Introduction to Internet

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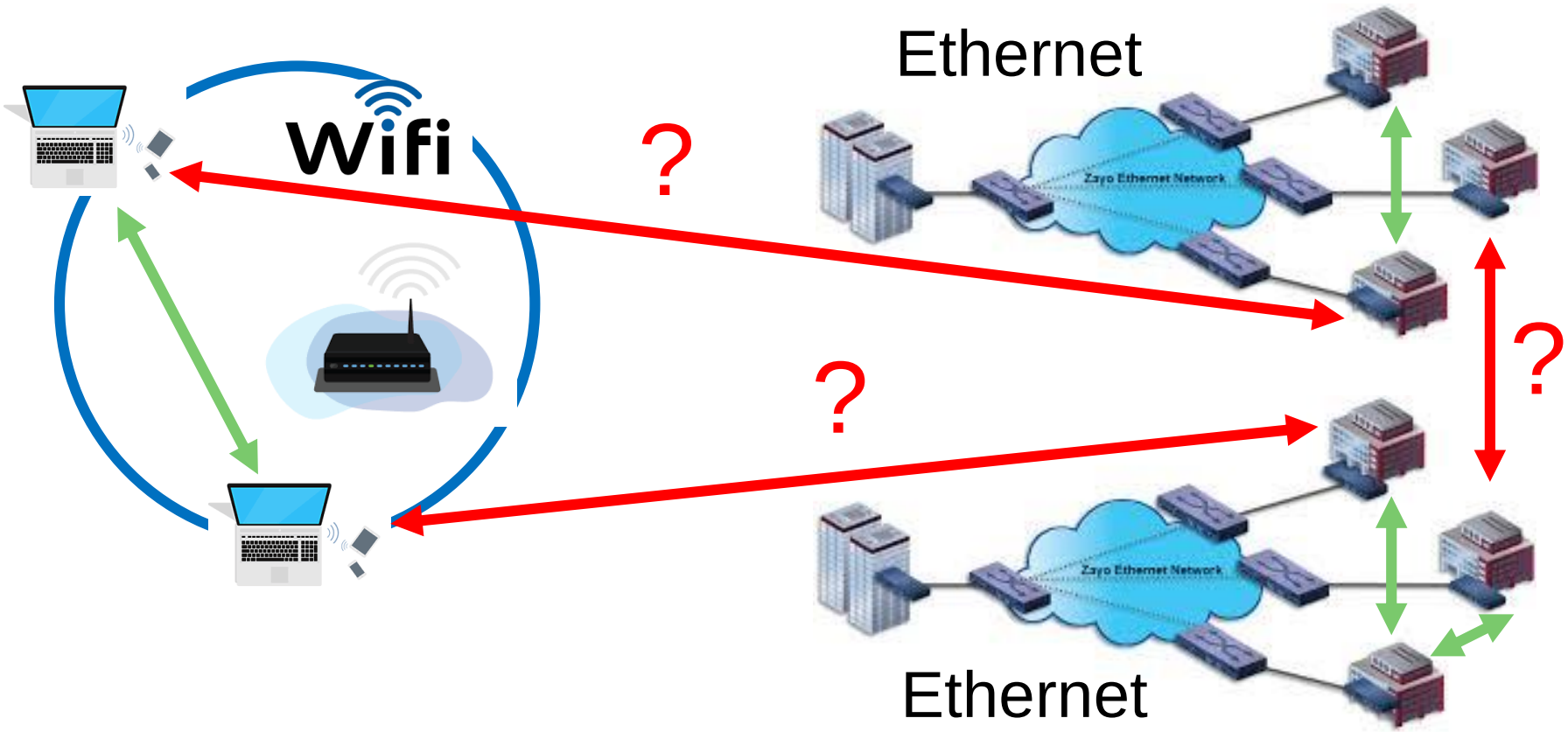
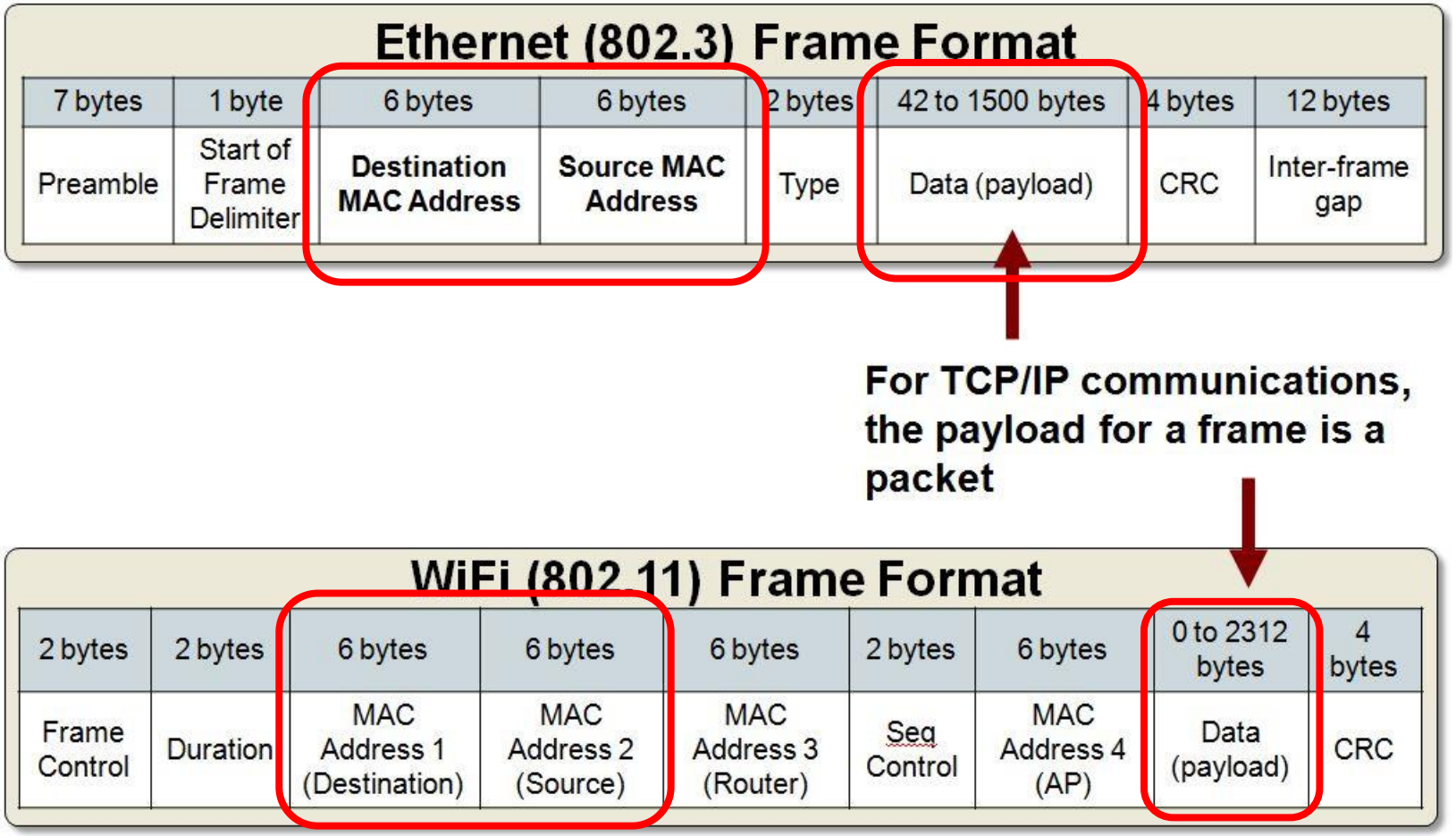
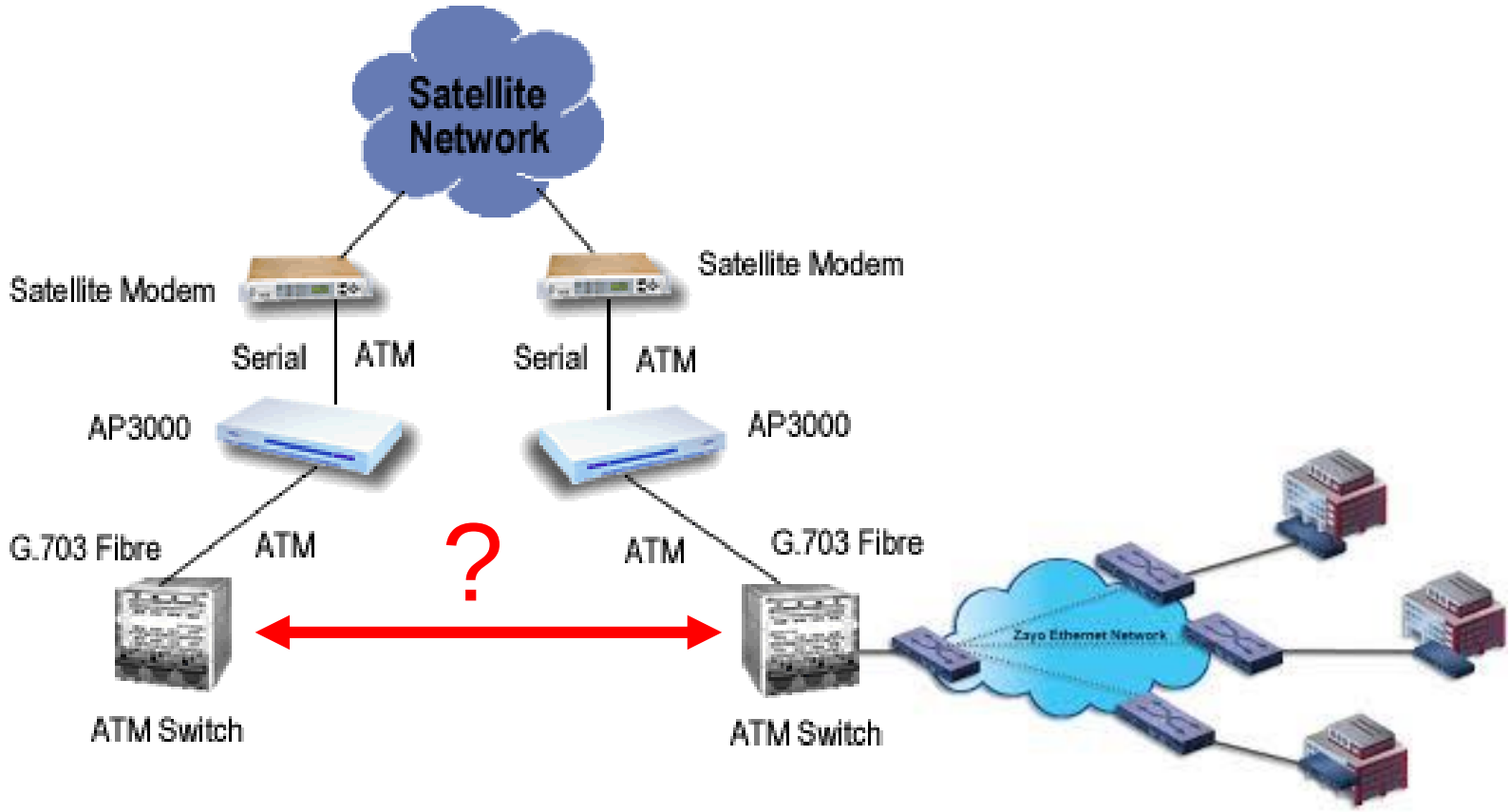
What about inter-networks communications ? Between LANs …



