

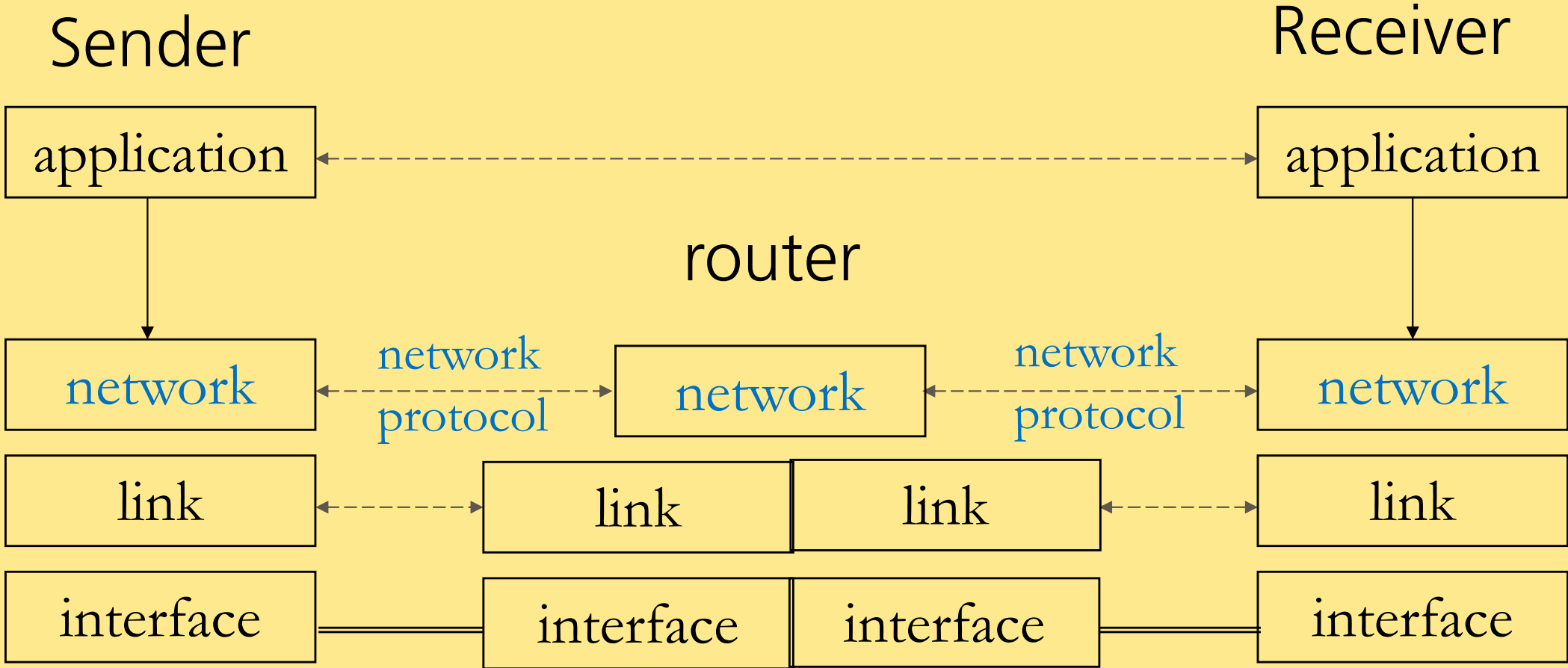
ETSF15: Lecture 6

- Transport protocols
- DHCP, DNS, ICMP
- Encapsulation
- Real Internets

Jens A Andersson



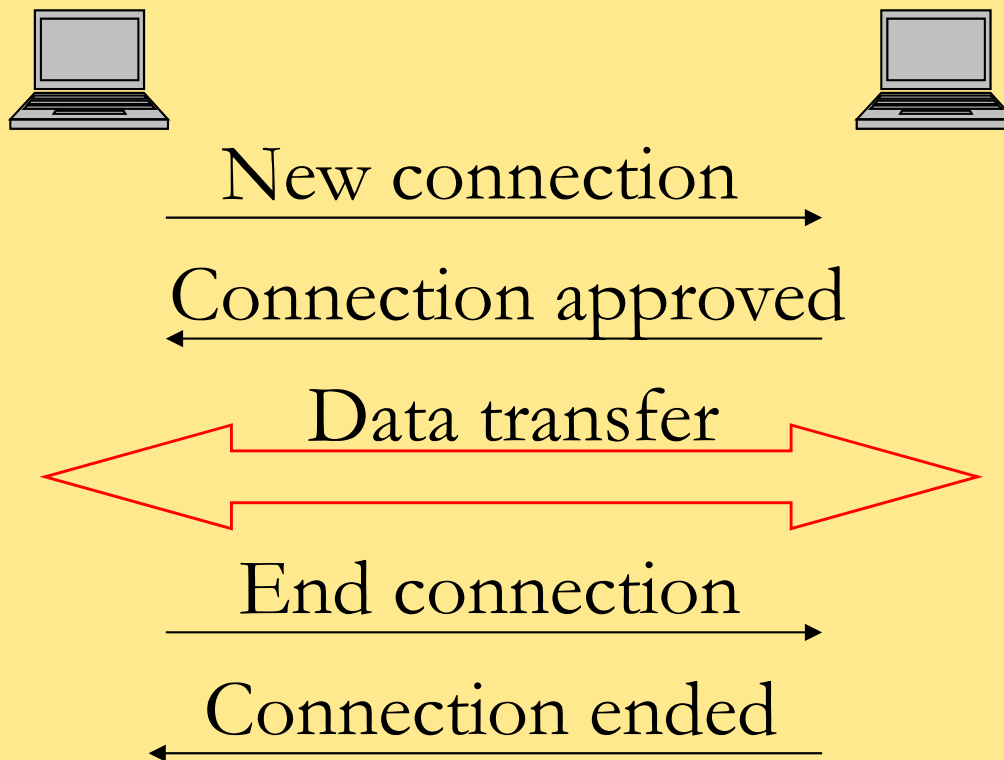
Network Protocol



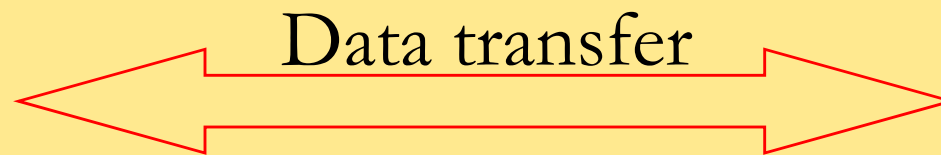
One Network Protocol: IP

- IP = Internet Protocol
- IP used on what is called Internet.
- IP defines IP addresses.
- Data transferred in IP packets/datagrams.
- Connection Free datatransfer.
- No error detection or control.
- This is called "best-effort".

Connection Oriented data transfer



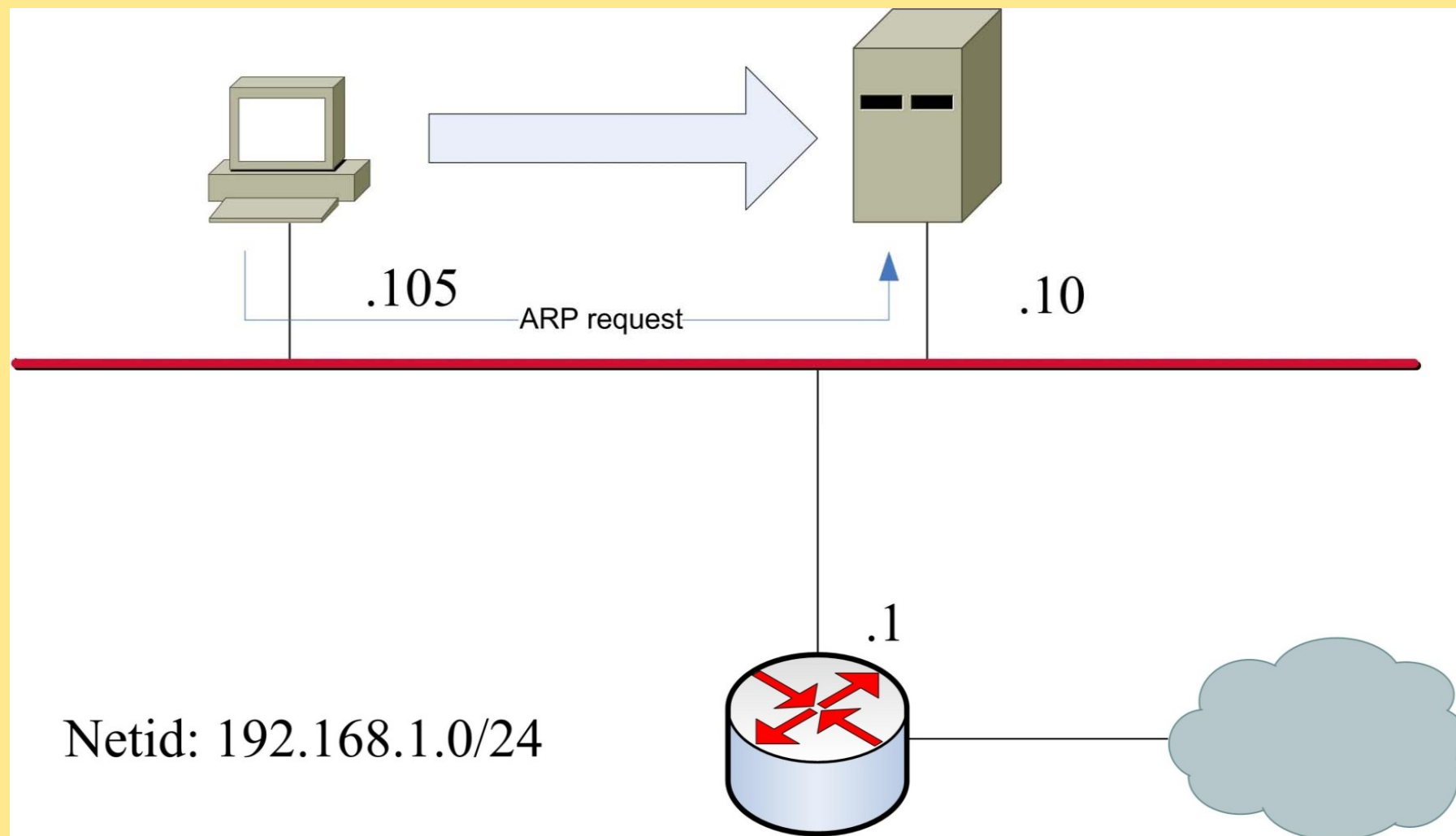
Connection Free data transfer



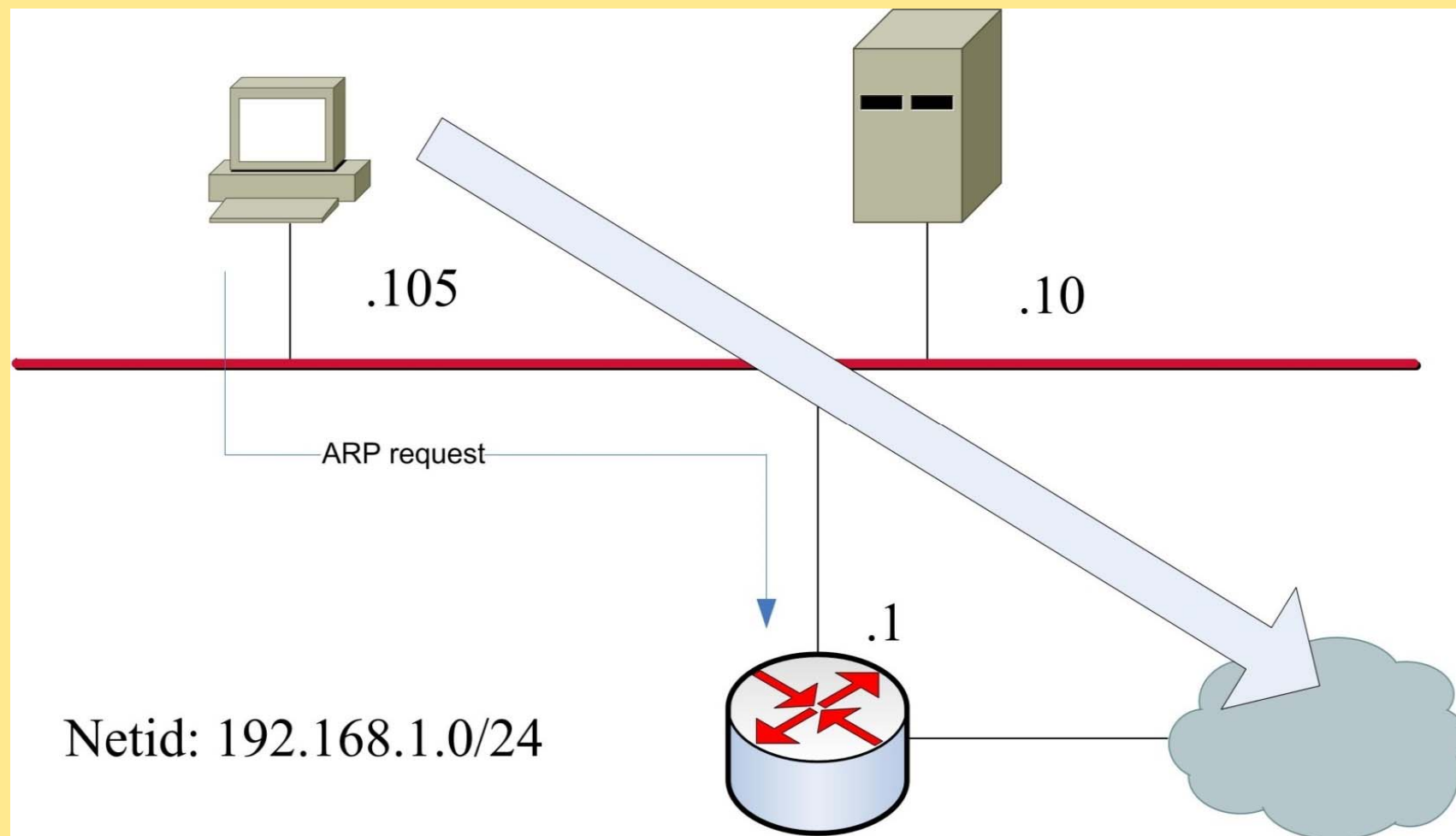
From IP address to MAC-address

- Hosts have to know MAC addresses to be able to communicate on one LAN
- Find out the MAC/IP address mapping
 - IPv6 uses sub protocol of Neighbor Discovery Protocol (NDP)
 - IPv4 uses Address Resolution Protocol (ARP)

ARP (1)



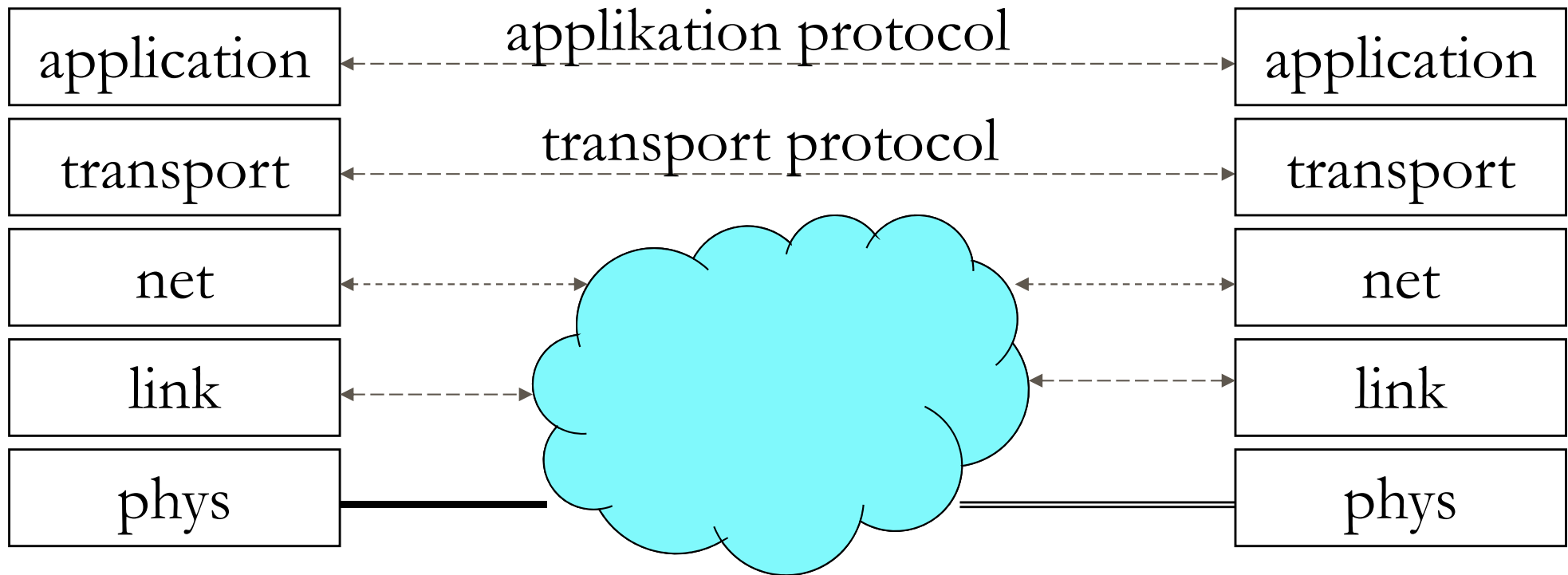
ARP (2)



Routing

- Routing = selection of best path to destination
 - ◆ Router generic name for a best path selector on layer 3
 - ◆ Some layer 2 protocols include some form of routing
- Adapt best path to dynamics in the network
- Based on Graph theory
 - ◆ E.g. Dijkstra Shortest Path First
- Switching/Forwarding = select output interface and next hop based on best path

