Lecture 1
Course Introduction

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The course

- About me
- Separate course descriptions
- Content
  - Data communication and computer networks
  - Basic network concepts, network layers and network protocols
  - The structure of the internet and the TCP/IP model
  - Protocols and services of the application layer, the transport layer, the network layer and the link layer
  - Security in computer networks
  - Analyzing network traffic
  - Socket programming

The course

- Goals
  - ..to accept that a Computer network (especially the Internet) can actually work.
  - ..to realize how and for what purposes, we can use the Internet.
  - ..to be able to code basic computer systems with a distributed functionality over the internet.
  - ..to be able to design a communication protocol to match the requirements of an application

The course

- The Exam:
  - Oral exam, the Danish 7-point grading scale.

- Examination conditions:
  - Mandatory exercises submitted on time and in accordance with the requirements specified during the semester. This applies **only** to:
    - Health Informatics and Technology
    - Game Development and Learning Technology (Bsc and Msc)
    - Exchange students

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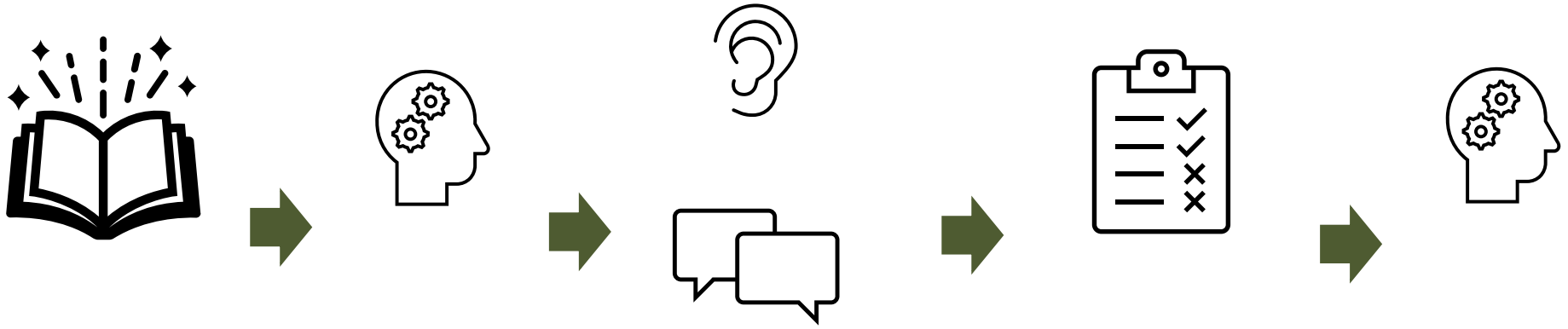
The course

Data Communication

Computer Networks

The Internet

Recommended Approach



Audio and video recordings

To allow a free discussion in the class, where everybody can ask questions and make comments of all kinds, it is **NOT allowed** to make audio nor video recordings in the classes.

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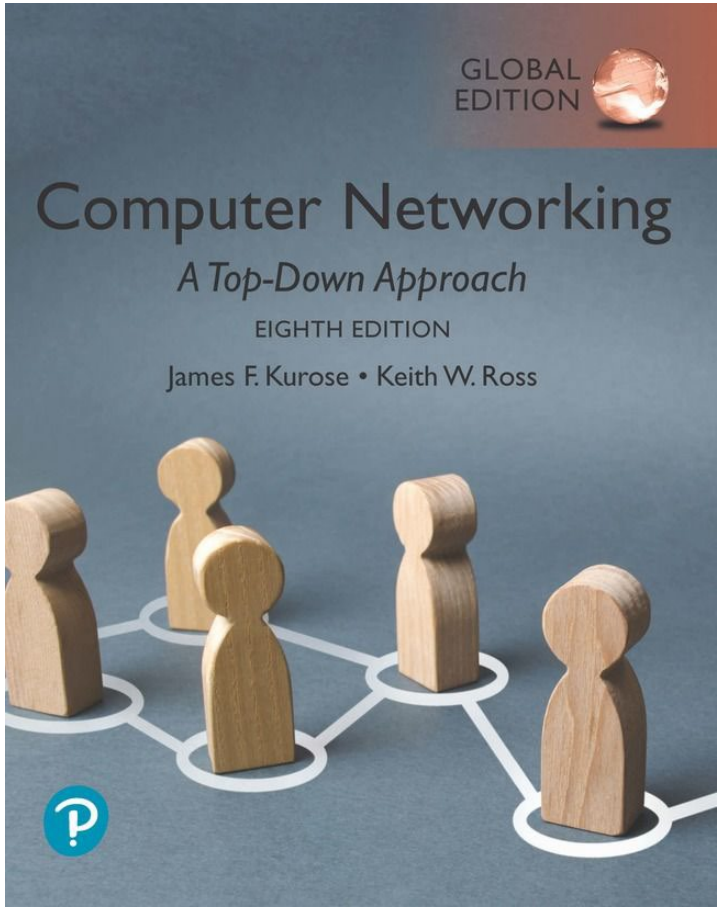
The book

