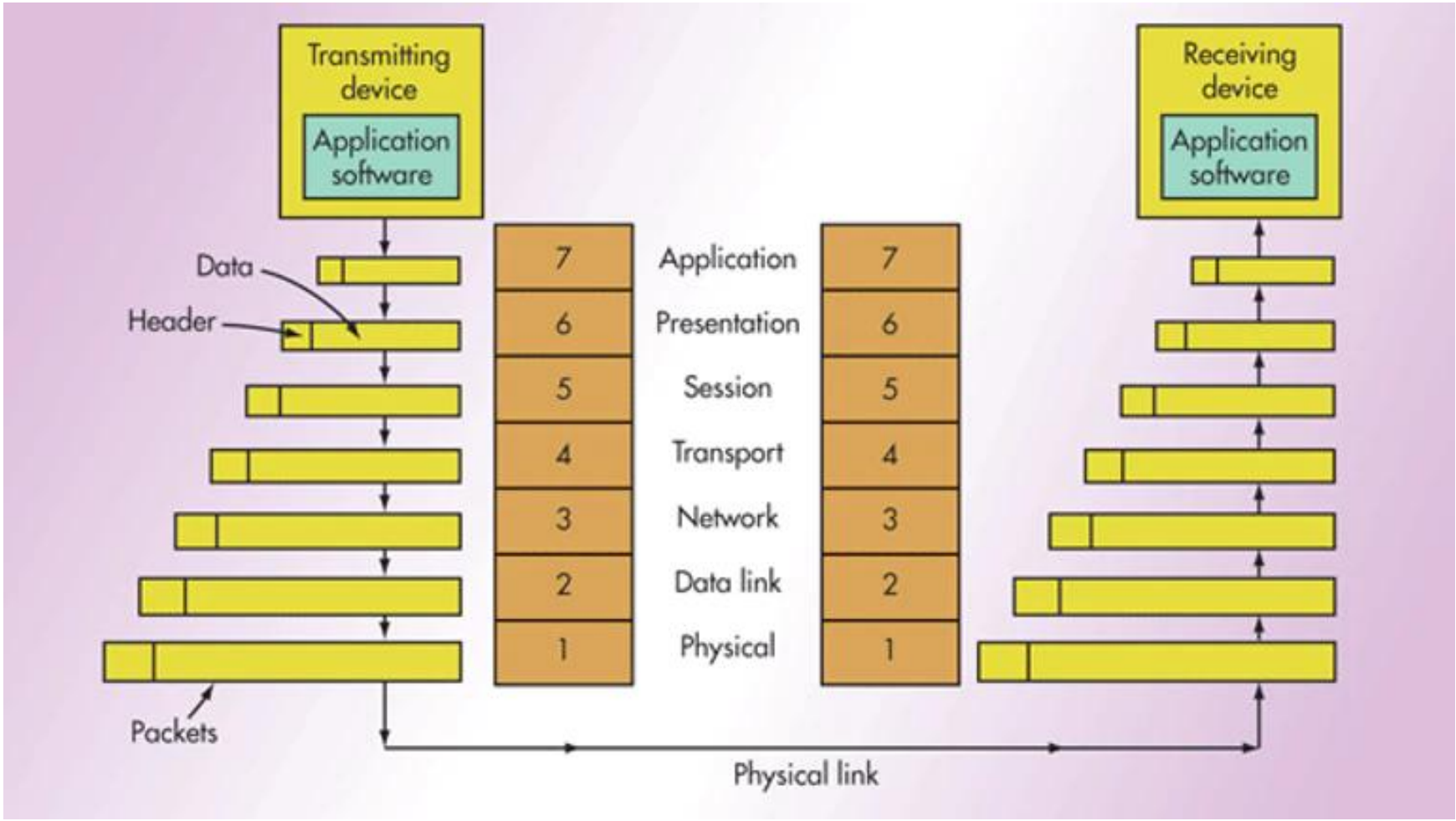
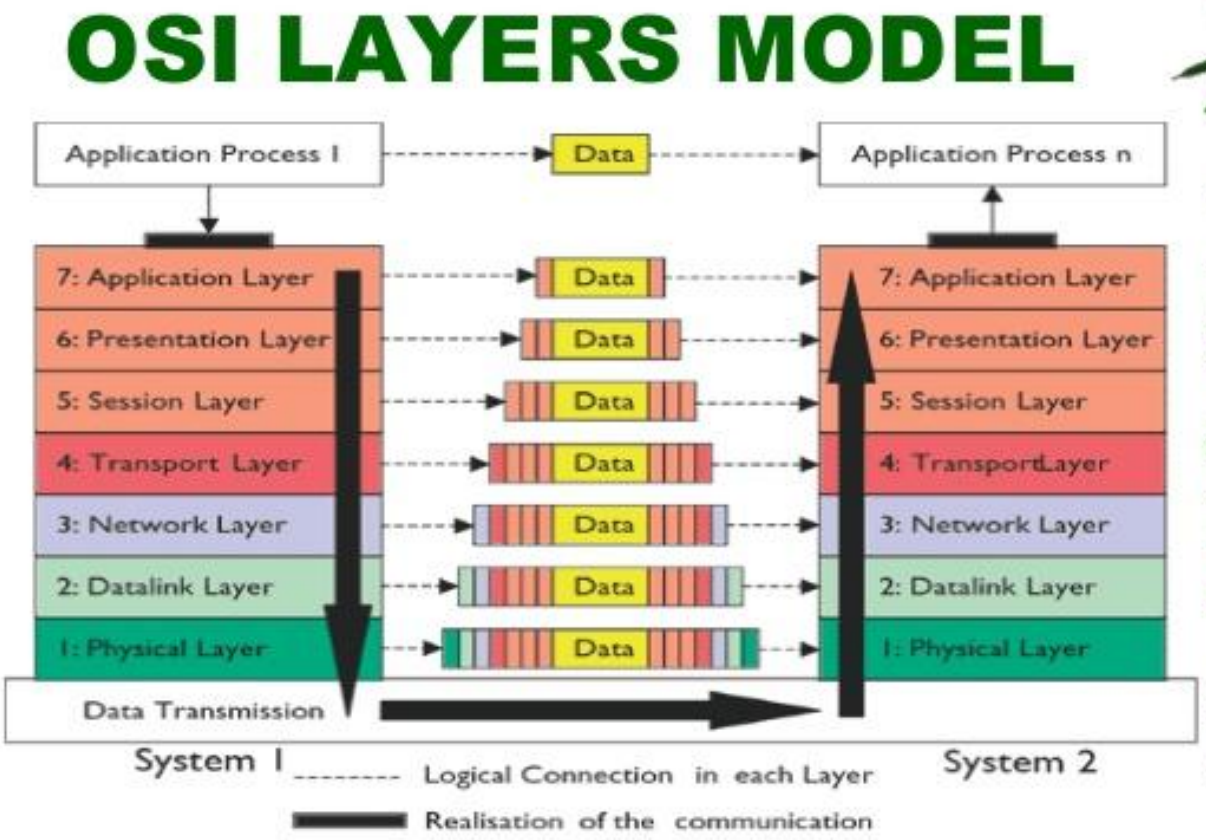


Fig: Communication & Interfaces in the OSI model

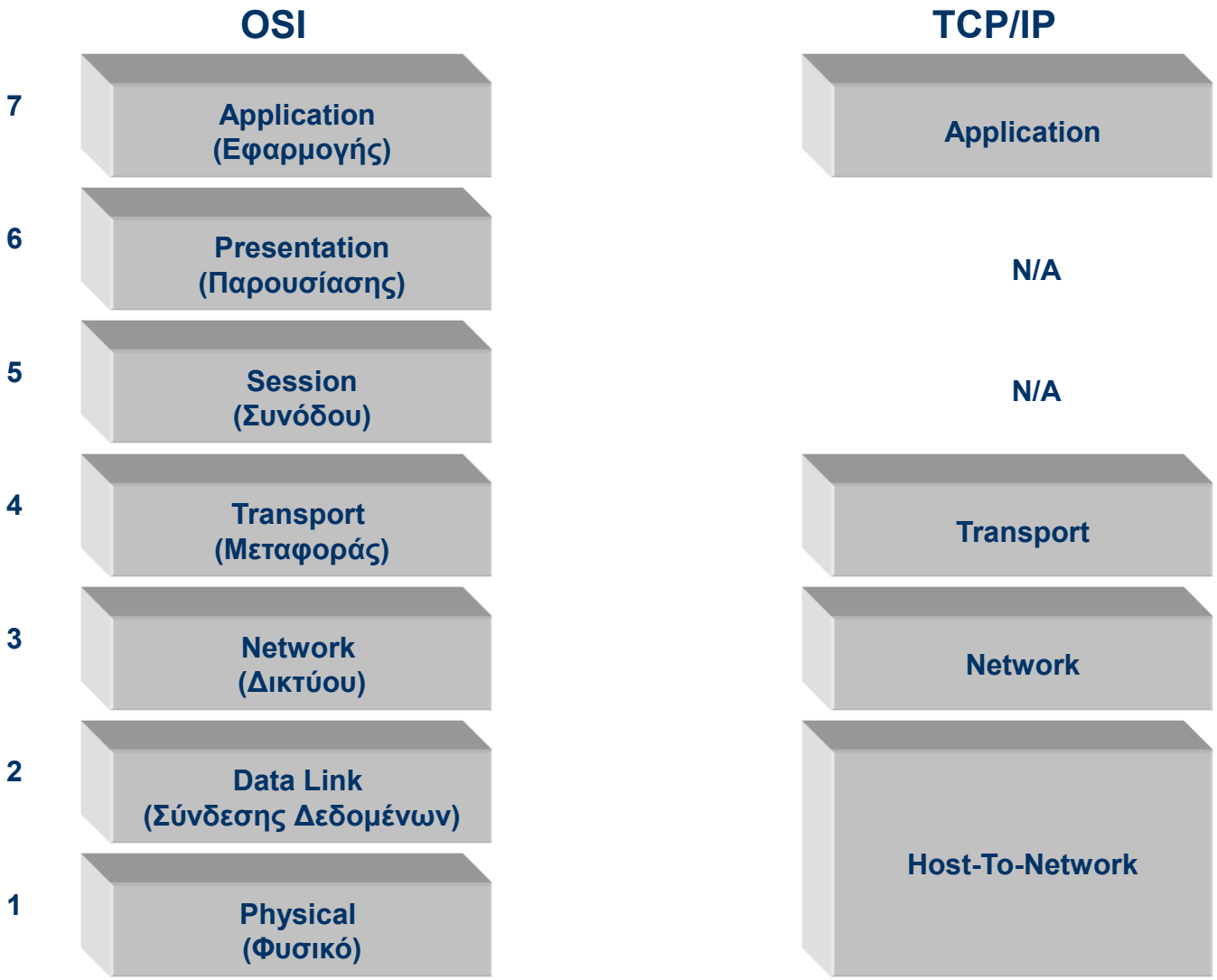

ISO 7-Layer Model
Applications communicate using services of 7 layers
B
application
application layer
presentation layer
session layer
transport layer
network layer
link layer
physical layer
application-centric layers
network-centric layers
network layer
link layer
physical layer
application
application layer
presentation layer
session layer
transport layer
network layer
link layer
physical layer


