COS
Computersystemer

Lektion #7
Computer netværk

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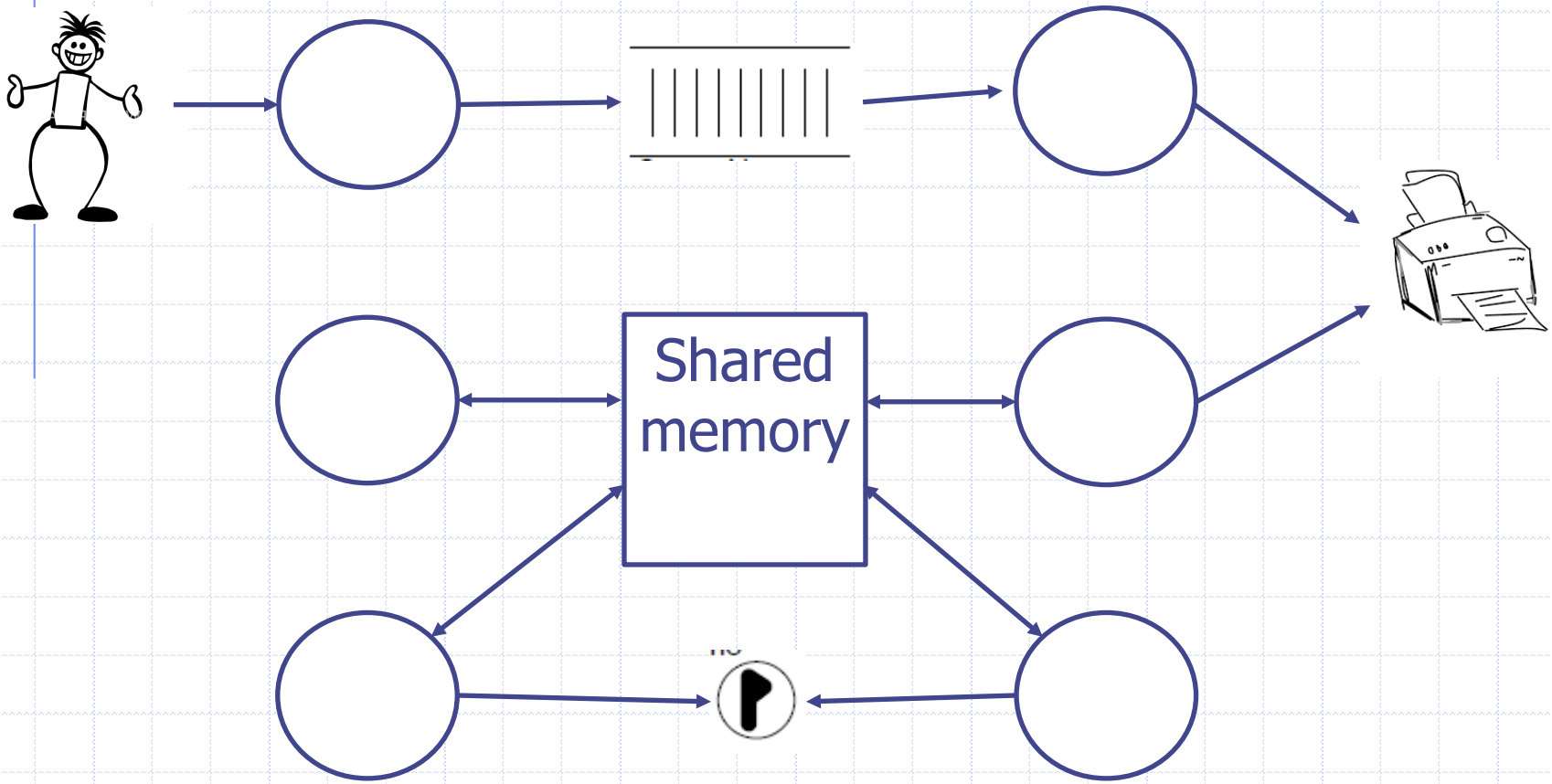
Processdiagram



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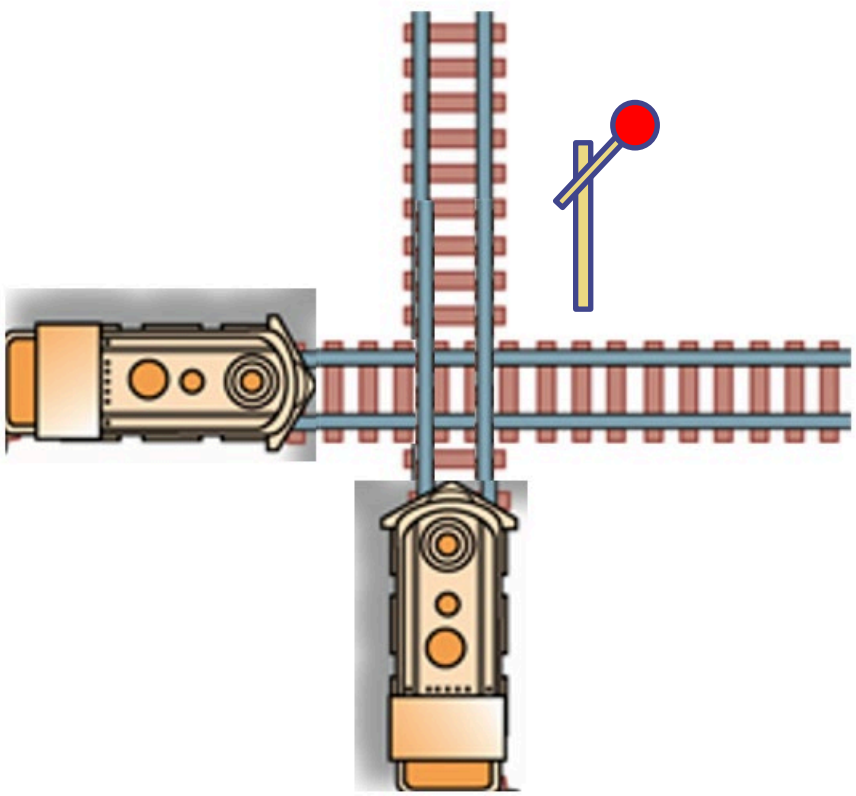
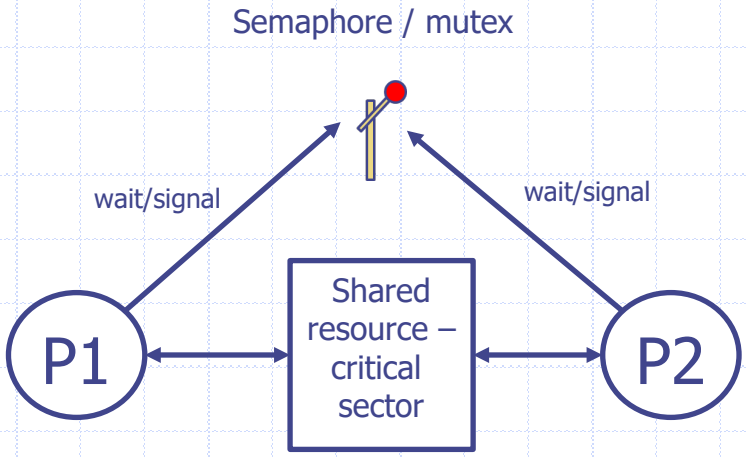
Kritisk sektor – semaphore - mutex





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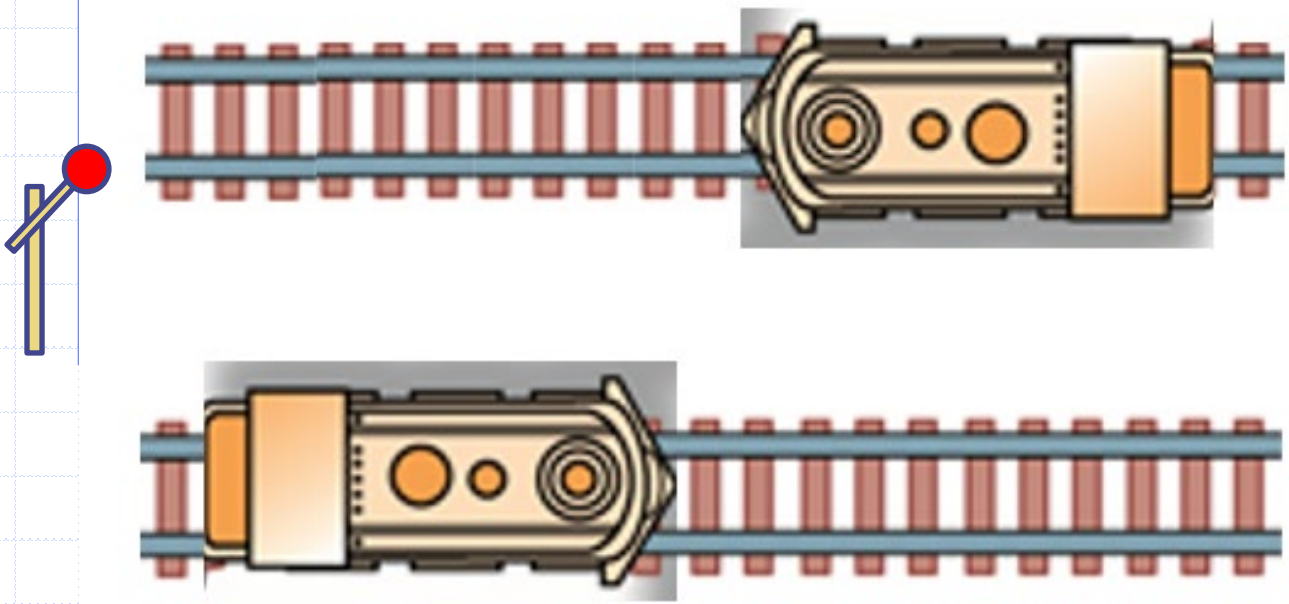
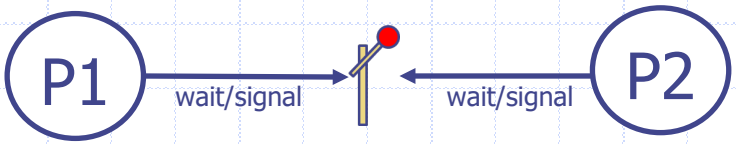
Signalerende semaphore



Semaphore / signaling semaphore



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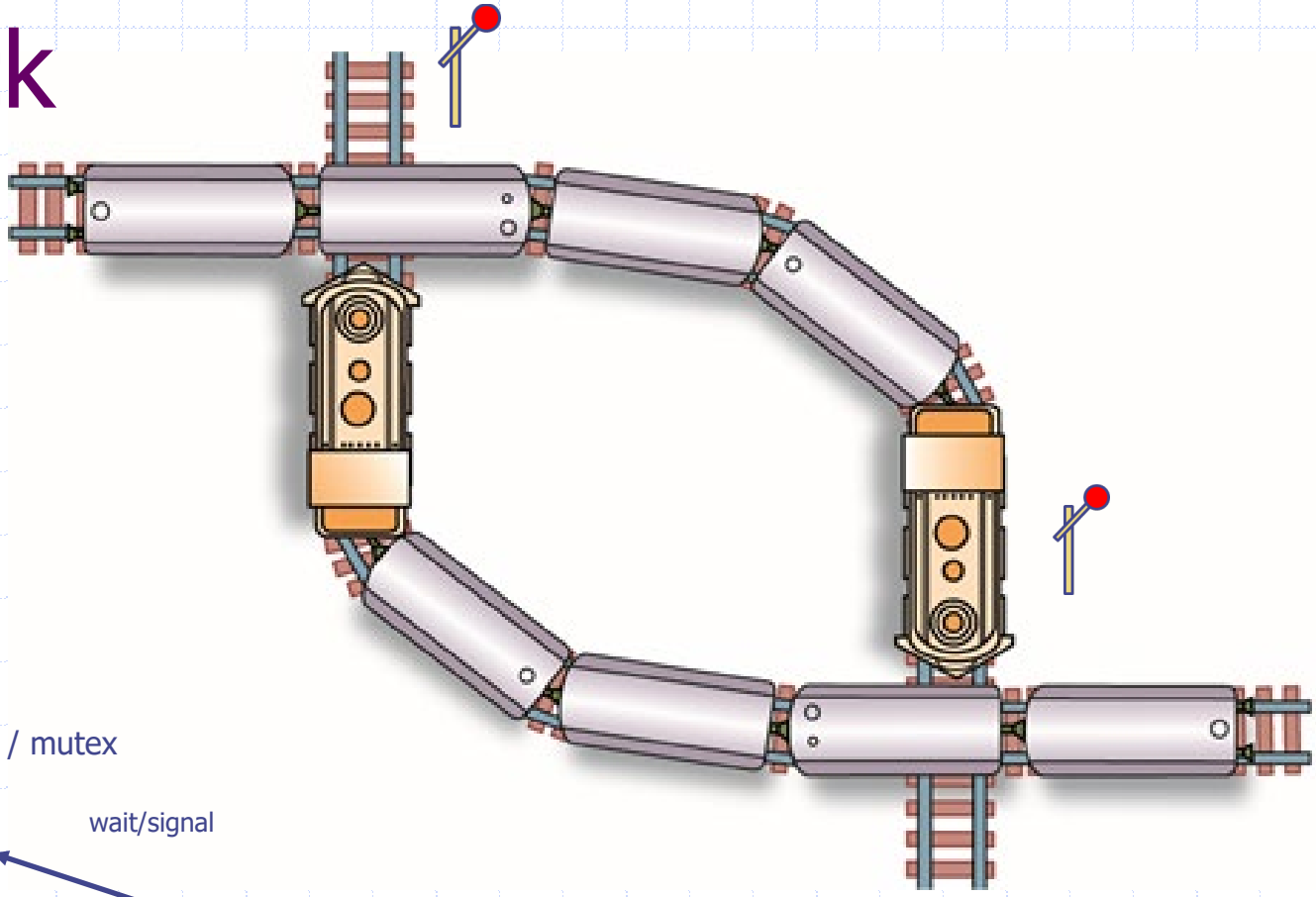
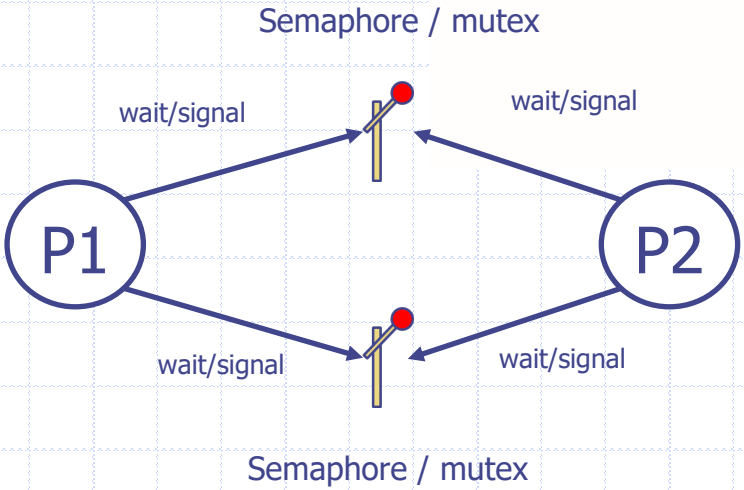
Deadlock