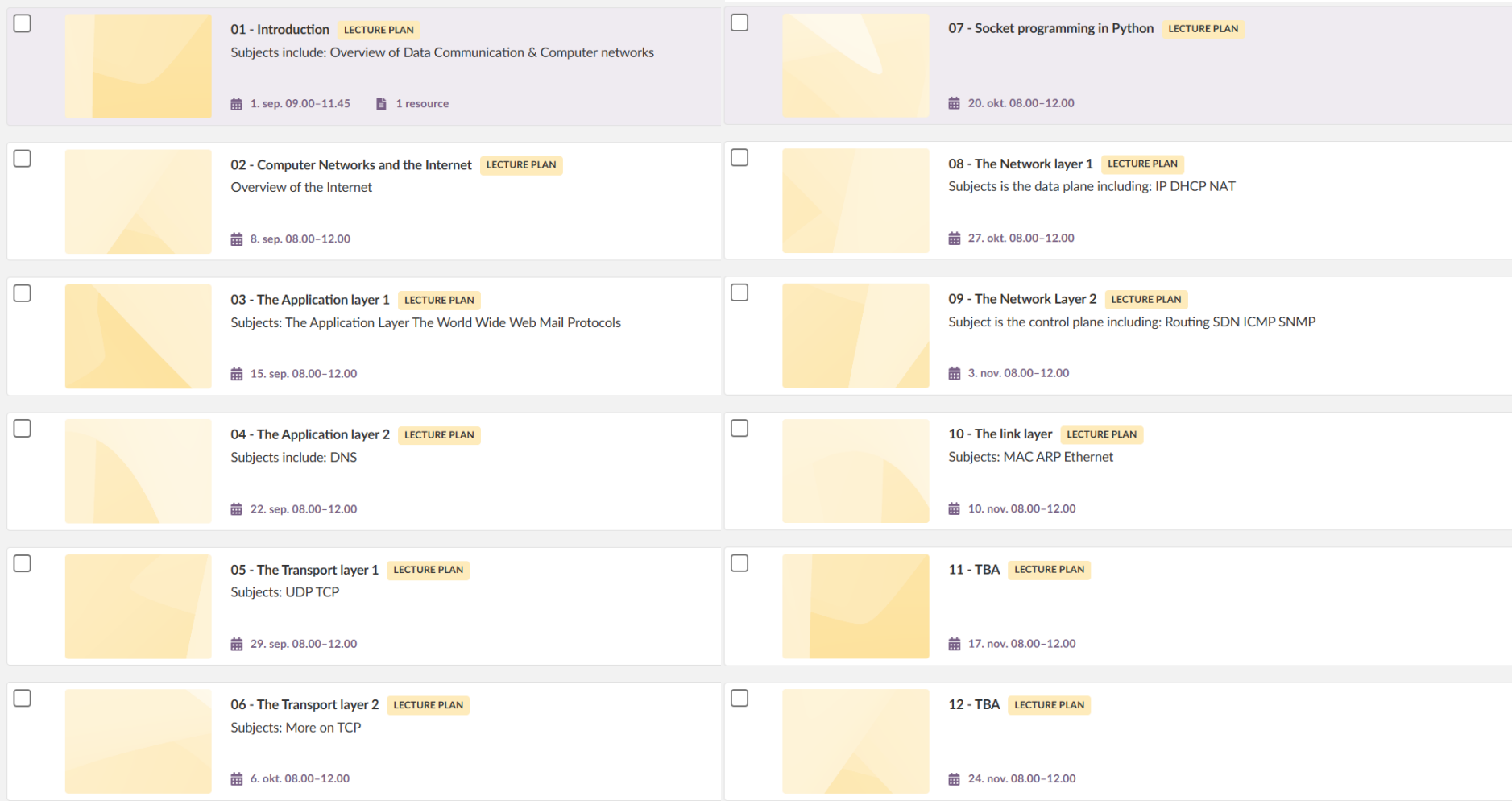
Kurose and Ross
Computer Networking: A Top-Down Approach, 8th Edition
ISBN-13: 978-1-292-40546-9



The Website: https://gaia.cs.umass.edu/kurose_ross/index.php
contains slides and exercises.