Transmitting device
Application software
Receiving device
Application software
Data
Header
Packets
7
6
5
4
3
2
1
Application
Presentation
Session
Transport
Network
Data link
Physical
7
6
5
4
3
2
1
Physical link

Data Transmission in the OSI Reference Model



Reference model - TCP/IP

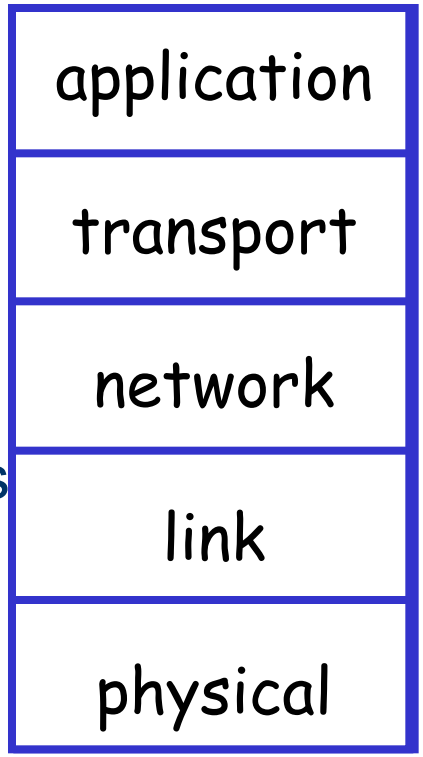


Reference Model ISO/OSI

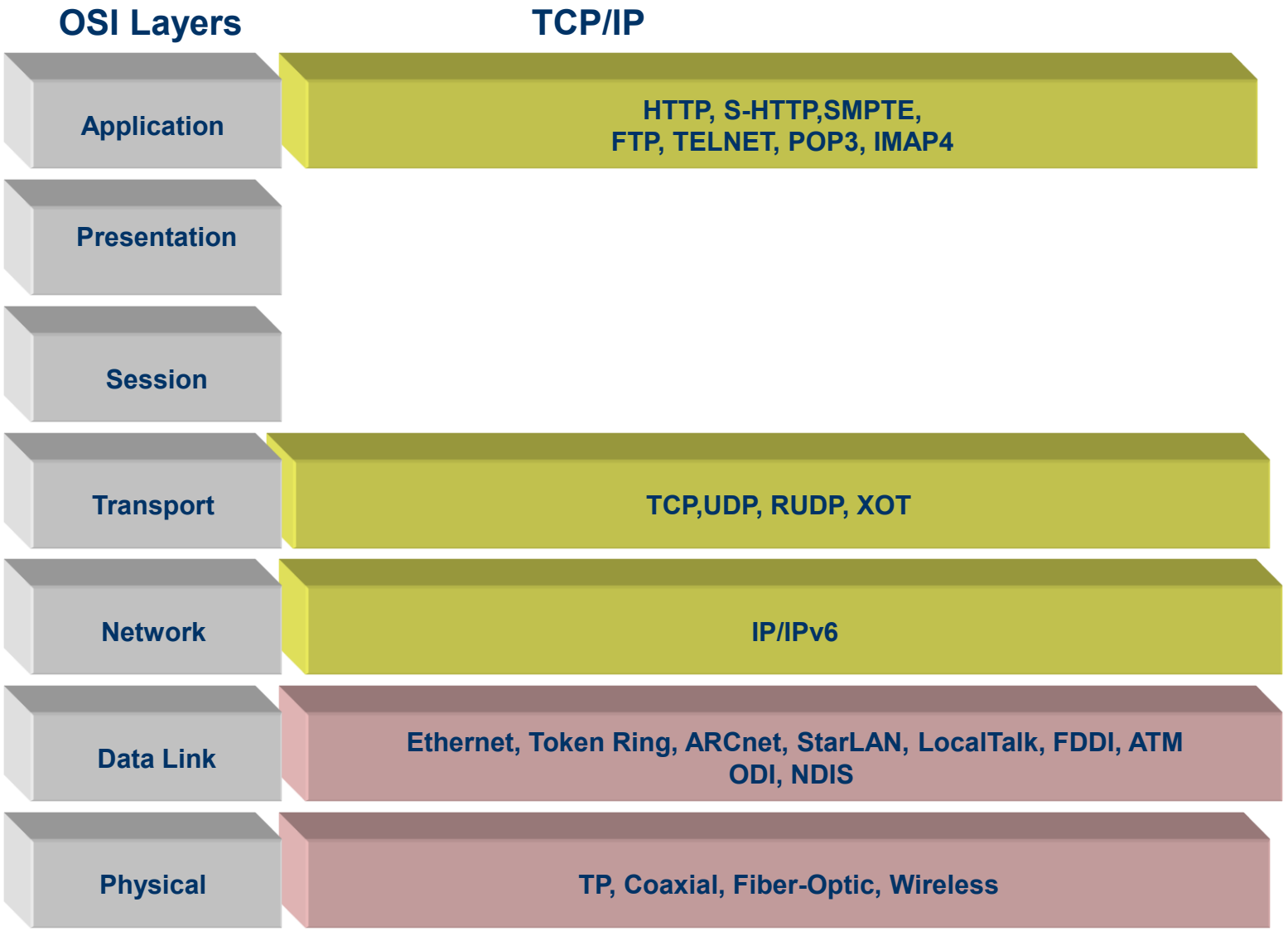
- presentation: cryptography, compression, description of application data
- *session:* synchronizing of data exchange, different flows per application
- Internet does not support these two layers
- If needed, they are supported at the application layers

Internet Protocol Stack

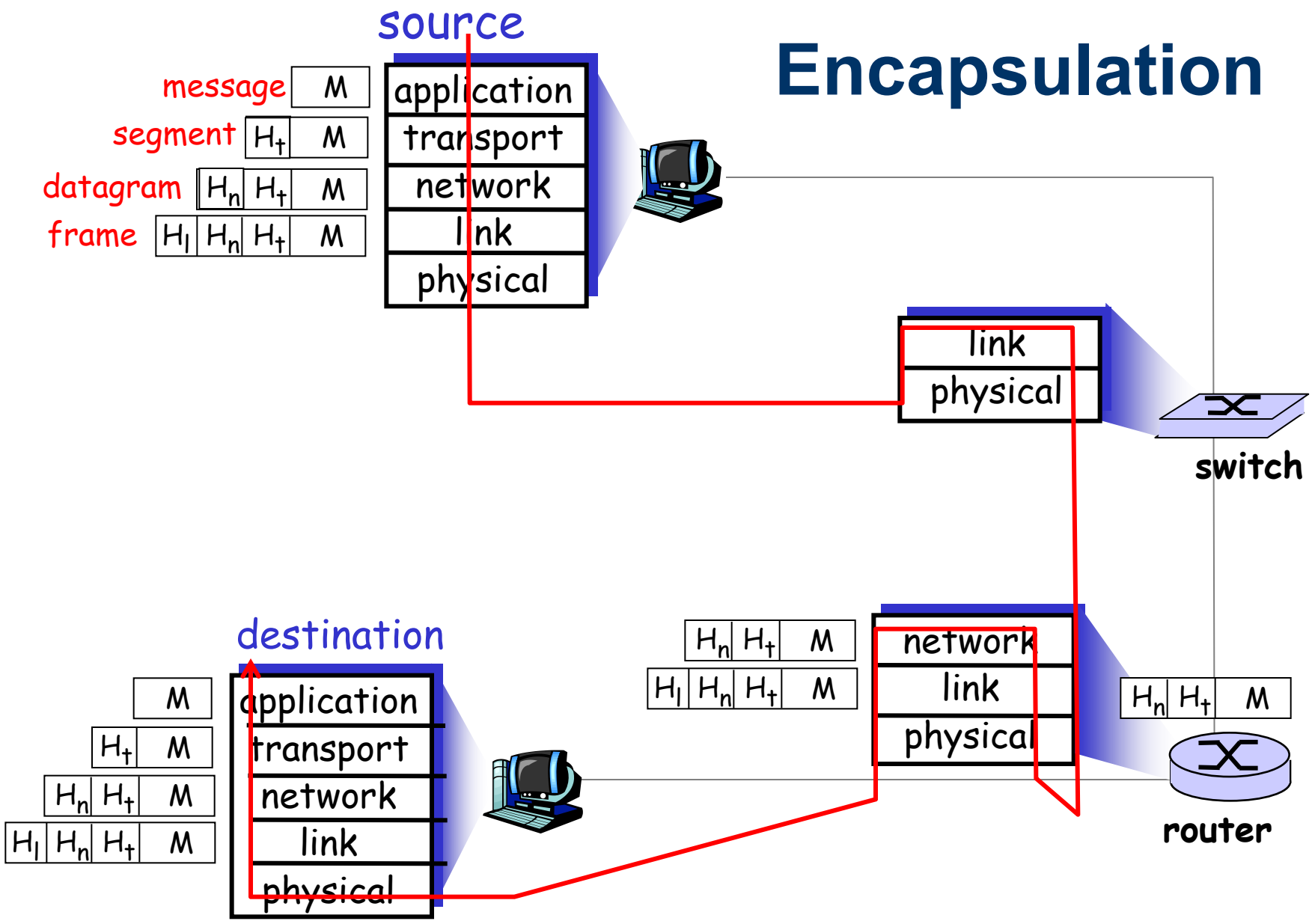
- application: support of network applications
  - **FTP, SMTP, HTTP**
- transport: transfer of application messages end-to-end
  - **TCP, UDP**
- network: routing of datagrams from source to destination
  - **IP, routing protocols**
- link: transfer of data between neighboring nodes in the network
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