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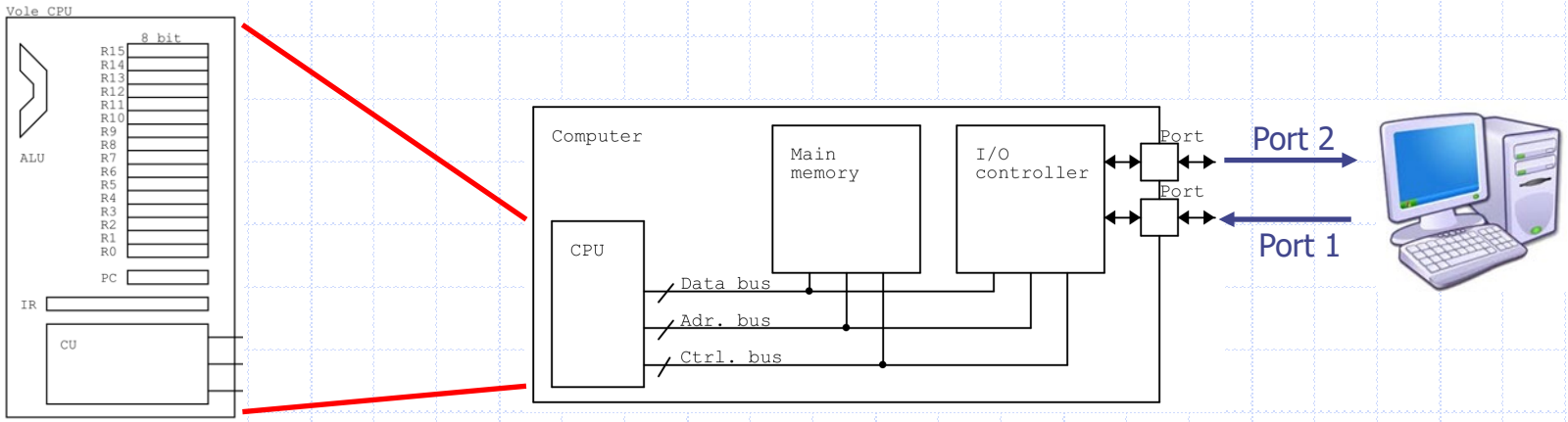
Eksempel med afvikling af program med I/O.




```
                                    # toUpper
0x10    0xD101  IN    1,1
0x12    0x2220  LOAD  2,#0xDF     while true:
0x14    0x8321  AND   3,2,1          print( input() & 0xDF )
0x16    0xE302  OUT   3,2
0x18    0xB018  JMP   0x10
```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Data Communication

Distributed system / application

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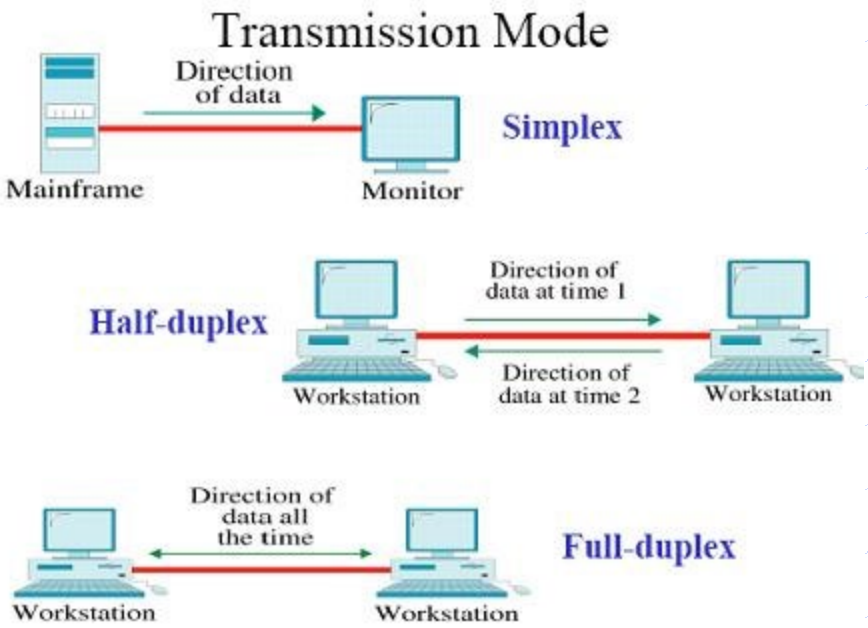
simplex – half duplex – duplex



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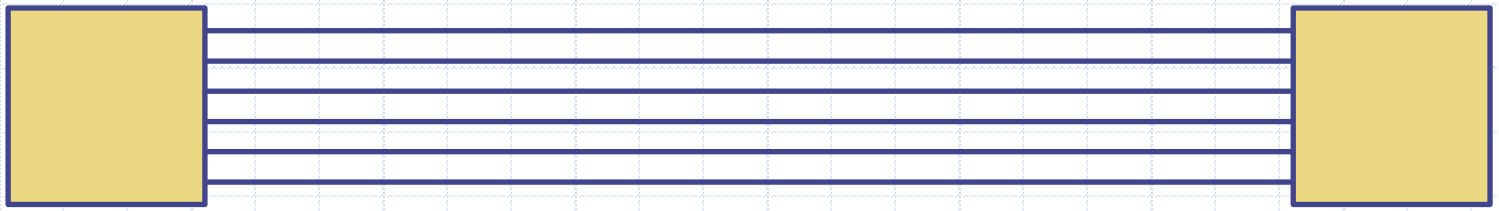
Communicating one bit.

Link (media)	'0'	'1'
Wire (kobber)	0V	5V
	12V	-12V
	FSK	
Radio (air)	AM	
	FM	
	frequency-hopping	

Link (media)	'0'	'1'
Light (fiber/air)	Color	
	No light	Light
	Flag down	Flag up

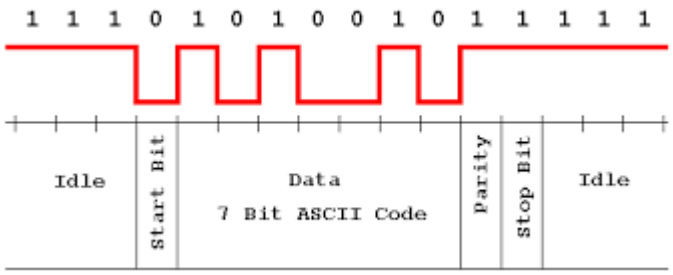
Communicating more information. (more bits).

Parrallel

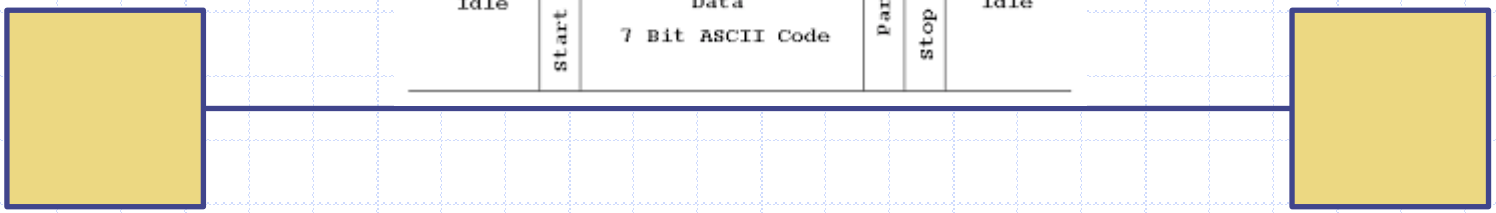


Computer/device

Computer/device



Seriel



Computer/device

Computer/device

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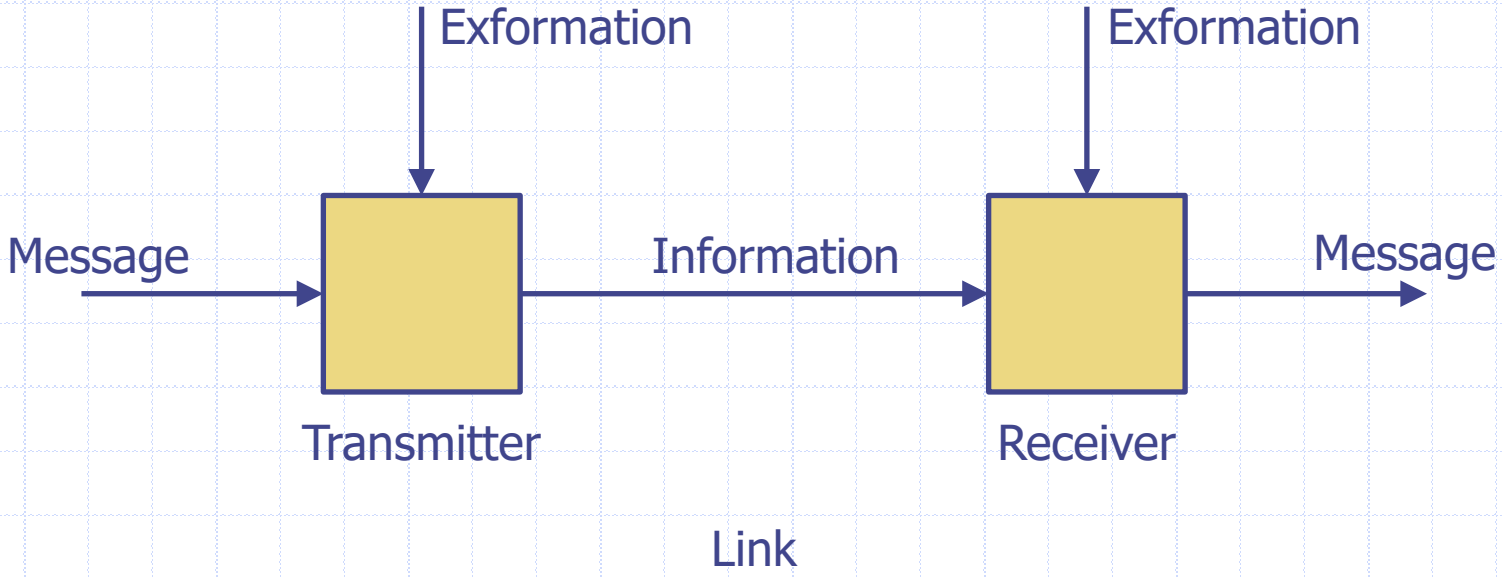
Information and exformation



To understand the message, the receiver needs to know the same exformation as the transmitter. They need to agree on a common protocol of communication.

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Data Communication

Distributed system / application

We will need an agreement or a protocol.

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Protocols

Even at 1 bit information, we need a protocol!

What does it mean?