9th edition just published!

The Plan – See ItsLearning



Data Communication

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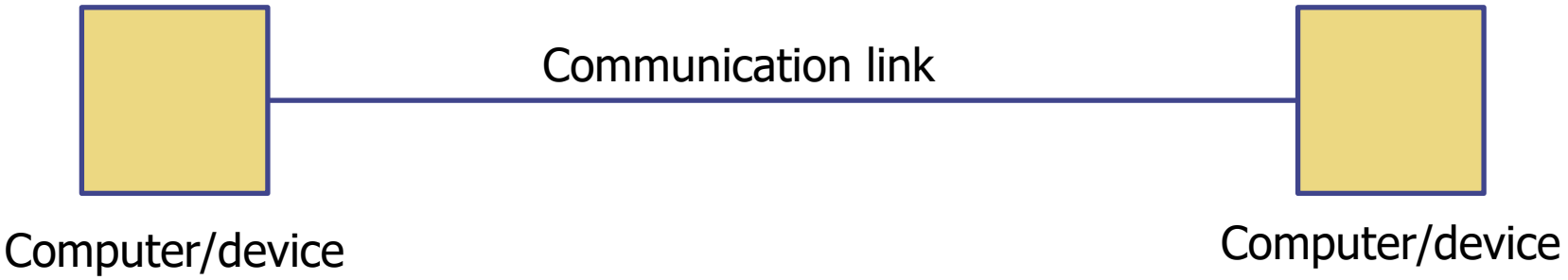
Subjects of today:

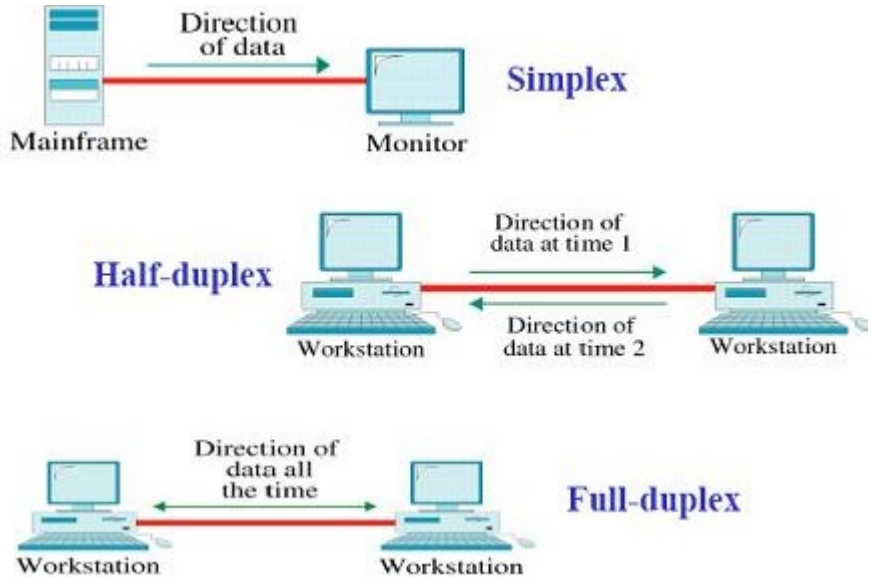
- Transmitter – media – receiver
- simplex – half duplex – duplex
- Protocols: ASCII / Binary
- Bits and bytes
- Big Endian / Little Endian
- Layering and encapsulation
- The OSI-model
- Multiplexing
- Network topologies
- peer-to-peer / Multidrop
- token / collision detect
- Bitrate and propagation delay