Example Similarities and Differences between Ethernet and Wifi



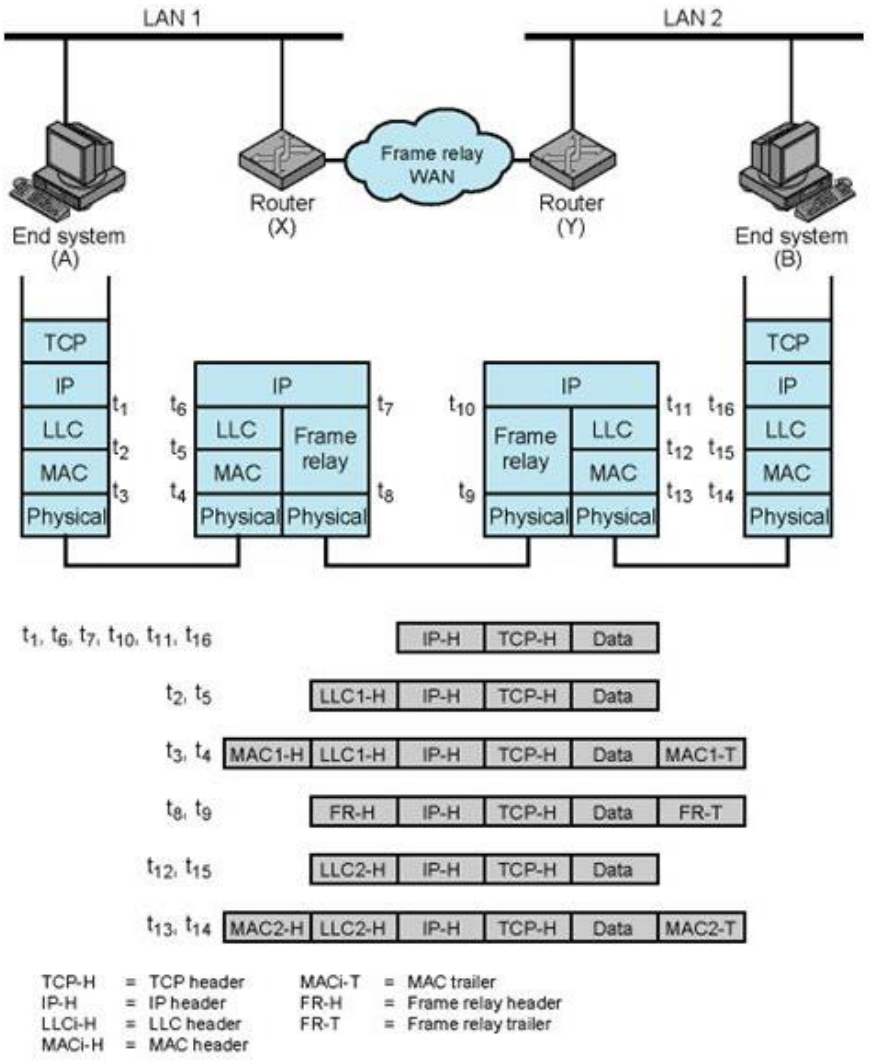
What about inter-networks communications ? Between WANs …