- Electrically, 0v – 5V
- Mathematically, 0 – 1
- Logically, on – off
- Functionally, light – no light

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What is a protocol.

protocols define format, order of messages sent and received among network entities, and actions taken on message transmission, receipt

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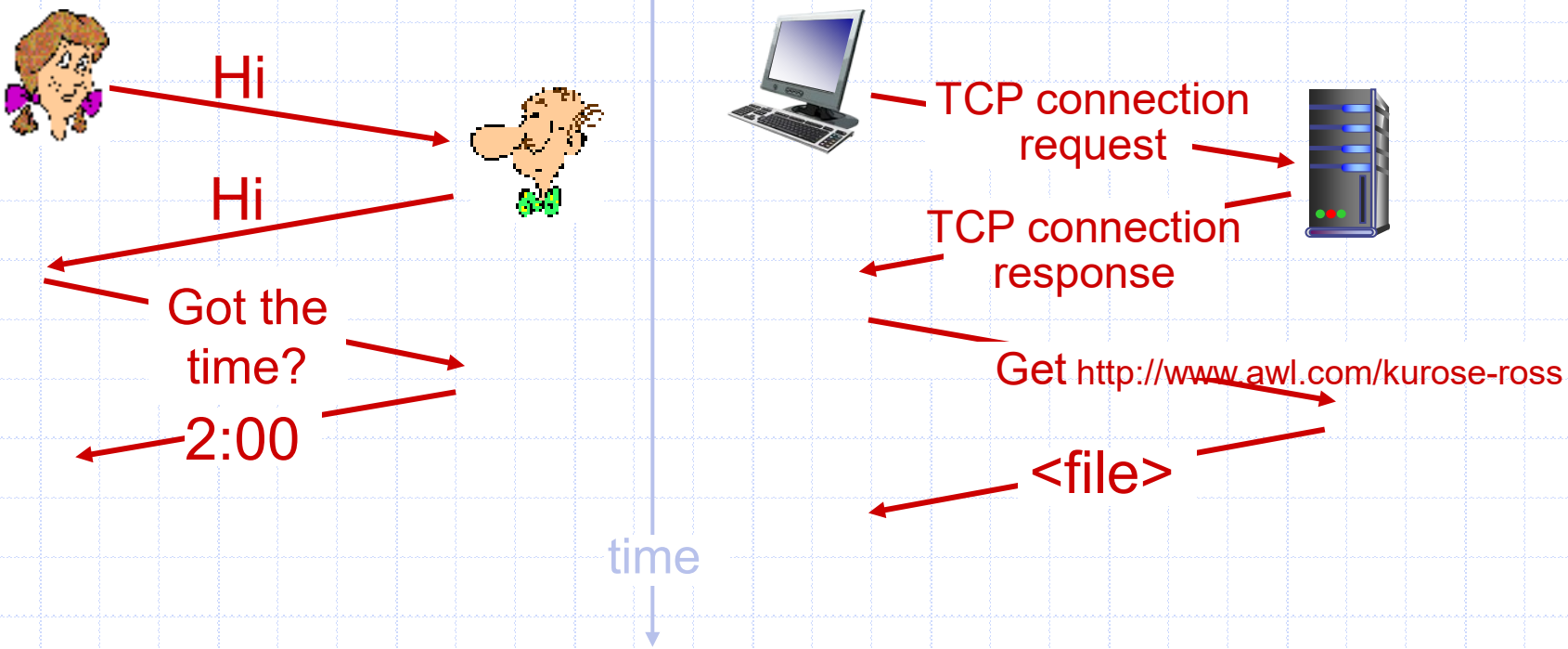
What's a protocol?

a human protocol and a computer network protocol:



Q: other human protocols?

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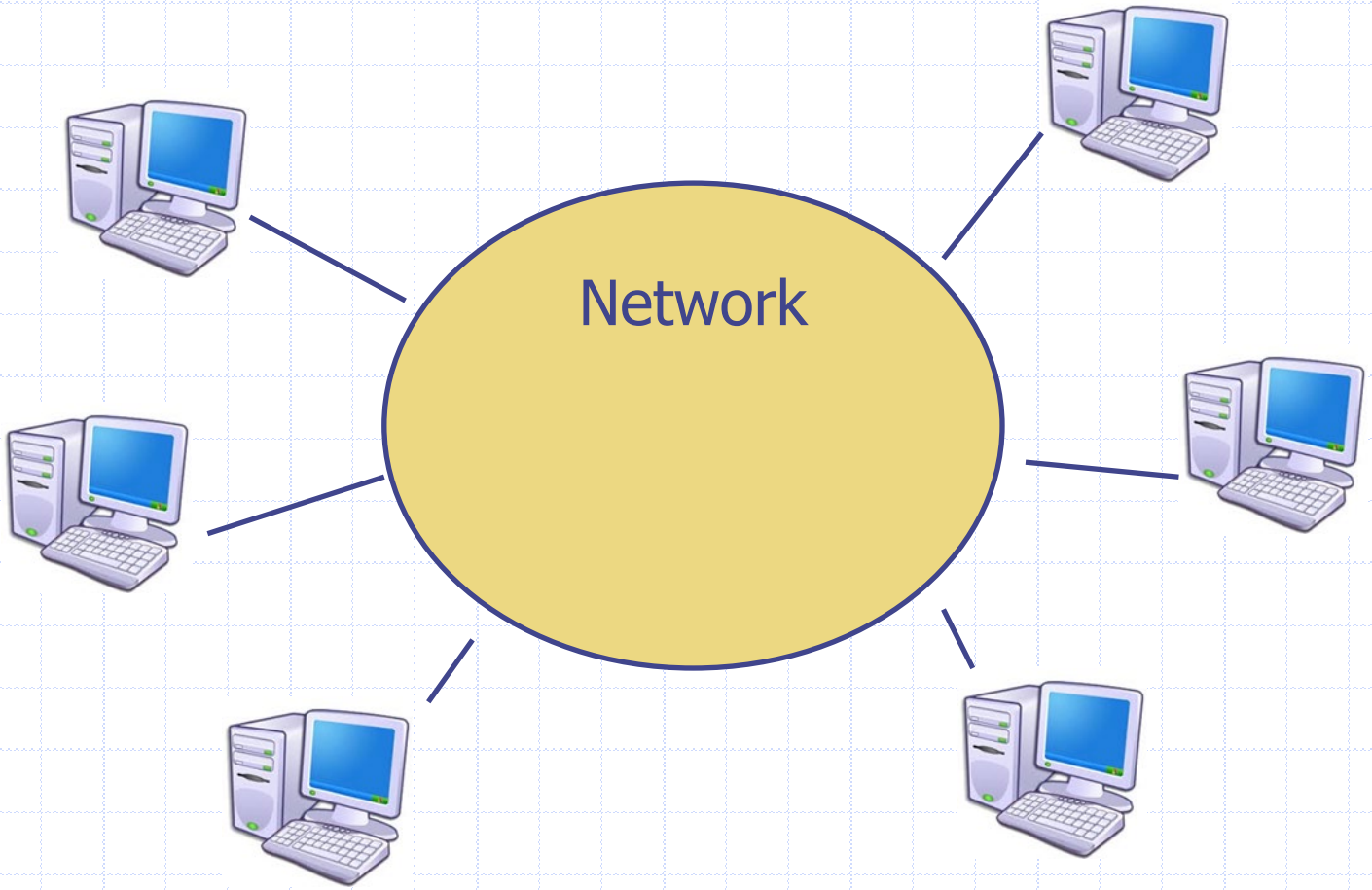
Communicating to more computers/devices.



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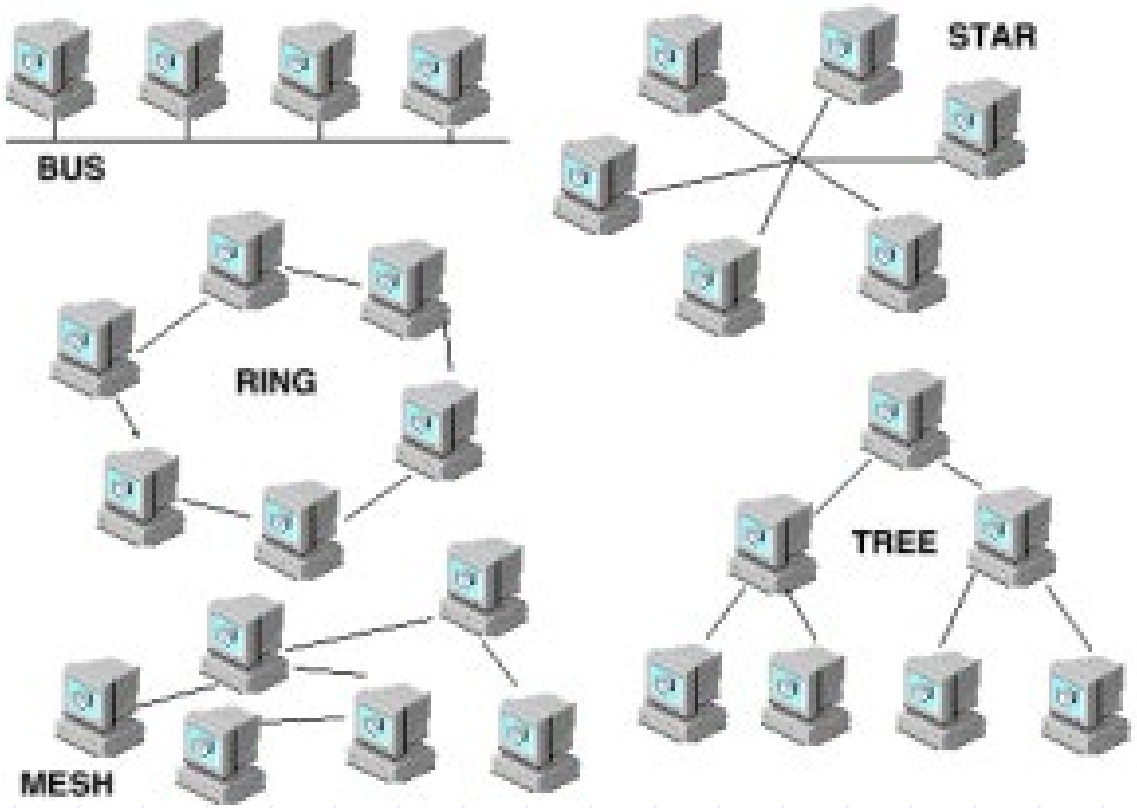
Network topologies



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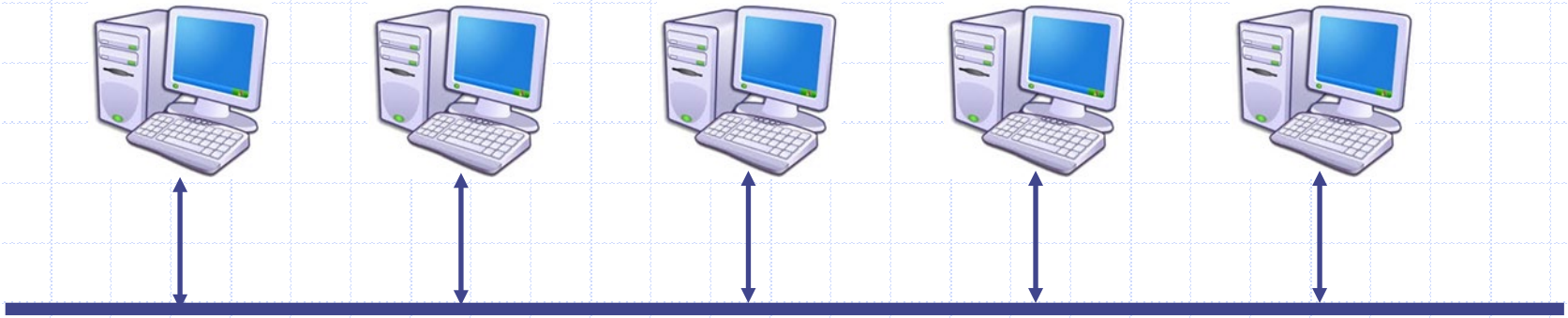
peer-to-peer / Multidrop

peer-to-peer

Multidrop



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Share the communication media.

- Synchronize.
- Token passing.
- FDM – Frequency Division Multiplexing.
- TDM – Time Division Multiplexing.
- Collision detect and recover.