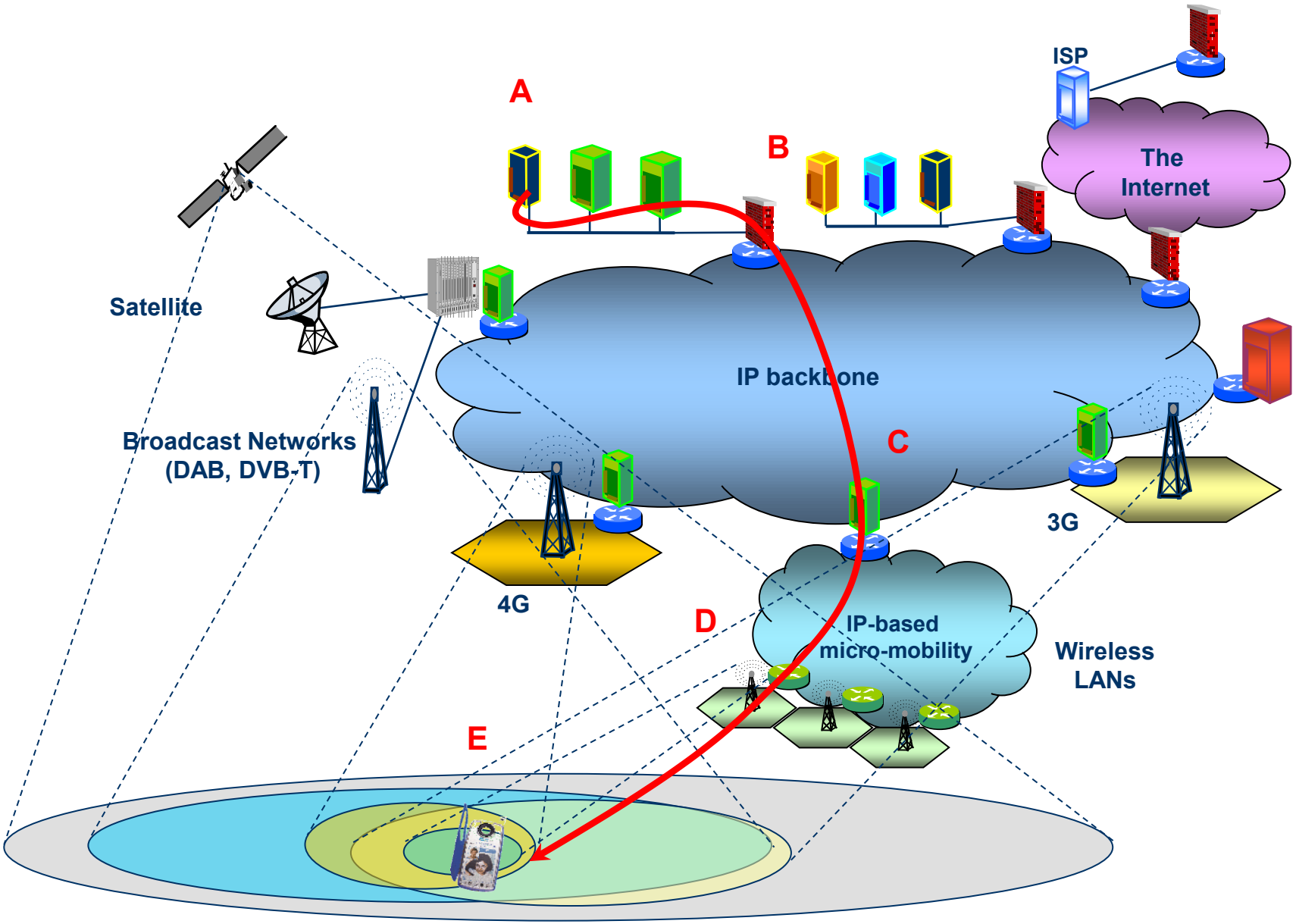


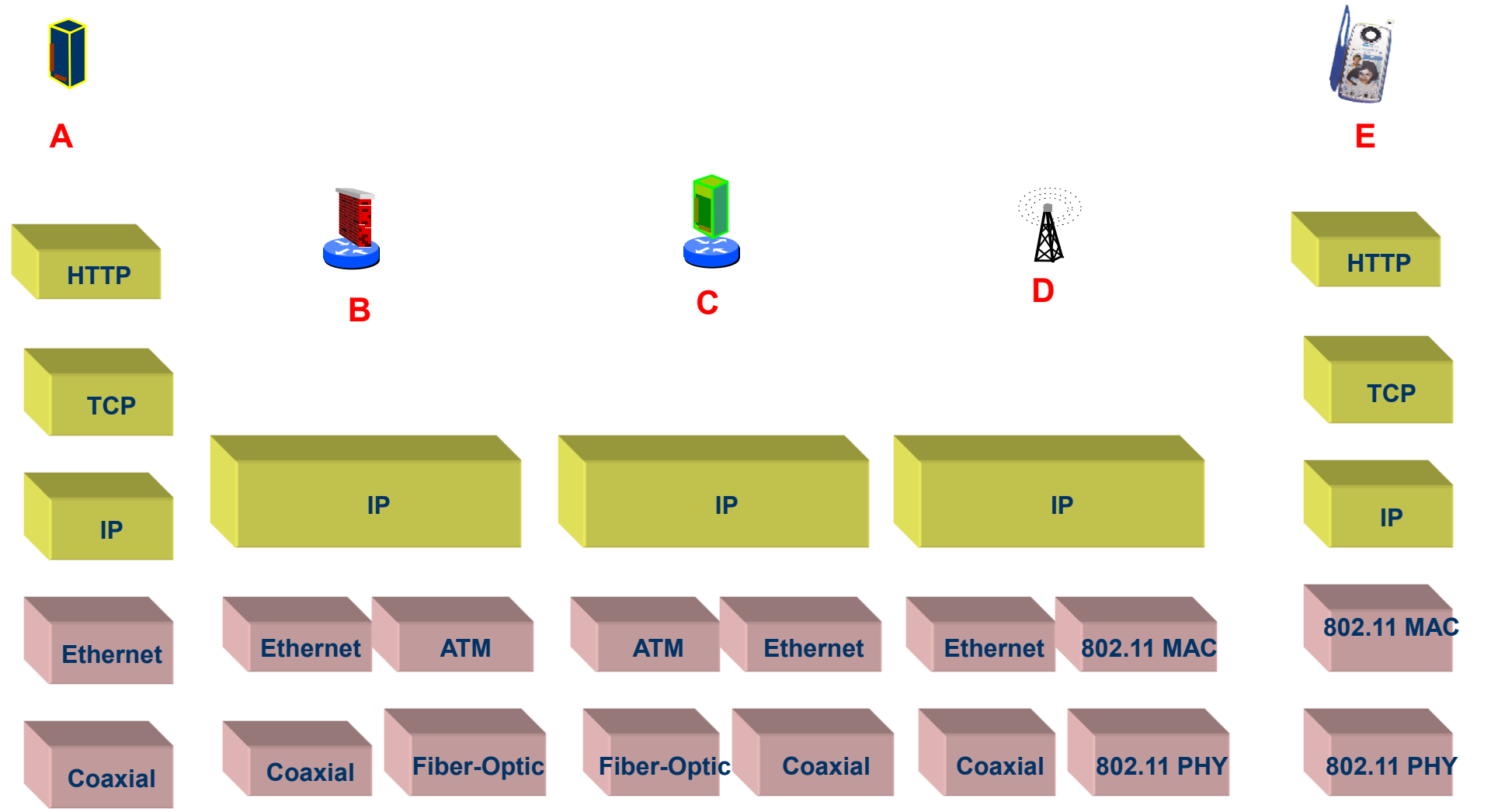
Reference model - TCP/IP



Encapsulation




A
B
ISP
The Internet
Satellite
IP backbone
Broadcast Networks
(DAB, DVB-T)
C
3G
4G
D
IP-based
micro-mobility
Wireless
LANs
E


A
B
C
D
E
HTTP
TCP
IP
Ethernet
Coaxial
IP
Ethernet
ATM
Coaxial
Fiber-Optic
IP
ATM
Ethernet
Fiber-Optic
Coaxial
IP
Ethernet
802.11 MAC
Coaxial
802.11 PHY
HTTP
TCP
IP
802.11 MAC
802.11 PHY

Protocol “Layers”