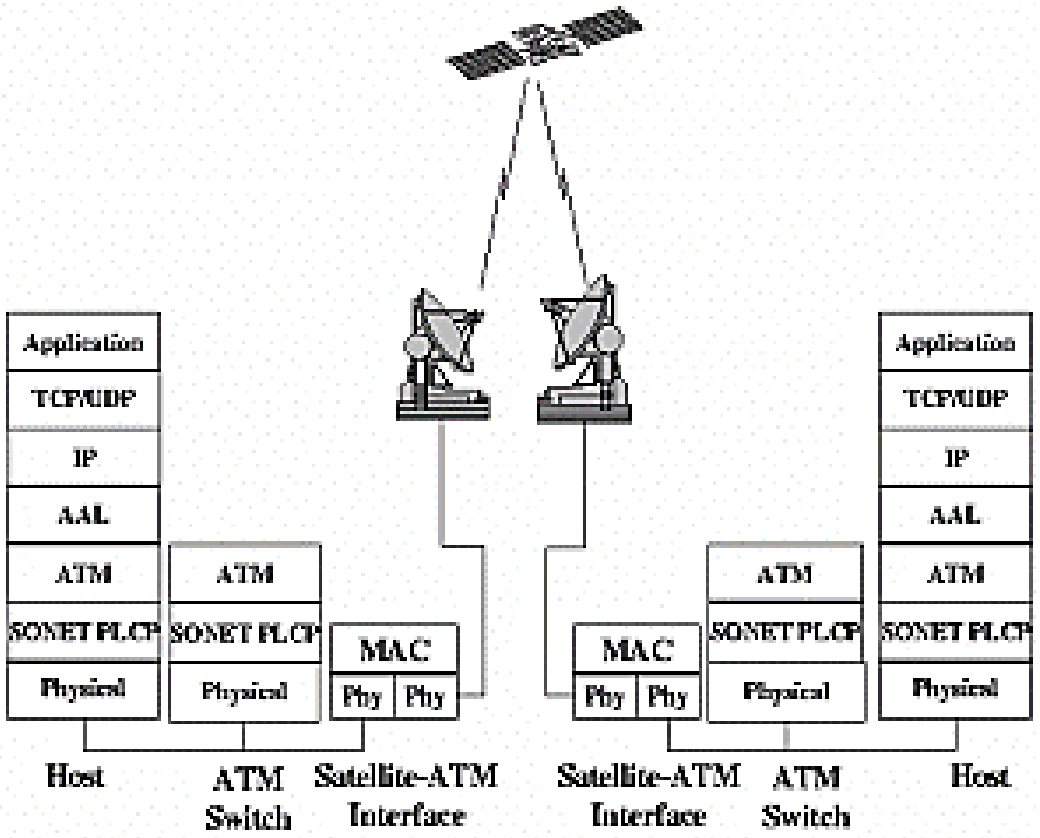
Internet Protocol Operation

EXAMPLE

- IP packet is encapsulted as Data in intermediary networks
- From intermediary network to another IP packet is carried

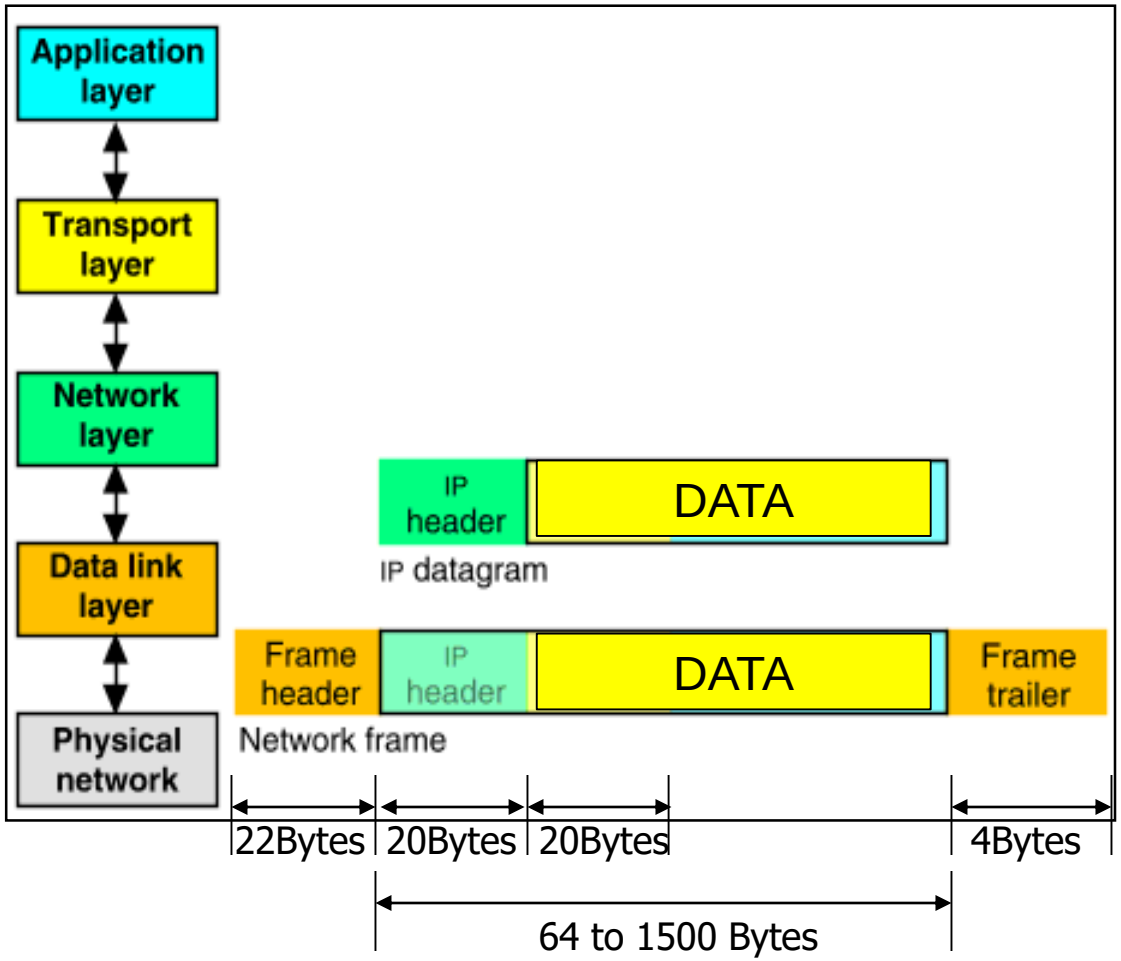


Example : TCP over Satellite-ATM Protocol Stack



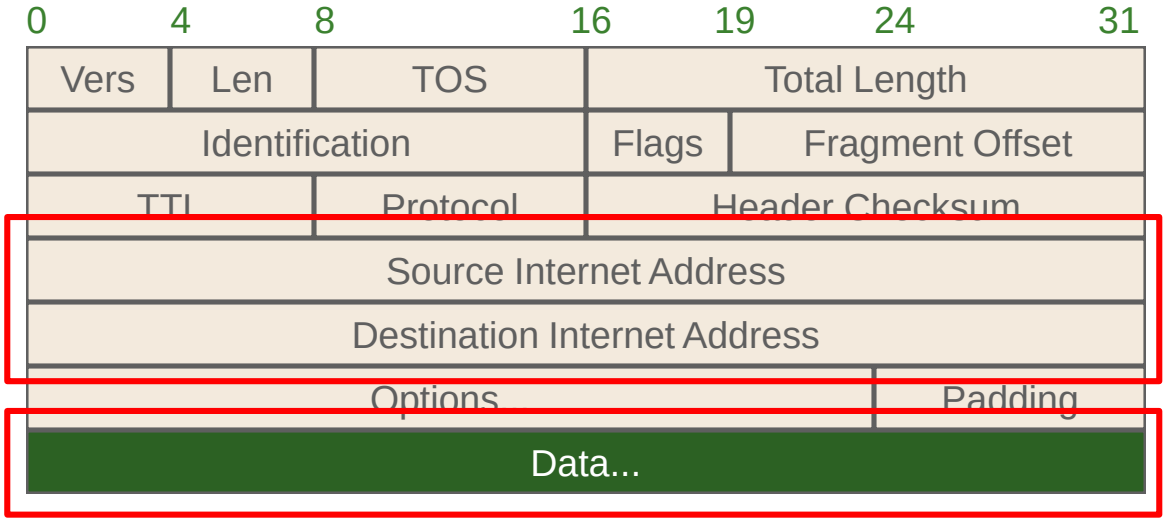
Packet Encapsulation in OSI/ISO model

- The data is sent down the protocol stack
- Each layer adds to the data by prepending headers