Transport protocols



- TCP: Förbindelseorienterat
- UDP: Förbindelsefritt

Transport protocols

- End to end = Application to application
- Independent of underlying network structures

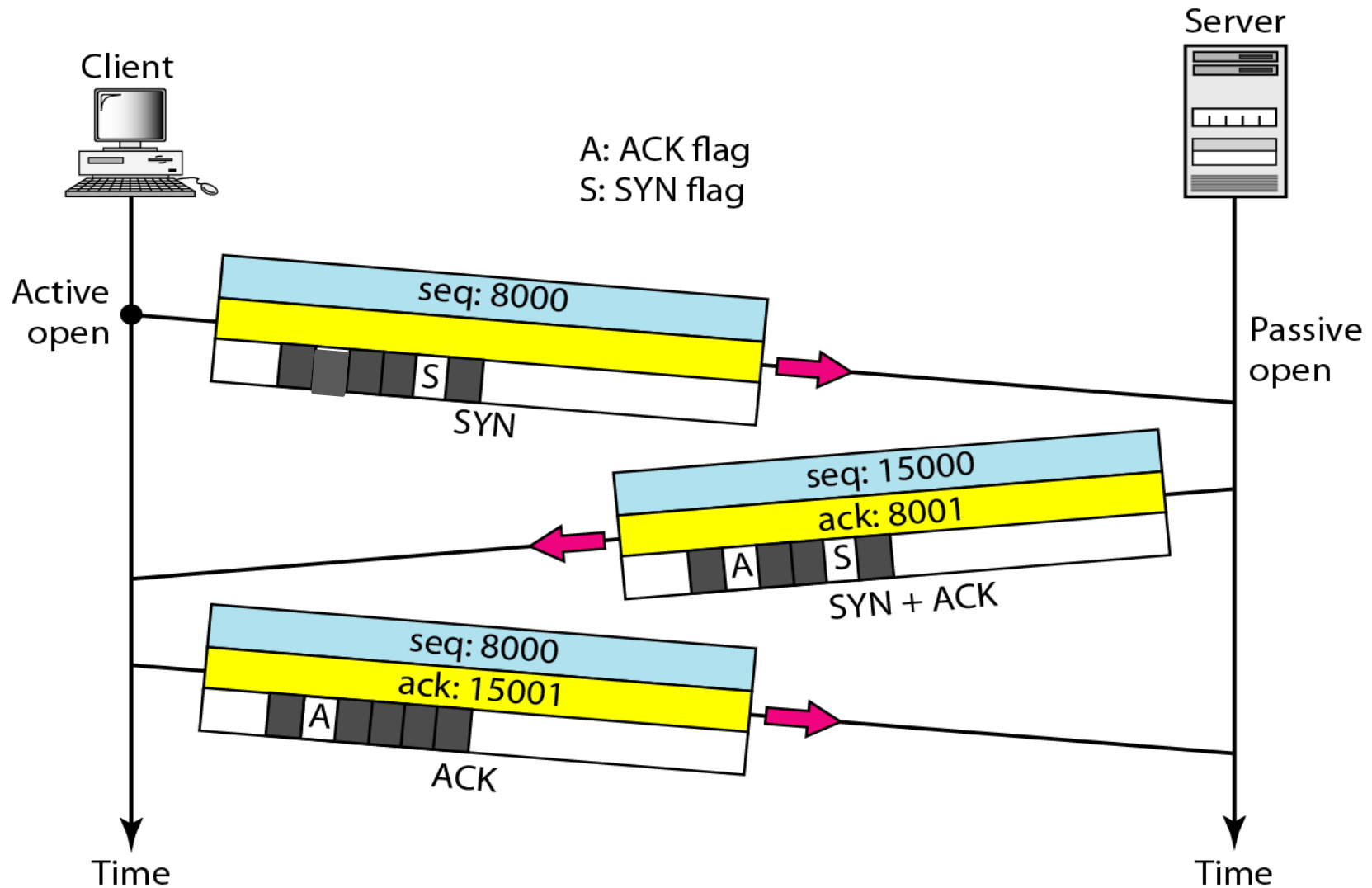
UDP

- UDP = User Datagram Protocol.
- Connection free.
- "best effort"
- Adds only multiplexing on top of IP.

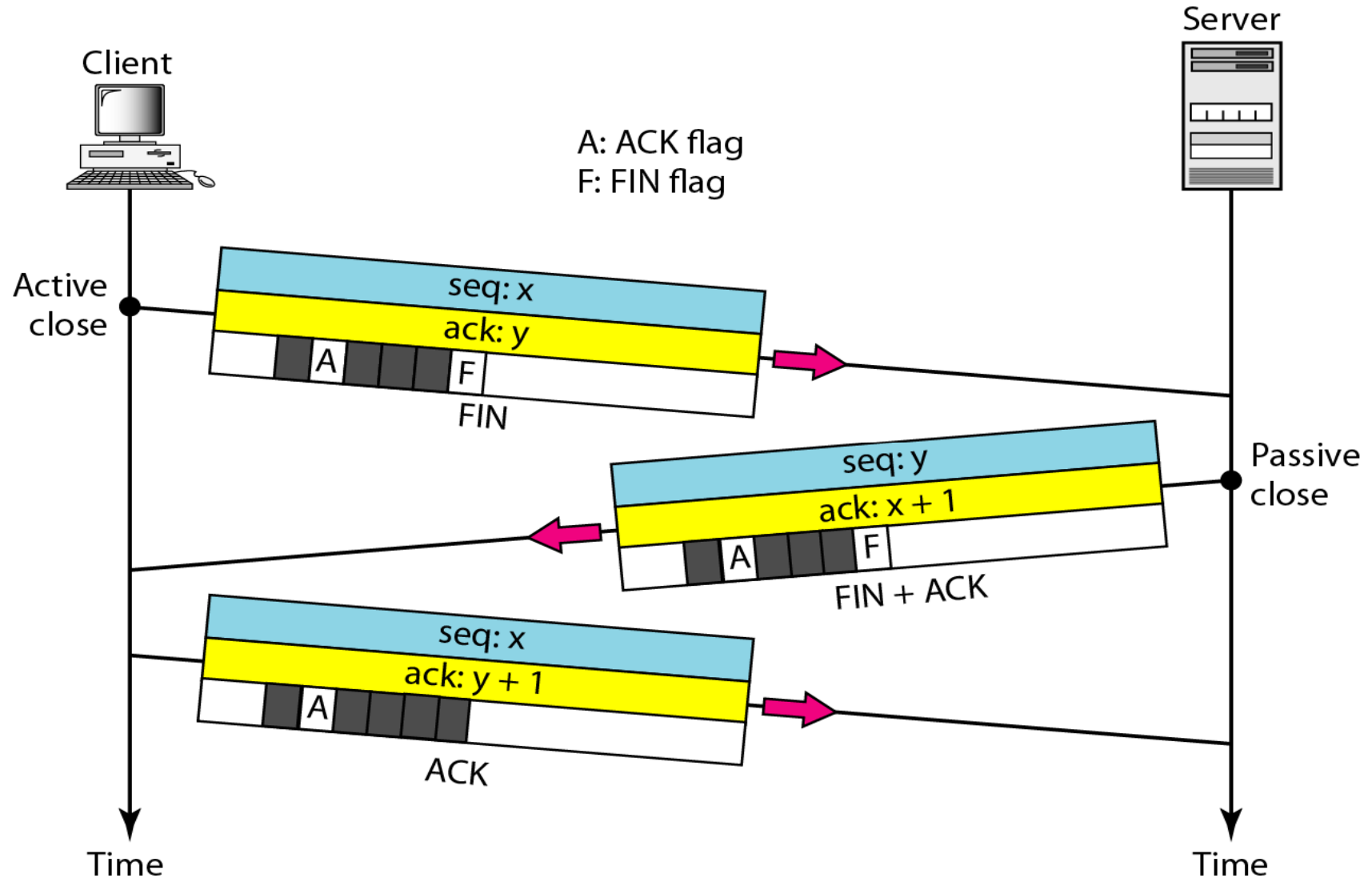
TCP

- TCP = Transport Control Protocol.
- Connection oriented.
- Reliable transfer.
 - ARQ = Go-Back-N
 - Flow control
 - Receiver control sender's window size
 - Congestion control
 - Requests for retransmission (= packet loss) indicates congestion
 - Controls sender's window size

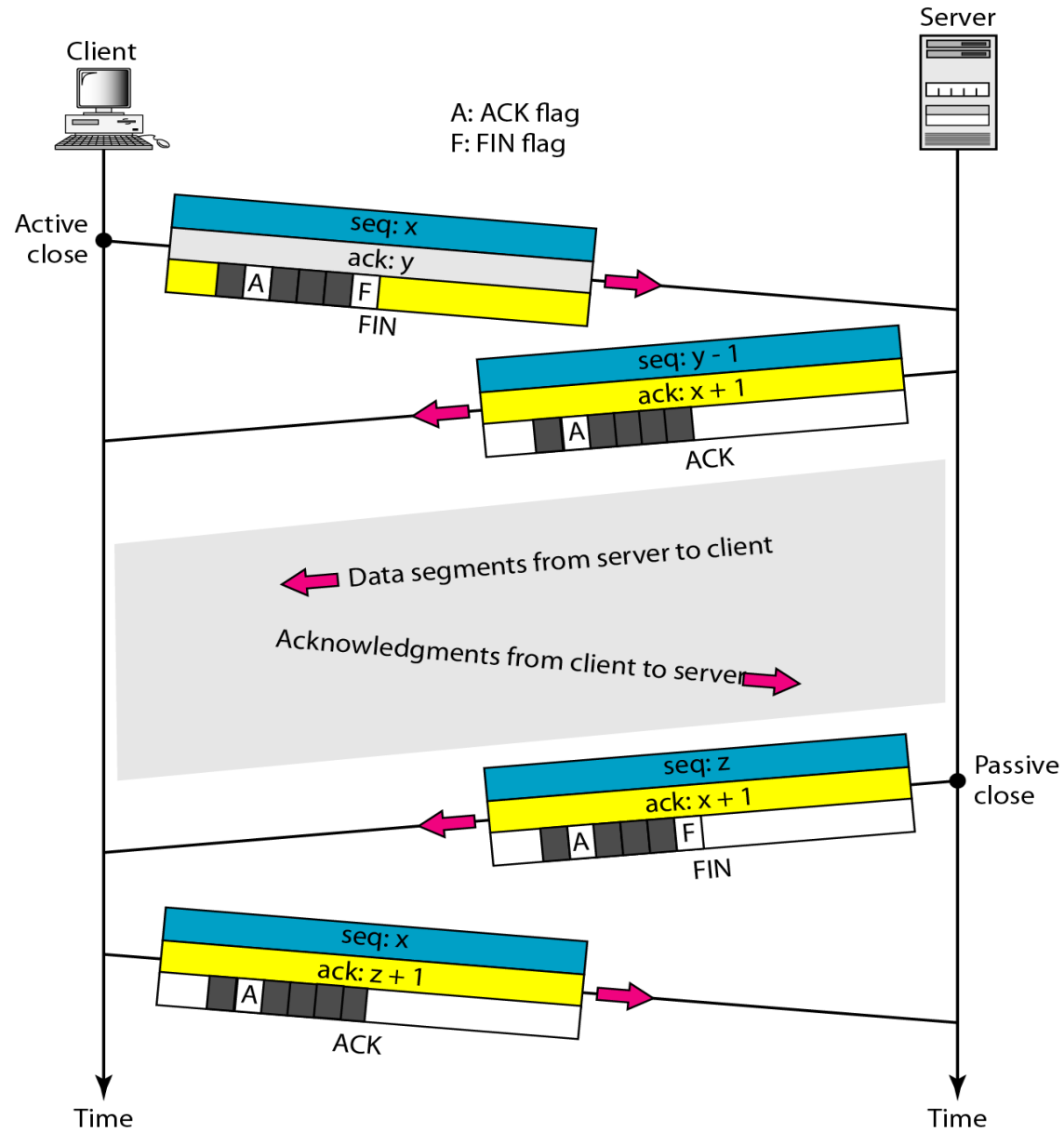
TCP Three Way Handshake



TCP Connection termination



TCP Half-close



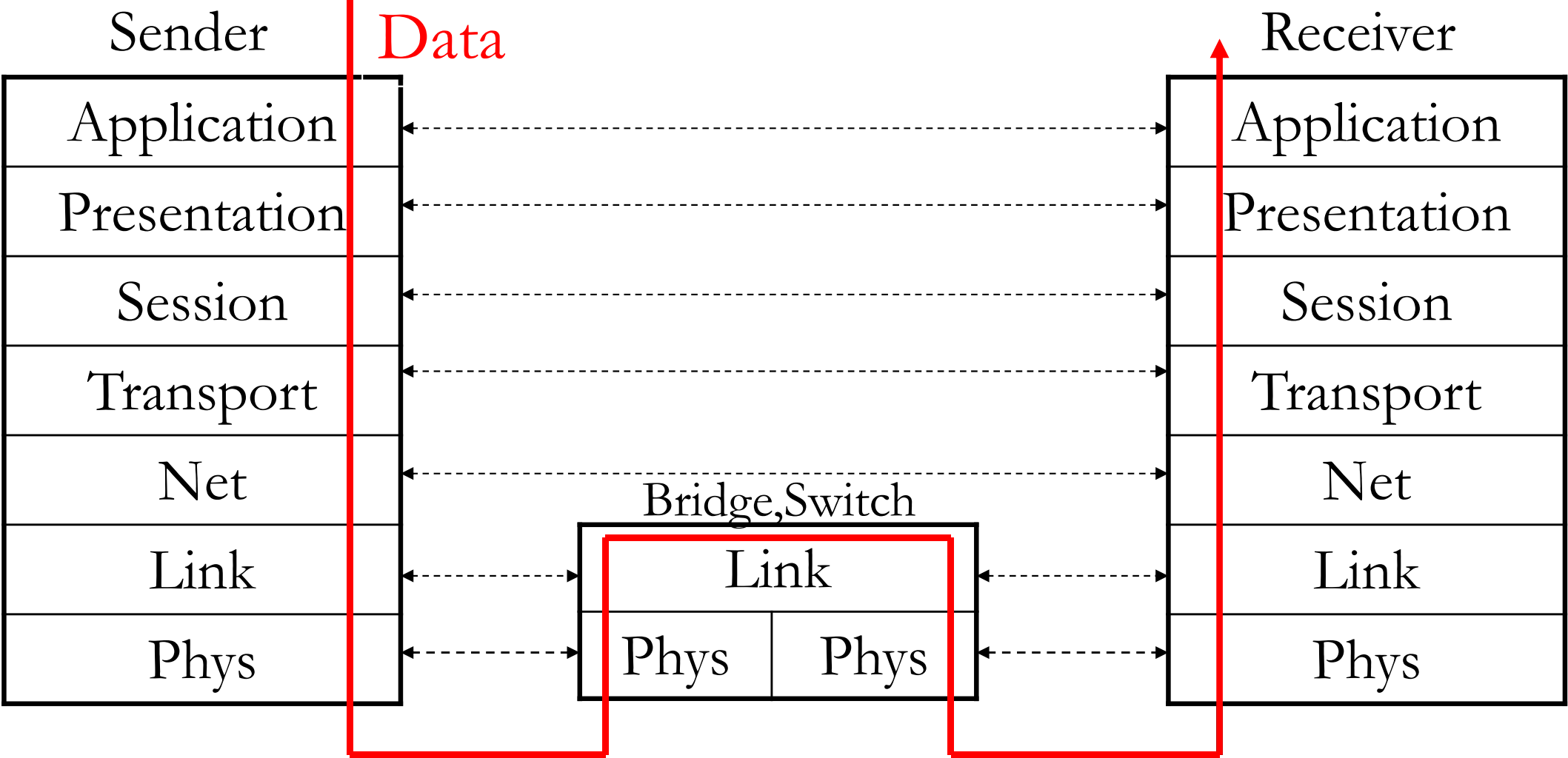
Addressis on transport layer

- Ports addresses application.
 - Source and destination
- Well defined destination ports:
 - 80 : http (web)
 - 25 : smtp (mail)
 - 22 : ssh
- Source randomly selected