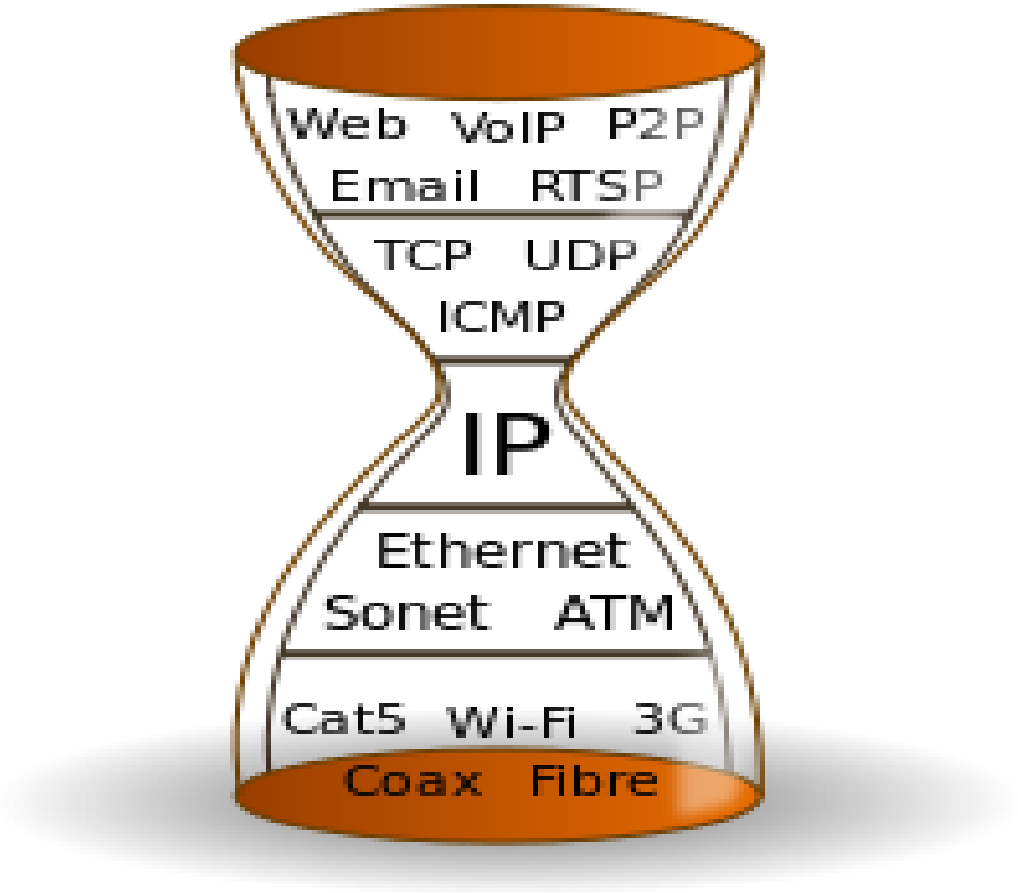
Networks are complicated!

- 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?