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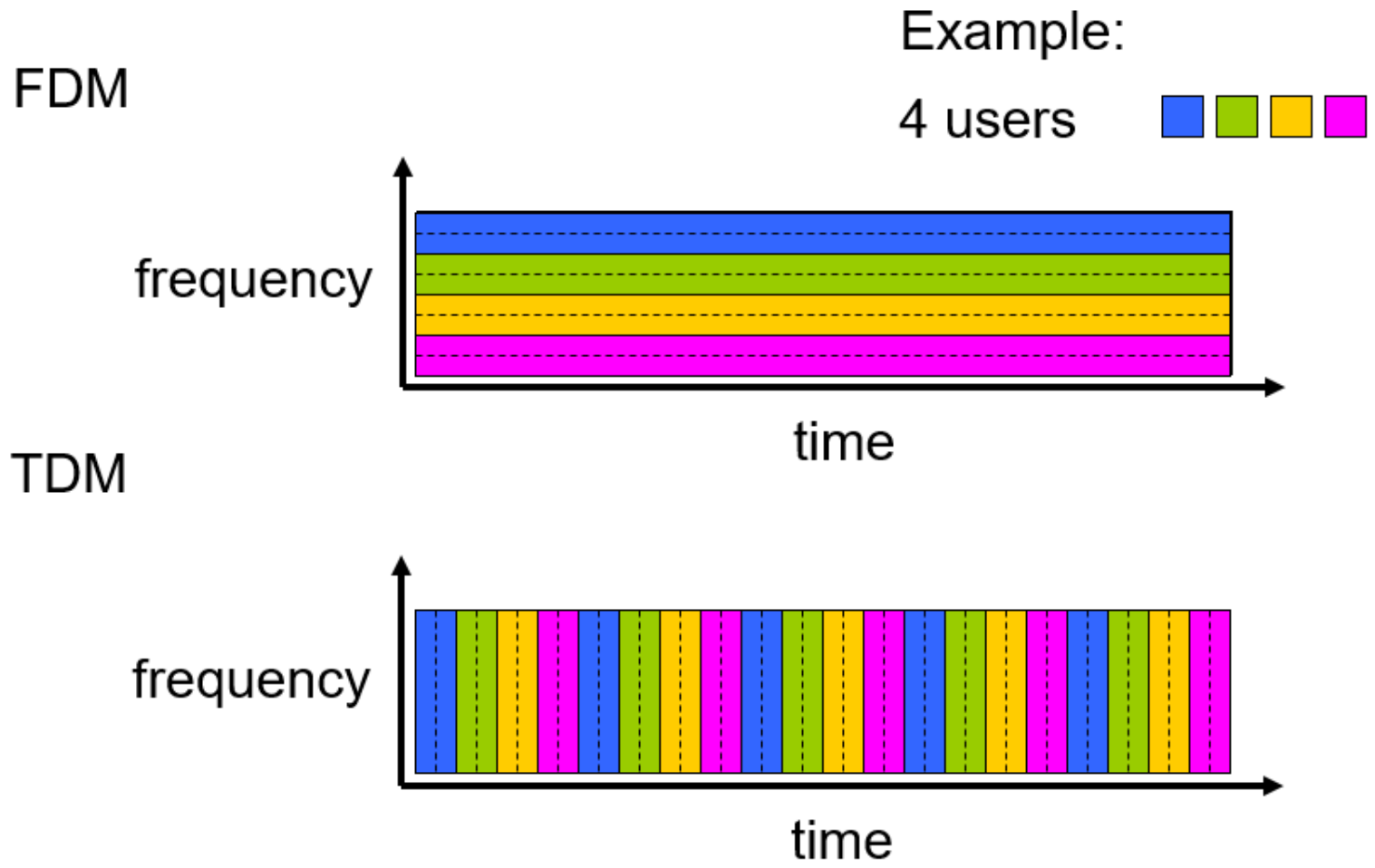
More links on one media.



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Hvad er: ”the Internet”?

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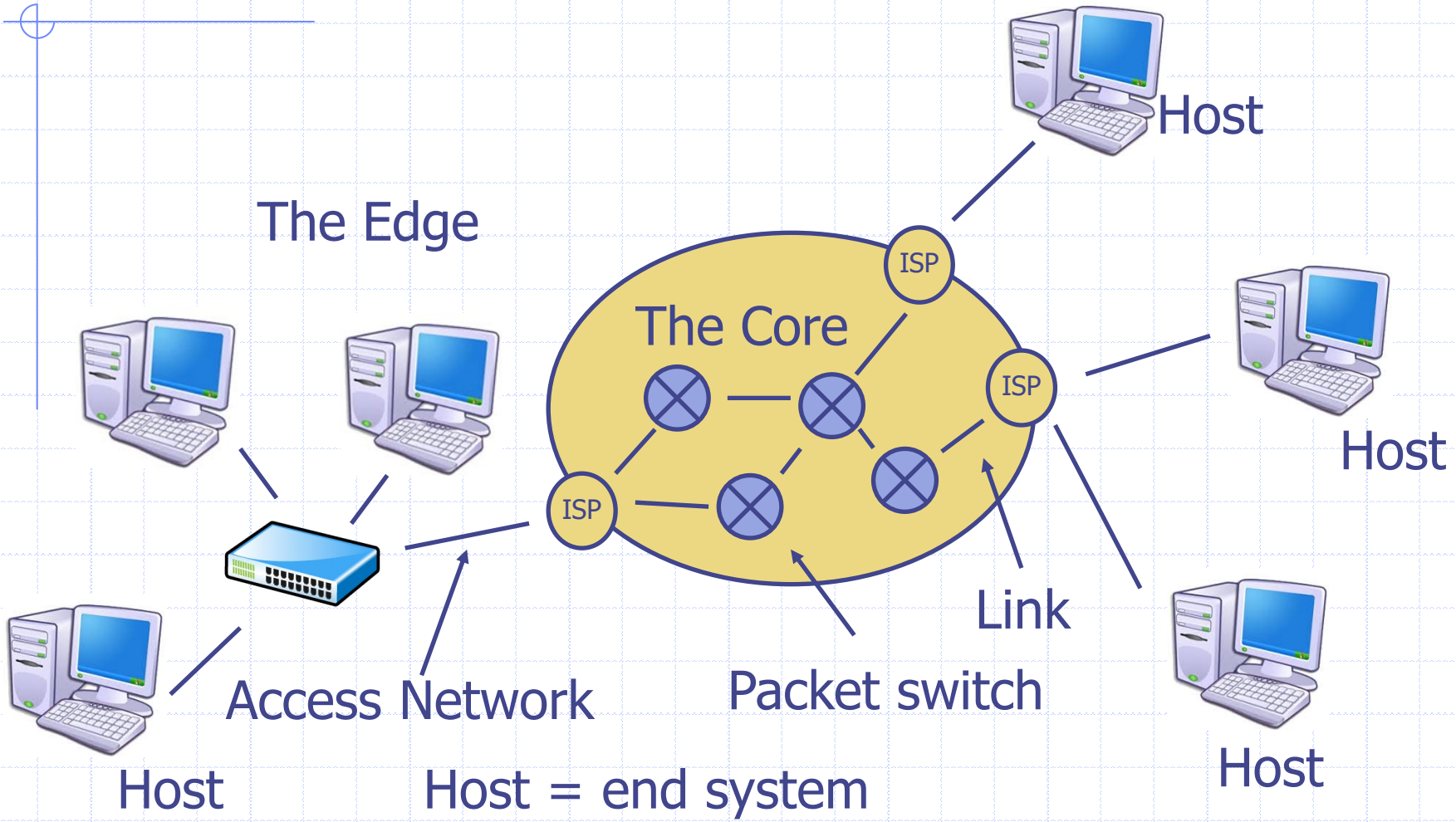
The Internet



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Nuts-and-Bolts of the internet

Host = end system

- Is hosting applications
- Can be a…
  - Computer
  - Device
  - Client
  - Server
  - ???

Packet switch

- Can be…
  - Link layer switch
  - Router

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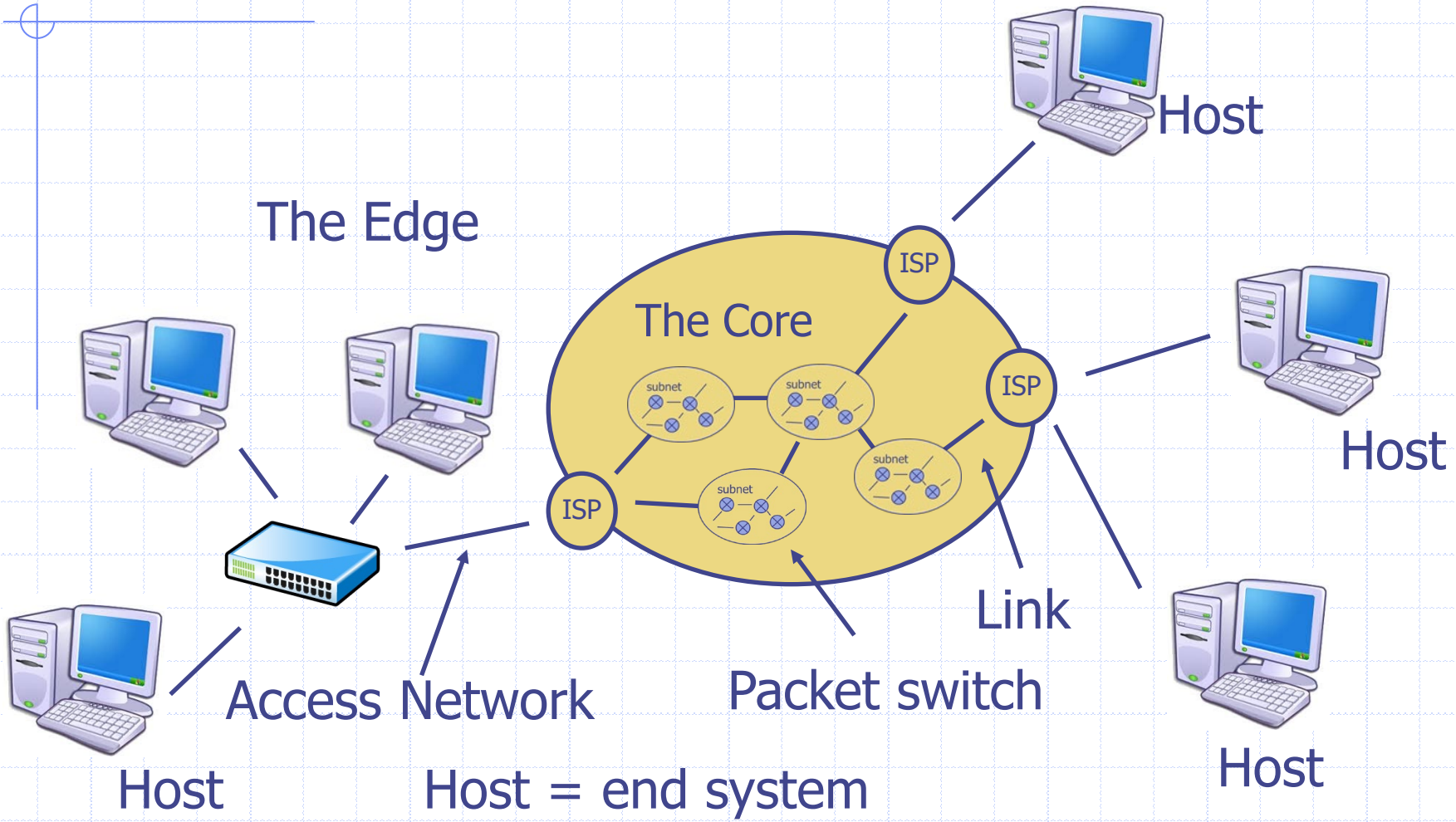
the Internet

Et netværk af netværk.



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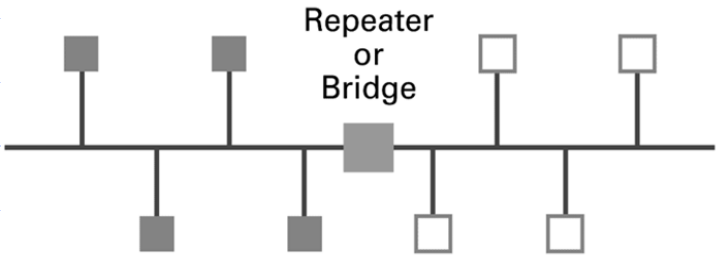
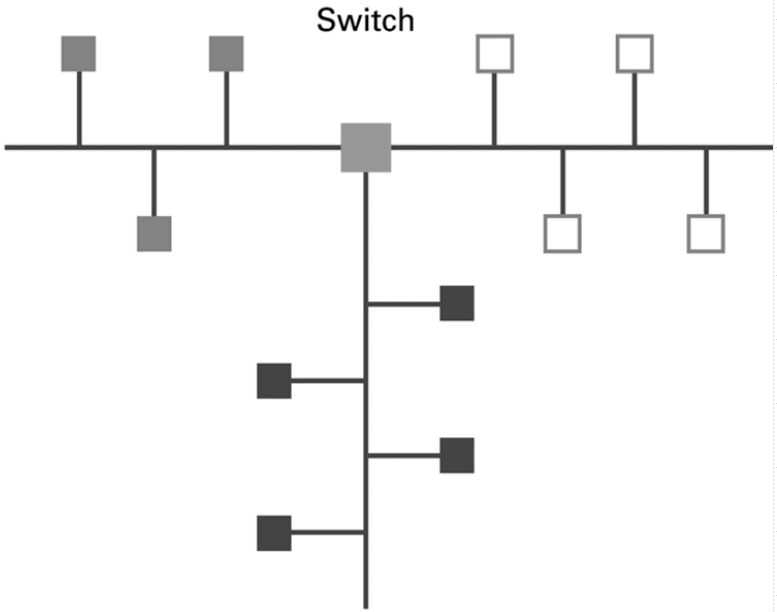
Building a large bus network from smaller ones



