Introduction to Internet

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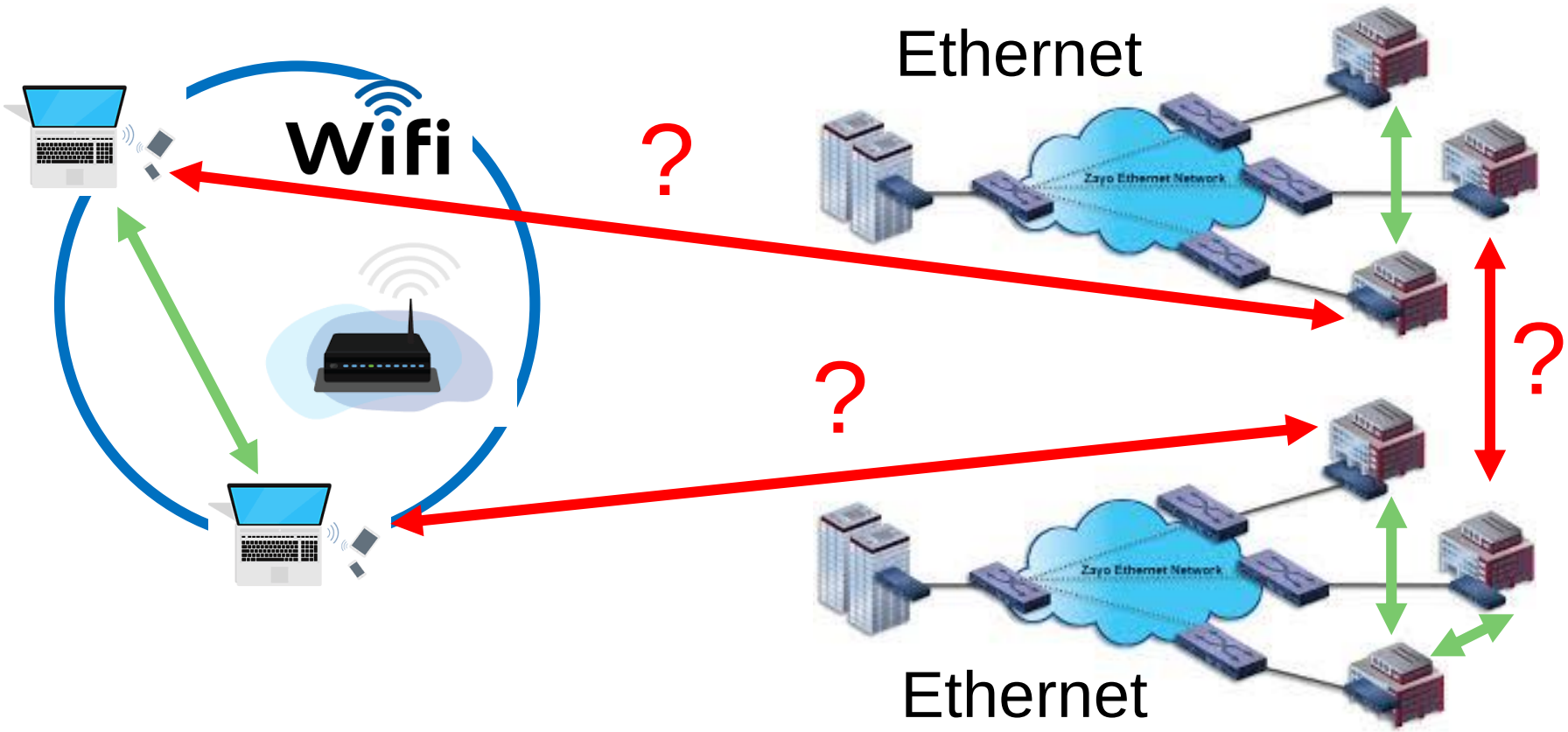
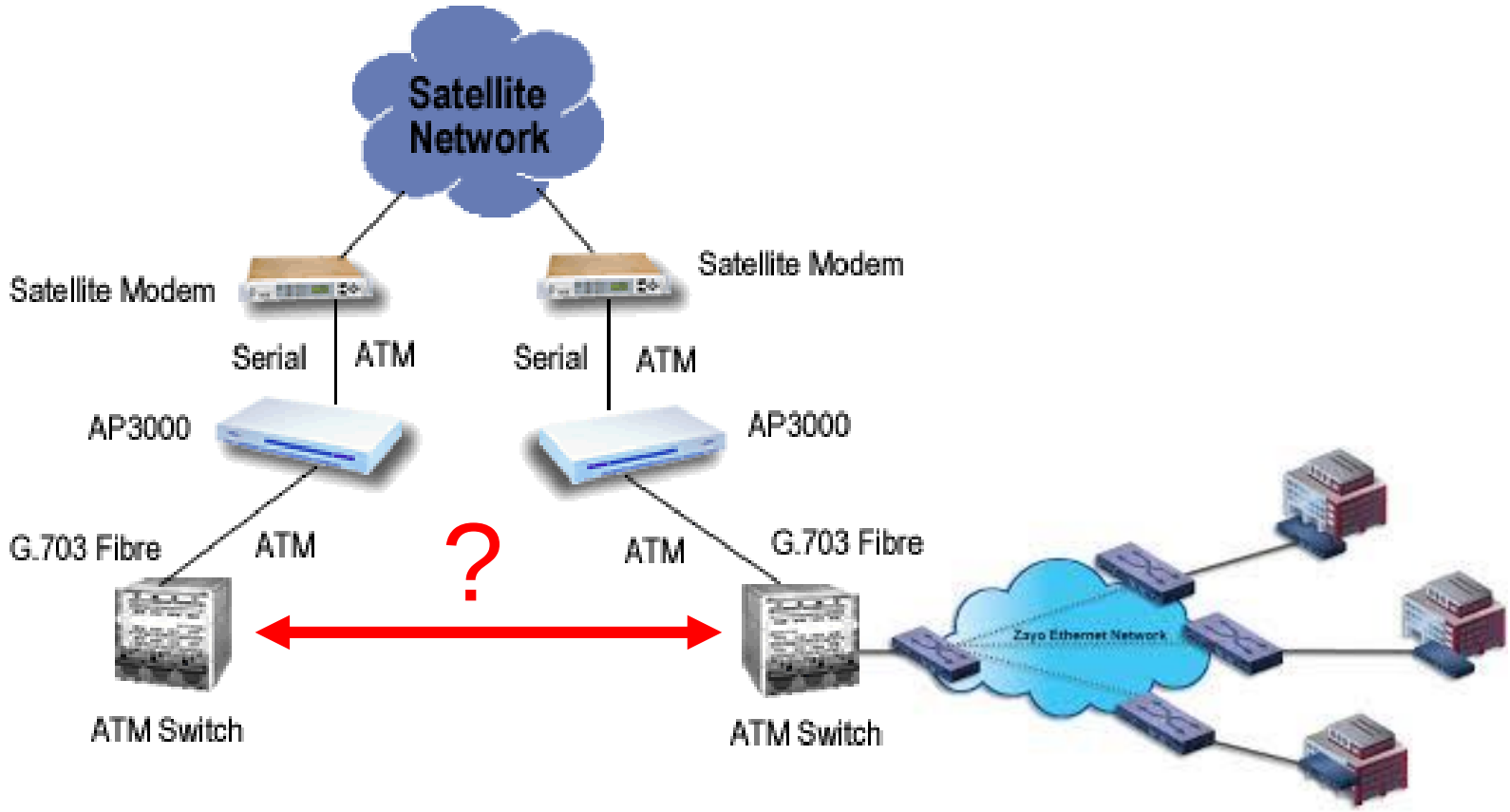
What about inter-networks communications ? Between LANs …