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

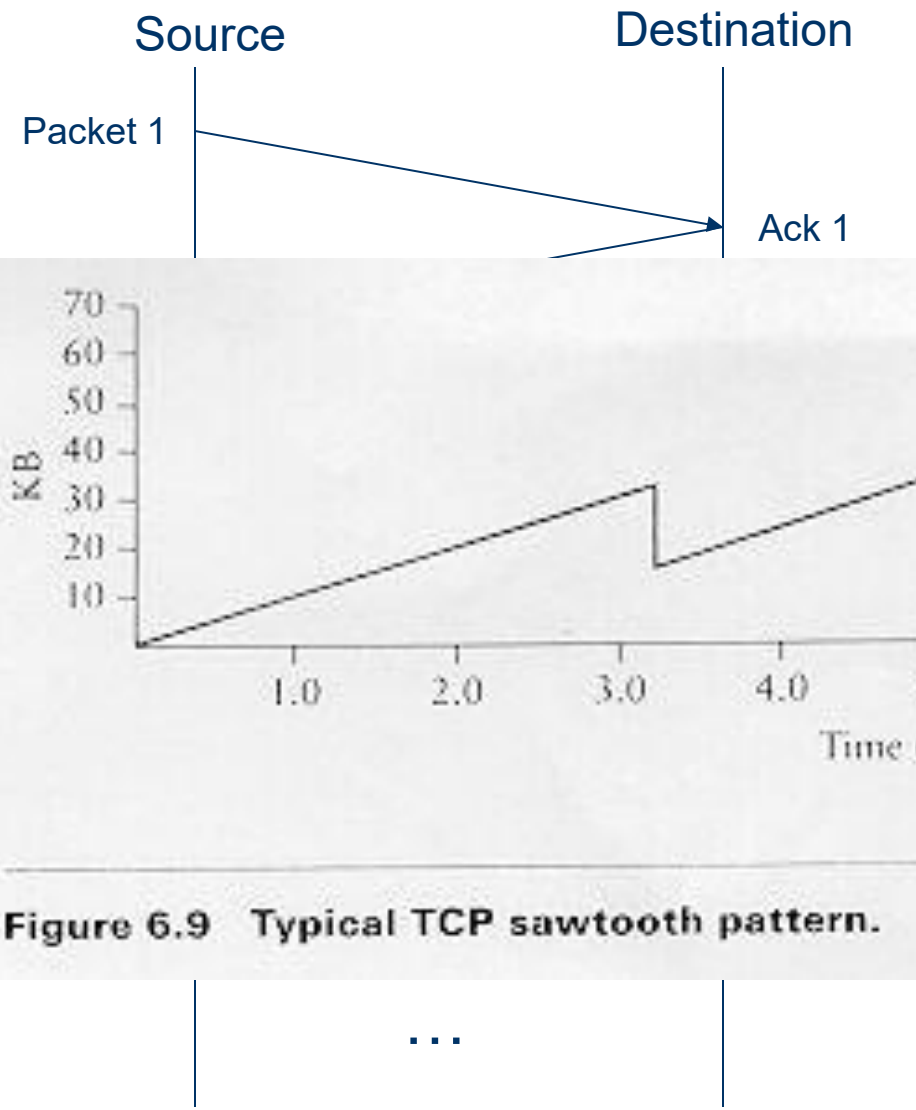
TCP

- 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



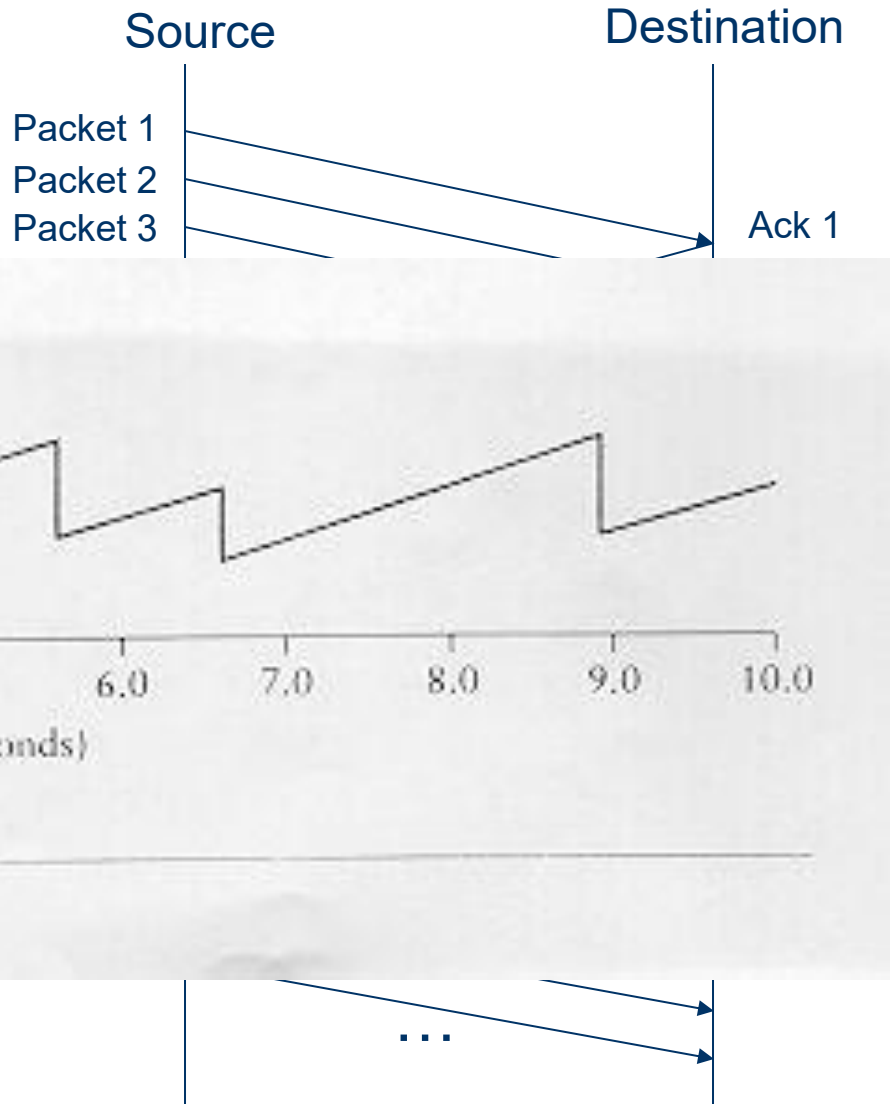
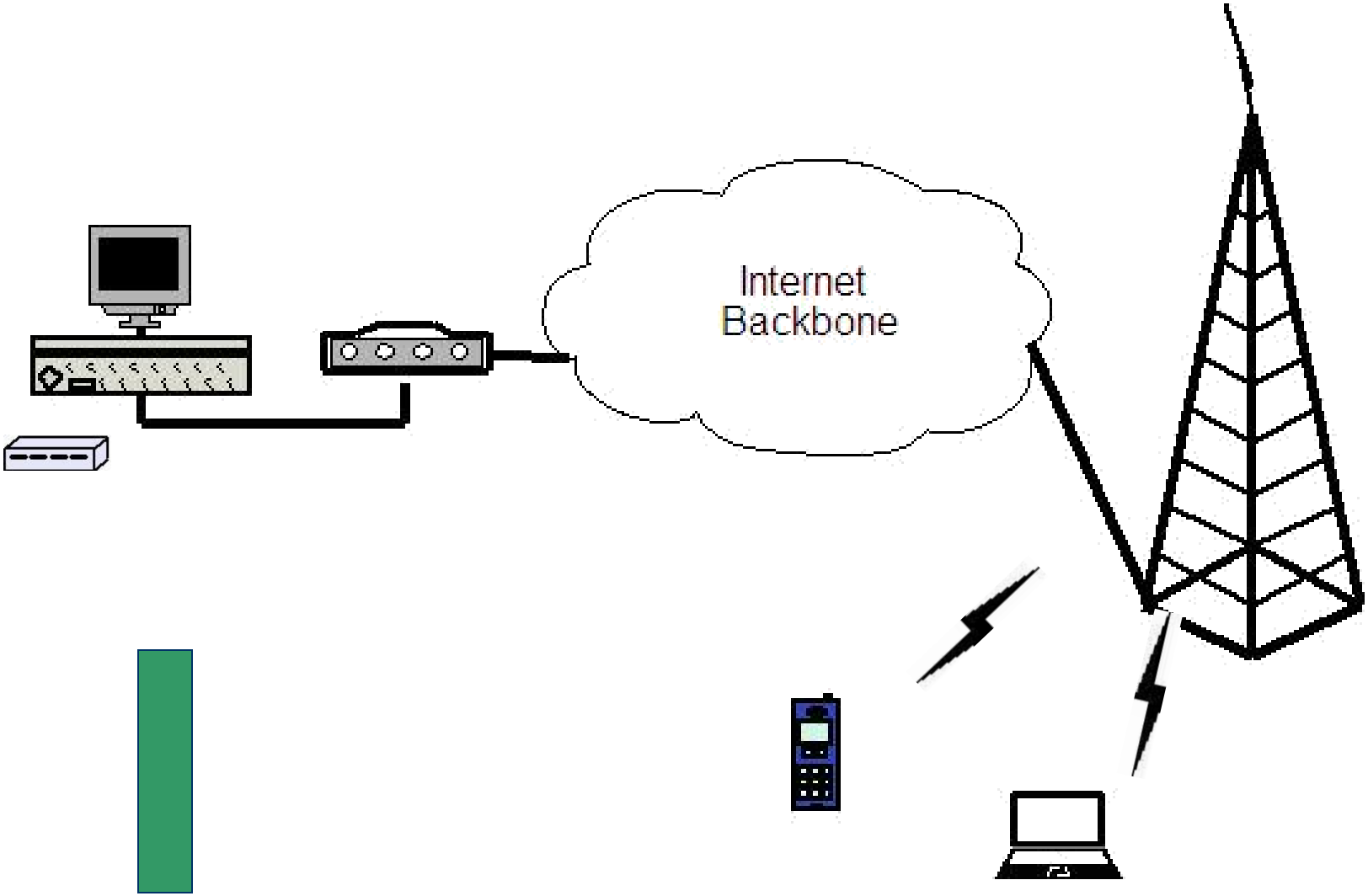
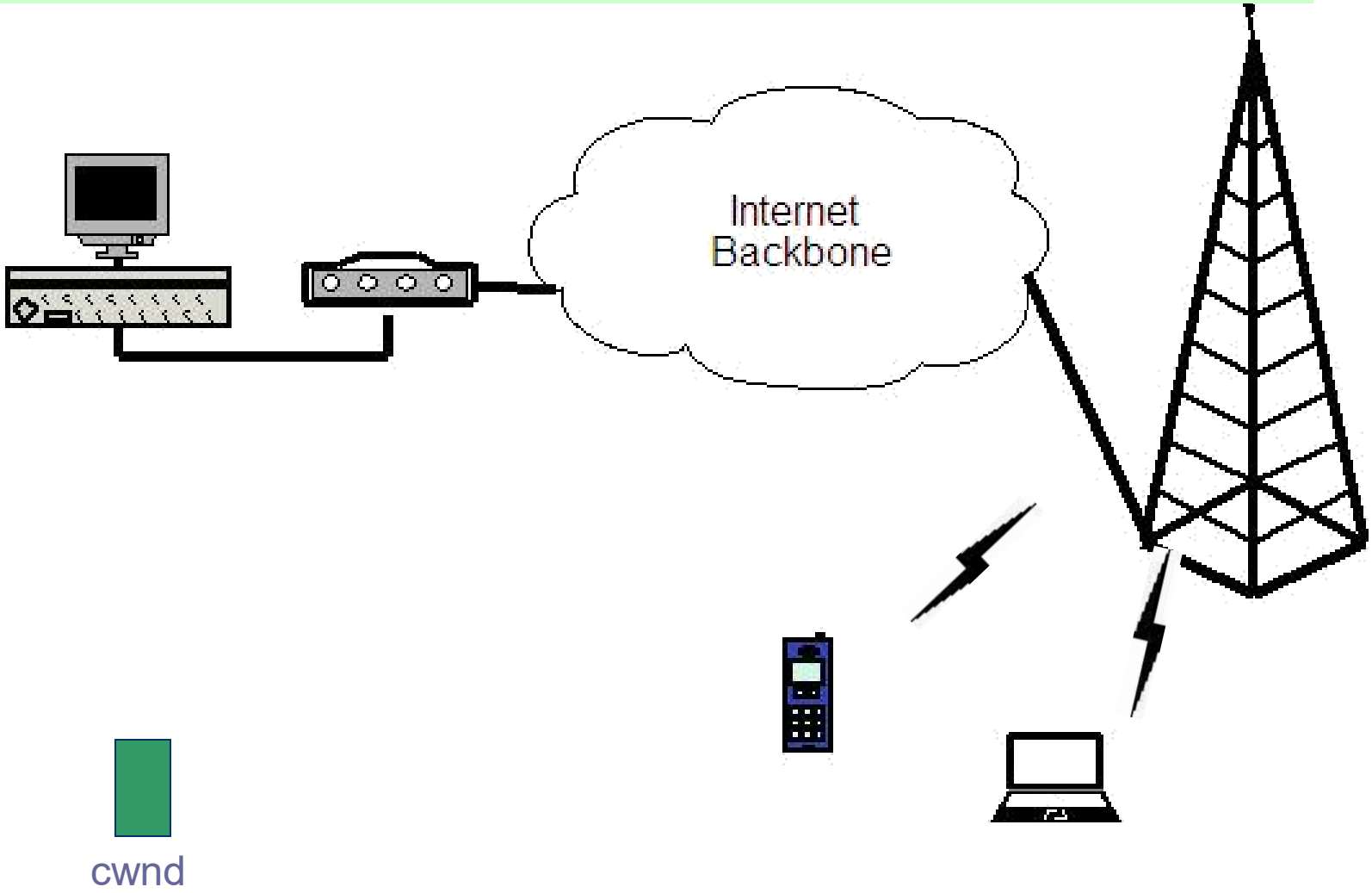
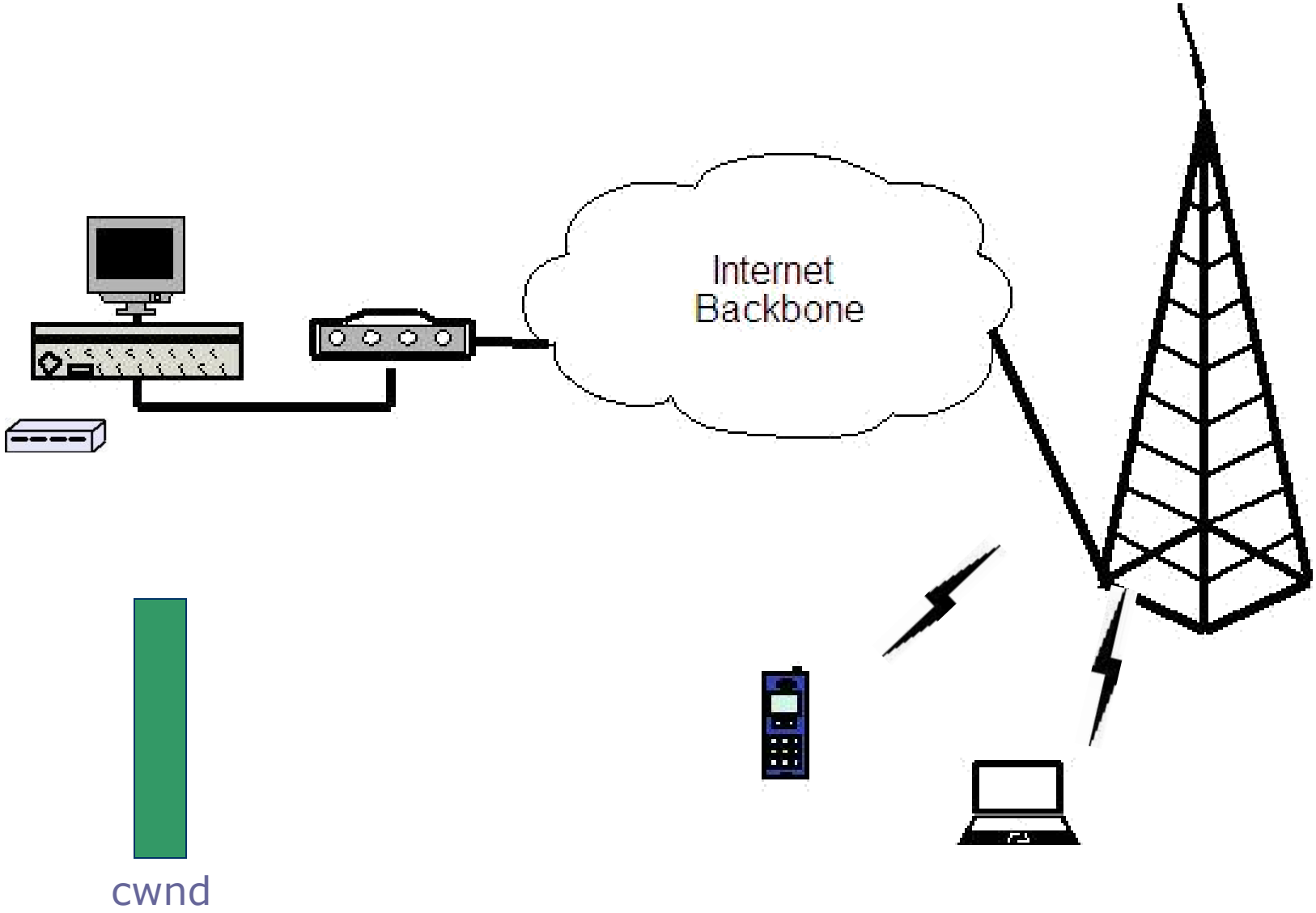