IP Datagram

Simplification

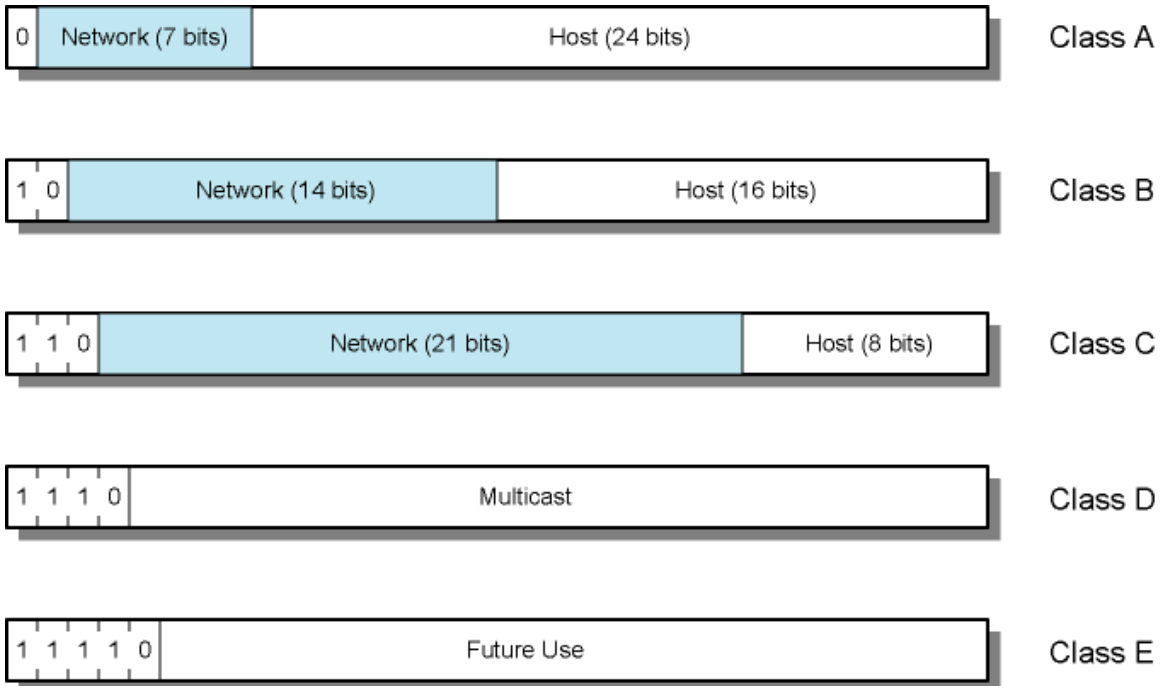


Field	Purpose
Vers	IP version number
Len	Length of IP header (4 octet units)
TOS	Type of Service
T. Length	Length of entire datagram (octets)
Ident.	IP datagram ID (for frag/reassembly)
Flags	Don't/More fragments
Frag Off	Fragment Offset

Field	Purpose
TTL	Time To Live - Max # of hops
Protocol	Higher level protocol (1=ICMP, 6=TCP, 17=UDP)
Checksum	Checksum for the IP header
Source IA	Originator's Internet Address
Dest. IA	Final Destination Internet Address
Options	Source route, time stamp, etc.
Data...	Higher level protocol data

IPv4 Address Formats

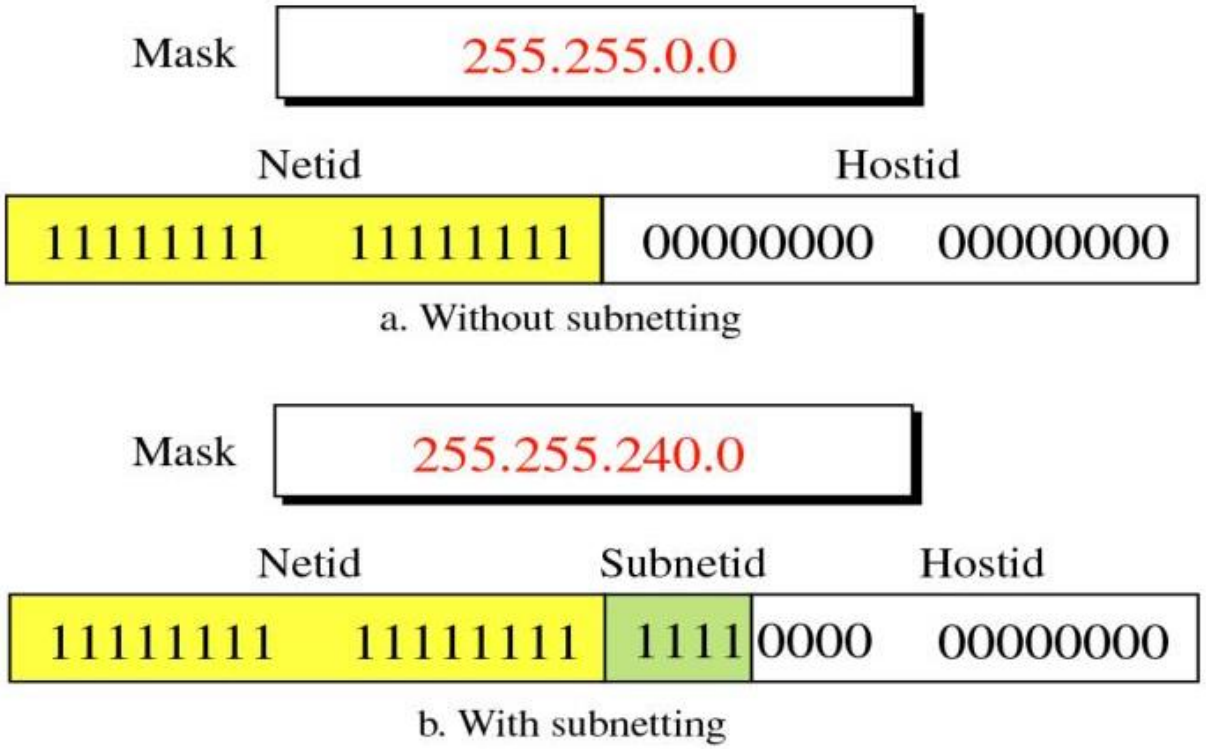
- 32 bit global Internet address
- Network part and host part



Network Masks

- Distinguishes which portion of the address identifies the network and which portion of the address identifies the node.
- Default masks:
  - Class A: 255.0.0.0
  - Class B: 255.255.0.0
  - Class C: 255.255.255.0