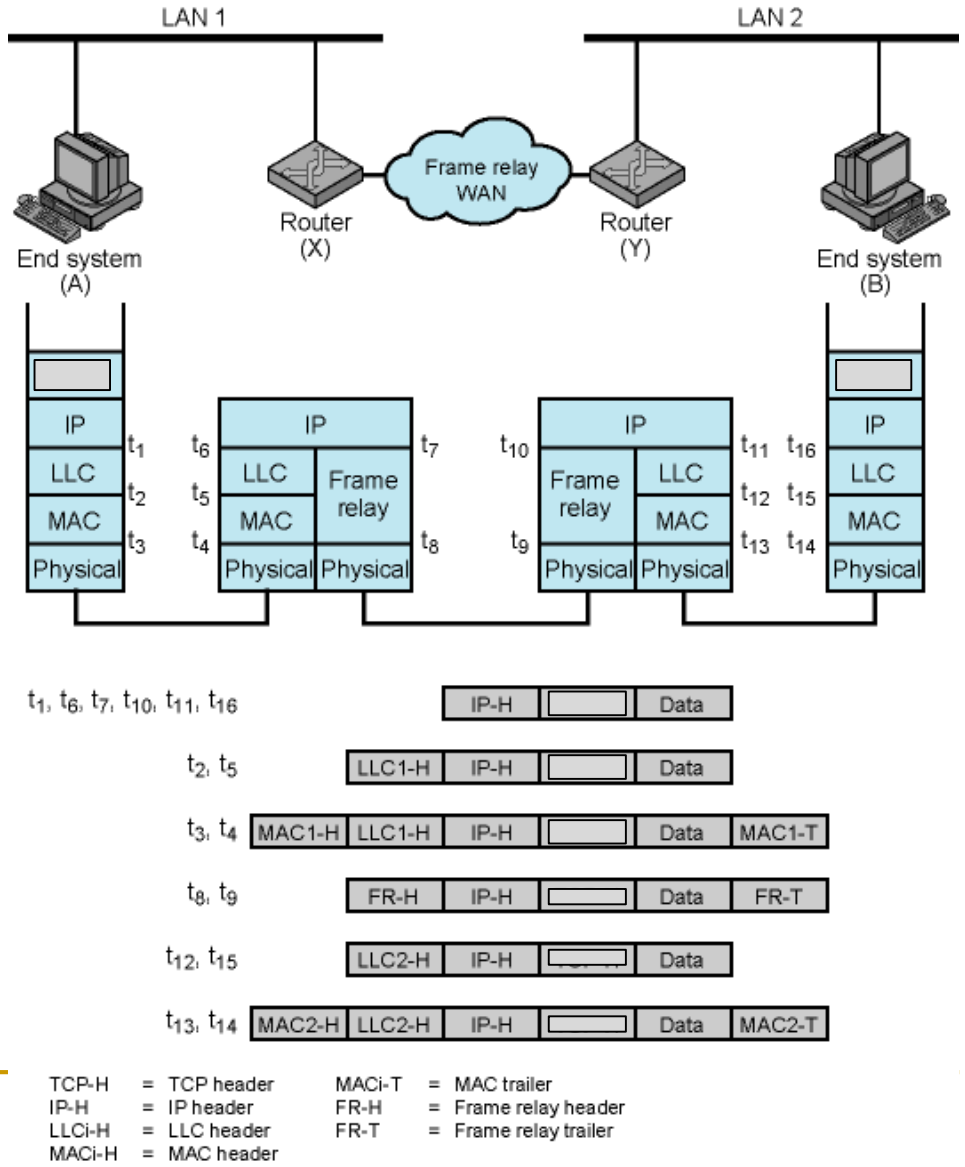


What about inter-networks communications ? Between WANs …

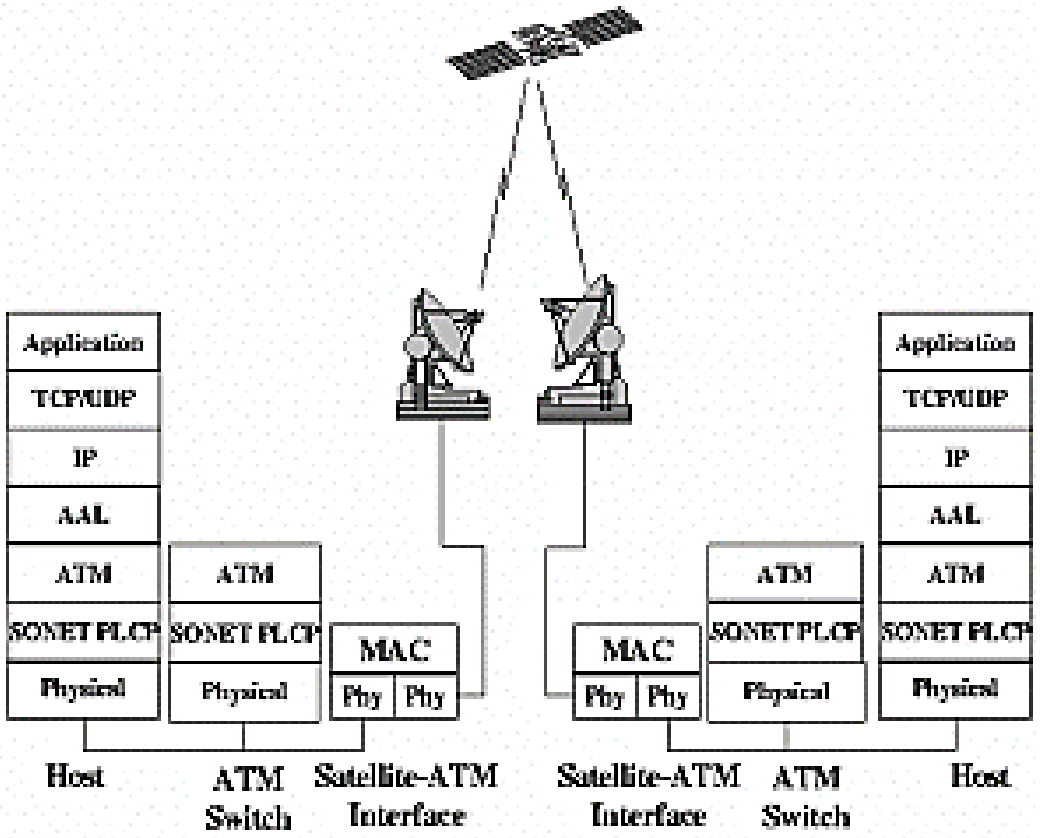


Internet Protocol Operation

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

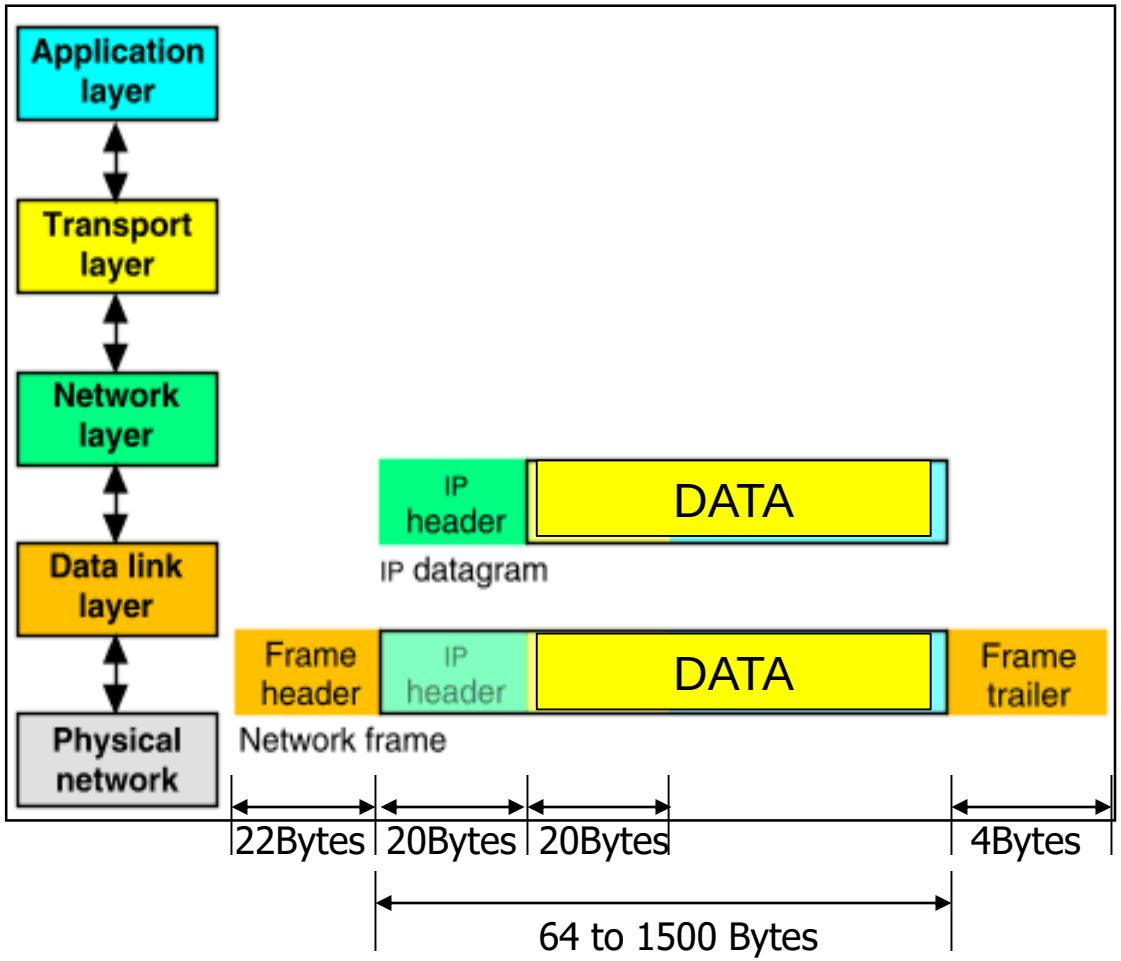


Example : TCP over Satellite-ATM Protocol Stack

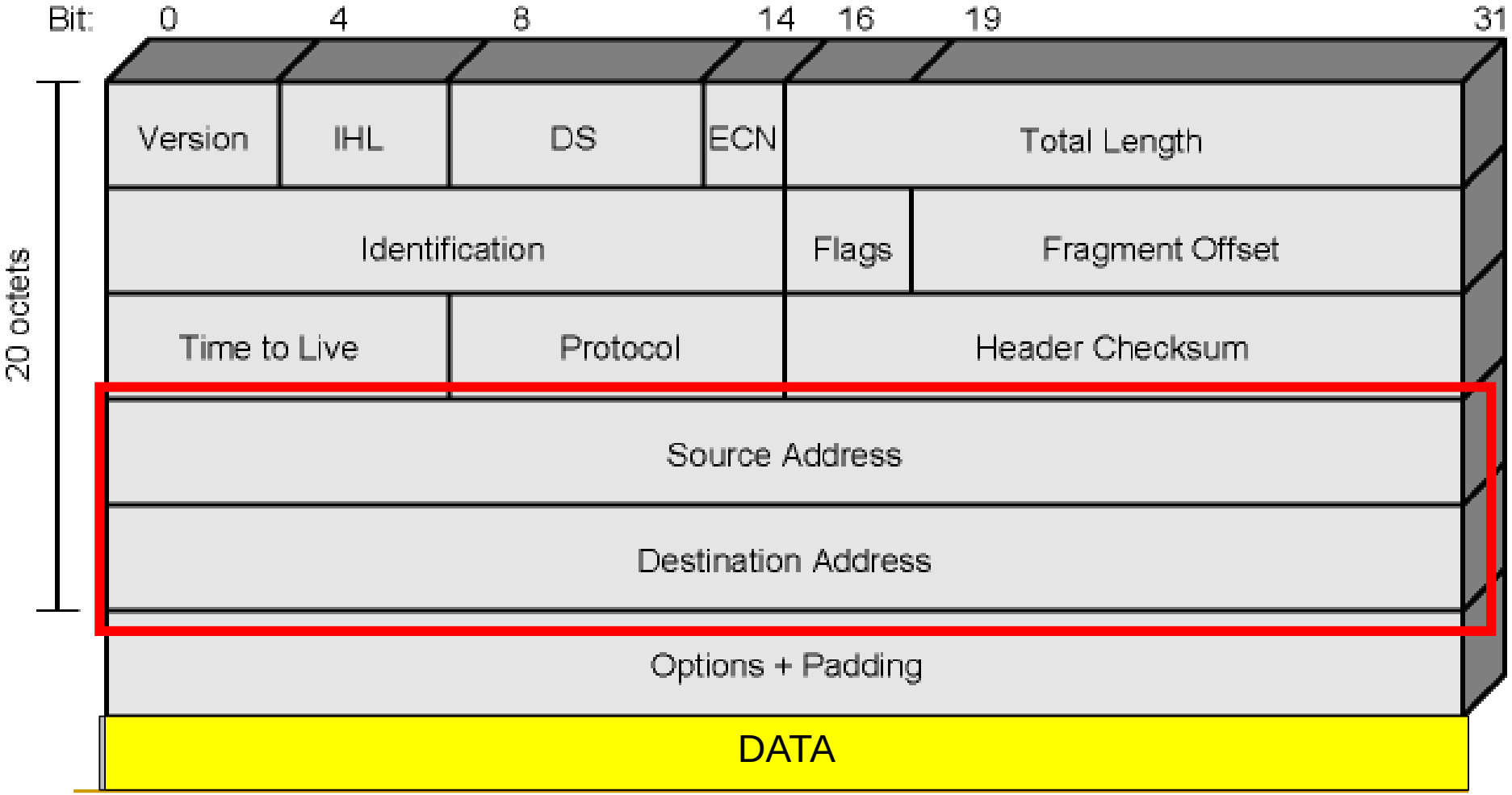


Packet Encapsulation in OSI/ISO model

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



IPv4 Header


Bit:
0
4
8
14
16
19
31
Version
IHL
DS
ECN
Total Length
Identification
Flags
Fragment Offset
Time to Live
Protocol
Header Checksum
Source Address
Destination Address
Options + Padding
DATA
20 octets