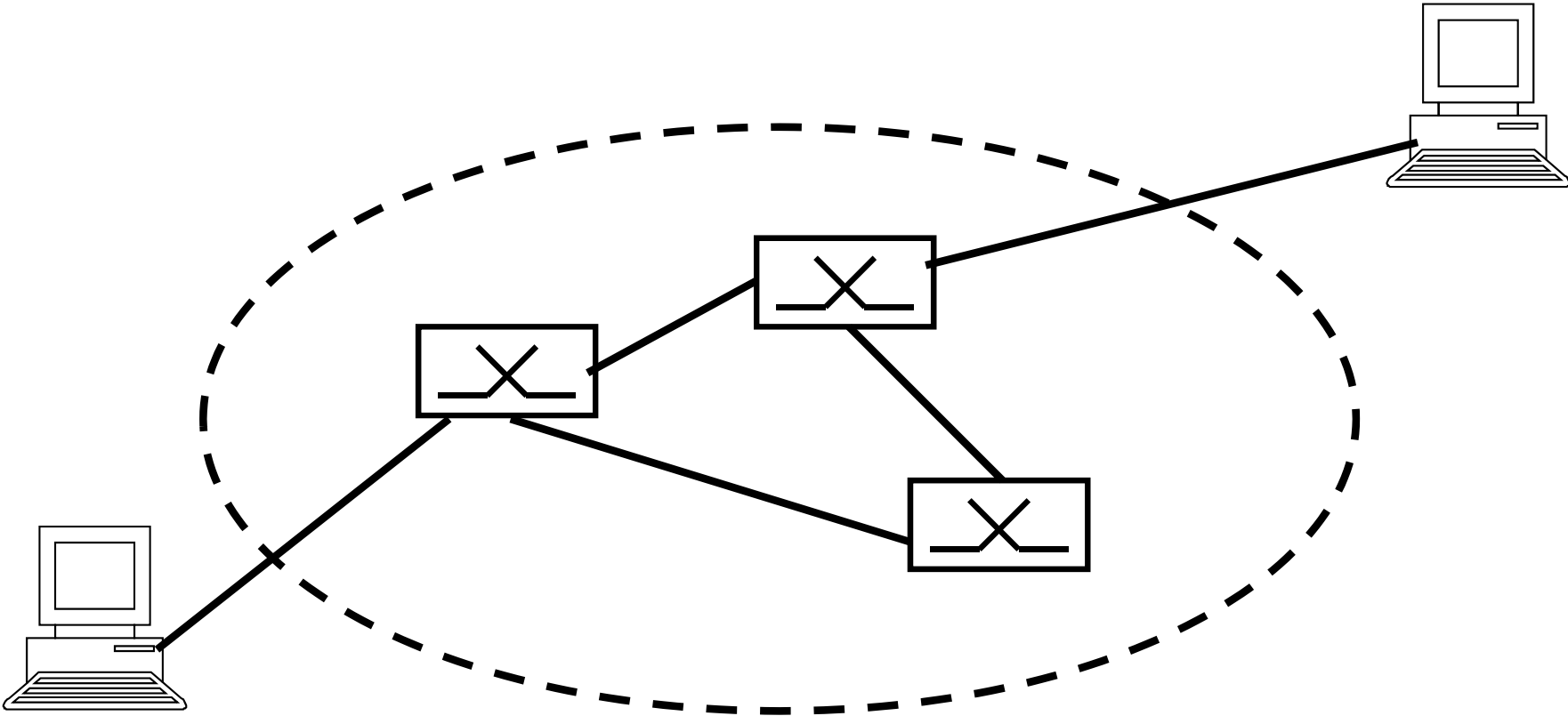
Two layered reference models

OSI model	TCP/IP model
Application	Application
Presentation	
Session	
Transport	Transport
Net	Net
Link	IP carrying nets
Physical	

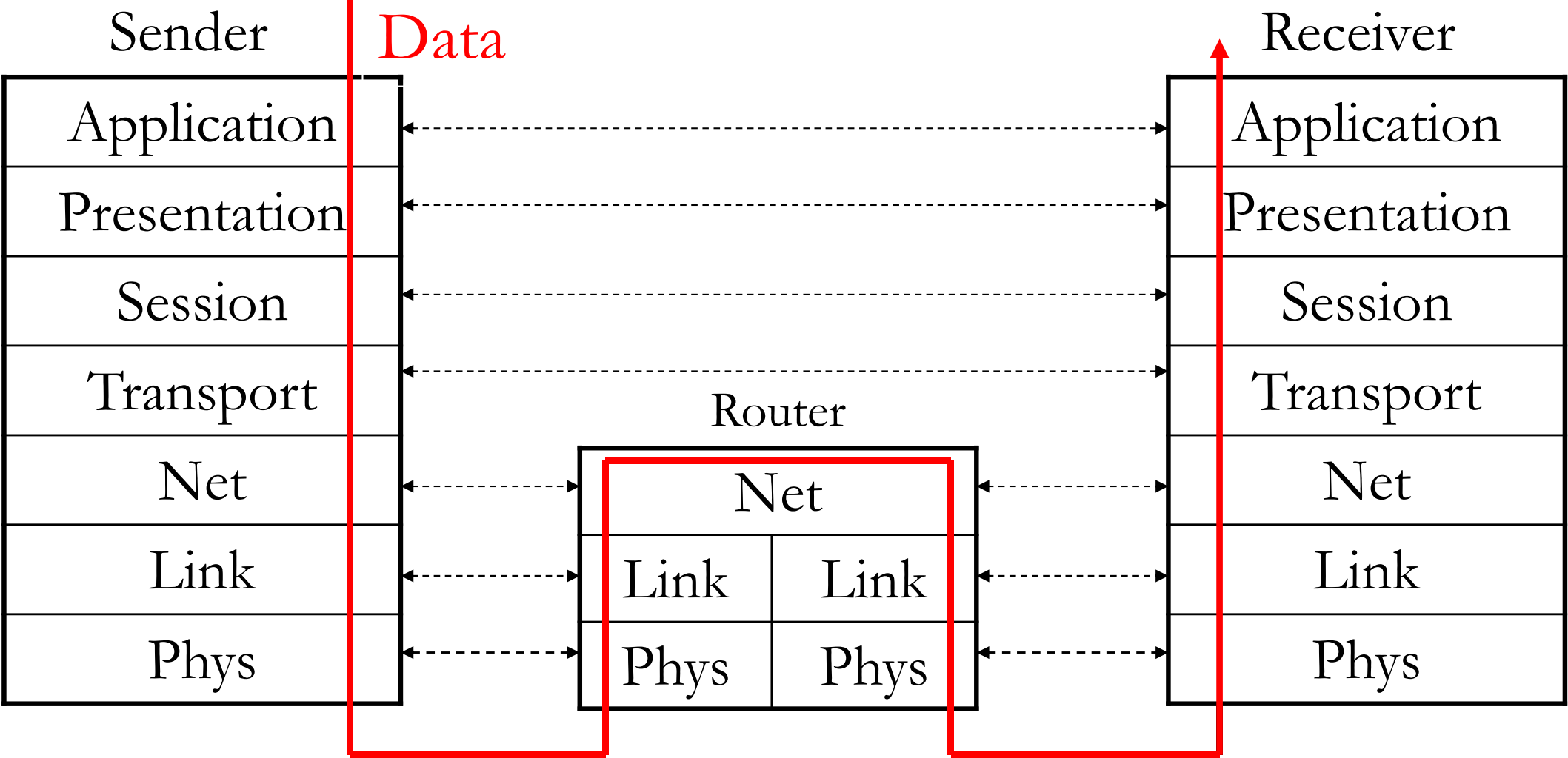
OSI model Protocol Stack (1)



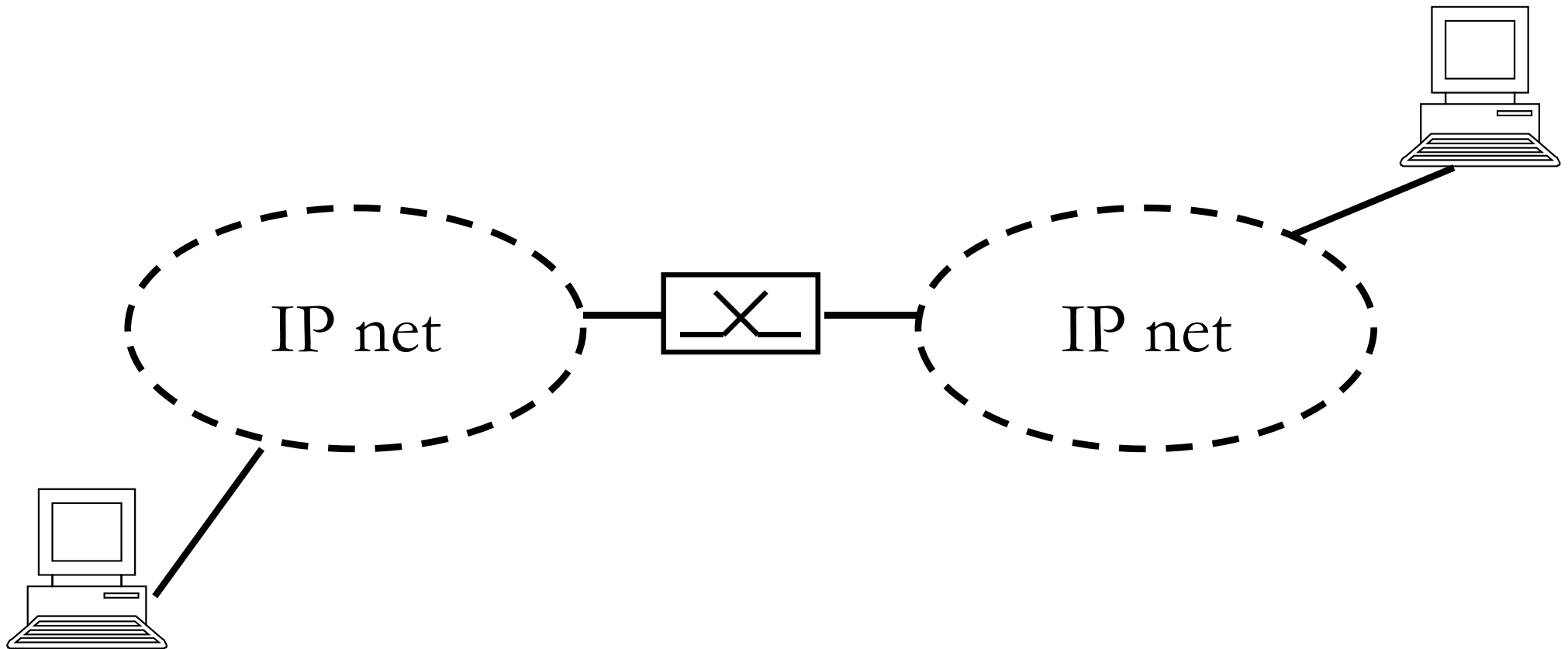
Switches used in a LAN



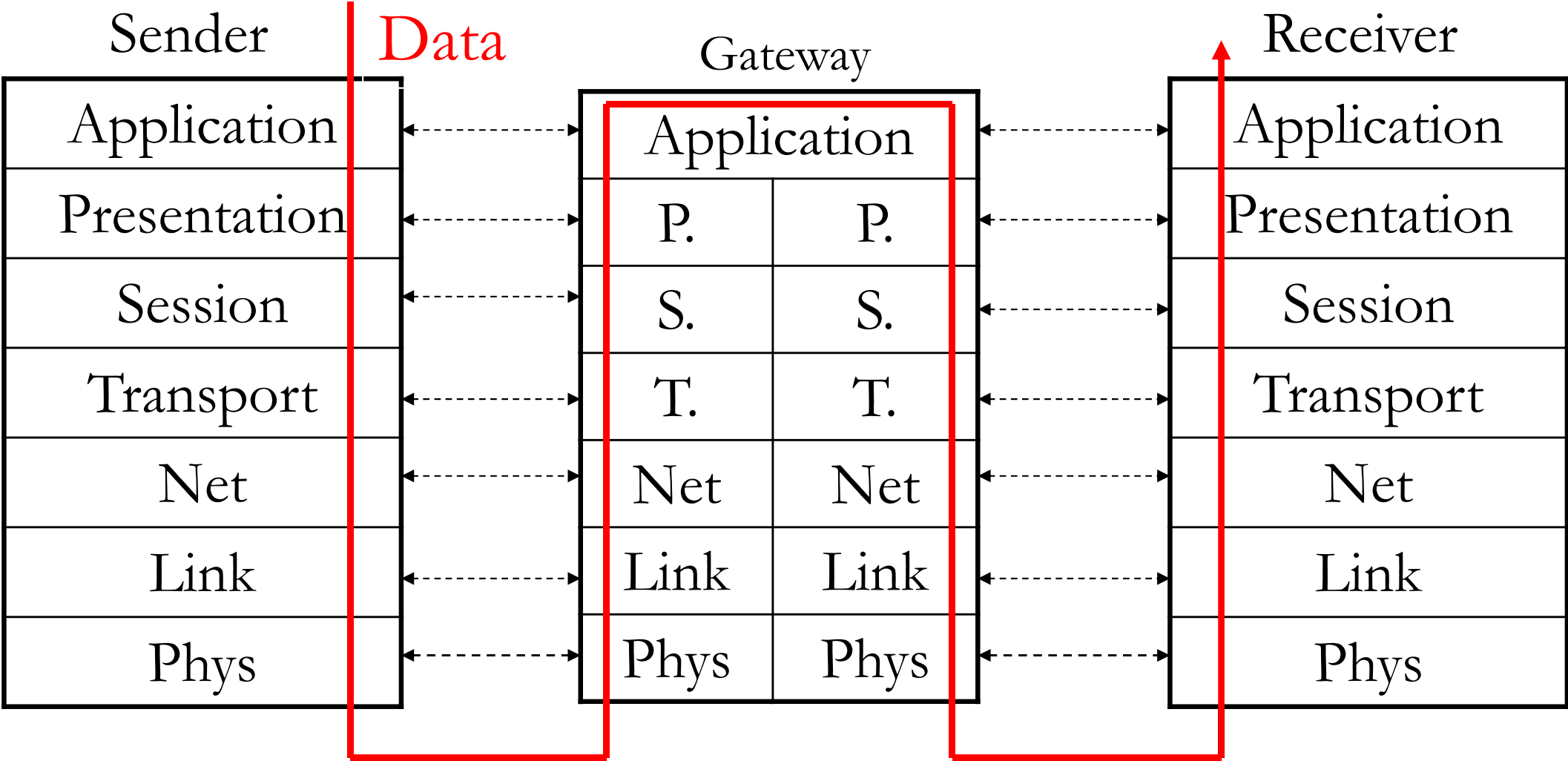
OSI model Protocol Stack (2)



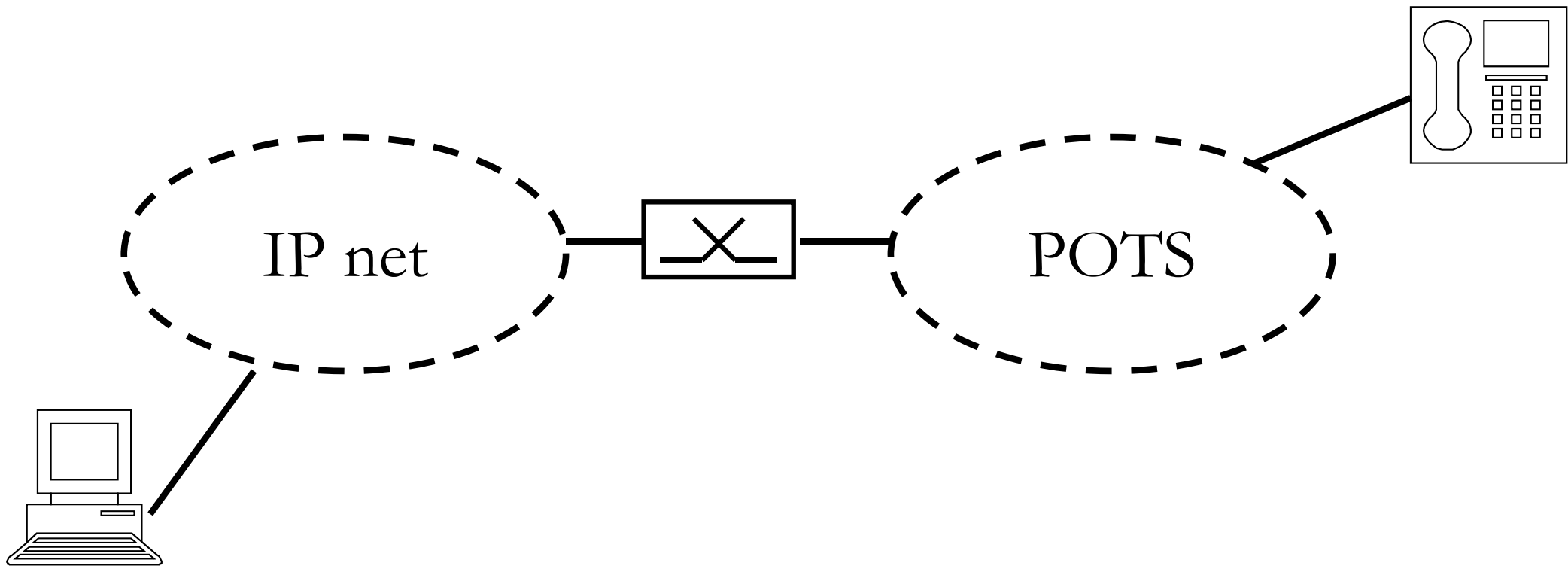
Routers used between networks with same net protocol



OSI model Protocol Stack (3)



Gateways used between nets with different application protocols



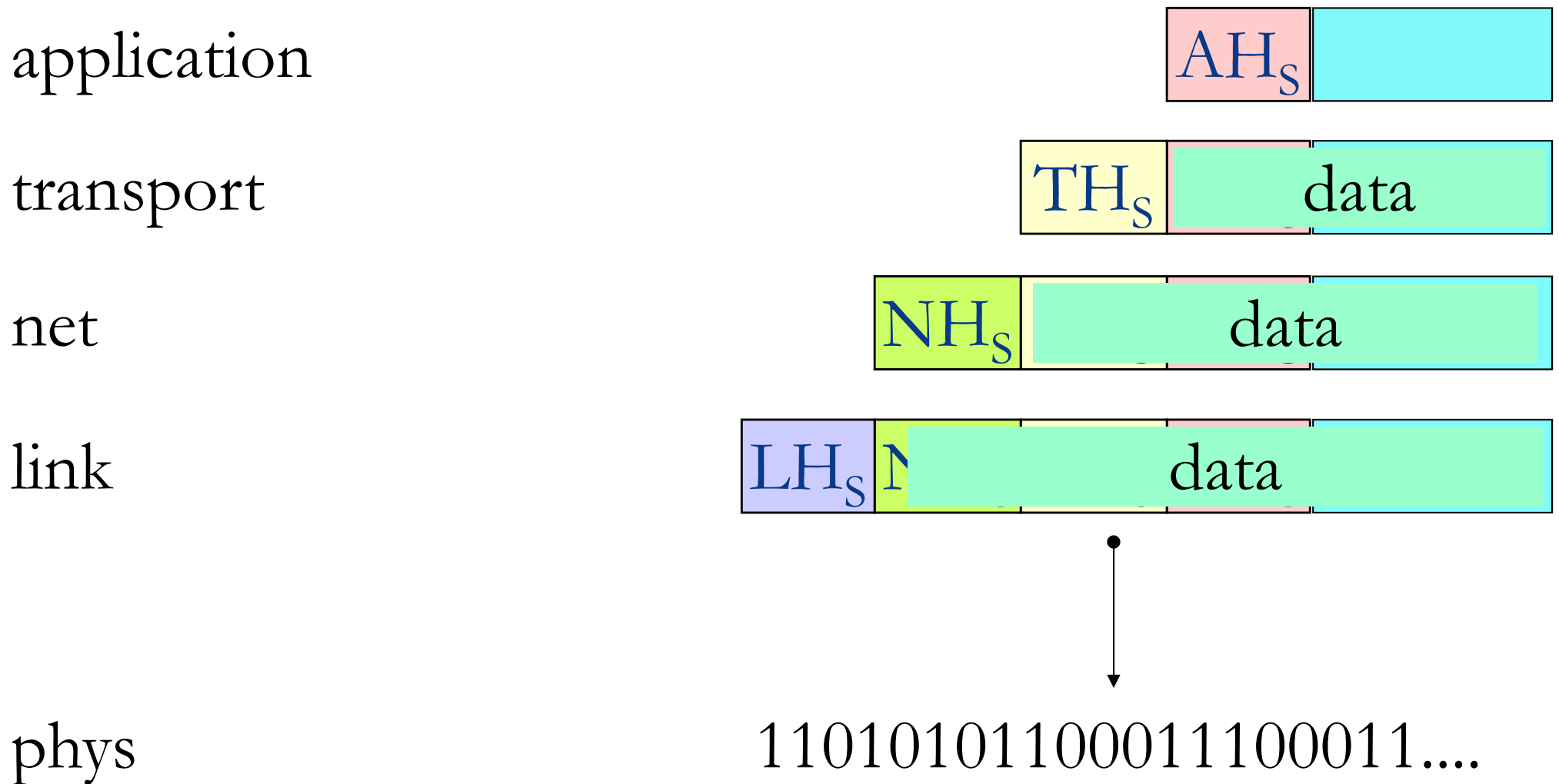
Internet's protocol stack

Application	HTTP, FTP, SMTP etc.	
Transport	TCP	UDP
Net	IP	
Link	Ethernet, PPP, ATM etc.	