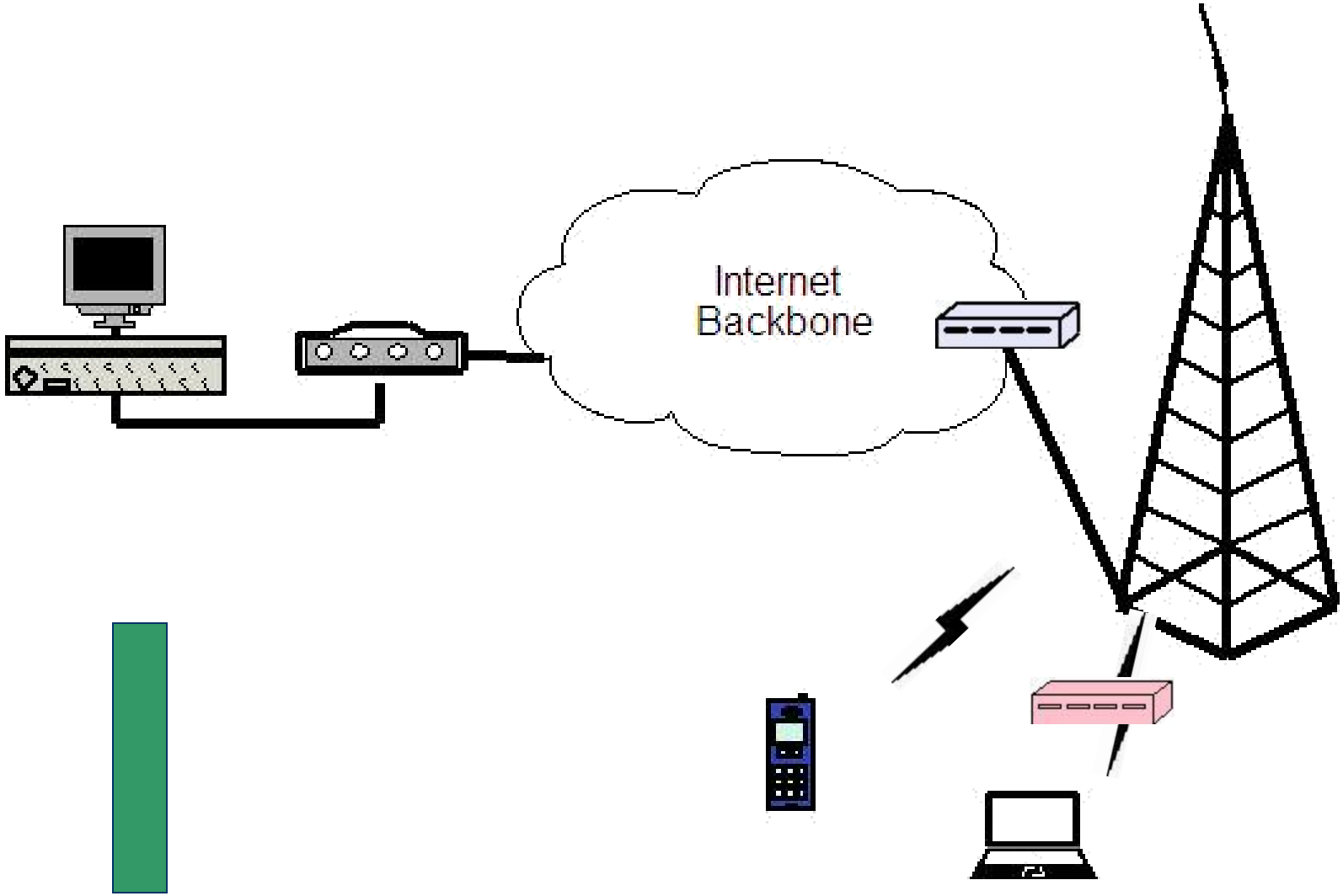
Figure 6.9 Typical TCP sawtooth pattern.


Internet
Backbone
cwnd

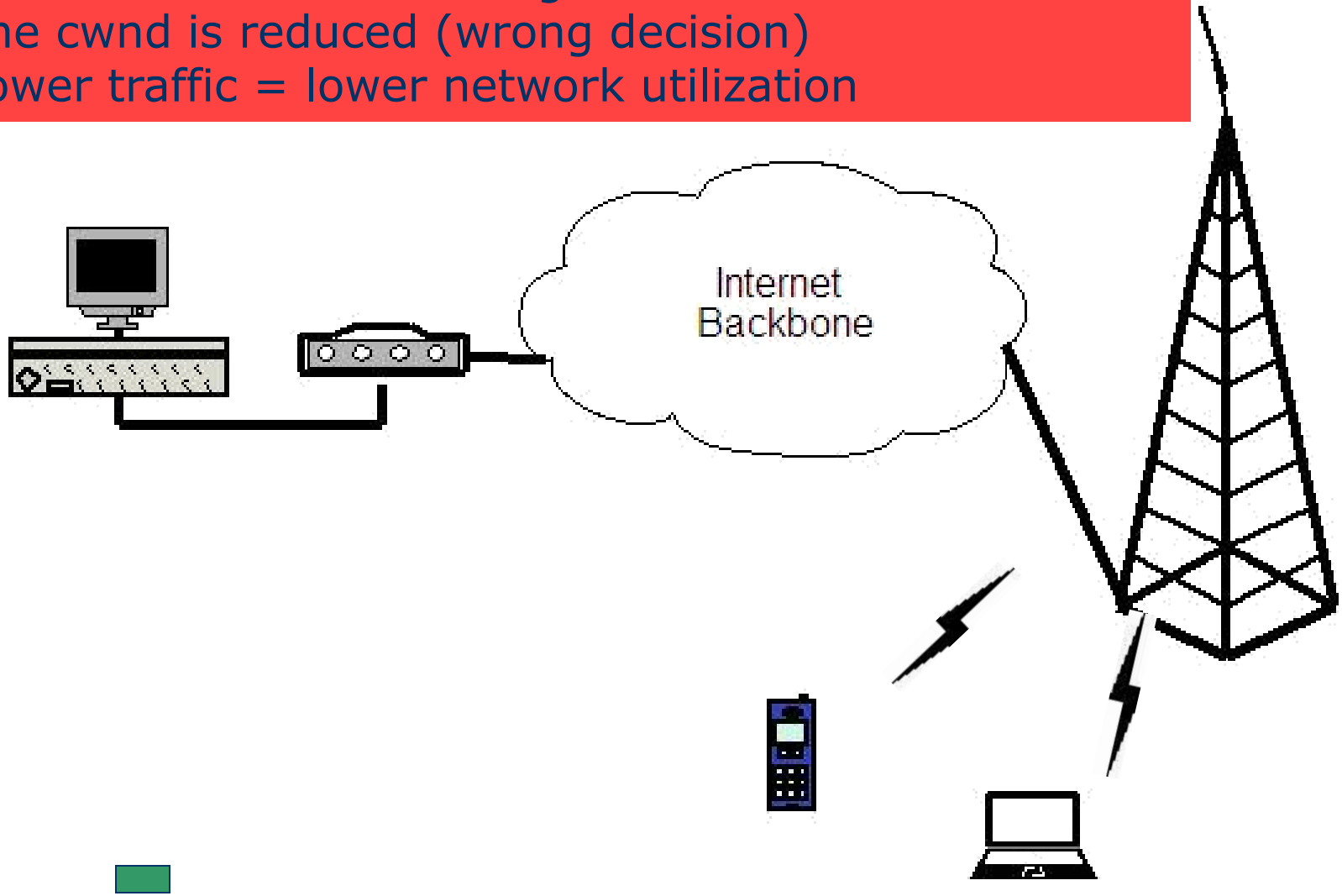
Loss of packet due to congestion
Reduction of cwnd
Reduction of data traffic