Header Fields (1)

- Version
  - Currently 4
  - IP v6 - see later
- Internet header length
  - Unit is 32 bit words
  - Including options
  - minimum 5 (means 20 octets)
- DS (Differentiated Services) and ECN (Explicit Congestion Notification)
  - previously used for “Type of Service”
  - now used by (interpreted as) DS and ECN
  - DS is for QoS support (that we will not cover)
  - we will see the concept of Explicit Congestion Notification later

Header Fields (2)

- Total length
  - of datagram (header + data), in octets
- Identification
  - Sequence number
  - Used with addresses and user protocol to identify datagram uniquely
- Flags
  - More bit
  - Don’t fragment
- Fragmentation offset
- Time to live
- Protocol
  - Next higher layer to receive data field at destination

Header Fields (3)

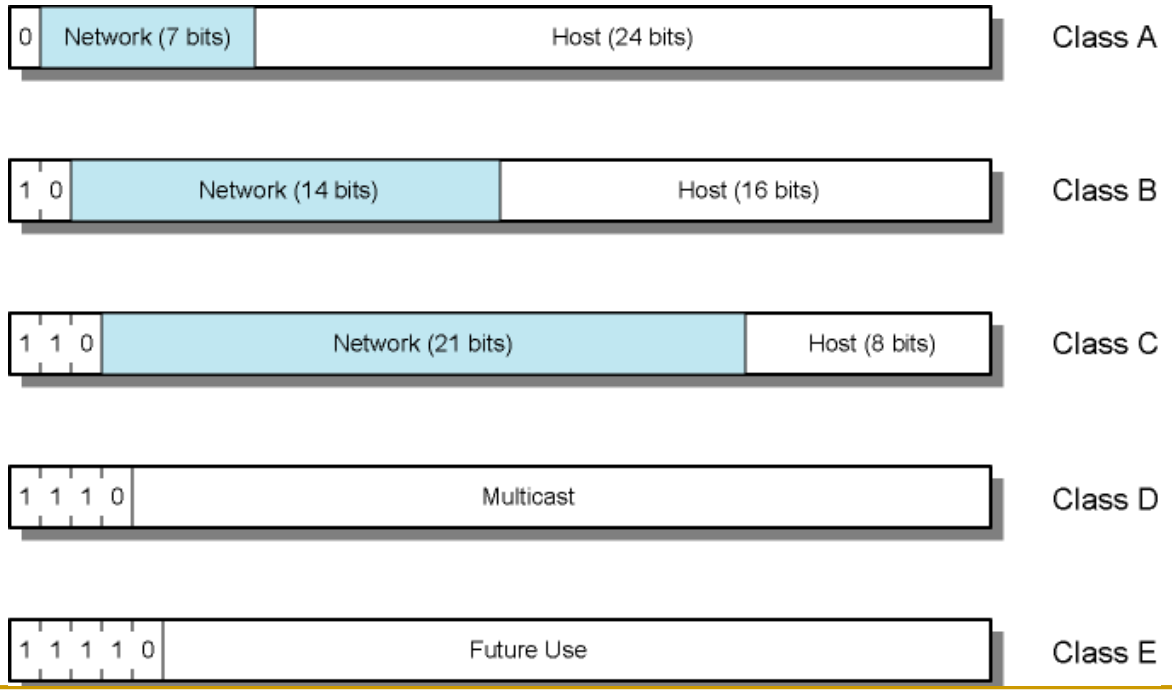
- Header checksum
  - Verified and recomputed at each router
- Source address
- Destination address
- Options
- Padding
  - To fill to multiple of 32 bits long

Data Field

- User (upper layer) data
- any octet length is OK
  - But max length of IP datagram (header plus data) is 65,535 octets

IPv4 Address Formats

- 32 bit global Internet address
- Network part and host part
- **All-zero host part identifies the network**
- **All-one host part means broadcast (limited to current network)**