a. A repeater or bridge connecting two buses



b. A switch connecting multiple buses

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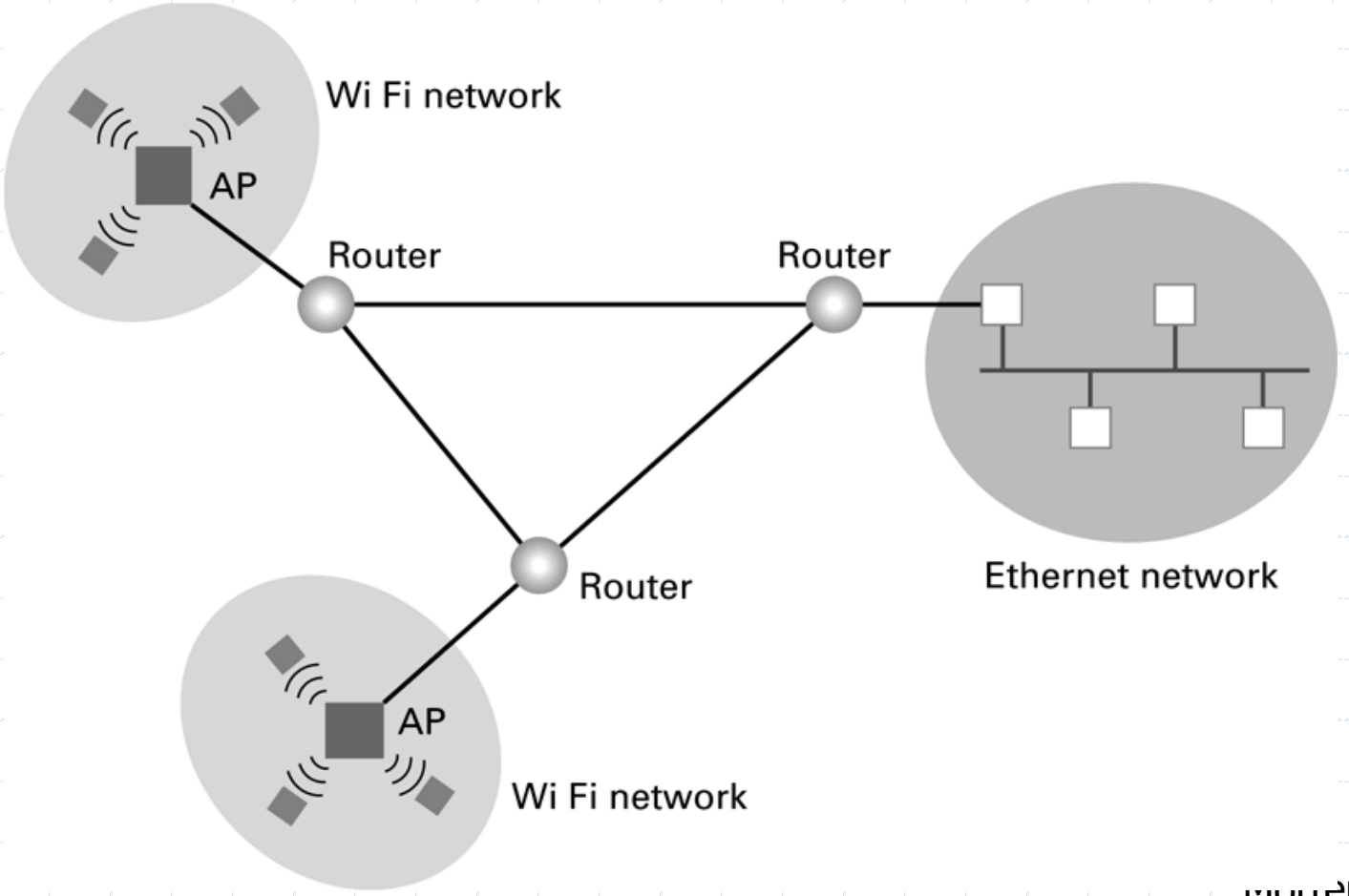
Routers connecting two WiFi networks and an Ethernet network to form an internet



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IP- adresser

- 32 bit
- 4 billion possible adresses.
- xxxxxxxx xxxxxxxx xxxxxxxx xxxxxxxx
- ddd.ddd.ddd.ddd
- f.eks.:
  - 192.168.1.12

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Subnetting

eksempler:

Subnet	Antal adresser	CIDR	Subnet mask
123.123.0.0	65536	123.123.0.0/16	255.255.0.0
123.123.123.128	128	123.123.123.128/25	255.255.255.128
123.123.122.0	512	123.123.122/23	255.255.254.0

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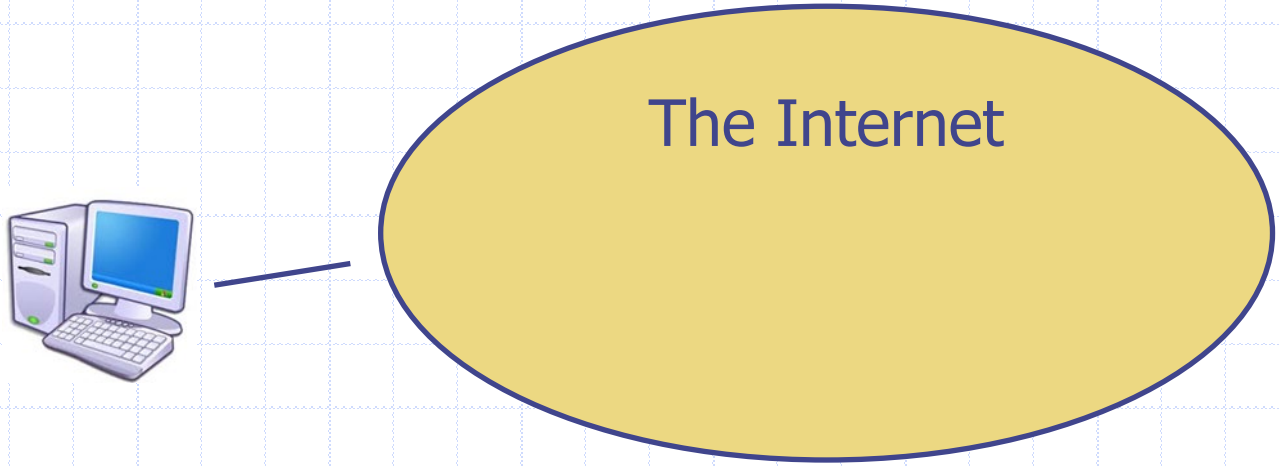
What services does the Internet offer?

You against the roar



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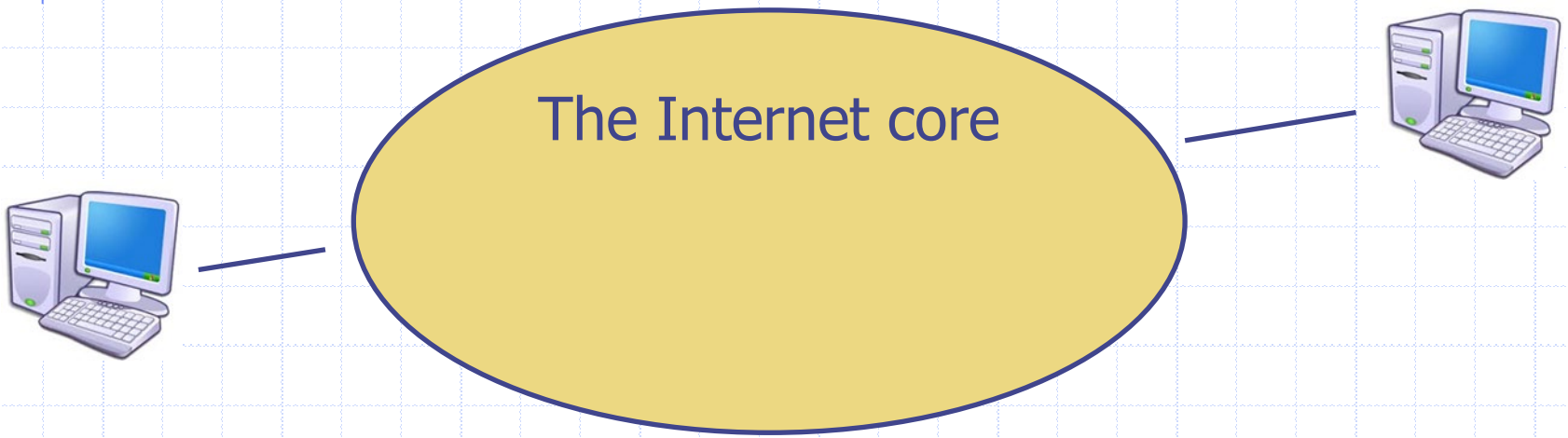
The Internet core offers transfer of messages from one end system to another end system



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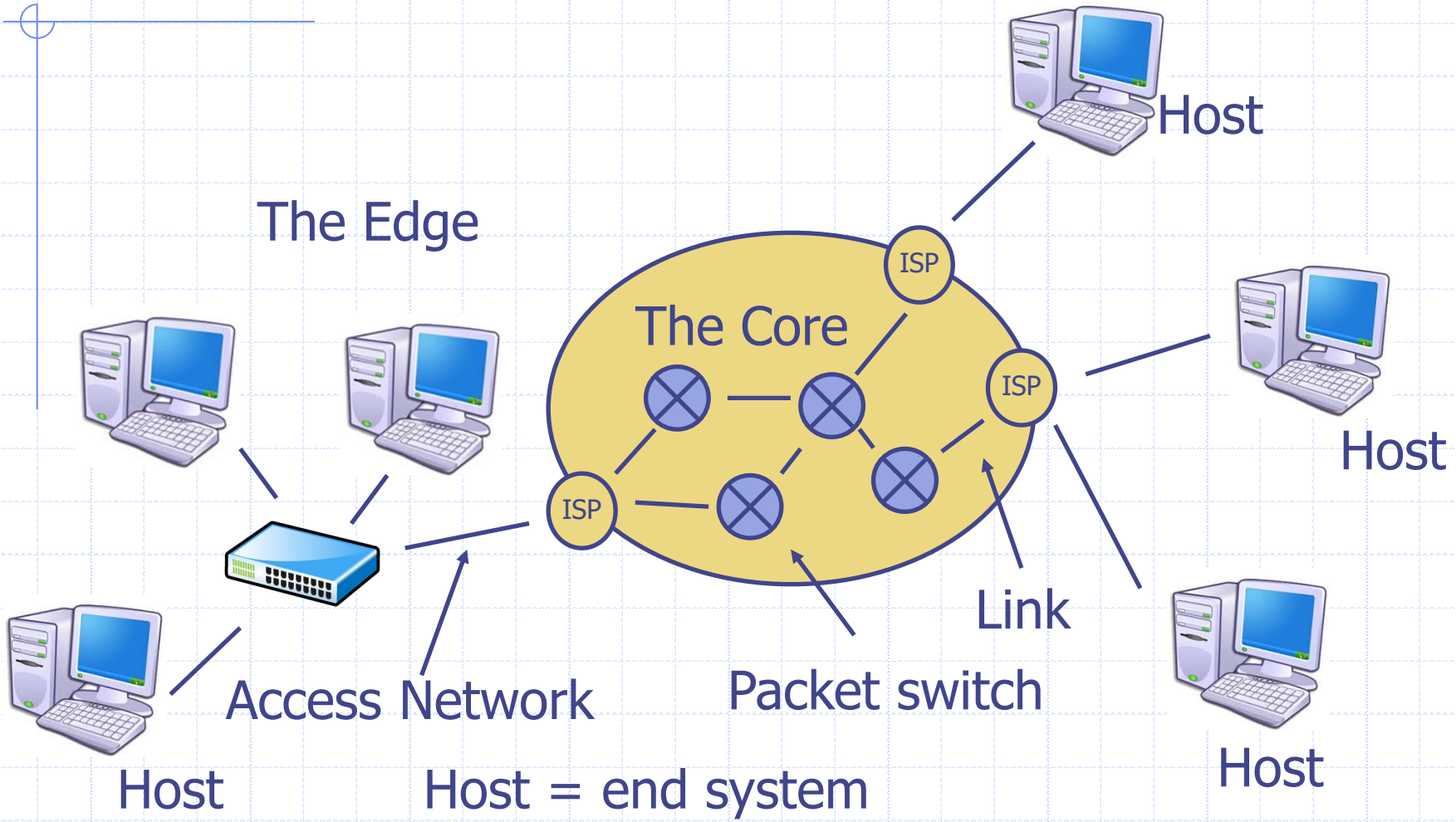
The core of the Internet