DNS

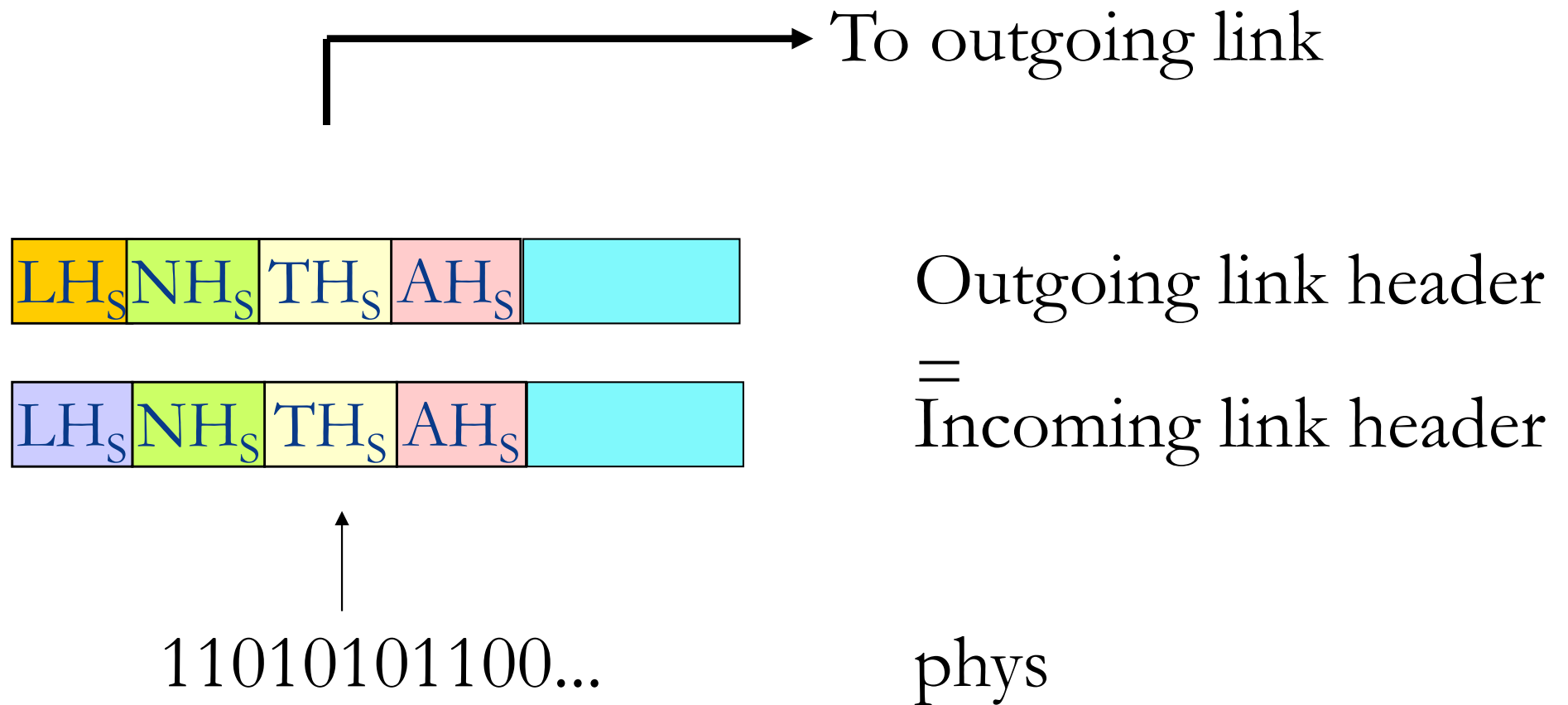
ICMP ARP

Encapsulation Sender Side



Switch

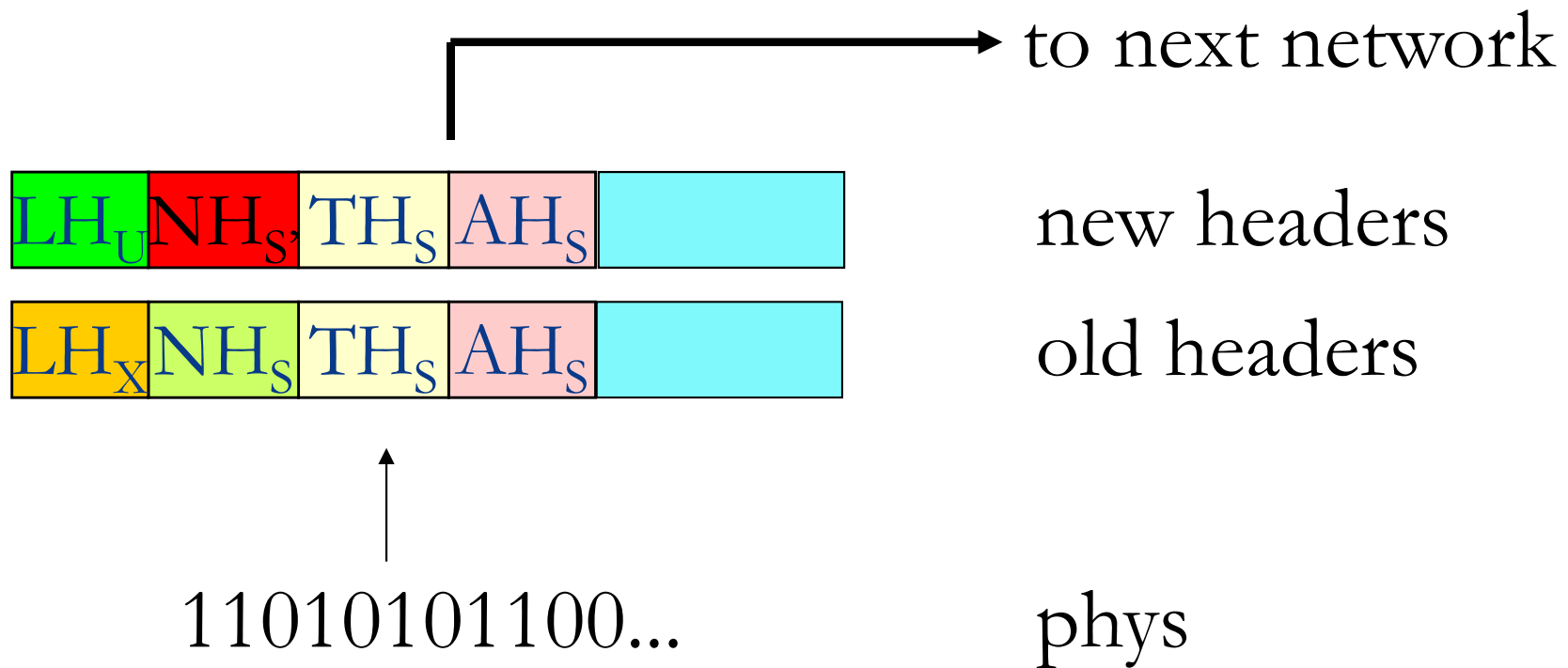
Ethernet switch do not change headers.



Router

Router creates new link header

Net header *basically(?)* unchanged.

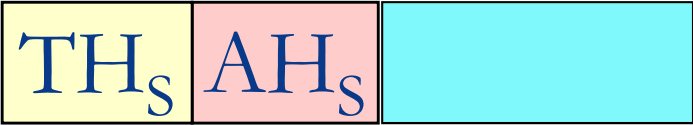


Receiver side decapsulation

application



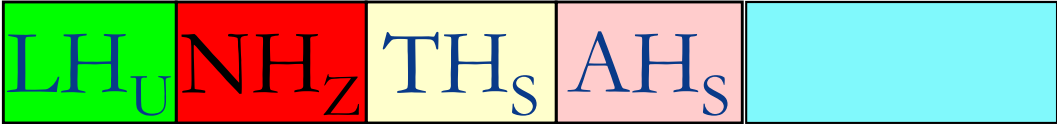
transport



net



link



phys

110100111011000011....



ICMP

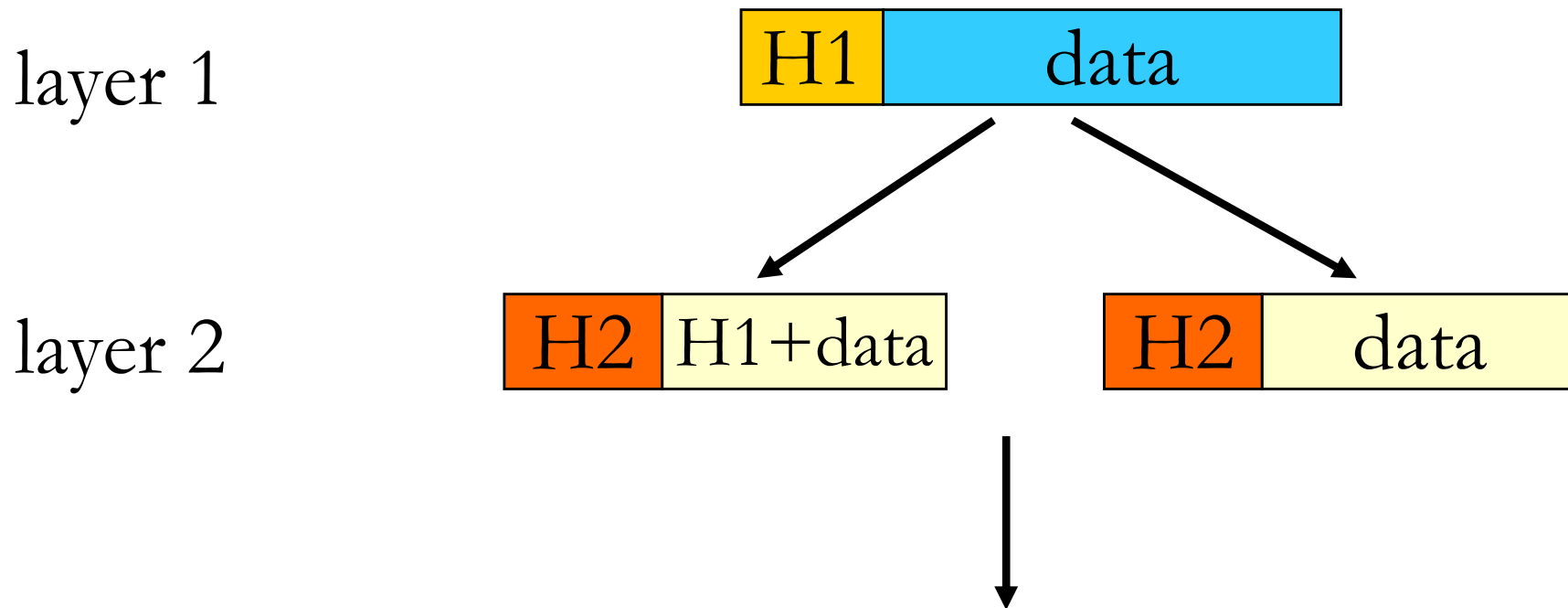
- IP supporting protocol
- Messages
 - ◆ Error msgs
 - Host unreachable
 - Net unreachable
 - TTL expired
 - ◆ Request
 - Echo request

MTU

- Maximum Transmission Unit
- Maximum payload size
- Exemple:
 - Ethernet MTU = 1500
 - PPP link over modem = 256/512
 - Gigabit Ethernet Jambo Frames = 9600
 - IPv4 = 65536 inkl header
 - IPv6 = 65536 exkl header

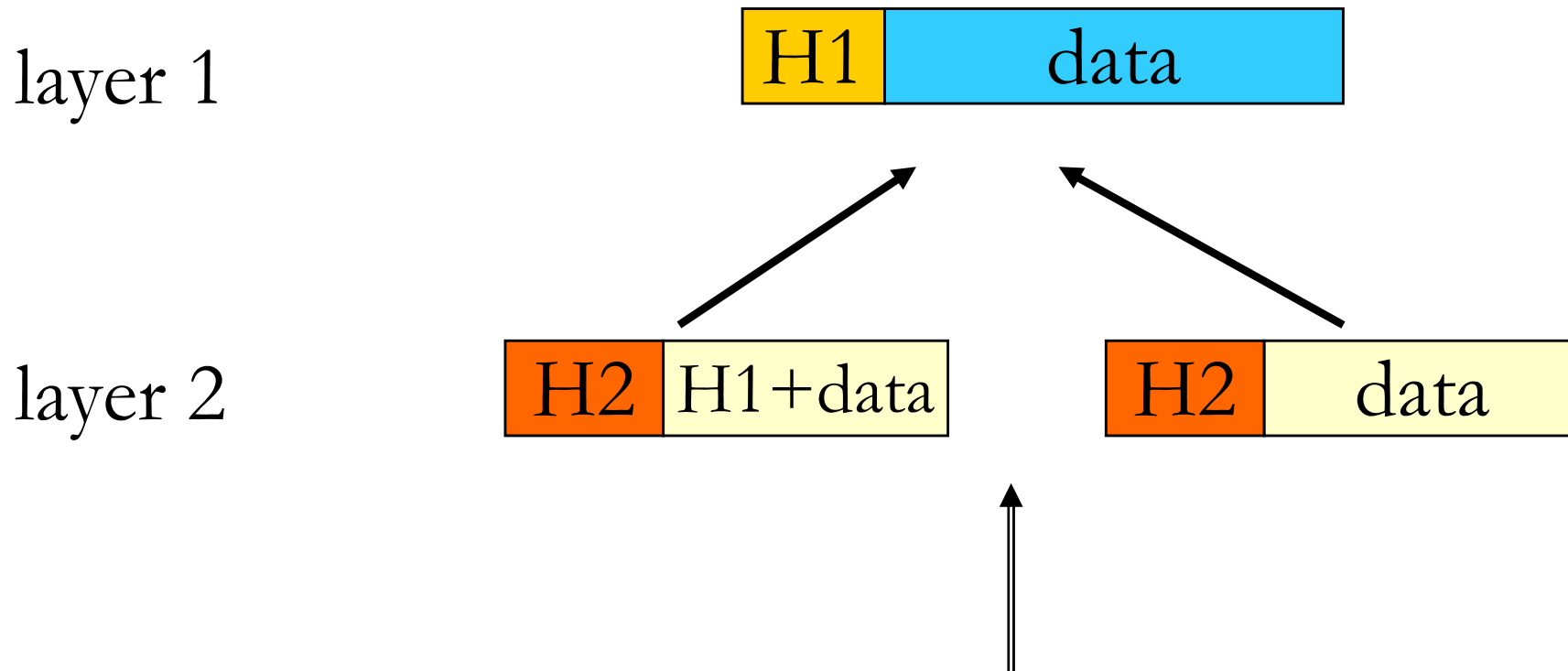
Fragmentation

- When upper layer frame is bigger than underlying payload to small



Defragmentation

- Performed by receiver



IP fragmentation

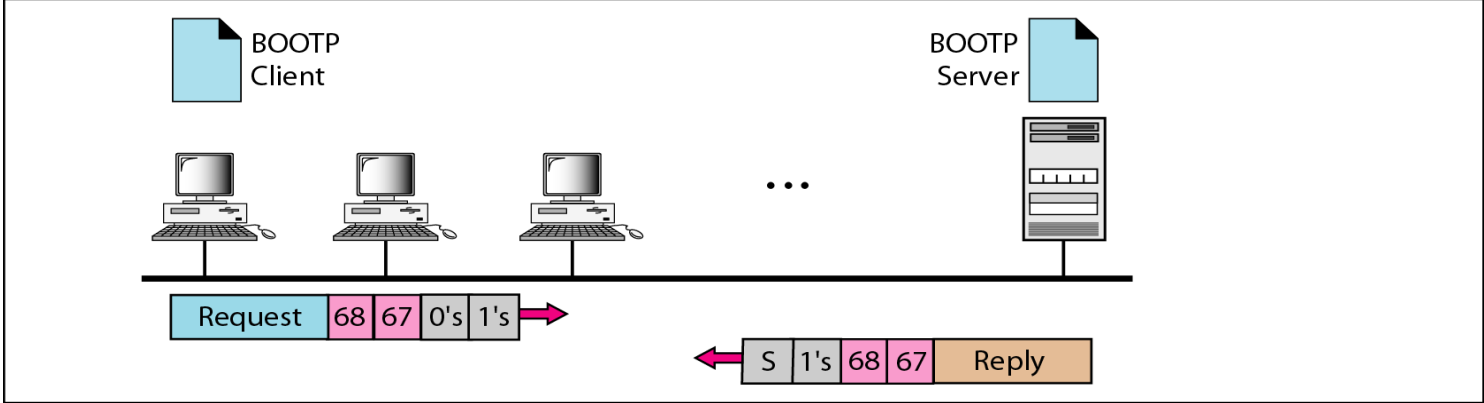
- IPv6: only performed by original source.
- IPv4: performed by routers if needed
- Defragmentation always performed by final receiver.