IP Addresses - Class A

- Start with binary 0
- 7-bit network - 24-bit host
- All zero
  - Special meaning (means “this computer”)
- 01111111 (127) (network part) reserved for loopback
  - Generally 127.0.0.1 is used
- Range 1.x.x.x to 126.x.x.x
  - 10.x.x.x is for private networks
- Few networks - many hosts
- All networks have been allocated

IP Addresses - Class B

- Starts with binary 10
- Range 128.x.x.x to 191.x.x.x
  - Second octet is also part of the network id.
- 14-bit network, 16-bit host number
  - 2^{14} = 16,384 class B addresses
  - 2^{16} = 65,536 hosts per network
    - Actually minus 2 due to network and broadcast addresses
- All networks have been allocated

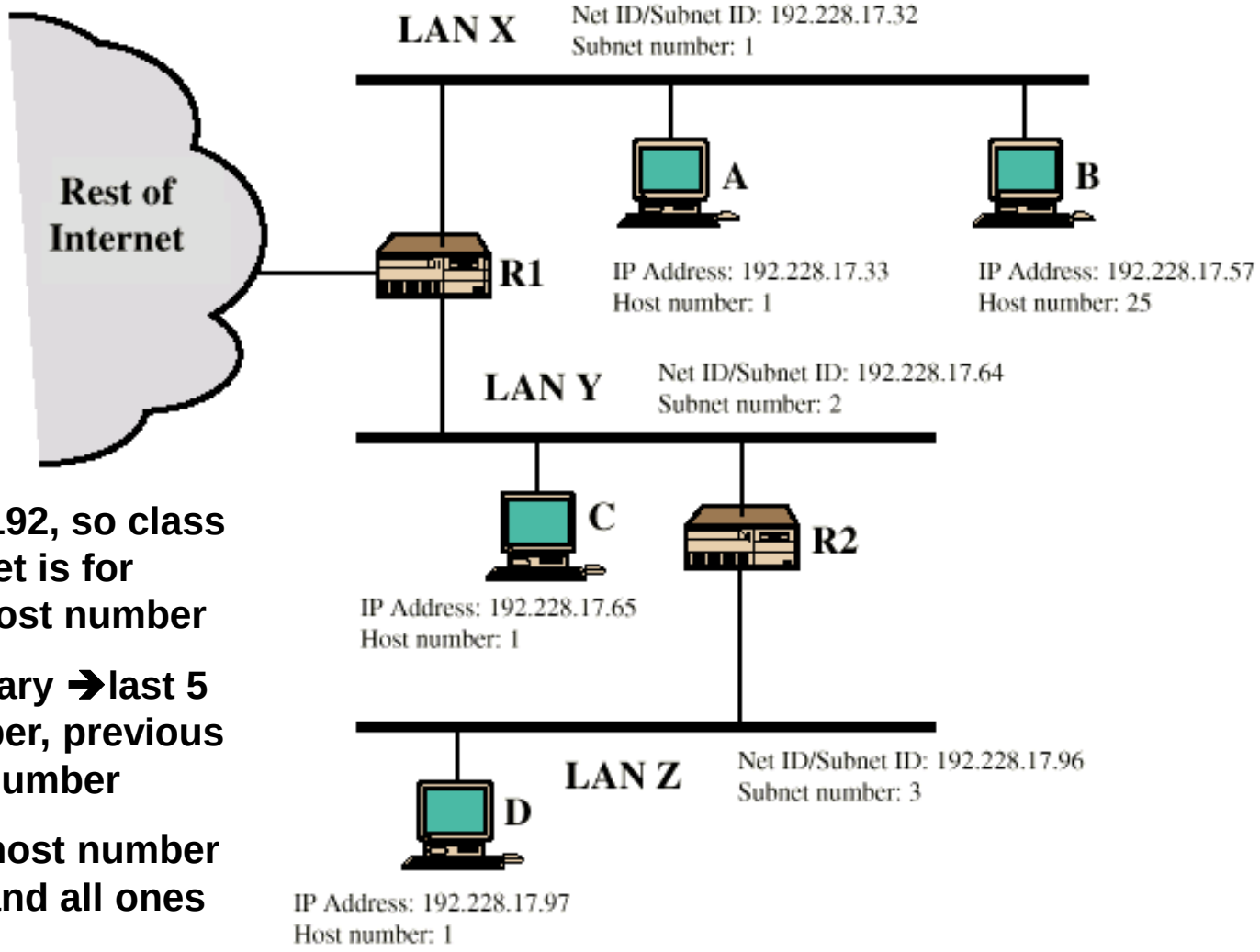
IP Addresses - Class C

- Start binary 110
- Range 192.x.x.x to 223.x.x.x
- Second and third octets are also part of network address
- 2^{21} = 2,097,152 addresses (networks)
- 256 – 2 = 254 hosts per network
- Nearly all allocated

Some Special IP address forms

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)

Routing Using Subnets (Example)