Netid, Hostid, Mask



Some Special IP address forms

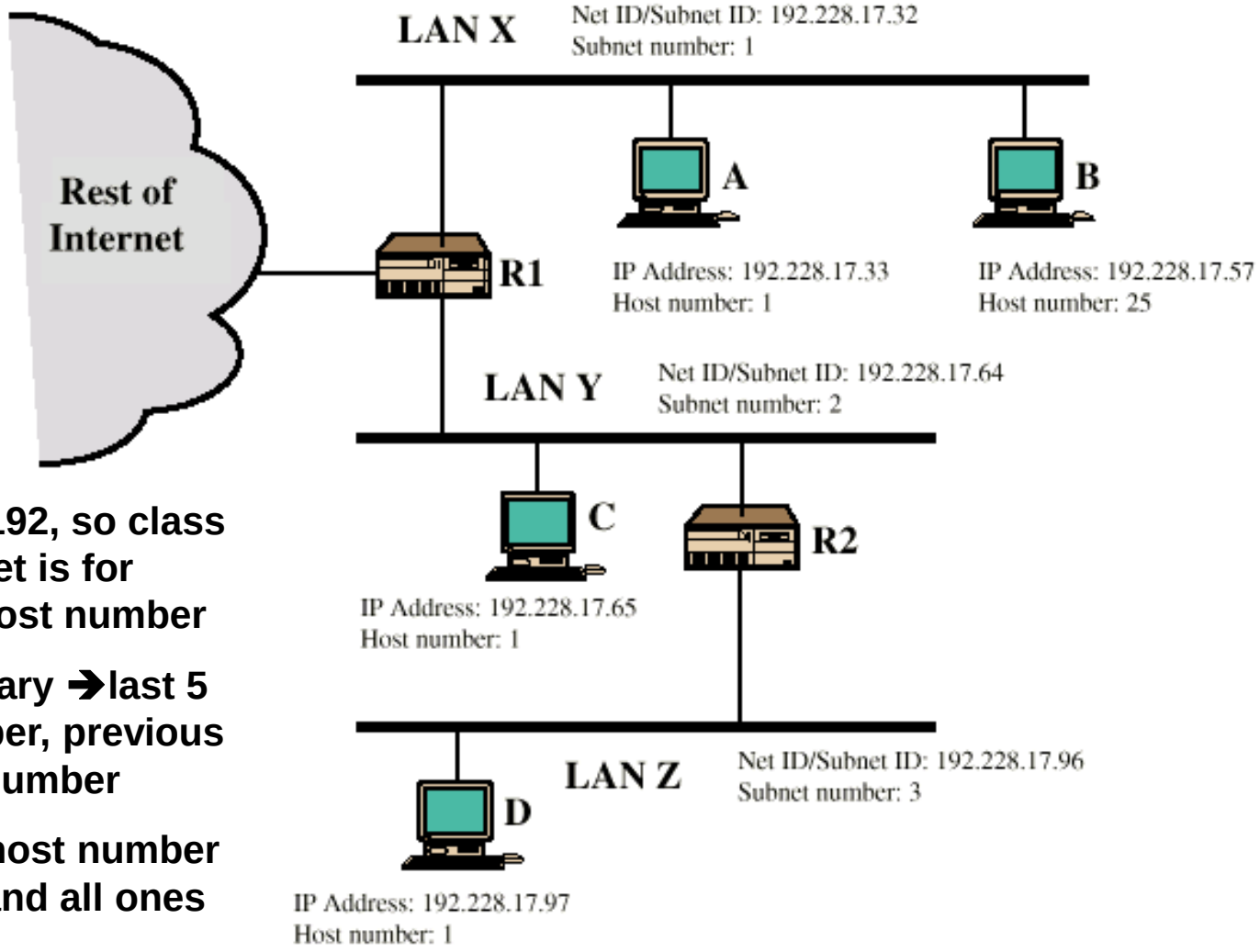
- All-zero host part identifies the network
- All-one host part means broadcast (limited to current network)

Prefix (network)	Suffix (host)	Type & Meaning
all zeros	all zeros	this computer (used during bootstrap)
network address	all zeros	identifies network
network address	all ones	broadcast on the specified network
all ones	all ones	broadcast on local network
127	any	loopback (for testing purposes)

Private Address Range

Address Class	Reserved Address Space
Class A	10.0.0.0 - 10.255.255.255
Class B	172.16.0.0 - 172.31.255.255
Class C	192.168.0.0 - 192.168.255.255

Routing Using Subnets (Example)



Subnet Mask:
255.255.255.224

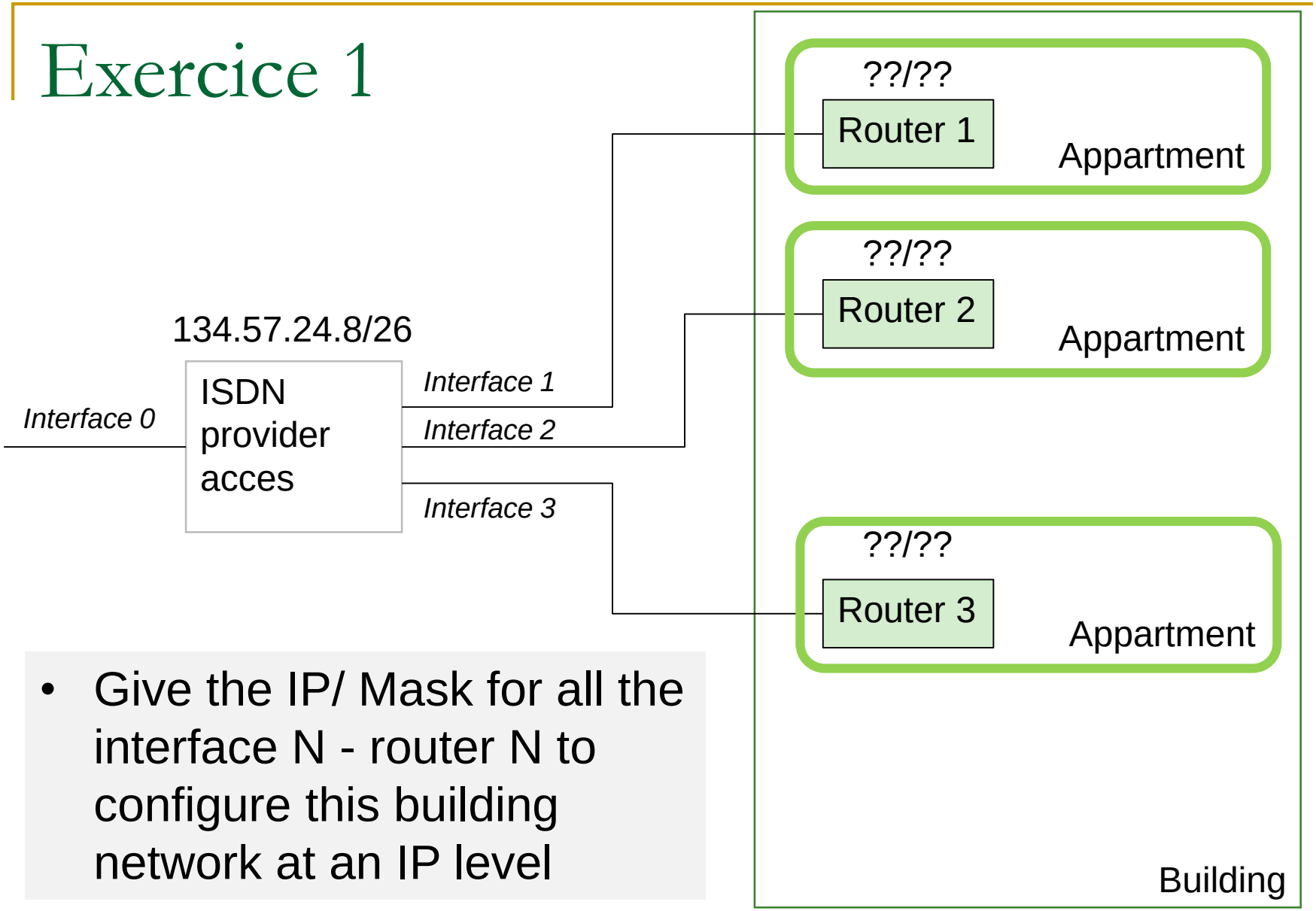
Addresses start with 192, so class C addresses. Last octet is for Subnet number and Host number