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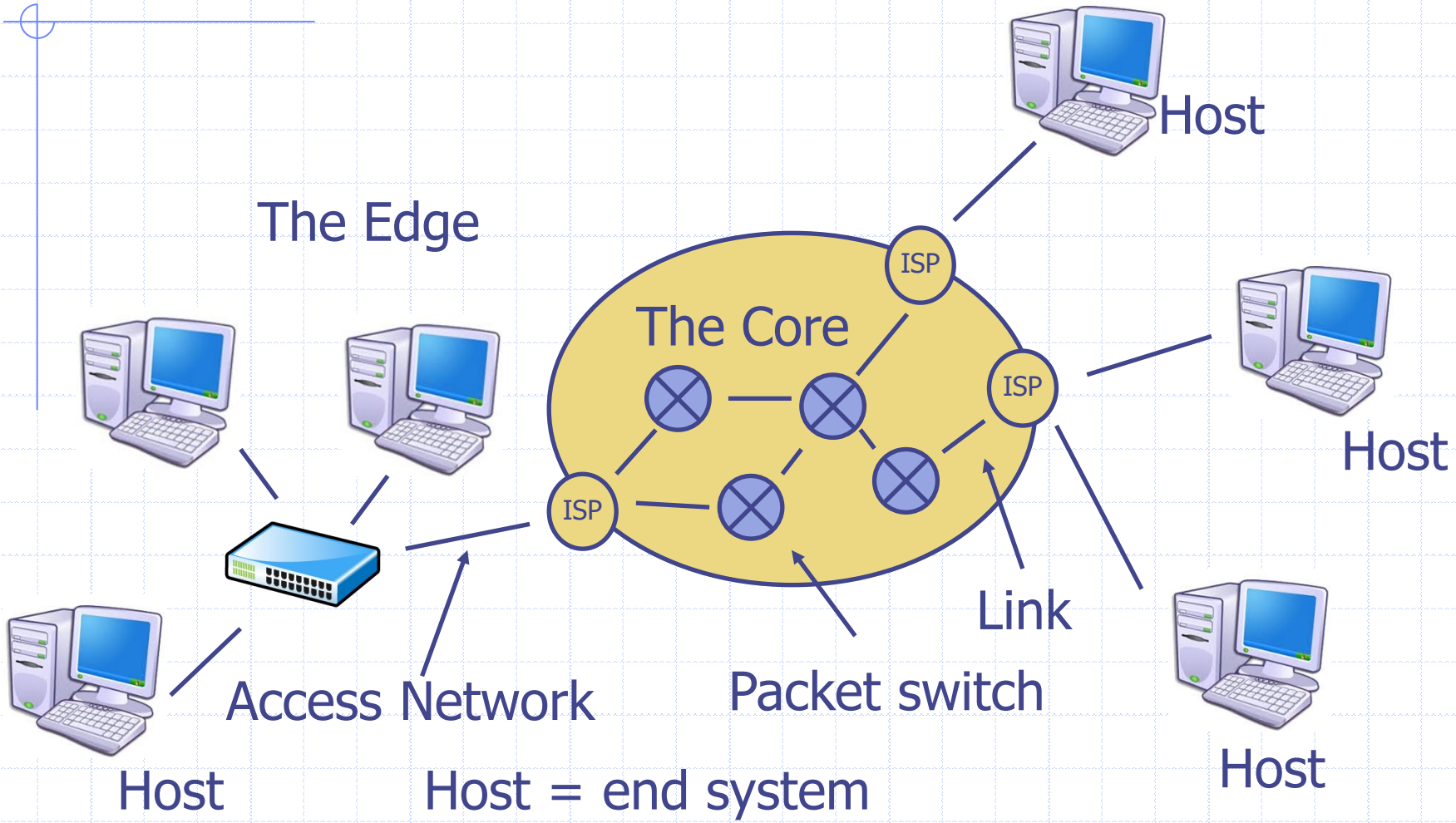
ISPs



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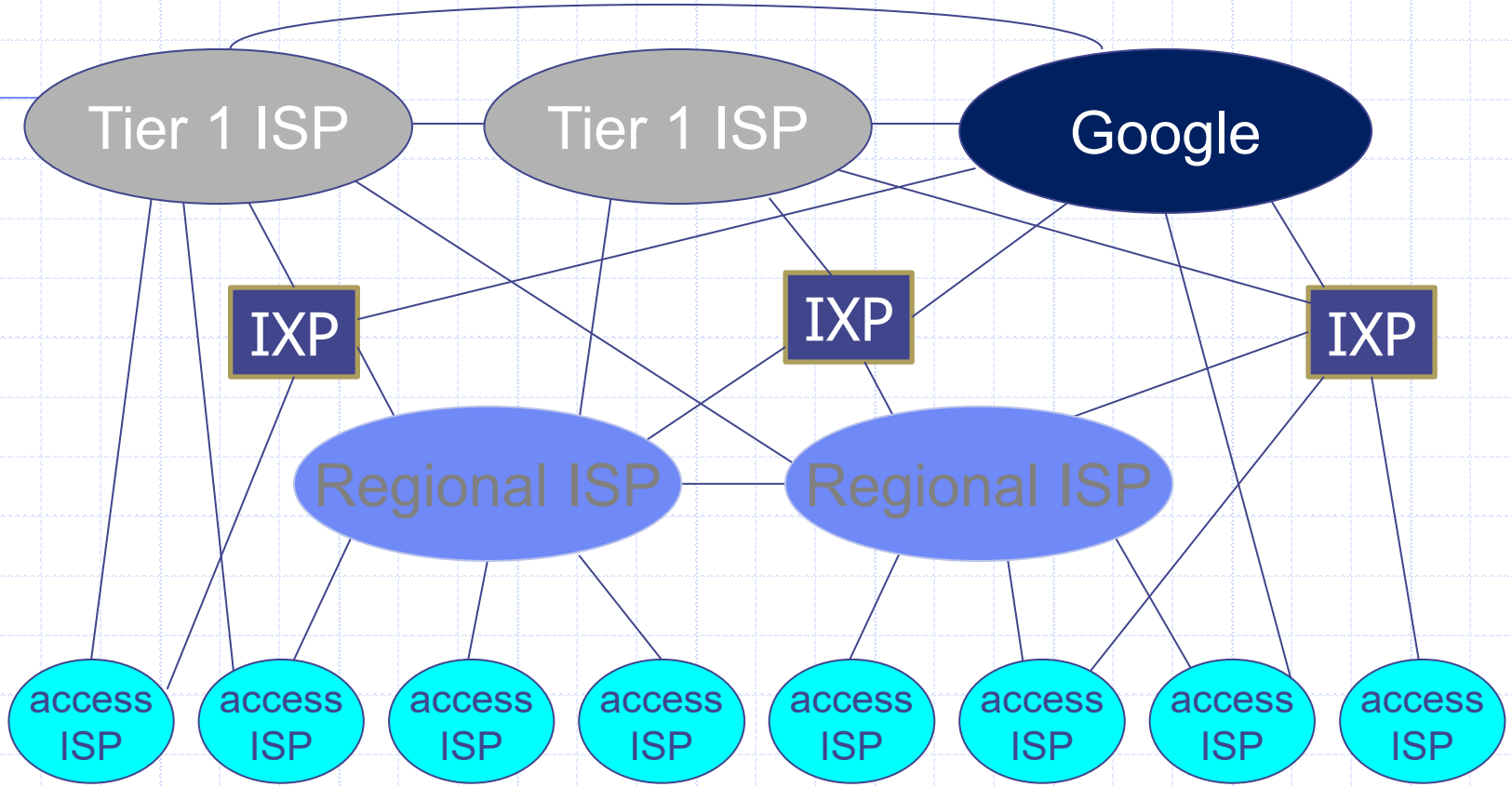
Internet structure: network of networks



- at center: small # of well-connected large networks
  - "tier-1" commercial ISPs (e.g., Level 3, Sprint, AT&T, NTT), national & international coverage
  - content provider network (e.g., Google): private network that connects it data centers to Internet, often bypassing tier-1, regional ISPs
- Internet Exchange points (IXPs)

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Internet Addressing

- IP address: pattern of 32 or 128 bits often represented in dotted decimal notation
- Mnemonic address:
  - Domain names
  - Top-Level Domains
- Domain name system (DNS)
  - Name servers
  - DNS lookup

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DNS: domain name system

people: many identifiers:

- SSN, name, passport #

Internet hosts, routers:

- IP address (32 bit) - used for addressing datagrams
- "name", e.g., www.yahoo.com - used by humans

Q: how to map between IP address and name, and vice versa ?

Domain Name System:

- *distributed database* implemented in hierarchy of many *name servers*
- *application-layer protocol:* hosts, name servers communicate to *resolve* names (address/name translation)
  - note: core Internet function, implemented as application-layer protocol
  - complexity at network's "edge"

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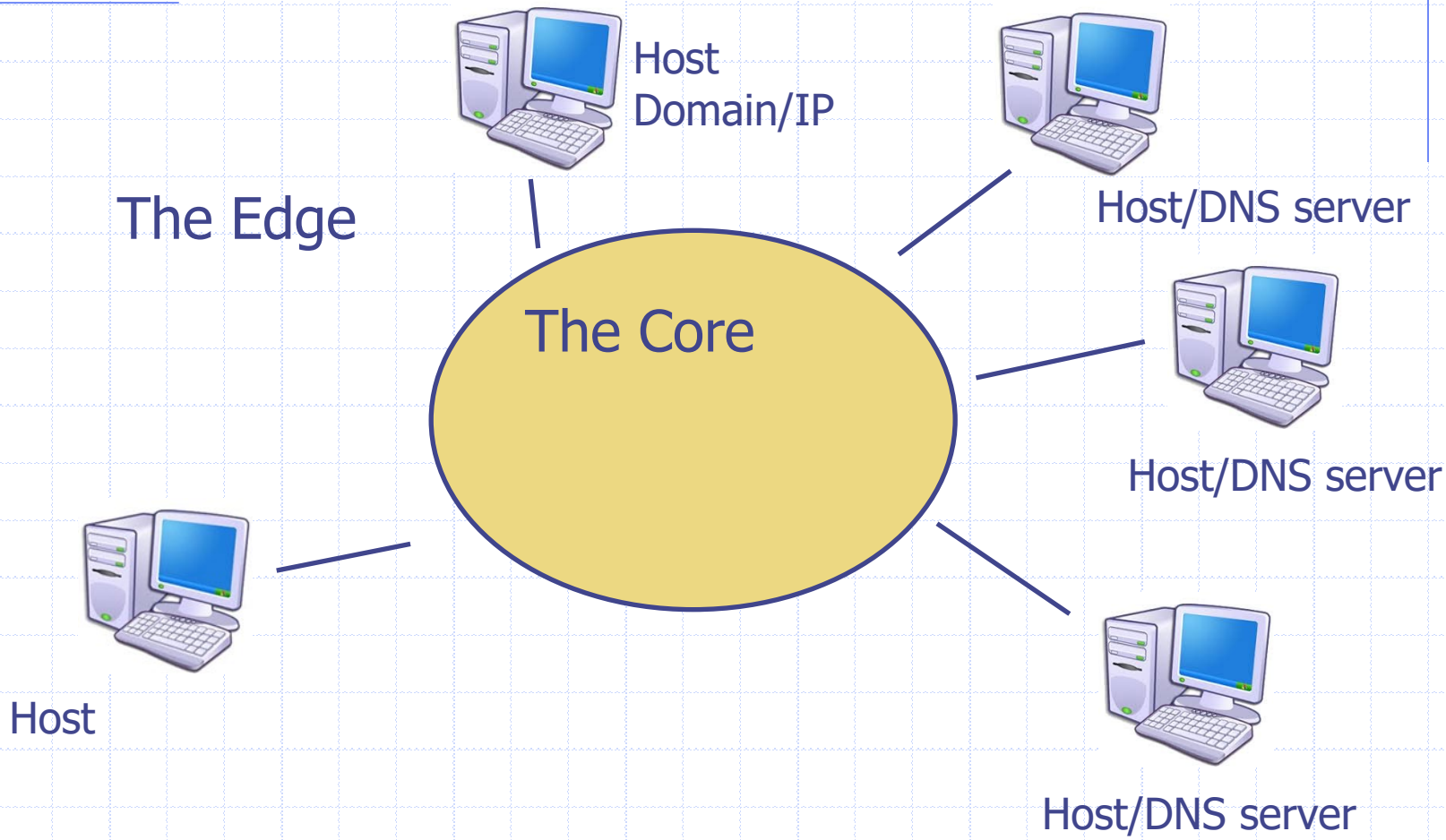
DNS. An application at the edge of the internet.



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DNS: services, structure

DNS services

- hostname to IP address translation
- host aliasing
  - canonical, alias names
- mail server aliasing
- load distribution
  - replicated Web servers: many IP addresses correspond to one name

why not centralize DNS?

- single point of failure
- traffic volume
- distant centralized database
- maintenance

A: doesn't scale!