Subnet Mask:
255.255.255.224

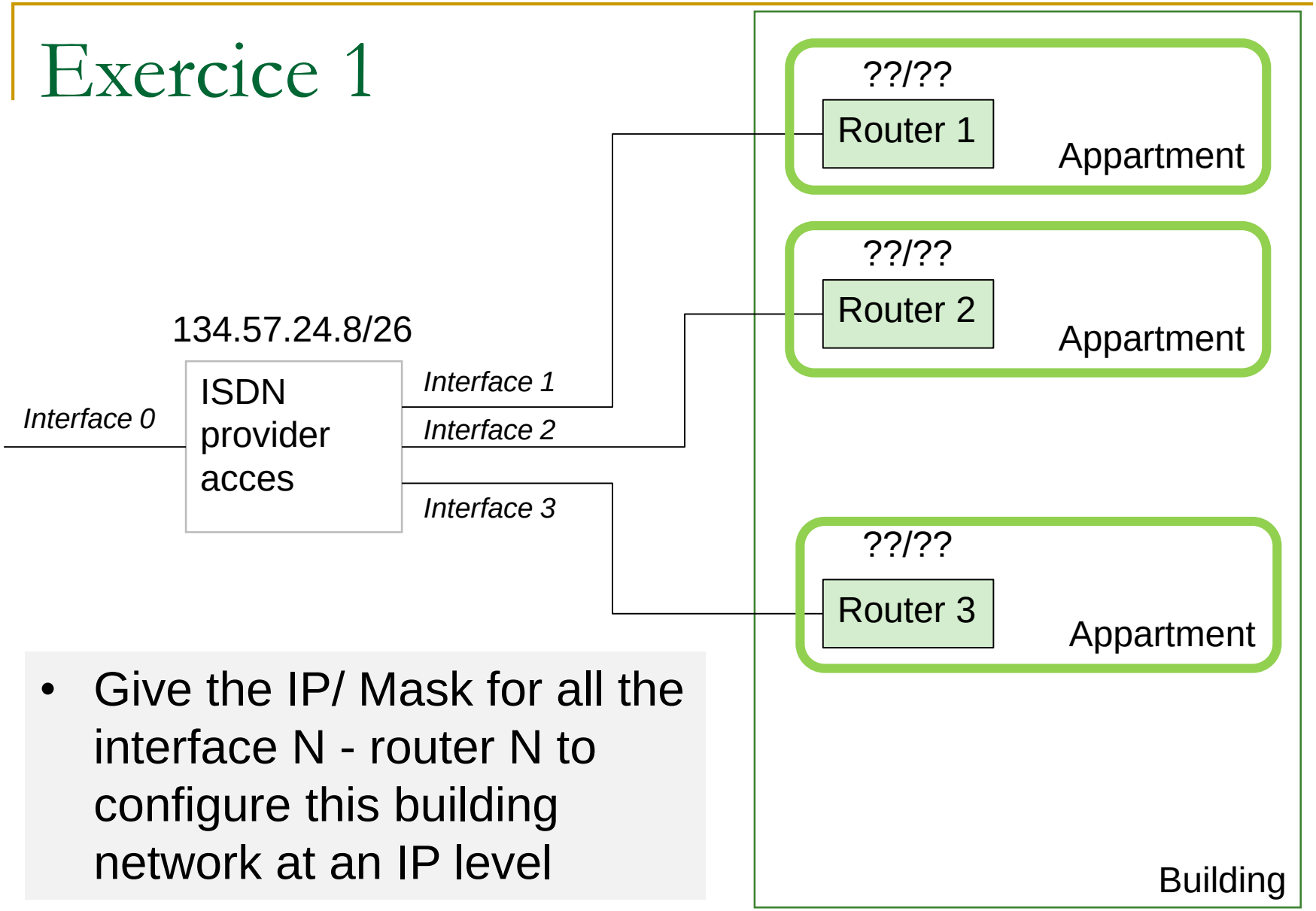
Addresses start with 192, so class C addresses. Last octet is for Subnet number and Host number