224 -> 11100000 in binary ➔last 5 bits are for Host number, previous 3 bits are for Subnet number

Don't forget! All zero host number identifies the subnet and all ones is used for broadcast

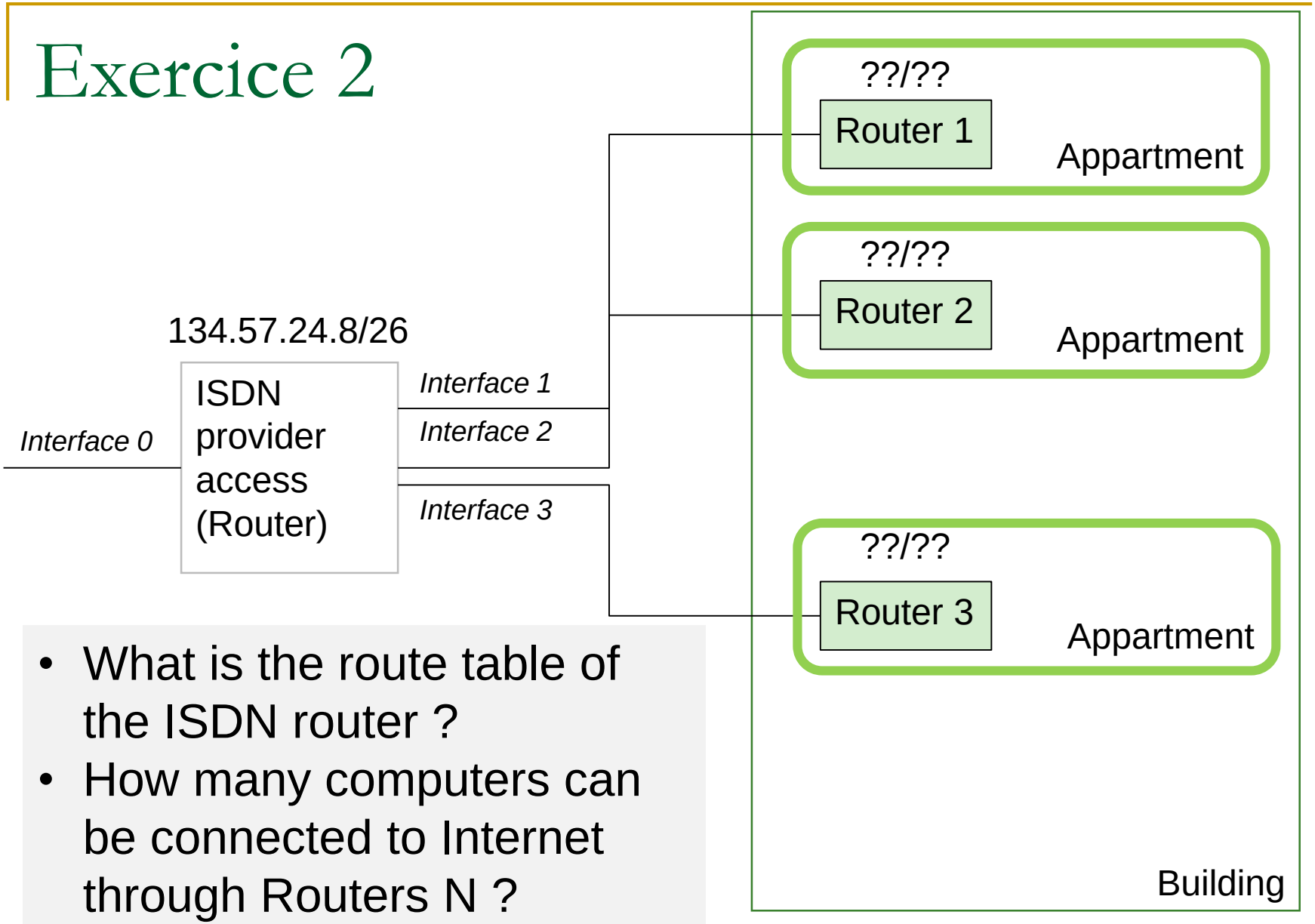
Addr Source	Addr Dest	DATA

Exercice 1



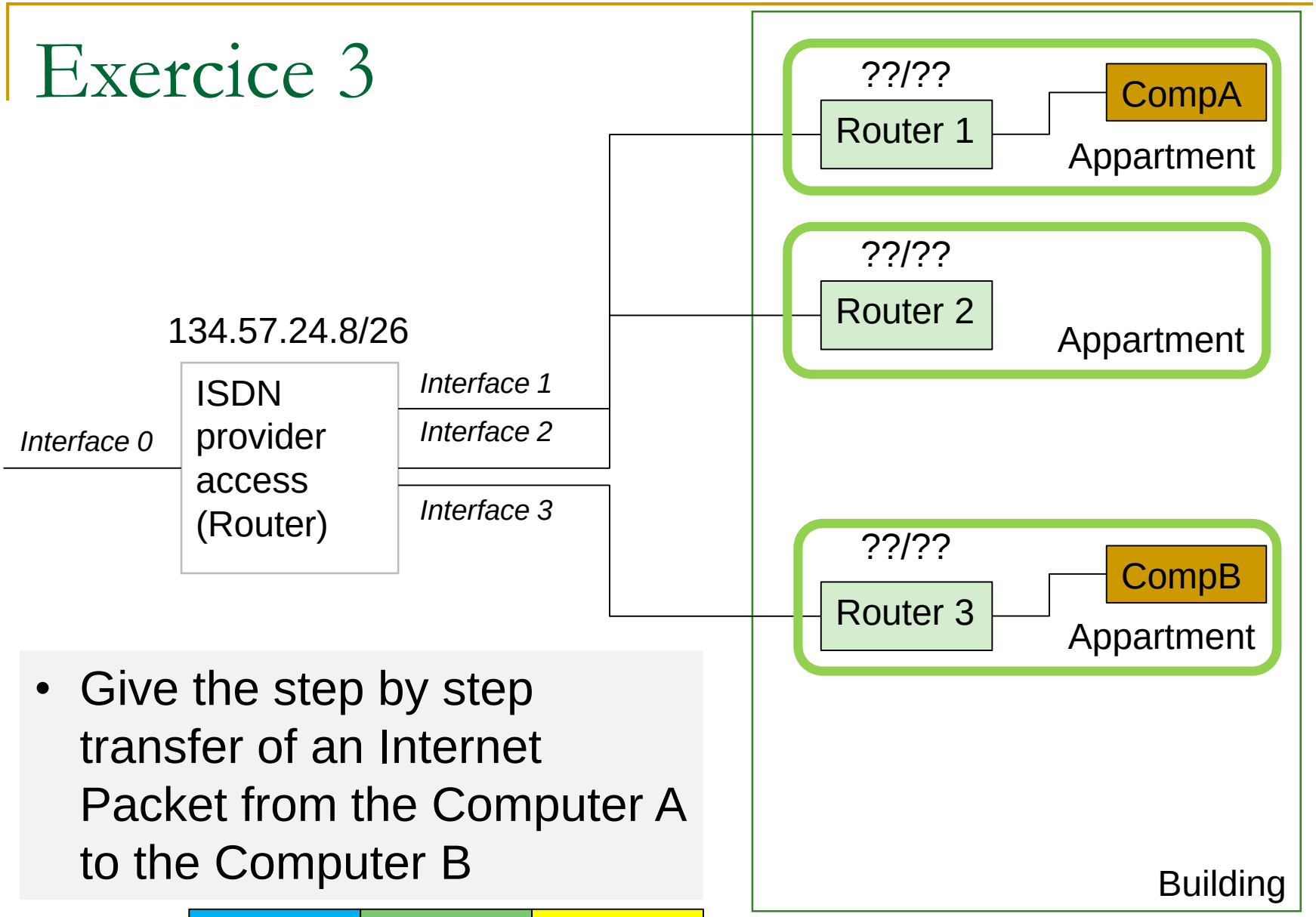
- Give the IP/ Mask for all the interface N - router N to configure this building network at an IP level

Exercice 2



- What is the route table of the ISDN router ?
- How many computers can be connected to Internet through Routers N ?