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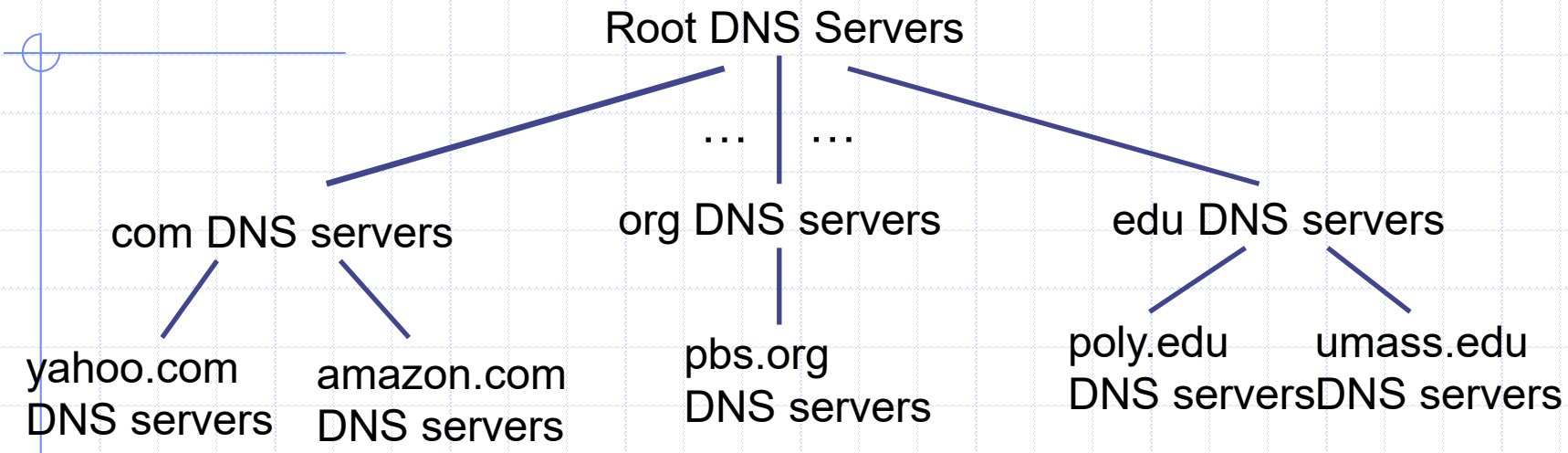
DNS: a distributed, hierarchical database



client wants IP for www.amazon.com; 1st approximation:

- client queries root server to find com DNS server
- client queries .com DNS server to get amazon.com DNS server
- client queries amazon.com DNS server to get IP address for www.amazon.com

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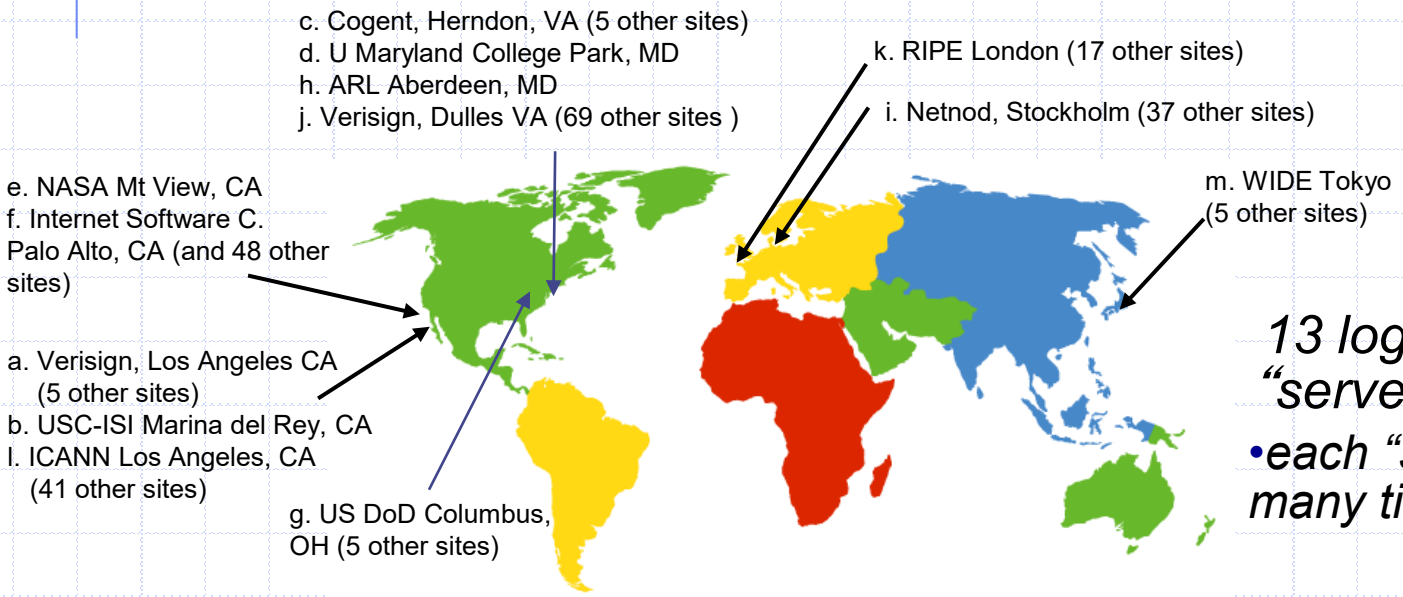
DNS: root name servers

- contacted by local name server that can not resolve name
- root name server:
  - contacts authoritative name server if name mapping not known
  - gets mapping
  - returns mapping to local name server



13 logical root name "servers" worldwide

- *each "server" replicated many times*

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Internet Corporation for Assigned Names & Numbers (ICANN)

- Allocates IP addresses to ISPs who then assign those addresses within their regions.
- Oversees the registration of domains and domain names.

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Early Internet Applications

- Network News Transfer Protocol (NNTP)
- File Transfer Protocol (FTP)
- Telnet and SSH
- Hypertext Transfer Protocol (HTTP)
- Electronic Mail (email)
  - Domain mail server collects incoming mail and transmits outing mail (SMTP)
  - Mail server delivers collected incoming mail to clients via POP3 or IMAP

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Some network apps

- e-mail
- web
- text messaging
- remote login
- P2P file sharing
- multi-user network games
- streaming stored video (YouTube, Hulu, Netflix)
- voice over IP (e.g., Skype)
- real-time video conferencing
- social networking
- search
- …
- …
- …
- Custom/proprietary applications.

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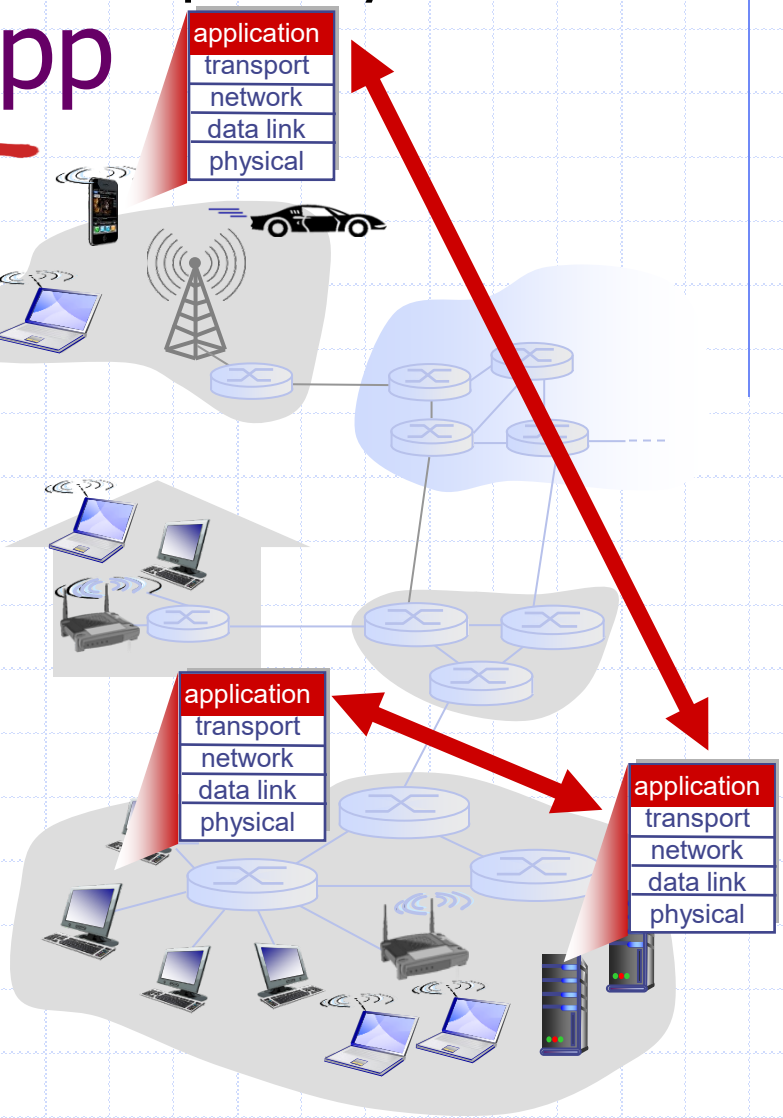
Creating a network app

write programs that:

- run on (different) *end systems*
- communicate over network
- e.g., web server software communicates with browser software

no need to write software for network-core devices

- network-core devices do not run user applications
- applications on end systems allows for rapid app development, propagation



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Distributed Systems

- Systems with parts that run on different computers
  - Cluster computing
  - Grid computing
  - Cloud computing
    - Amazon's Elastic Compute Cloud
    - Google Drive

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Application architectures

possible structure of applications:

- client-server
- peer-to-peer (P2P)
- Publish / subscribe

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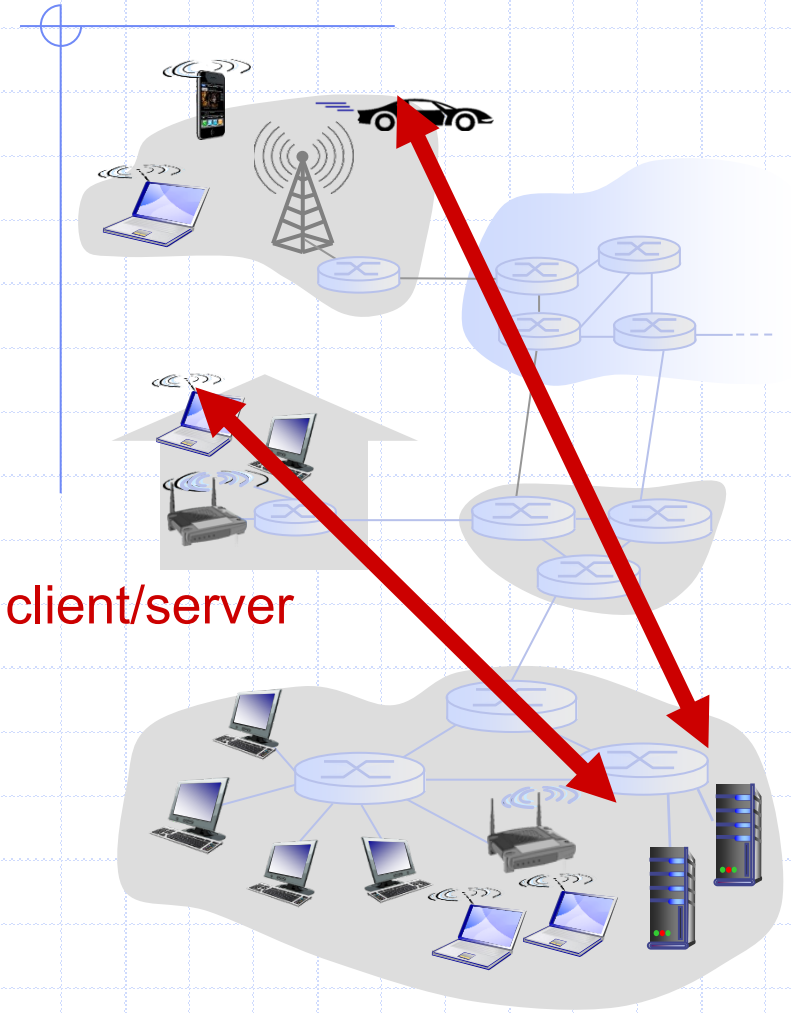
Client-server architecture



server:

- always-on host
- permanent IP address
- data centers for scaling

clients:

- communicate with server
- may be intermittently connected
- may have dynamic IP addresses
- do not communicate directly with each other

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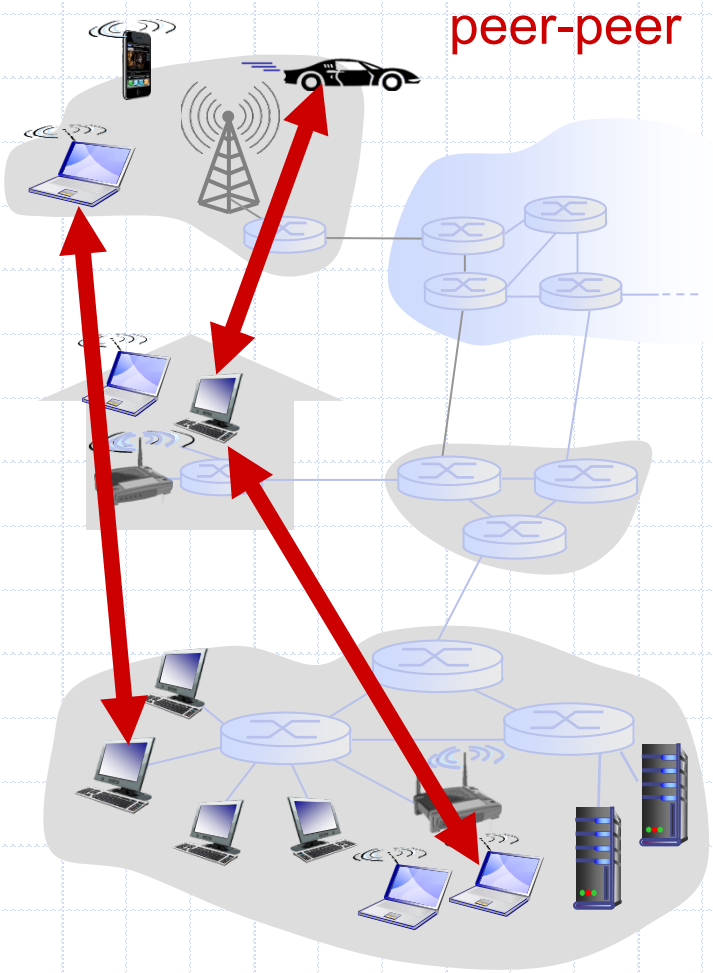
P2P architecture