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

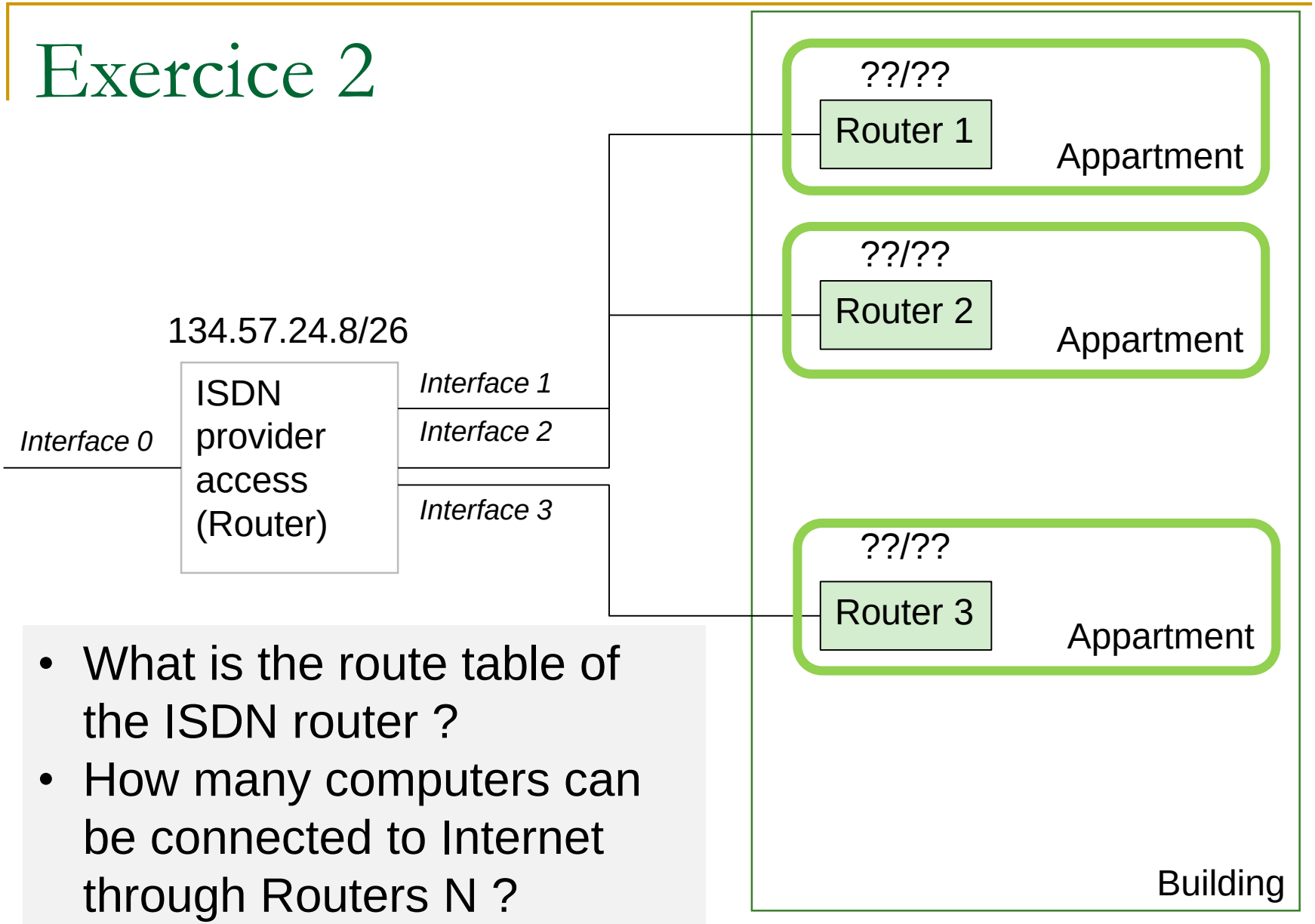
Addr Source	Addr Dest	DATA

Exercice 1



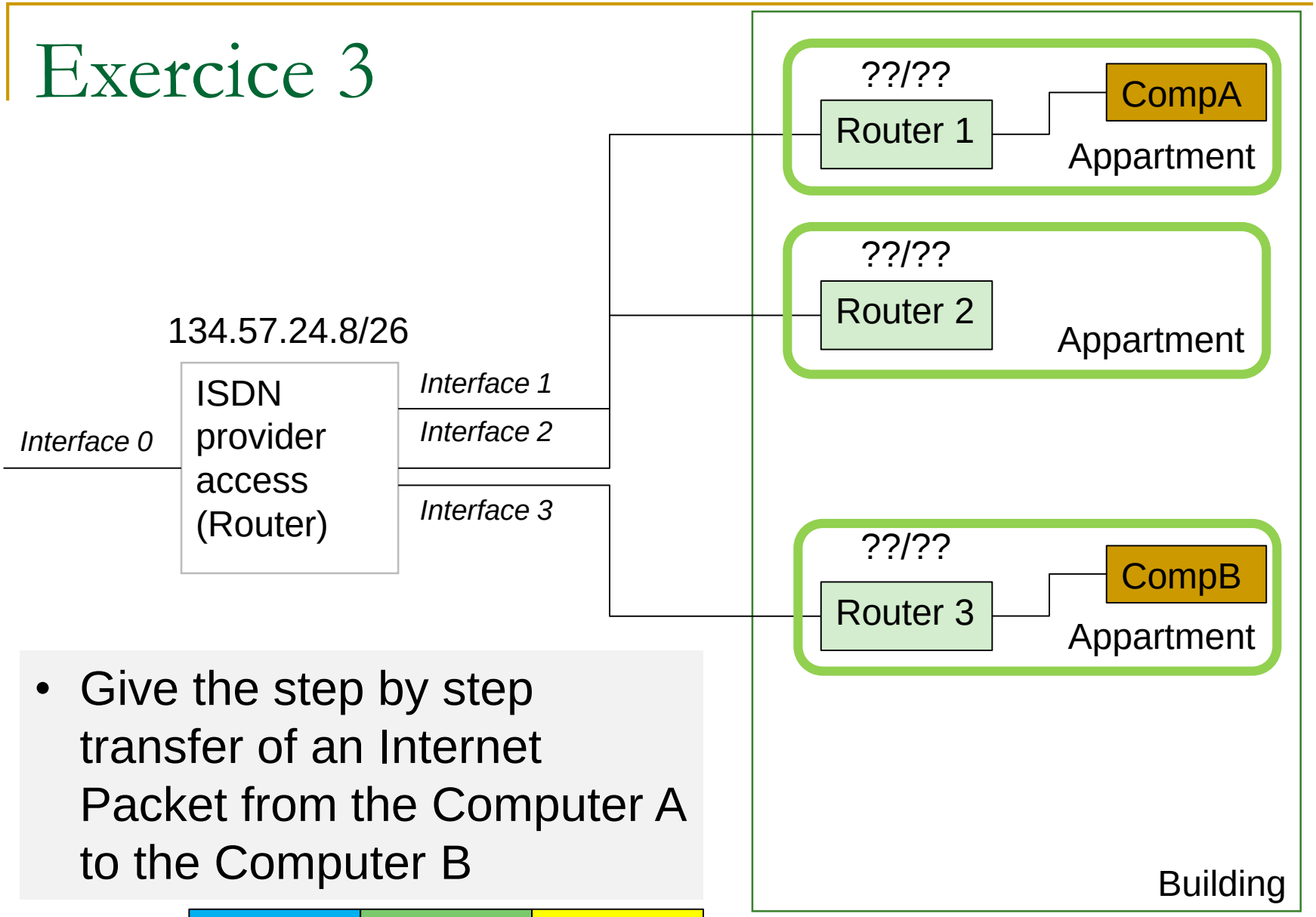
- Give the IP/ Mask for all the interface N - router N to configure this building network at an IP level