What to configure

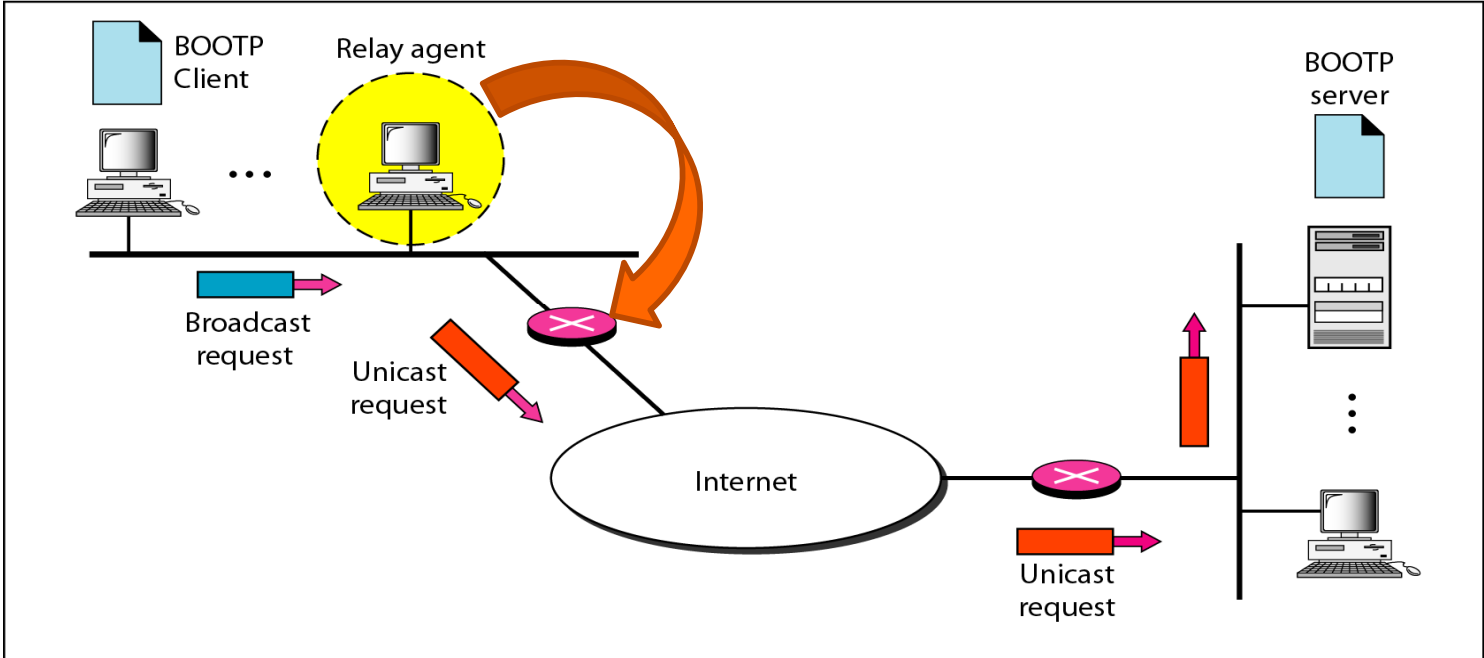
- IP address
- Net mask (specifies network id)
- Default Gateway (at least one)
- DNS server (at least one)
 - ◆ Server's ip address
- Other stuff
 - ◆ TFTP server
 - ◆ Configuration file
 - ◆ Executable image download

Obtaining an IP address (bootp)

- Bootstrap



a. Client and server on the same network



b. Client and server on different networks

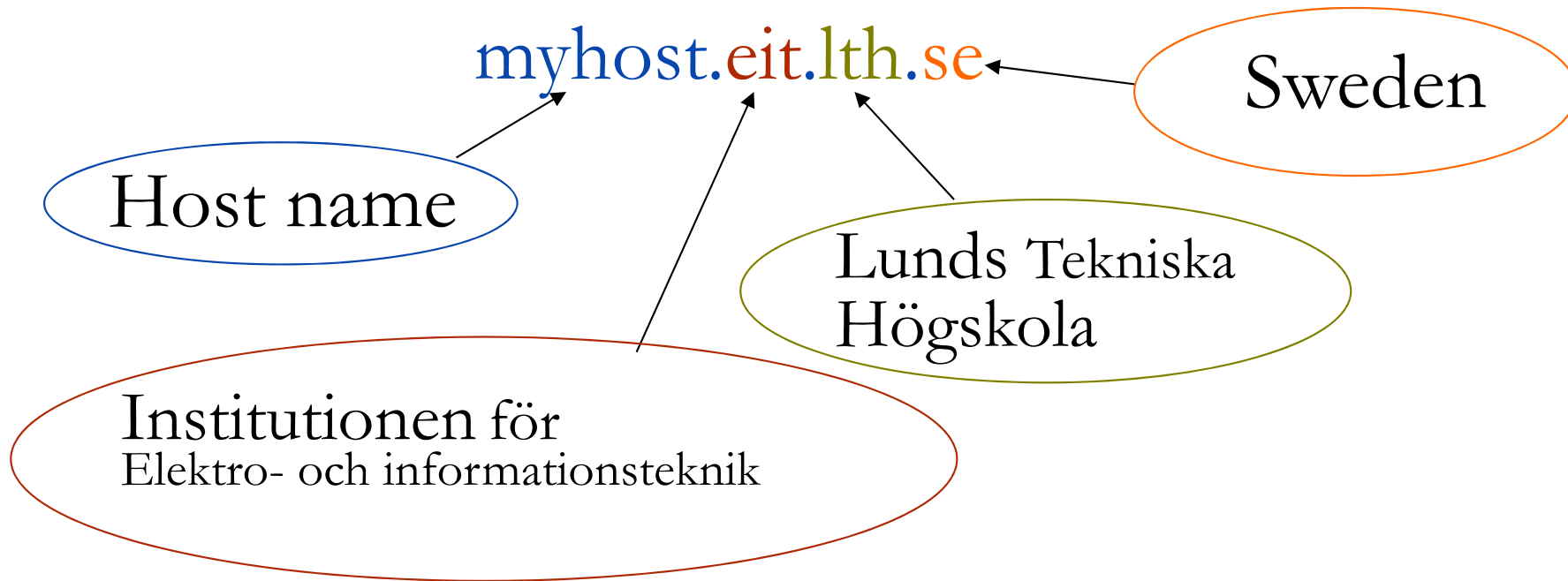
Dynamic Host Configuration Protocol (DHCP)

- BOOTP
 - ◆ Not dynamic!
- DHCP
 - ◆ IP address
 - Allocation from pool or static
 - ◆ Network mask
 - ◆ Default gateway
 - ◆ DNS server(s)

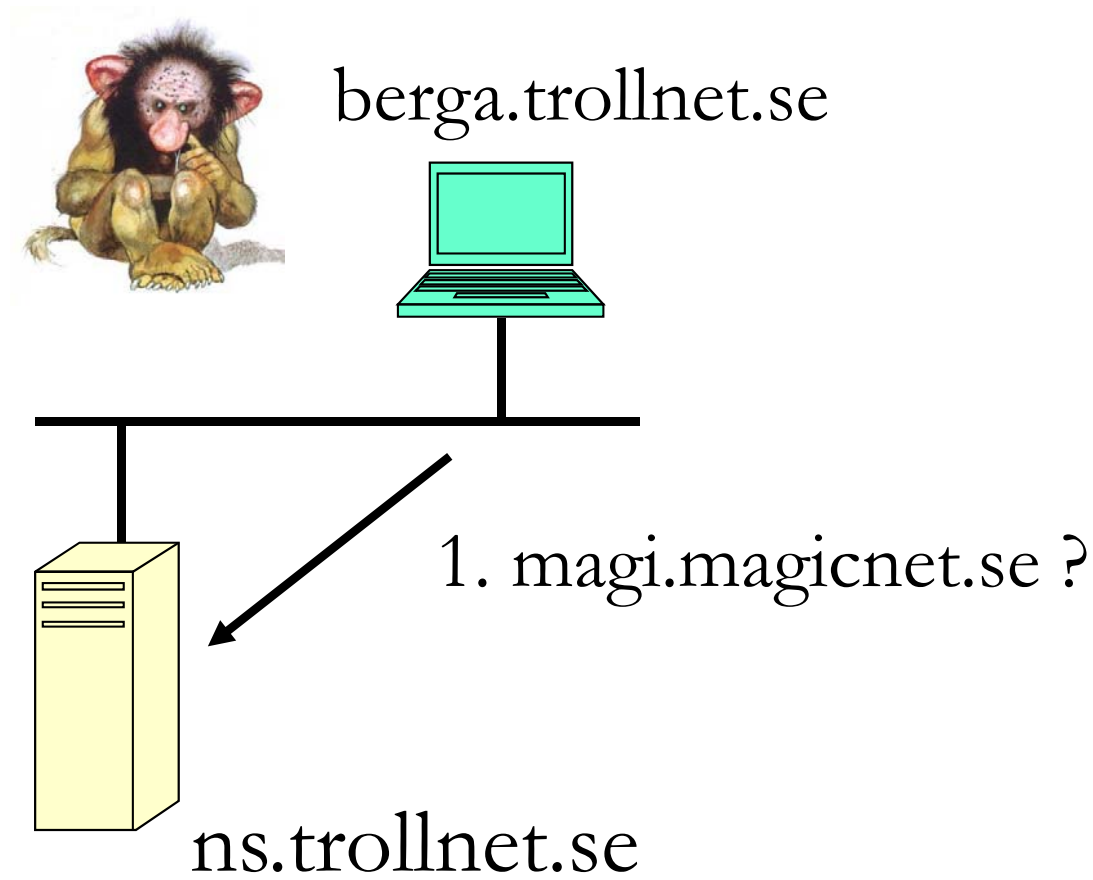
Domain Name System (DNS)

- Hierarchical name system consisting of a number of levels.
- Internet is divided into a number of domains, and each domain has its own name.
- On top geographical or generic root domains.
- Each domain contains subdomains.
- Relies on Domain Name Servers and resolvers (clients)

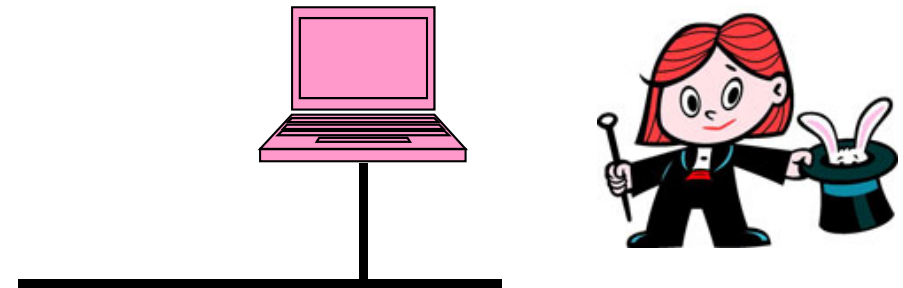
DNS example



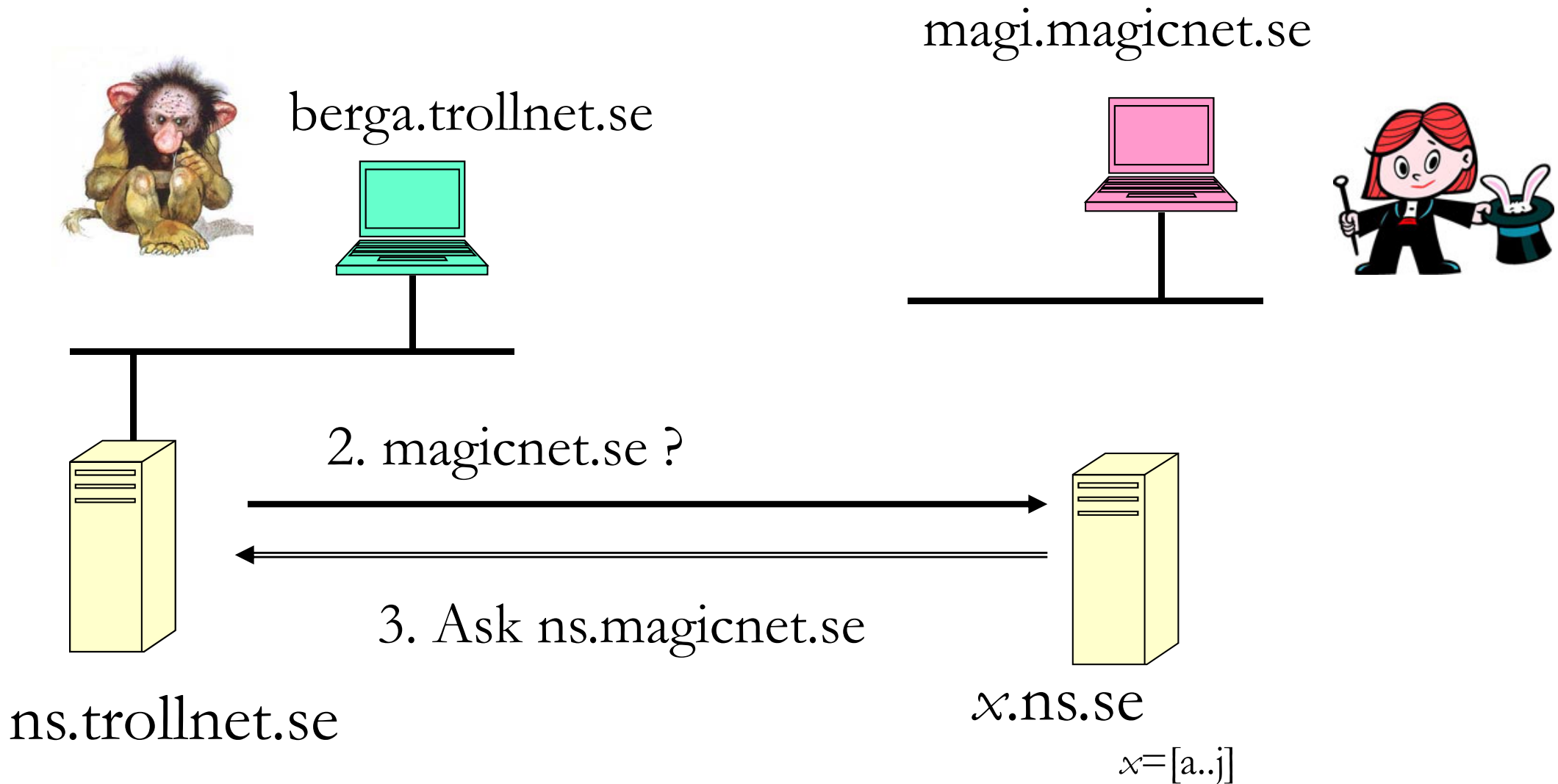
From name to IP address (1)