Internet
Backbone
cwnd

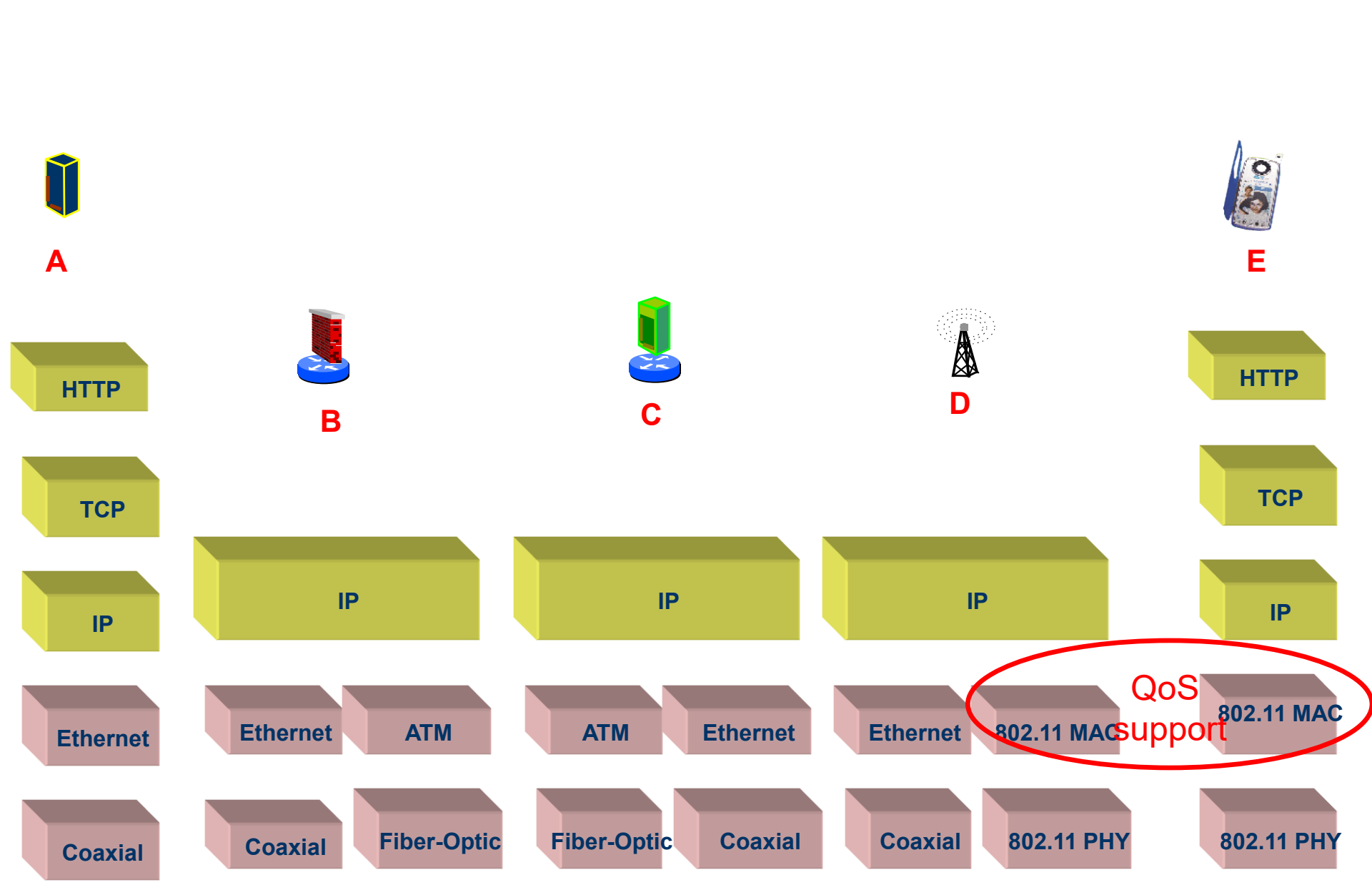

Internet
Backbone
cwnd

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



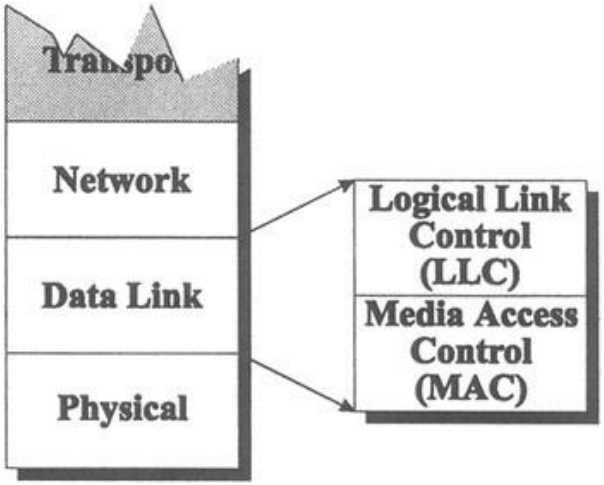
2. «Best Effort»

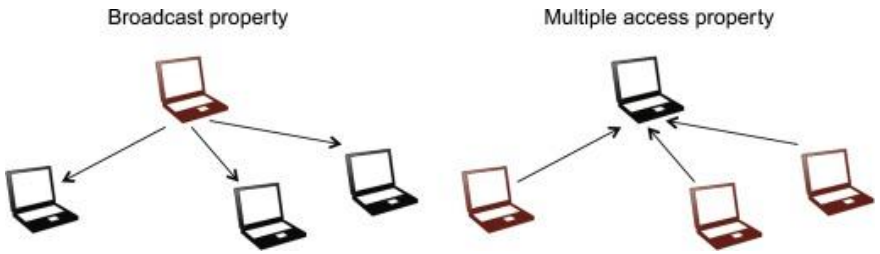
- All types of information are formed as IP packets and sent to the network
- IP does not have mechanism to guarantee quality characteristcs for each traffic flow (delay, packet loss, etc.)
- Only UDP or TCP traffic is not enough
- The need for QoS guarantees is much bigger due to the low capacity and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

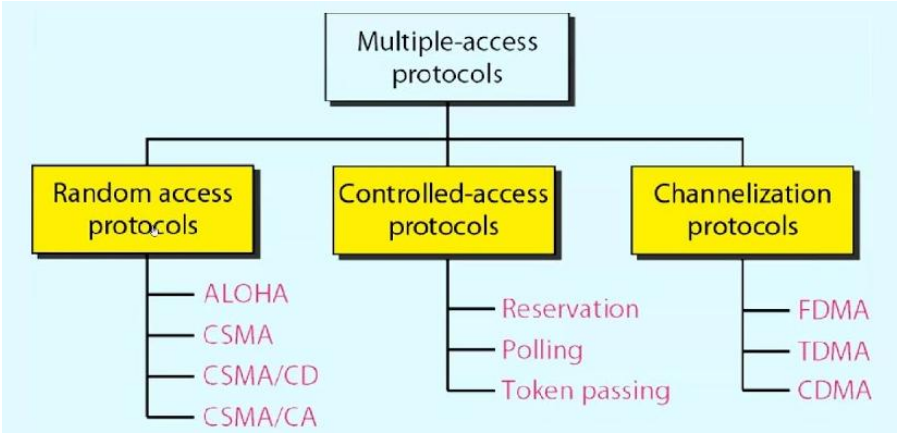

A
B
C
D
E
HTTP
TCP
IP
Ethernet
Coaxial
IP
Ethernet
ATM
Coaxial
Fiber-Optic
IP
ATM
Ethernet
Fiber-Optic
Coaxial
IP
Ethernet
802.11 MAC
Coaxial
802.11 PHY
QoS
support
HTTP
TCP
IP
802.11 MAC
802.11 PHY

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 in based an a static scheme of IP addresses

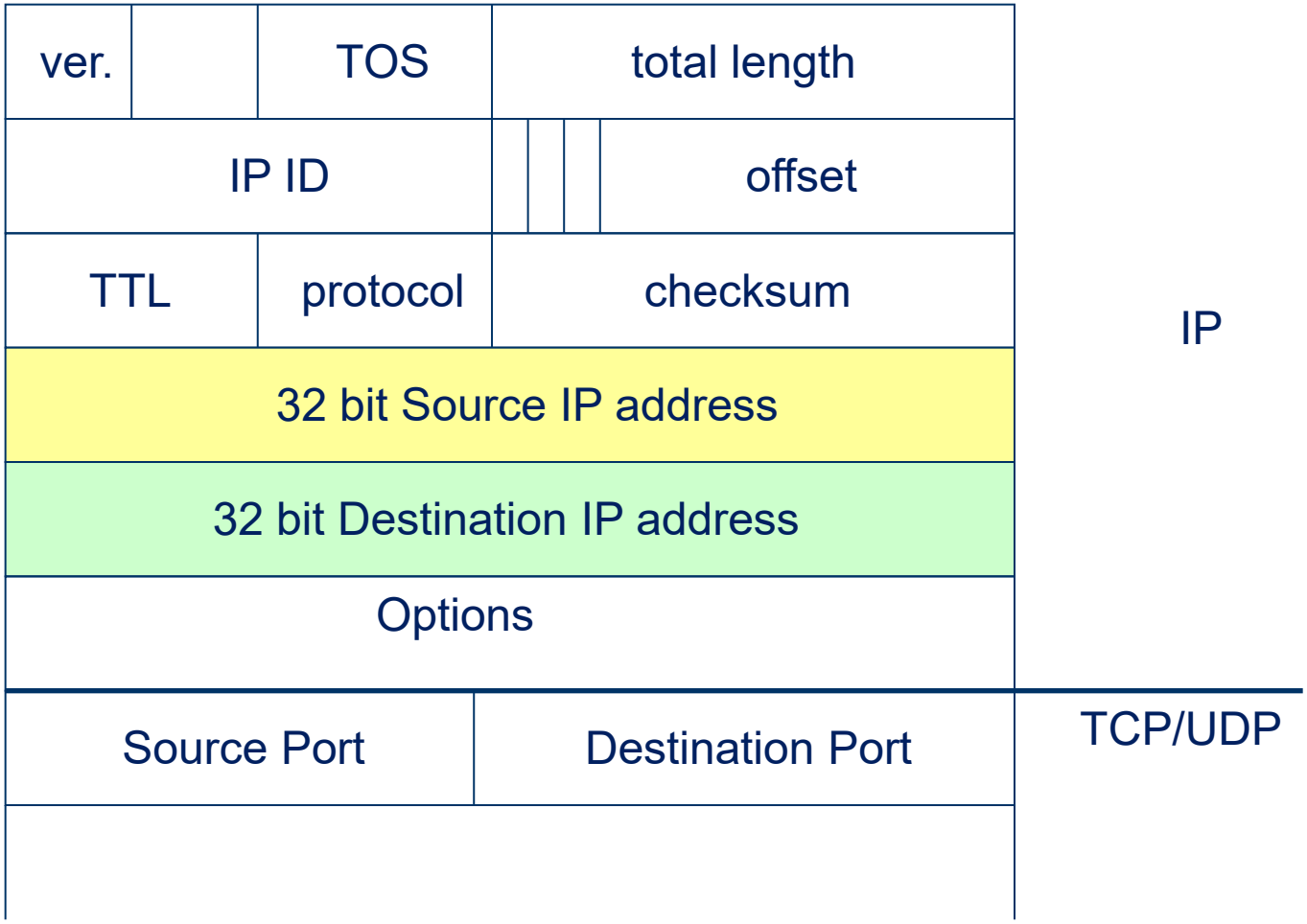
- A static address depends on the static connection point of the terminal to the network