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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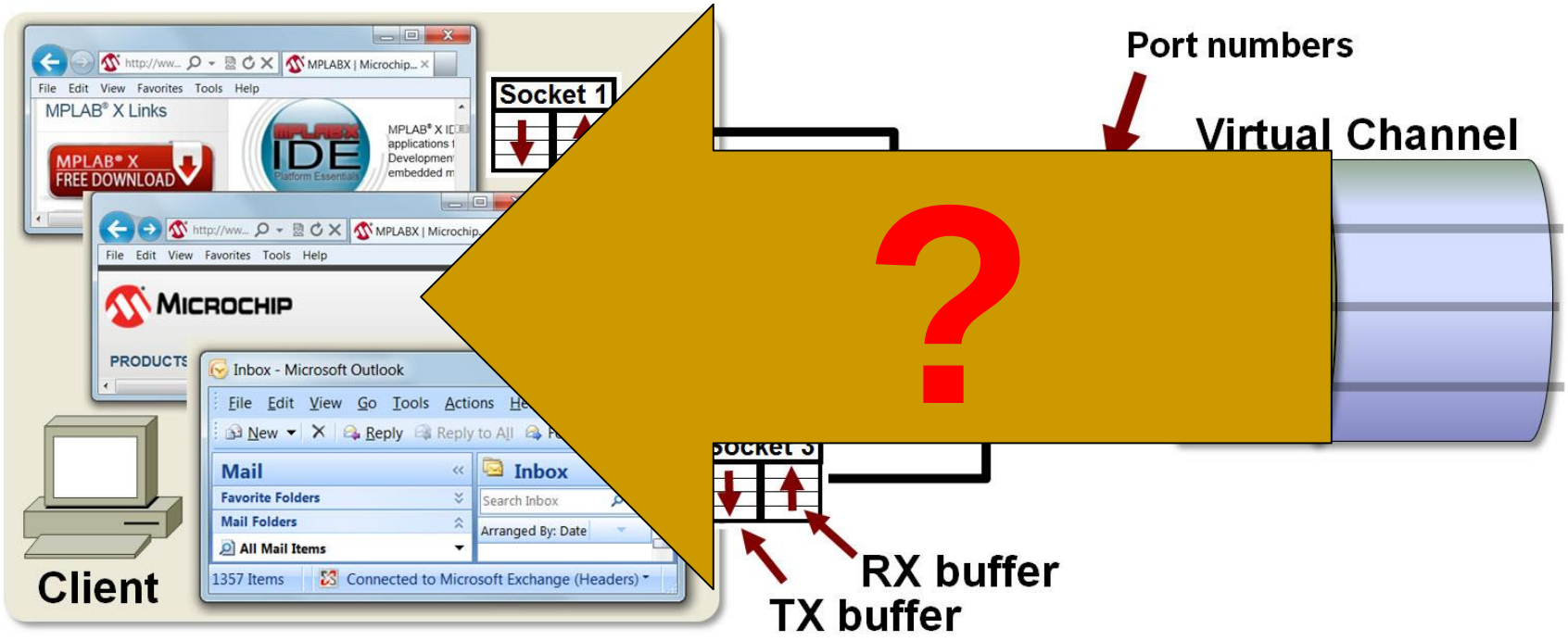
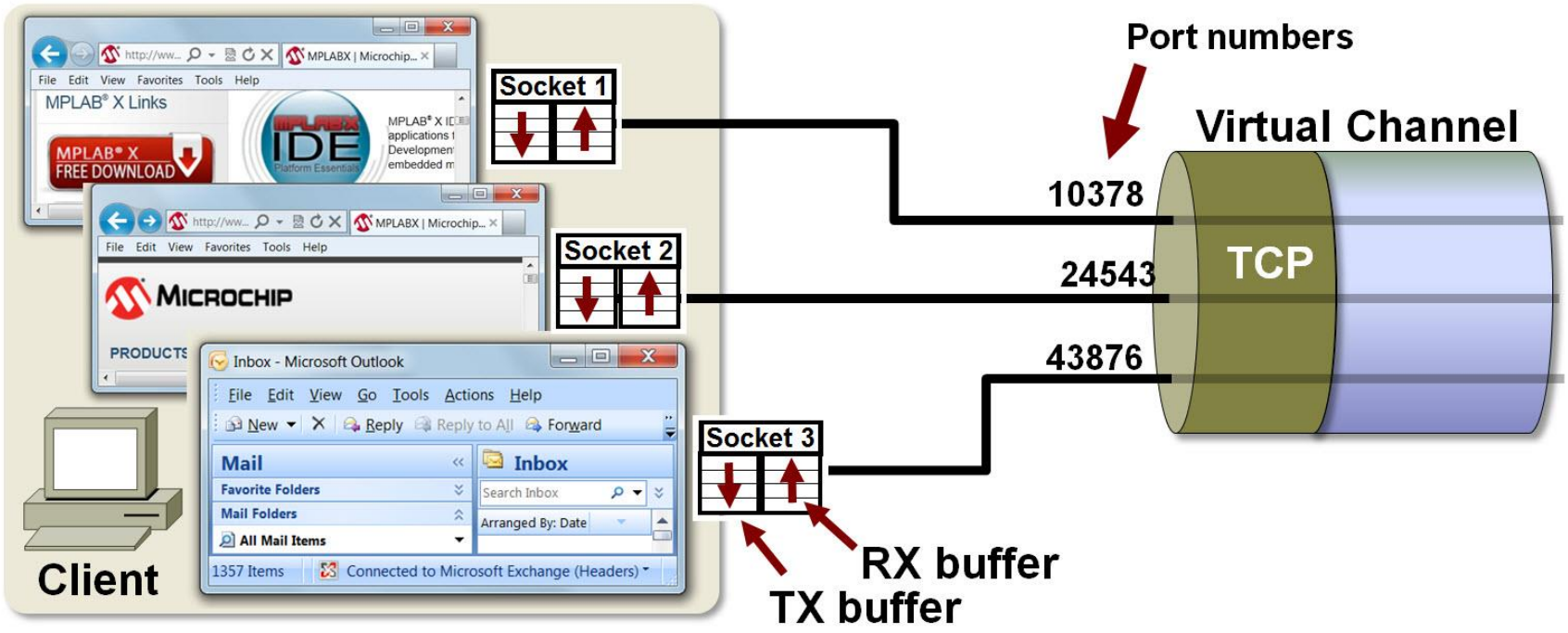
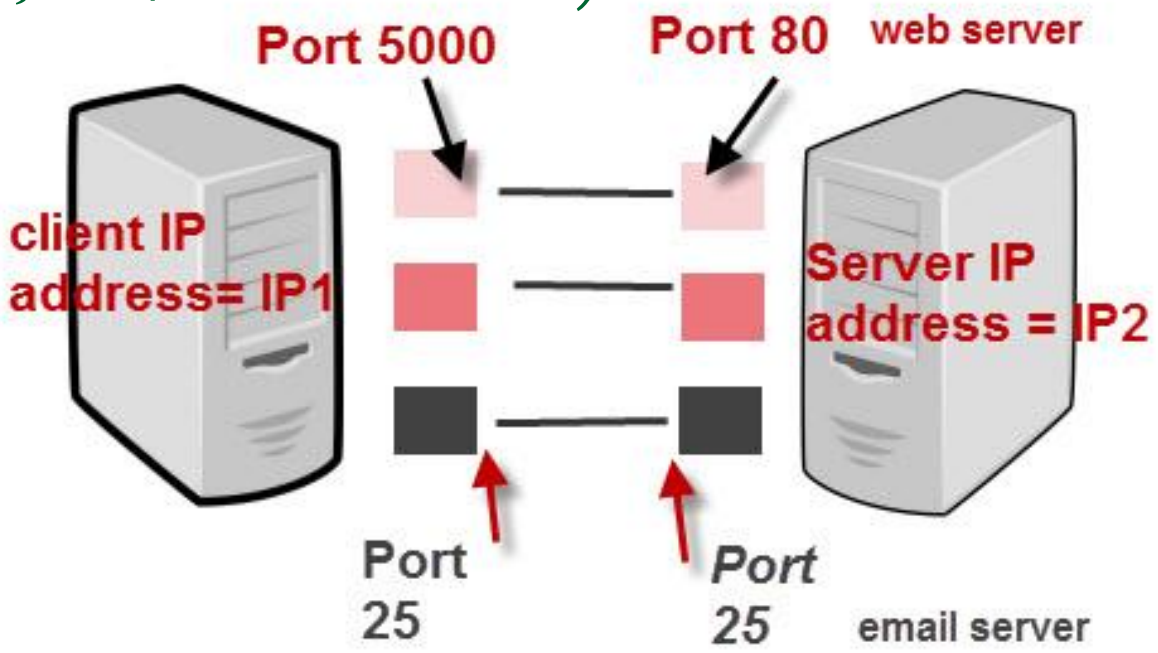
How multiple programs can communicate over internet ?



Adding Port number to IP Address



Commmunication Channels are (IP/Port Src, IP/Port Dest)



IP Address + Port number = Socket

TCP/IP Ports And Sockets