Exercice 3



- Give the step by step transfer of an Internet Packet from the Computer A to the Computer B

IPv6 Enhancements

- Expanded address space
  - 128 bit
  - $6*10^{23}$ addresses per square meter on earth!
- Improved option mechanism
  - Separate optional headers between IPv6 header and transport layer PDU
  - Some are not examined by intermediate routers
    - Improved speed and simplified router processing
  - Easier to extend with new options
    - Flexible protocol

Introduction to Transport Protocols over IP : UDP / TCP

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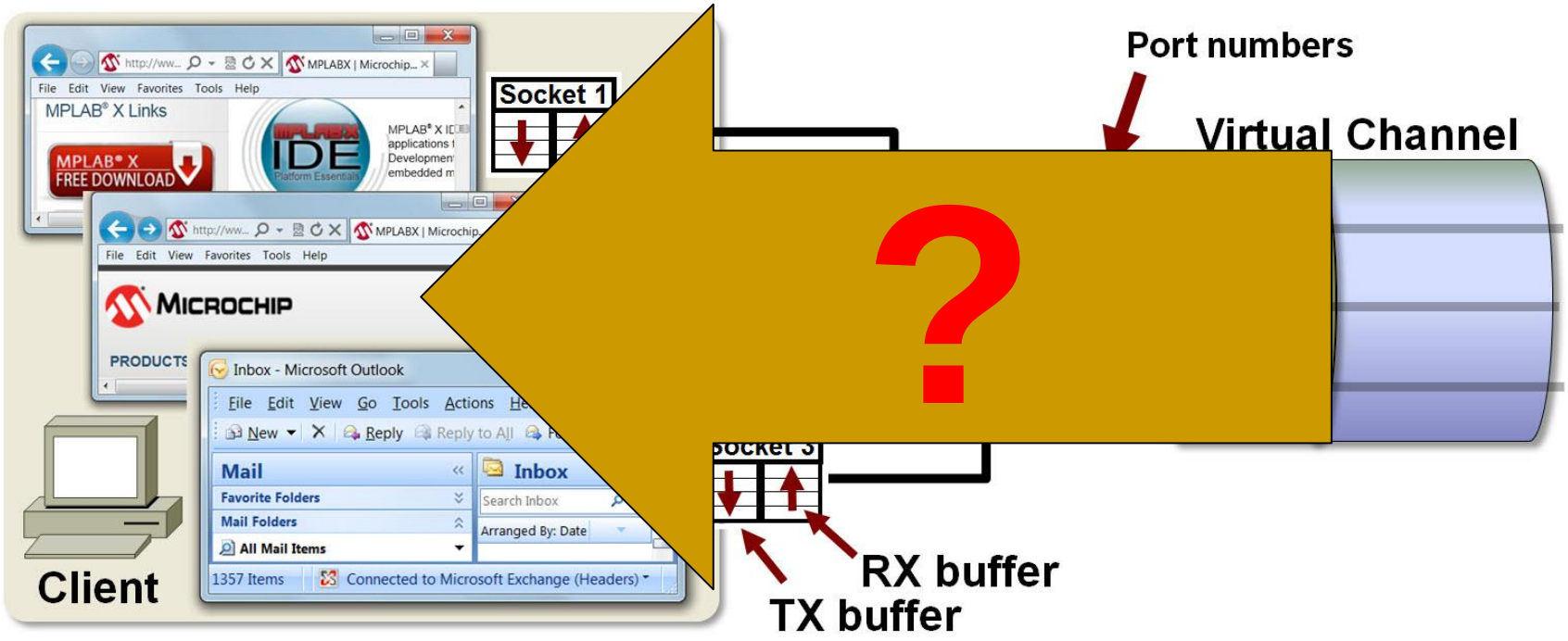
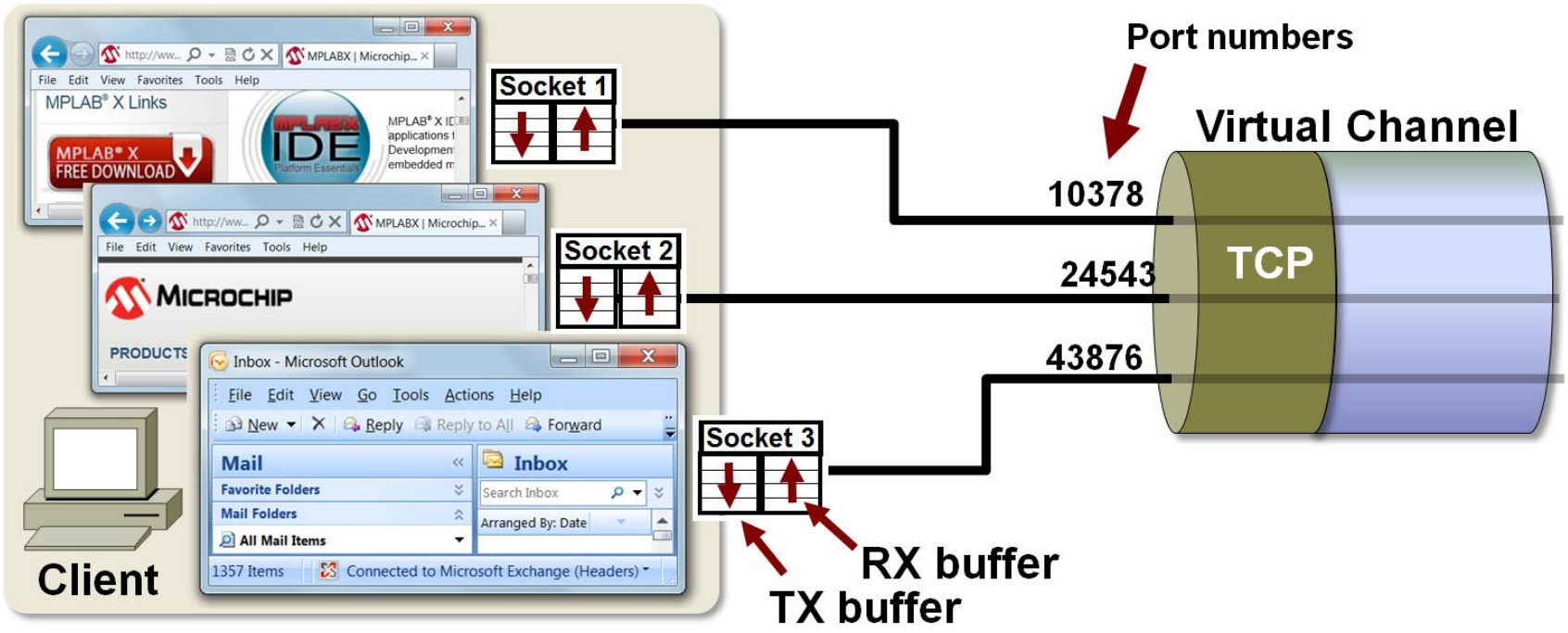
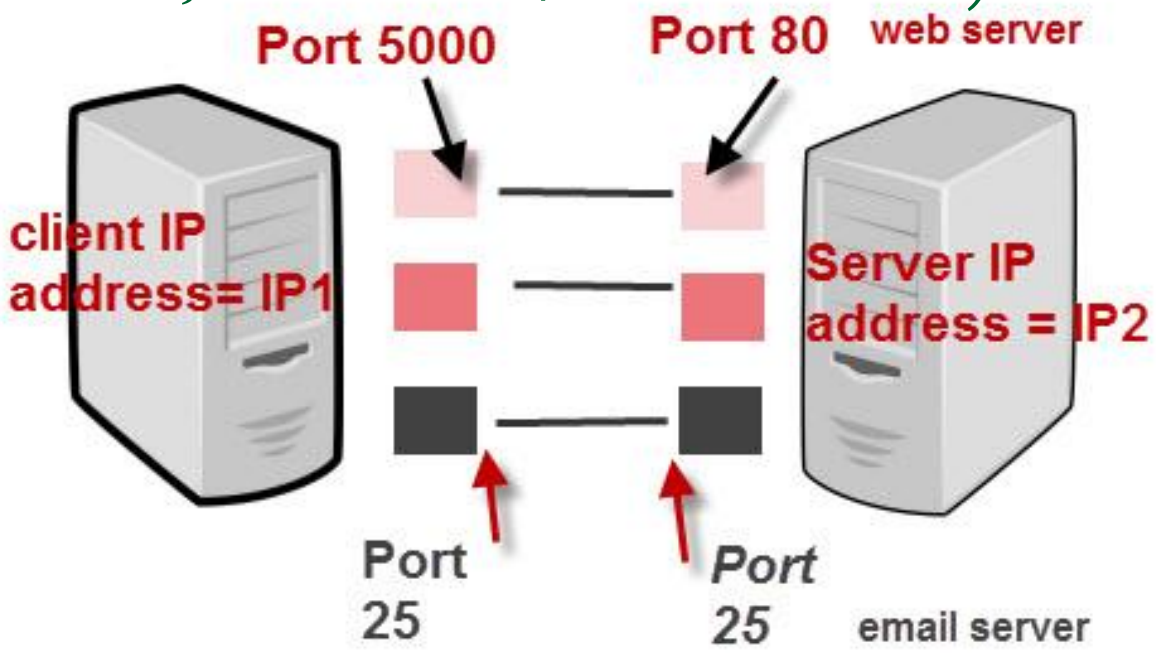
How multiple programs can communicate over internet ?