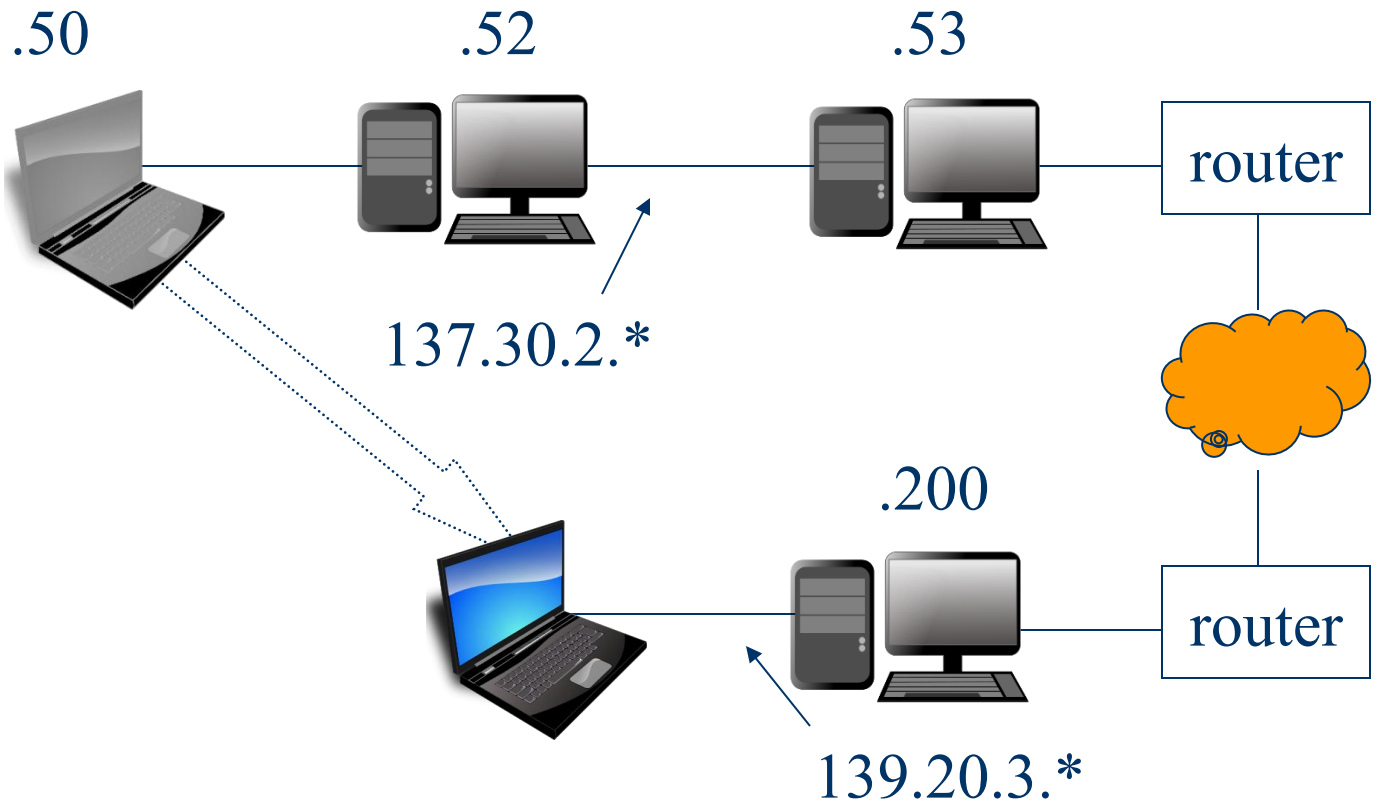
- If the connection point changes without change of address the packets are routed to the old connection point

- But of the address changes how this can be communicated to the rest of the world?

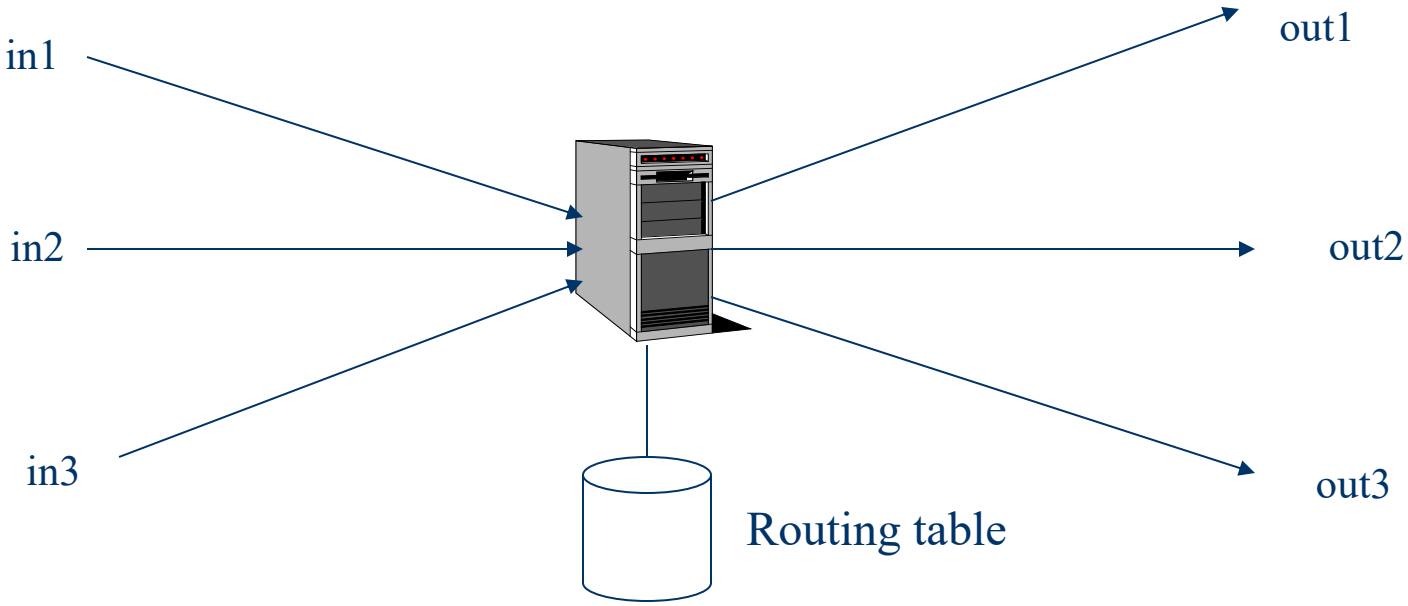
- Impossible to inform the network each time a terminal changes its connection point

IP Header


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

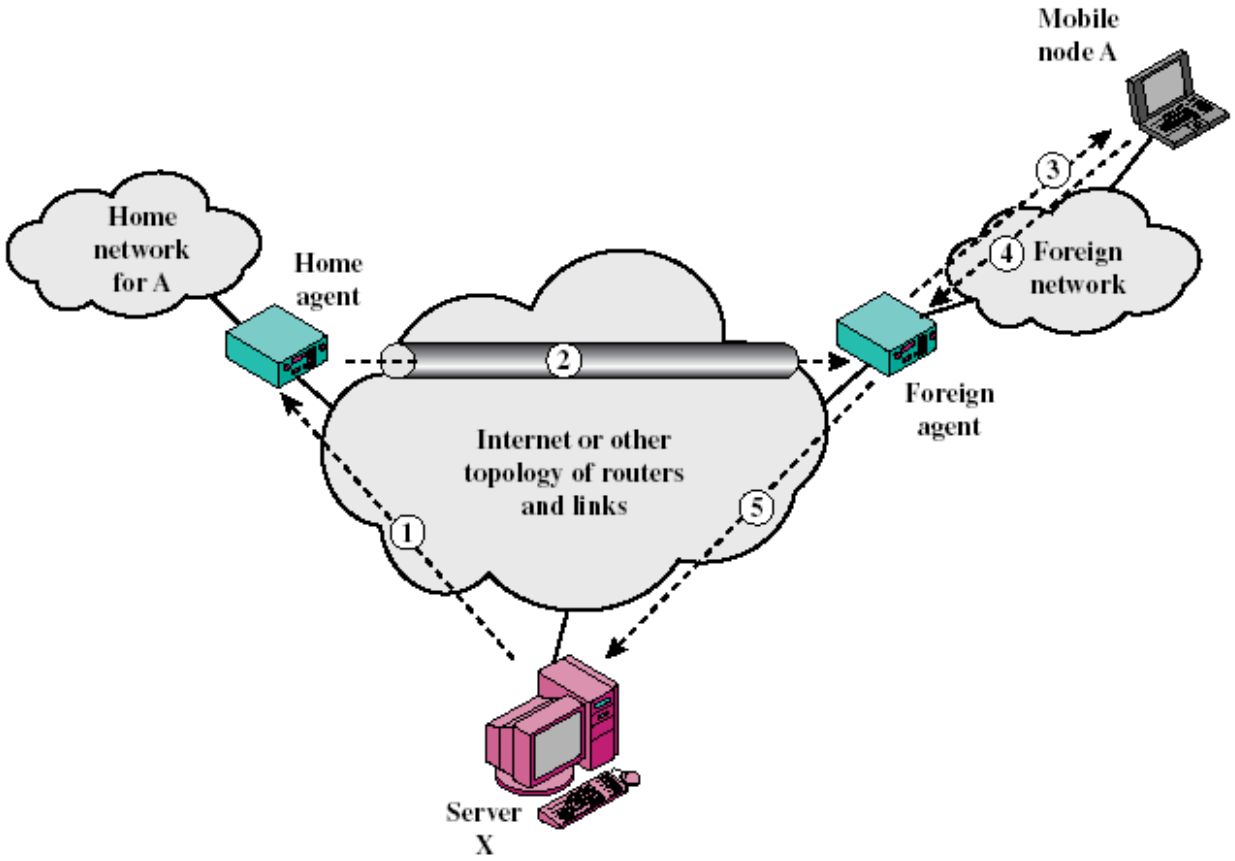

.50
.52
.53
router
137.30.2.*
.200
router
139.20.3.*

IP routing



137.30.2.x	out1
137.30.3.x	out2
default	out3

Mobile IP


Mobile
node A
Home
network
for A
Home
agent
Foreign
network
Foreign
agent
Internet or other
topology of routers
and links
Server
X
1
2
3
4
5

Mobile IP terminology

Correspondent Node (CN)

Home Agent (HA)

Foreign Agent (FA)

home address

care-of address

Mobile Node (MN)

Οικείο δίκτυο

home network

foreign network