- *no* always-on server
- arbitrary end systems directly communicate
- peers request service from other peers, provide service in return to other peers
  - *self scalability* – new peers bring new service capacity, as well as new service demands
- peers are intermittently connected and change IP addresses
  - complex management



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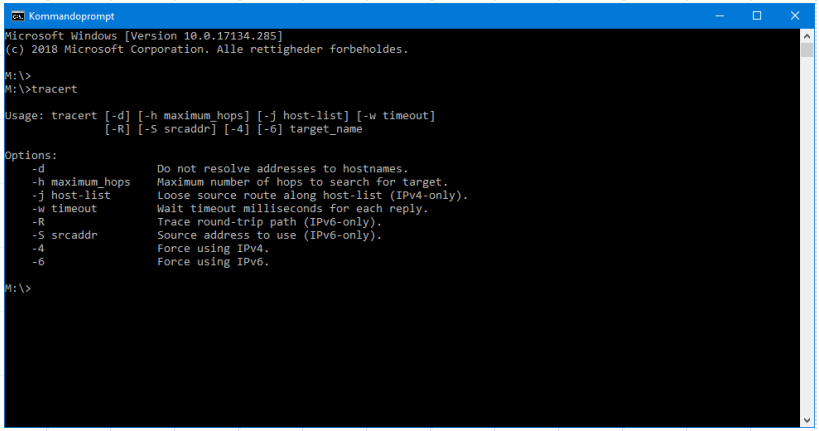
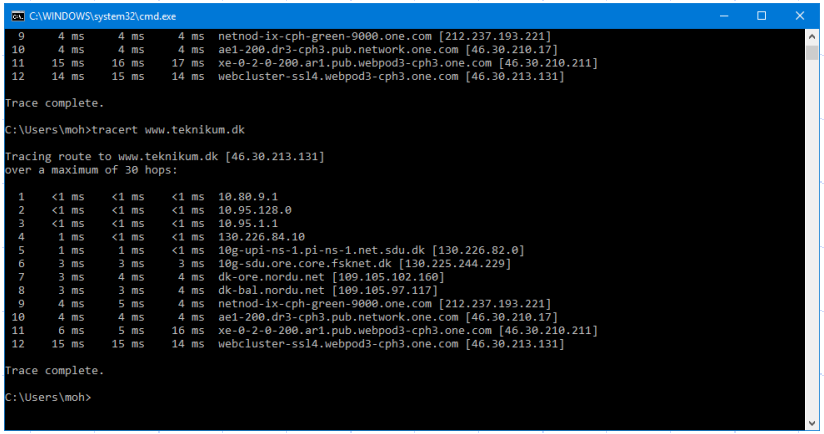
EXTRA: <traceroute

Type: tracert in the command prompt.





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Traceroute

- www.traceroute.org
- Find your public ip-address. Eg. at: www.whatismyip.com
- Traceroute utilizes the TTL (Time to Live or hop limit) field of the ip-protocol.

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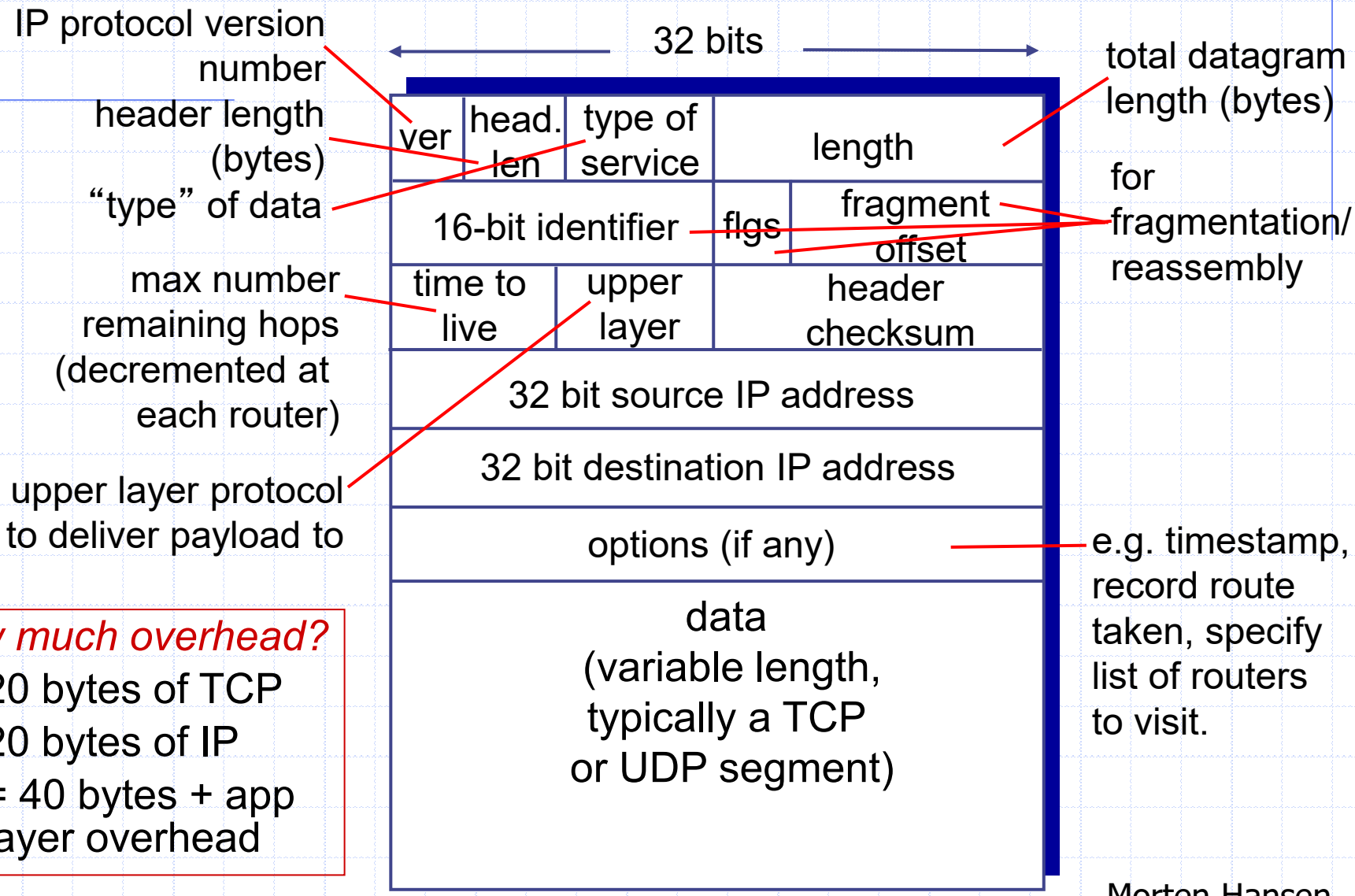
IP datagram format



how much overhead?

- 20 bytes of TCP
- 20 bytes of IP
- = 40 bytes + app layer overhead

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"Real" Internet delays, routes

traceroute: gaia.cs.umass.edu to www.eurecom.fr

3 delay measurements from gaia.cs.umass.edu to cs-gw.cs.umass.edu

```
1  cs-gw (128.119.240.254)  1 ms  1 ms  2 ms
2  border1-rt-fa5-1-0.gw.umass.edu (128.119.3.145)  1 ms  1 ms  2 ms
3  cht-vbns.gw.umass.edu (128.119.3.130)  6 ms 5 ms 5 ms
4  jn1-at1-0-0-19.wor.vbns.net (204.147.132.129)  16 ms 11 ms 13 ms
5  jn1-so7-0-0-0.wae.vbns.net (204.147.136.136)  21 ms 18 ms 18 ms
6  abilene-vbns.abilene.ucaid.edu (198.32.11.9)  22 ms  18 ms  22 ms
7  nycm-wash.abilene.ucaid.edu (198.32.8.46)  22 ms  22 ms  22 ms
8  62.40.103.253 (62.40.103.253)  104 ms 109 ms 106 ms
9  de2-1.de1.de.geant.net (62.40.96.129)  109 ms 102 ms 104 ms
10  de.fr1.fr.geant.net (62.40.96.50)  113 ms 121 ms 114 ms
11  renater-gw.fr1.fr.geant.net (62.40.103.54)  112 ms  114 ms  112 ms
12  nio-n2.cssi.renater.fr (193.51.206.13)  111 ms  114 ms  116 ms
13  nice.cssi.renater.fr (195.220.98.102)  123 ms  125 ms  124 ms
14  r3t2-nice.cssi.renater.fr (195.220.98.110)  126 ms  126 ms  124 ms
15  eurecom-valbonne.r3t2.ft.net (193.48.50.54)  135 ms  128 ms  133 ms
16  194.214.211.25 (194.214.211.25)  126 ms  128 ms  126 ms
17  * * *
18  * * *
19  fantasia.eurecom.fr (193.55.113.142)  132 ms  128 ms  136 ms
```

trans-oceanic link

* means no response (probe lost, router not replying)

* Do some traceroutes from exotic countries at www.traceroute.org

Introduction 1-50

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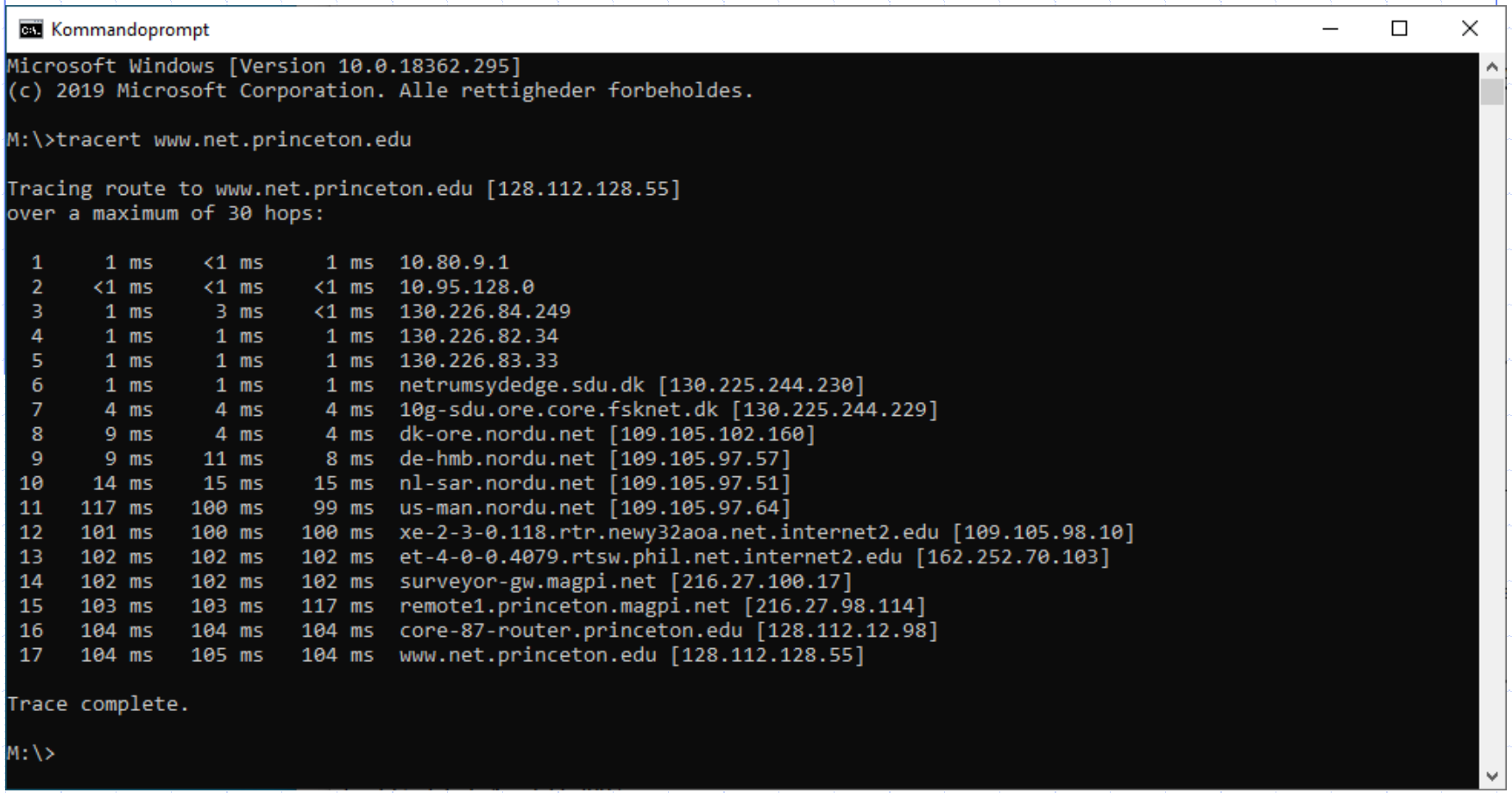
Teachers example



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Spørgsmål?

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