Adding Port number to IP Address



Communication endpoints are (IP_Src/Port Src, IP_Dest/Port Dest)



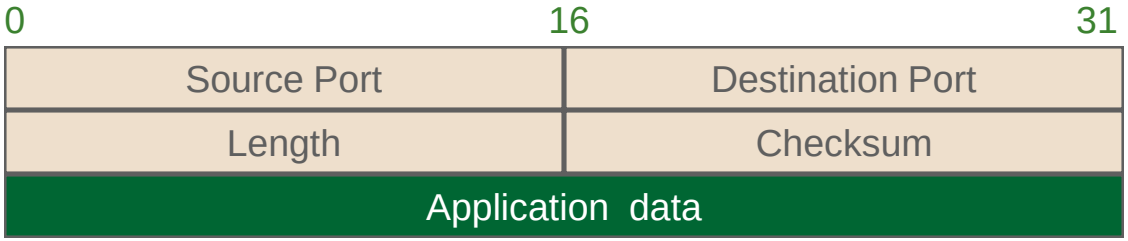
IP Address + Port number = Socket

TCP/IP Ports And Sockets

UDP

- Source and destination *ports*
  - Ports are used to associate a packet with a specific application at each end Thin layer on top of IP
- Adds packet length + checksum
  - Guard against corrupted packets
- Still unreliable:
  - Duplication, loss, out-of-orderness possible

UDP datagram



Field	Purpose
Source Port	16-bit port number identifying originating application
Destination Port	16-bit port number identifying destination application
Length	Length of UDP datagram (UDP header + data)
Checksum	Checksum of IP pseudo header, UDP header, and data

Typical applications of UDP

- Where packet loss etc is better handled by the application than the network stack
- Where the overhead of setting up a connection isn't wanted

- VOIP
- NFS – Network File System
- Most games

TCP

- Reliable, *full-duplex*, *connection-oriented*, *stream* delivery
  - Interface presented to the application doesn't require data in individual packets
  - Data is guaranteed to arrive, and in the correct order without duplications
    - Or the connection will be dropped
  - Imposes significant overheads

Applications of TCP

- Most things!
  - HTTP, FTP, …
- Saves the application a lot of work, so used unless there's a good reason not to

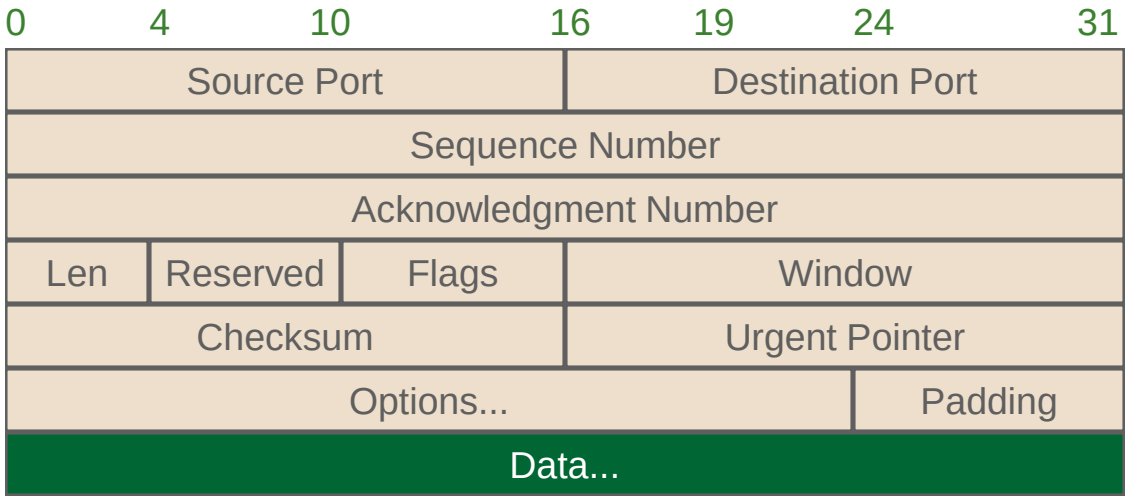
TCP implementation

- Connections are established using a *three-way handshake*
- Data is divided up into packets by the operating system
- Packets are numbered, and received packets are acknowledged
- Connections are explicitly closed
  - (or may abnormally terminate)

TCP Packets

- Source + destination ports
- Sequence number (used to order packets)
- Acknowledgement number (used to verify packets are received)

TCP Segment



Field	Purpose
Source Port	Identifies originating application
Destination Port	Identifies destination application
Sequence Number	Sequence number of first octet in the segment
Acknowledgment #	Sequence number of the next expected octet (if ACK flag set)
Len	Length of TCP header in 4 octet units
Flags	TCP flags: SYN, FIN, RST, PSH, ACK, URG
Window	Number of octets from ACK that sender will accept
Checksum	Checksum of IP pseudo-header + TCP header + data
Urgent Pointer	Pointer to end of “urgent data”
Options	Special TCP options such as MSS and Window Scale

You just need to know port numbers, seq and ack are added

TCP : Data transfer