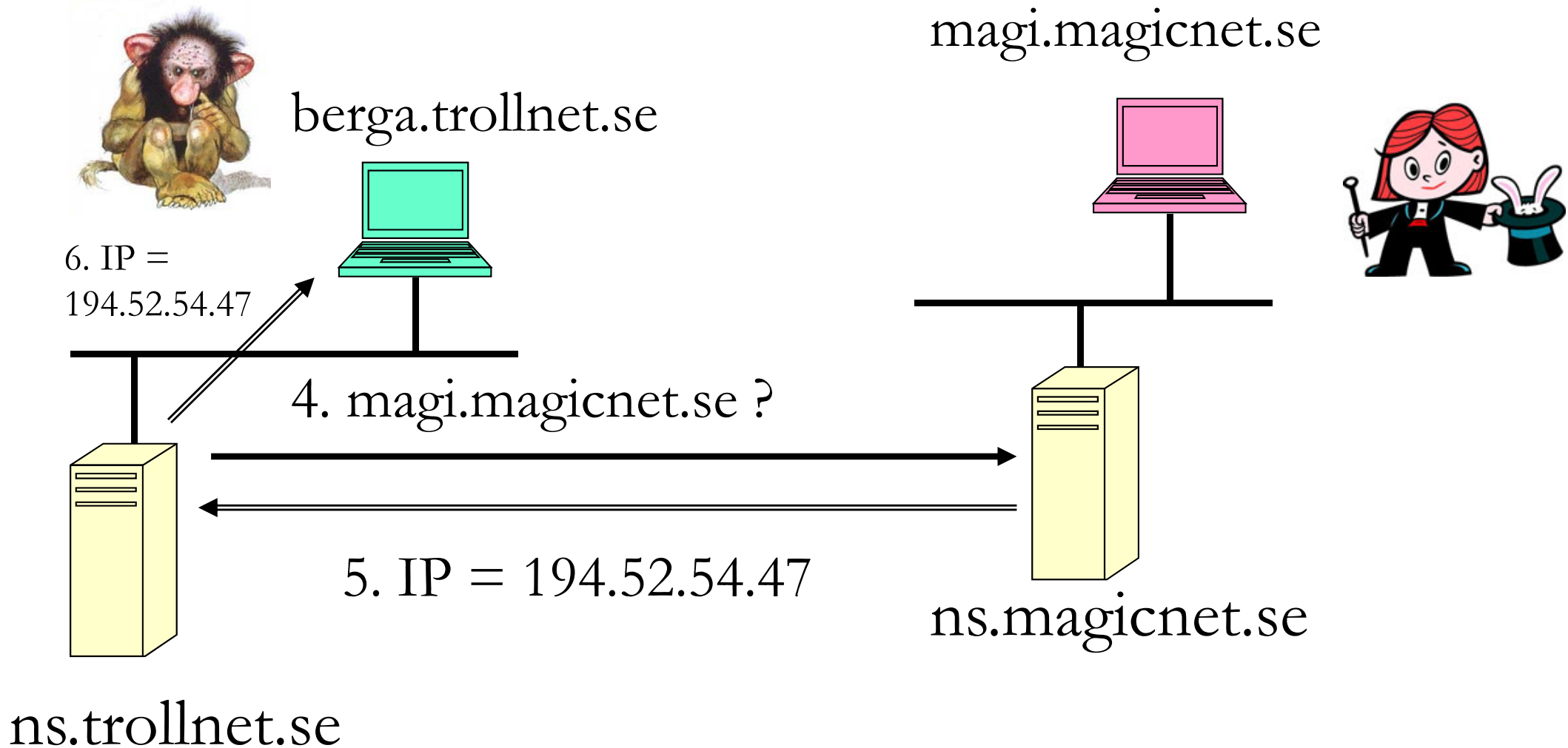
magi.magicnet.se



From name to IP address (2)



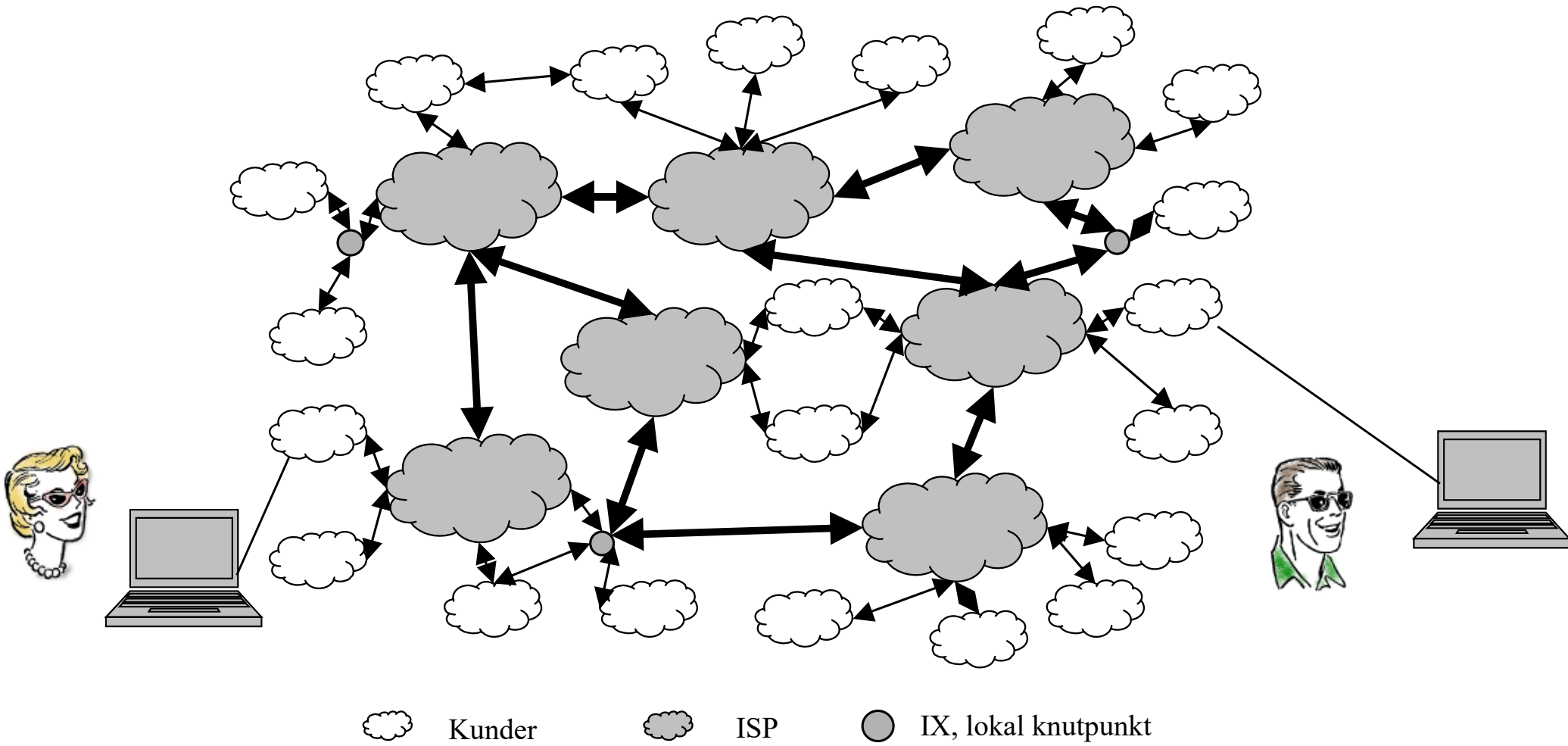
From name to IP address (3)



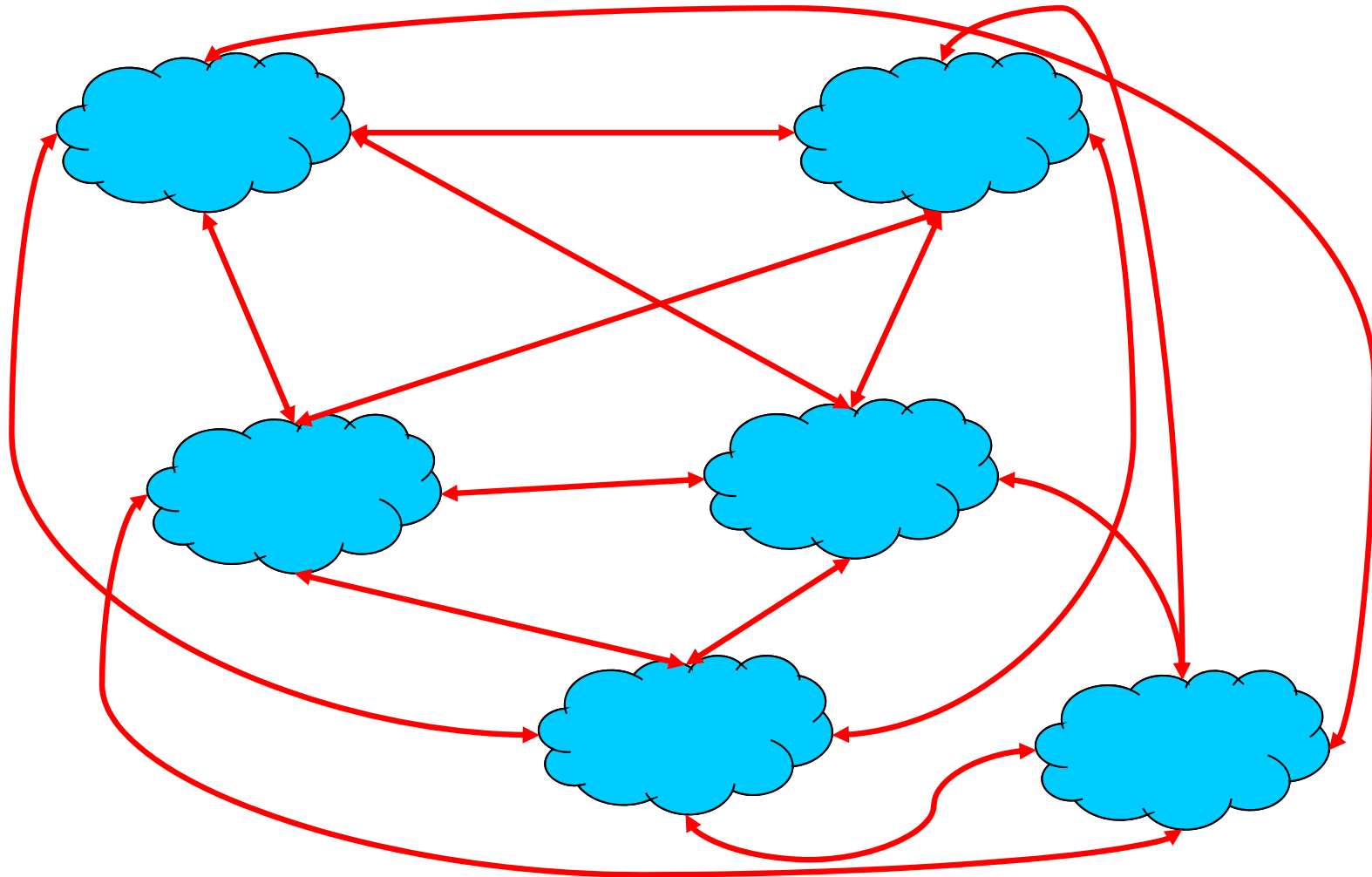
Internet?

- Consists of linked independent networks all running TCP/IP.
- "Controlled" by Internet Society (ISOC).

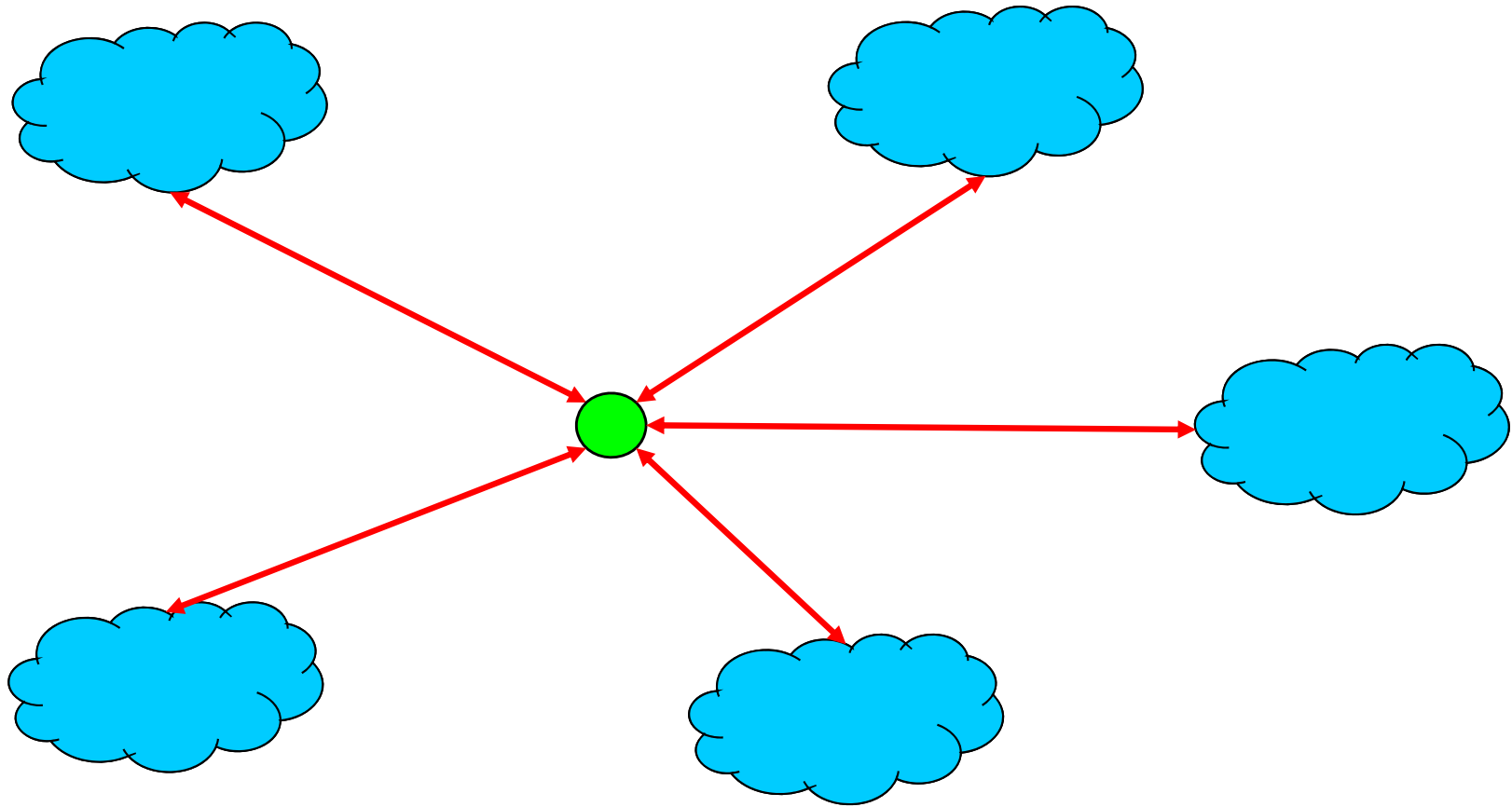
Internet's structure



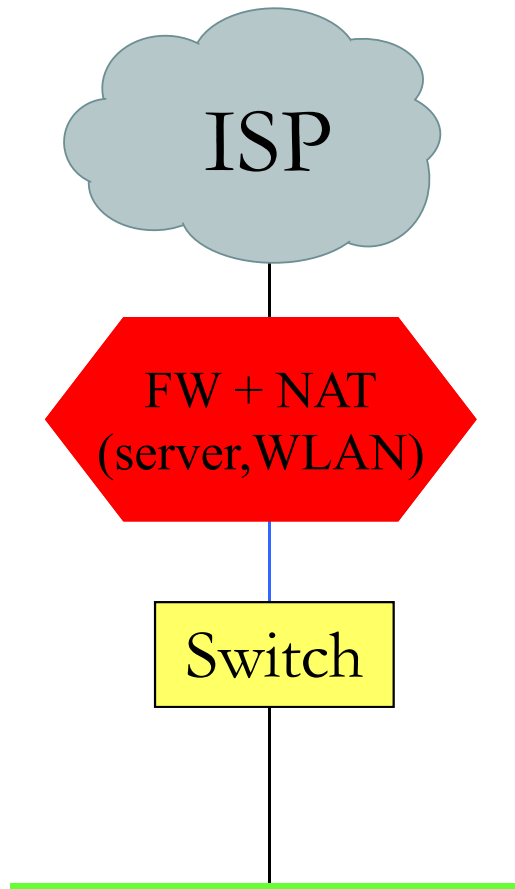
Traffic exchange, pair



Traffic exchange, internet exchange

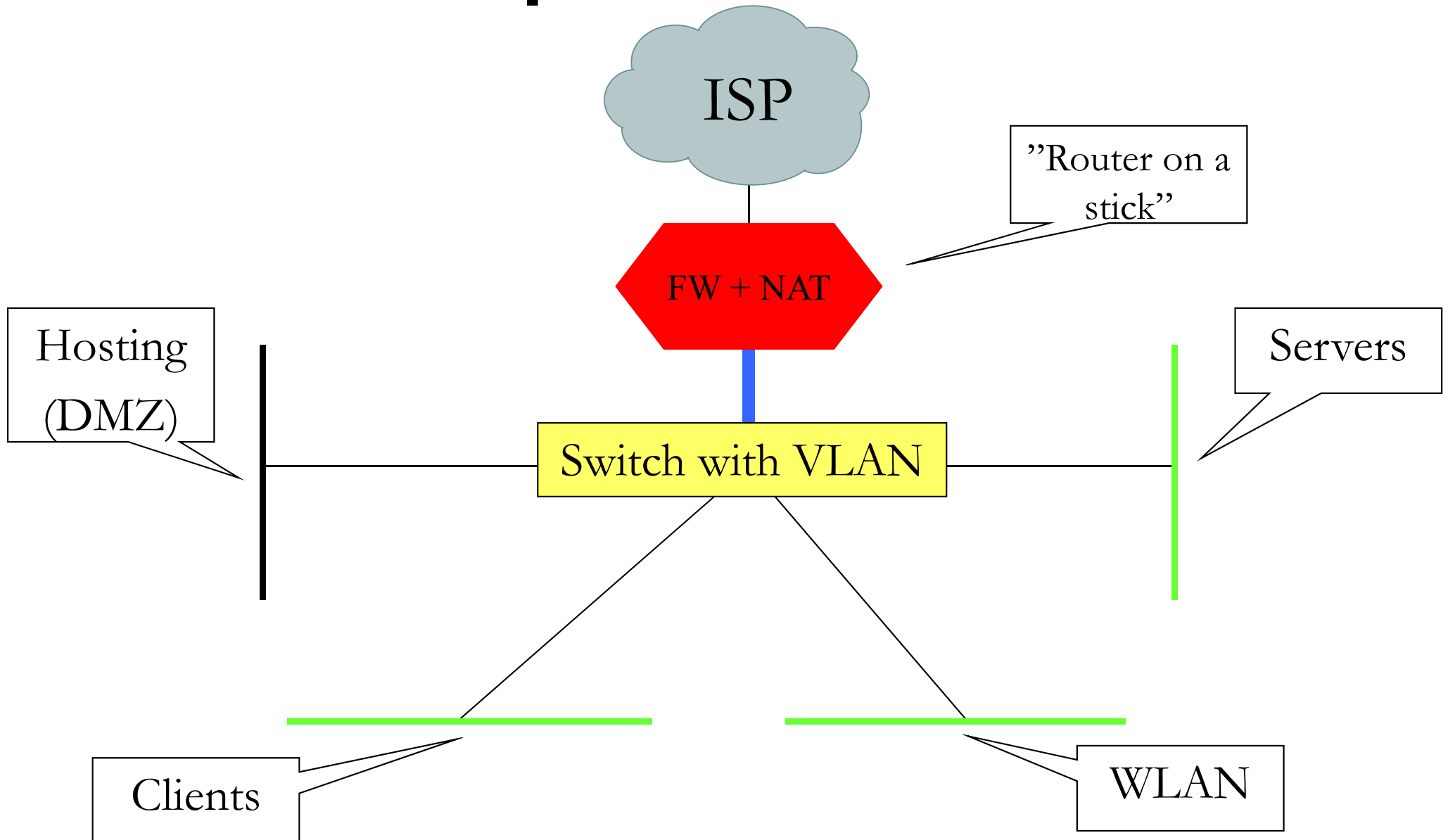


The home net



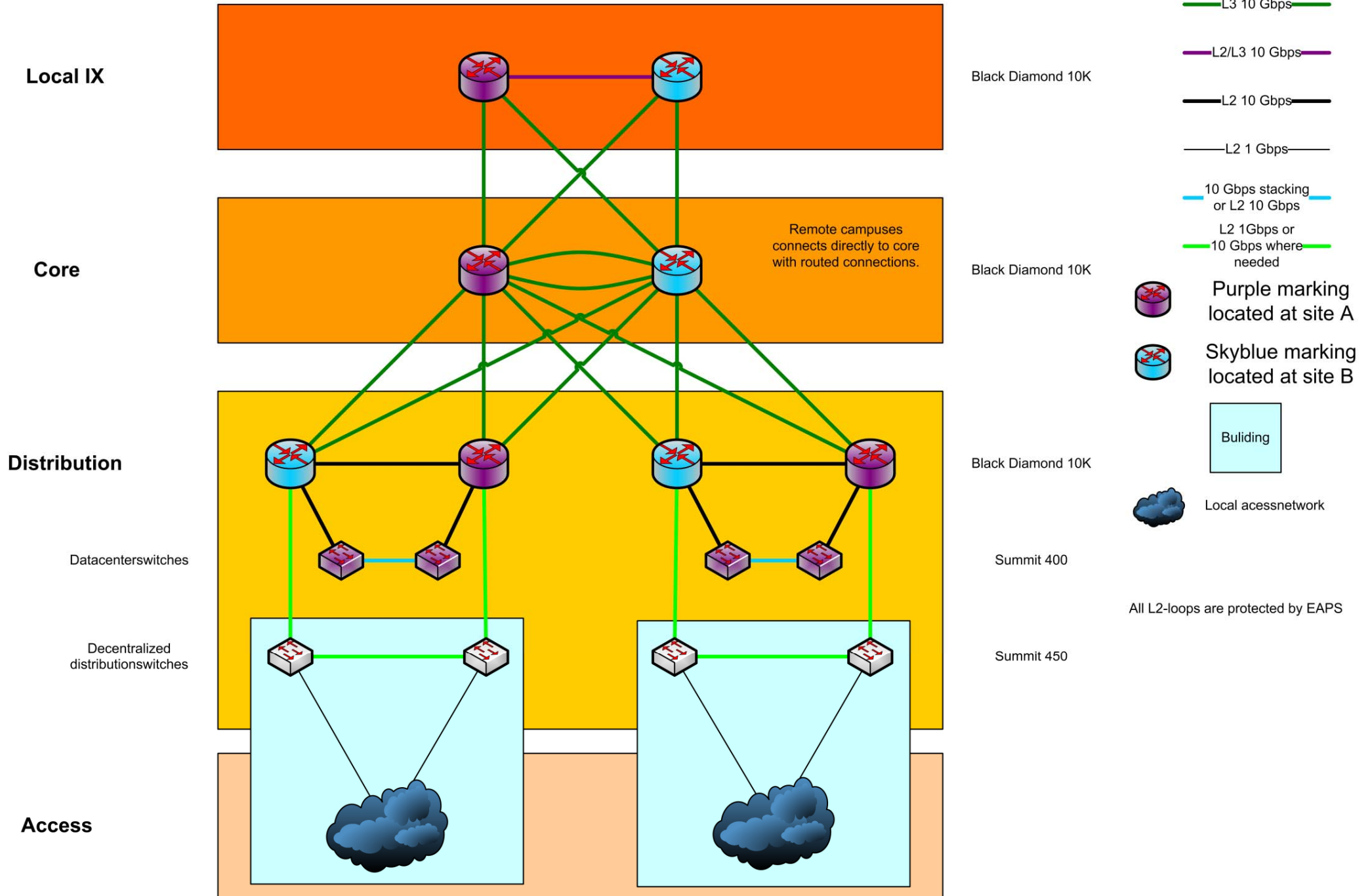
- CPE
- Firewall
- Router

Minor enterprise



GigaLUNET design Campus Lund

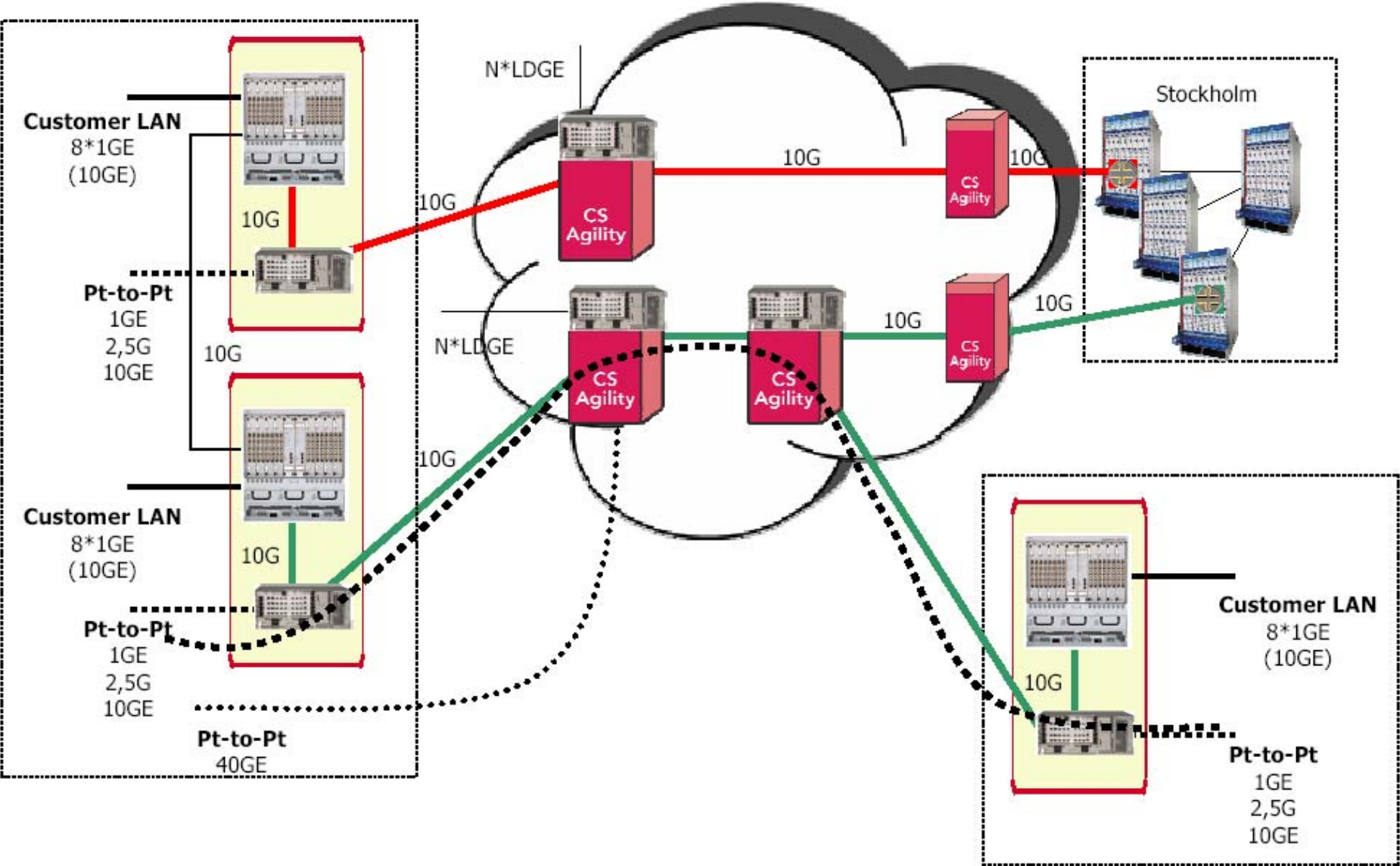
2005-08-19 06:30 / mjh



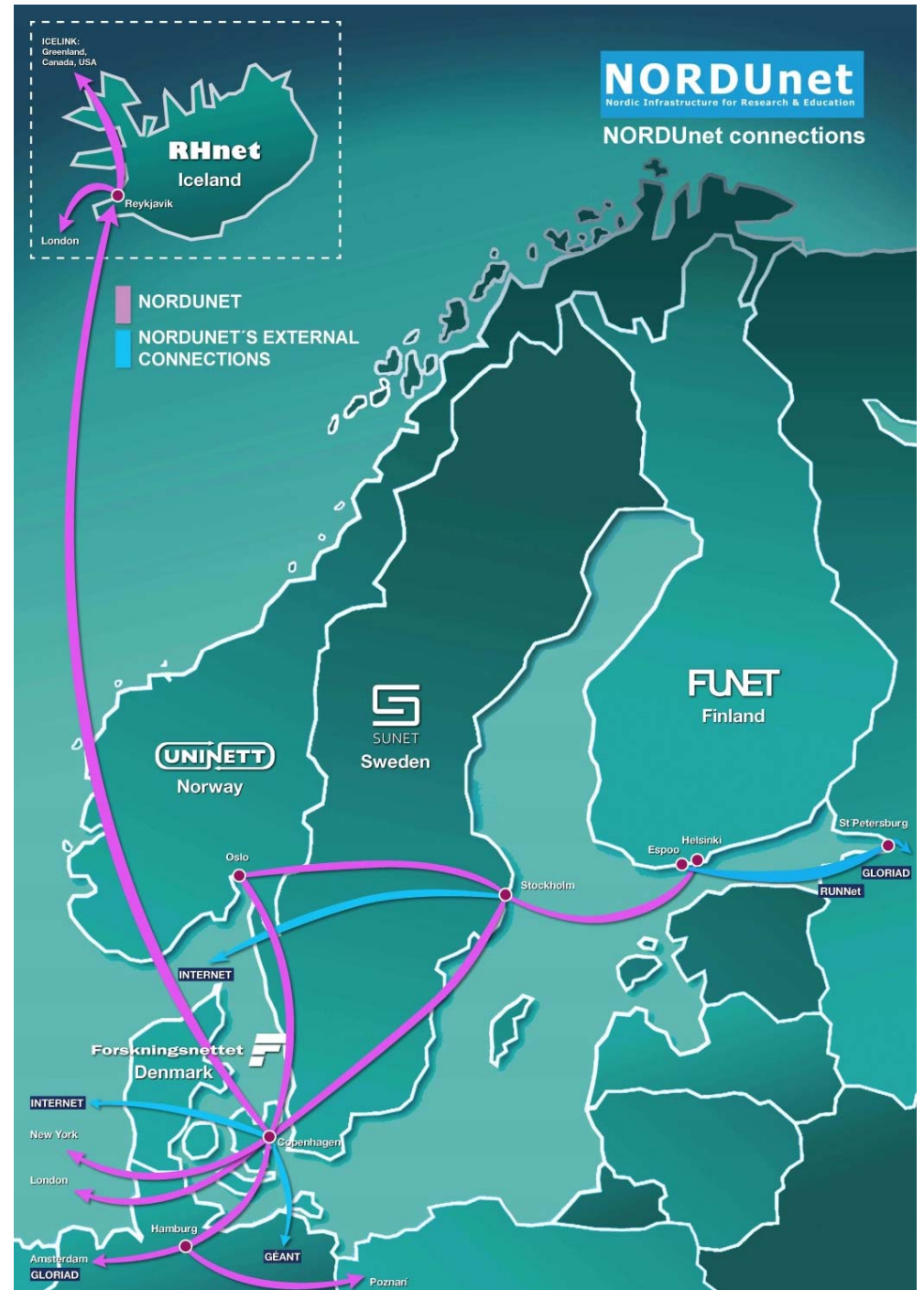
OptoSUNET



OptoSUNET



NORDUnet



NORDUnet NOX



GLIF (Global Lambda Integrated Facility)



ARPAnet was developed in 1968

- Robert Taylor at ARPA (later DARPA) had three terminals for connecting with different sites:
- “For each of these three terminals, I had three different sets of user commands. So if I was talking online with someone at S.D.C. and I wanted to talk to someone I knew at Berkeley or M.I.T. about this, I had to get up from the S.D.C. terminal, go over and log into the other terminal and get in touch with them. I said, oh, man, it's obvious what to do: If you have these three terminals, there ought to be one terminal that goes anywhere you want to go where you have interactive computing. That idea is the ARPAnet.”

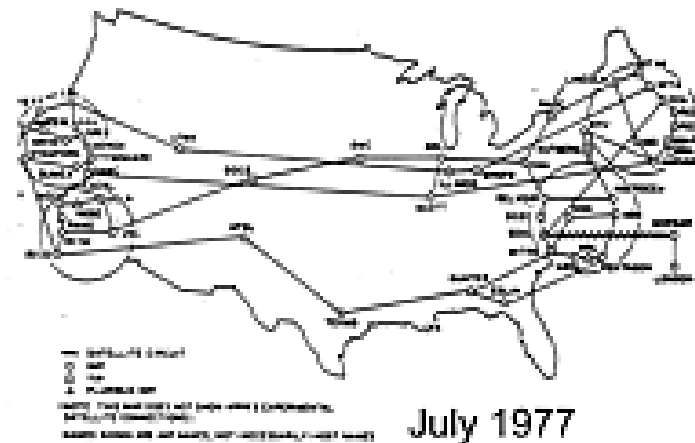
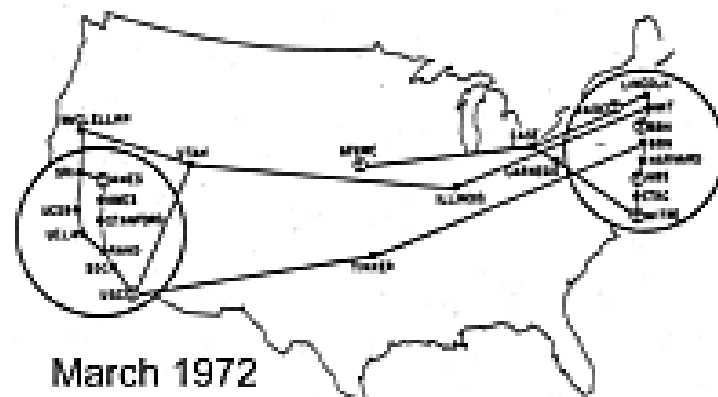
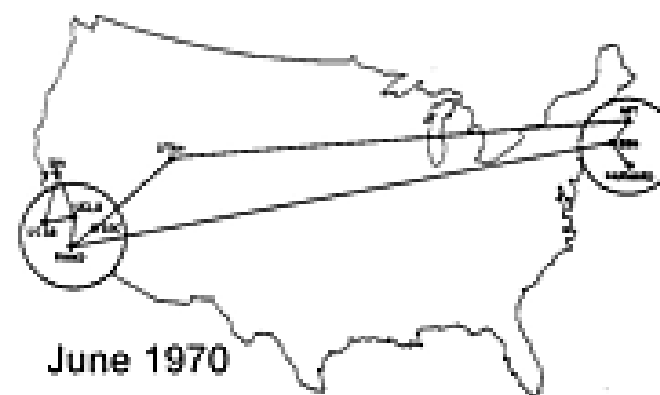


ARPAnet

- Four Interactive Message Processors (IMP) at four universities connected with leased lines of 50 kbps.
- The IMPs could store and forward messages.
- The picture shows Leonard Kleinrock with the first IMP at UCLA.

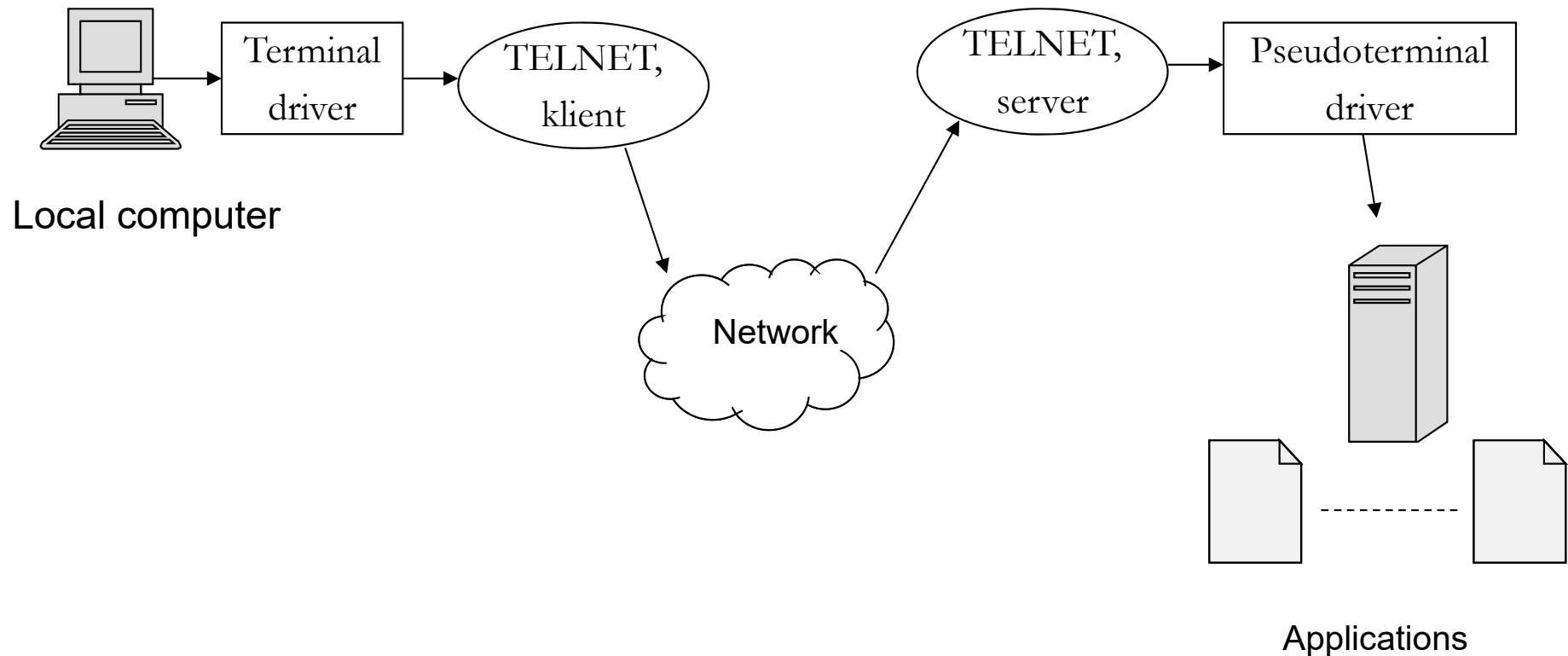


ARPAnet evolution



Telnet

- Telnet was invented in 1969, and provided access to a remote terminal.



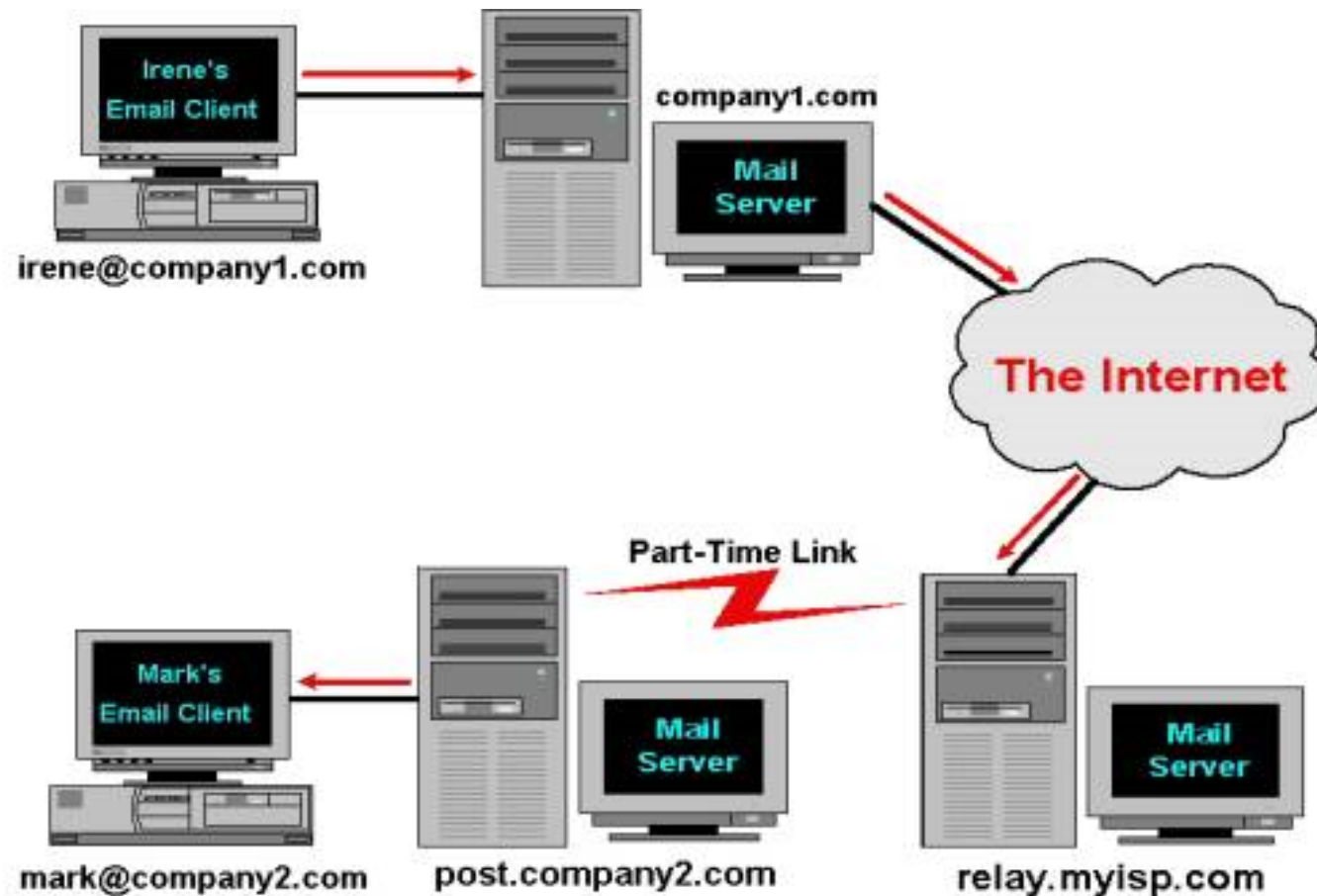
Email

- Ray Tomlinson sent the first email in 1971 between two computers in the same room.
- To separate a specific user on a host computer, he used the ”@” sign, which was unused on the keyboard.



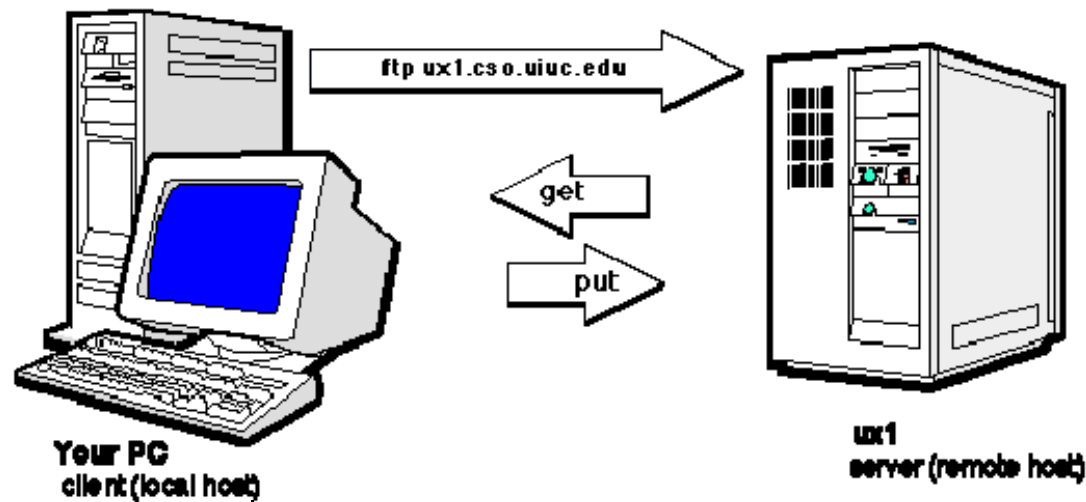
Email

- Today, email basically works the same way:



File Transfer Protocol (FTP)

- Another original application was FTP, which was developed in 1971, and that enabled file transfer between two host computers.

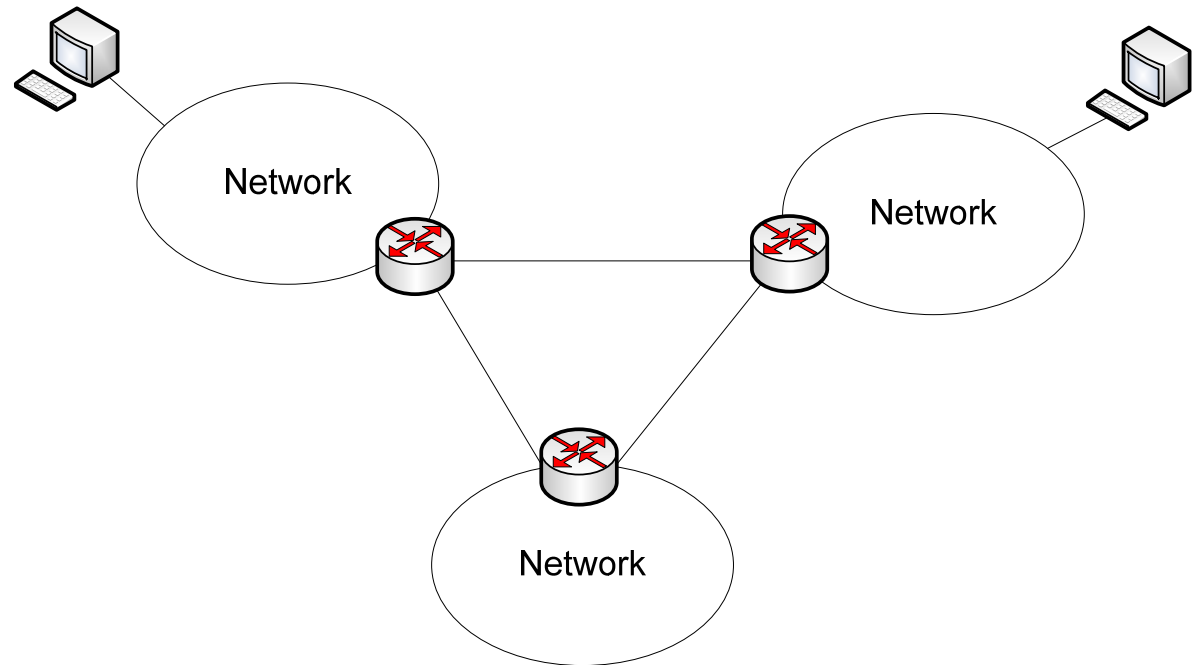


Internet protocol

- In 1973, Robert E. Kahn and Vincent Cerf at DARPA developed the ideas of an internetwork protocol that made it possible for hosts on different networks to communicate with each other.
- The ideas were defined as the Transmission Control Protocol (TCP) protocol in 1974, where the term "Internet" was introduced.
- Later, some parts of the TCP protocol were moved to the Internet protocol (IP), creating the TCP/IP protocol suite.

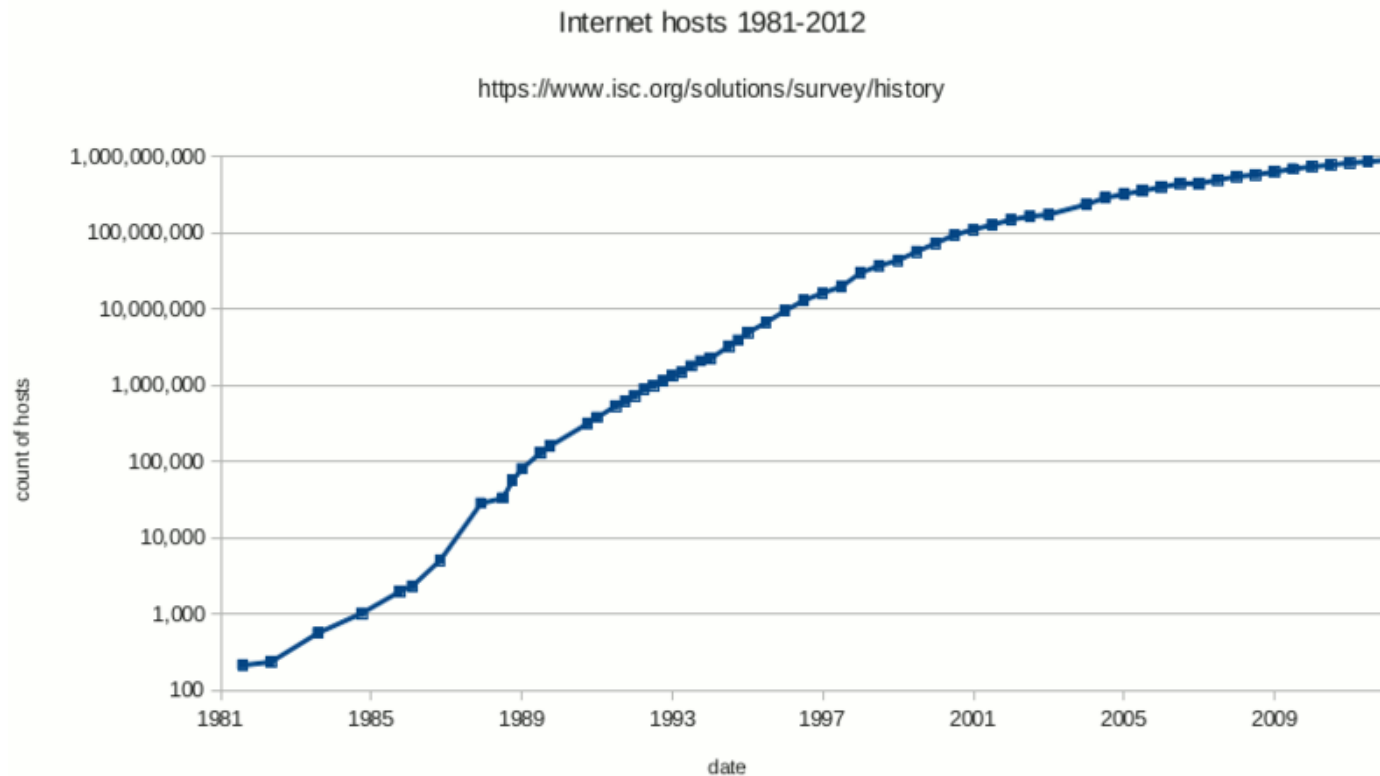
Basic idea of Kahn and Cerf's internetworking

- Host identification (Addresses)
- Forwarding of messages between networks (routing)
- End-to-end reliability (error and flow control)



Internet was born

- The Internet protocol suite was formalized in 1982.
- Jan 1 1983, all networks connected to the Internet had to use the TCP/IP protocol suite.



1991: World Wide Web (WWW)

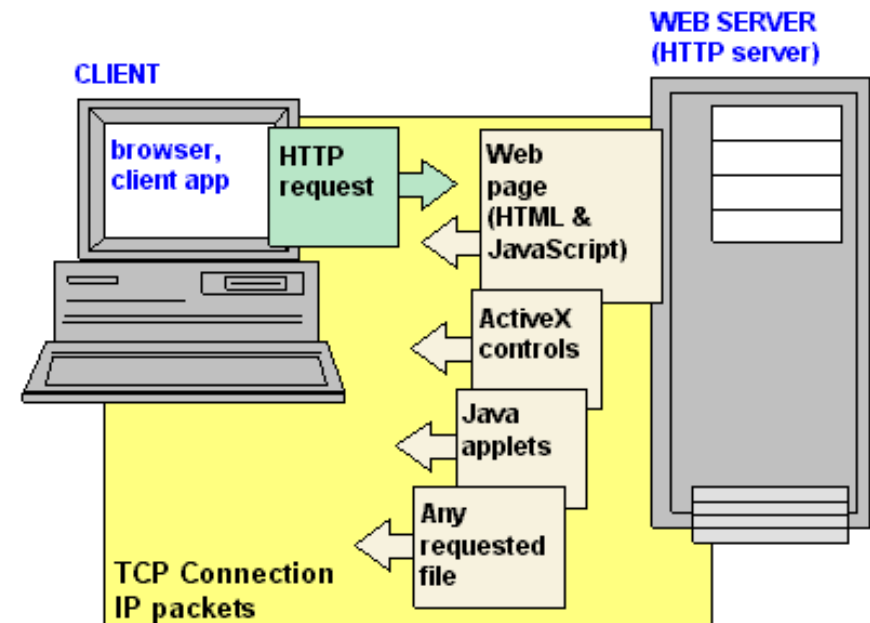
- 1984-1990: Tim Berners-Lee and his group at CERN worked on the ideas of information presentation and sharing.
- 1990: HyperText Transfer Protocol (HTTP), HyperText Markup Language (HTML), a web browser, and server software were presented at CERN.
- 1991: WWW goes public
- 1993: Mosaic, the first public web browser



First web site: <http://info.cern.ch>

- The first web site is still working.
- WWW is based on a simple client/server protocol HTTP, where clients send requests for pages to the server.

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1991: The Trojan Coffee room pot

- The people working at the Computer Laboratory at the University of Cambridge implemented the first real-time Internet video application for their coffee pot.
- The application server sent real-time images of the coffee pot to the clients.



The rest is almost not history

- 1994: Pizza Hut started first online webshop
- 1997: AOL instant messenger
- 1997: Sixdegrees.com (first modern social network)
- 1997: Google.com
- 1999: Napster
- 2001: BitTorrent
- 2003: Skype
- 2005: YouTube
- 2005: Facebook.com
- 2008: Spotify