Data Communication



Distributed system / application

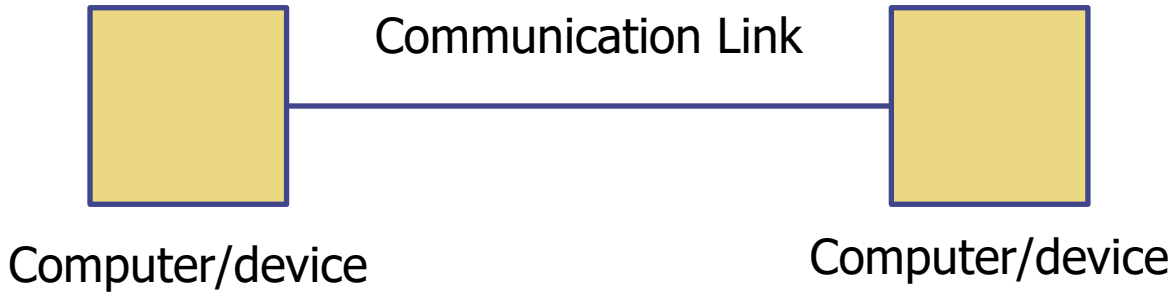
Transmission Modes



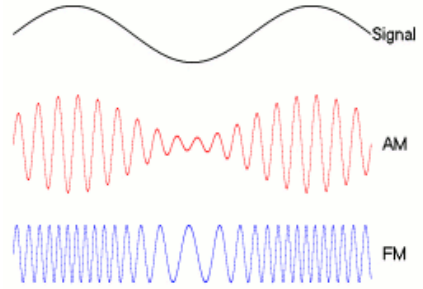
Bits and bytes

- Bit is the unit of information.
- 1 bit is the smallest amount of information.
- Information is a measurement of the magnitude of possibilities. E.g.
  - On or off (1 bit)
  - 4 states (2 bits)
  - Numbers (→ more bits)
- Number of possible outcome = 2^n, where n is the number of bits.
- We like to gather bits in chunks of 8, called: bytes.

Communicating one bit.



Link (media)	'0'	'1'
Wire (copper)	0V	5V
	12V	-12V
	FSK	
Radio (air)	AM	
	FM	
	frequency-hopping	
Light (fiber/air)	Color	
	No light	Light
	Flag down	Flag up



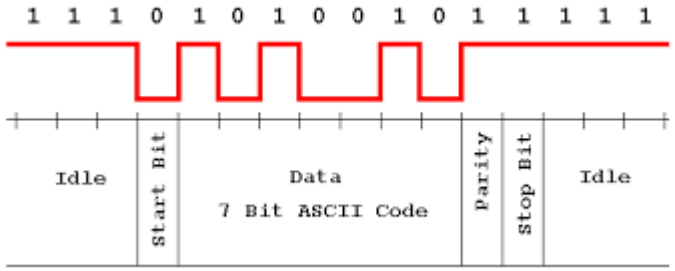
Source: https://en.wikipedia.org/wiki/Amplitude_modulation

Communicating more information. (more bits).

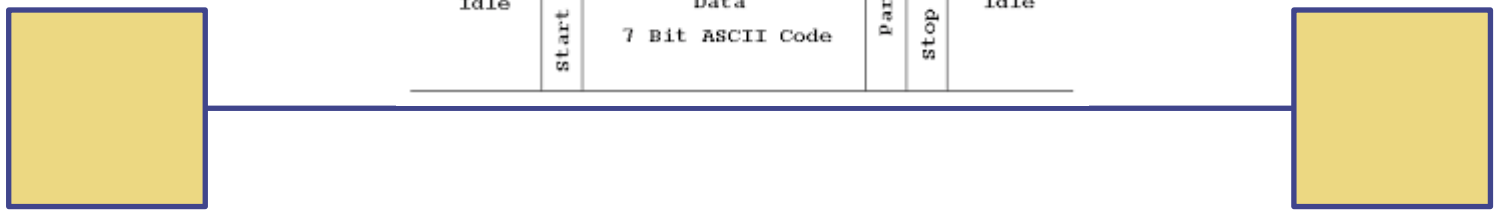
Parrallel

Computer/device

Computer/device



Serial



Computer/device

Computer/device

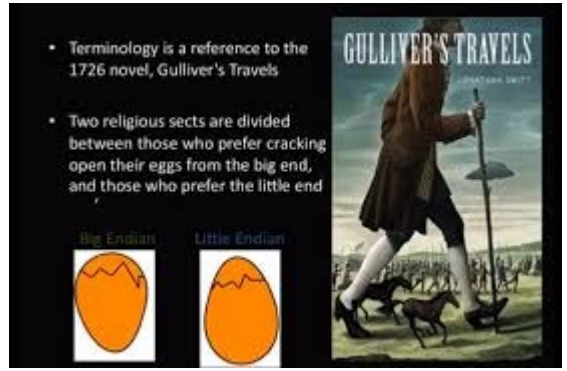
Endianness

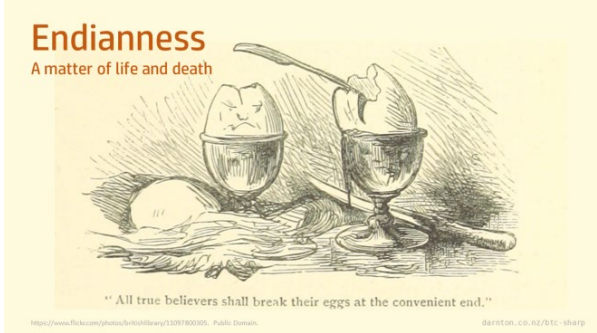
- Big Endian (Motorola a.o.)

MSB			LSB

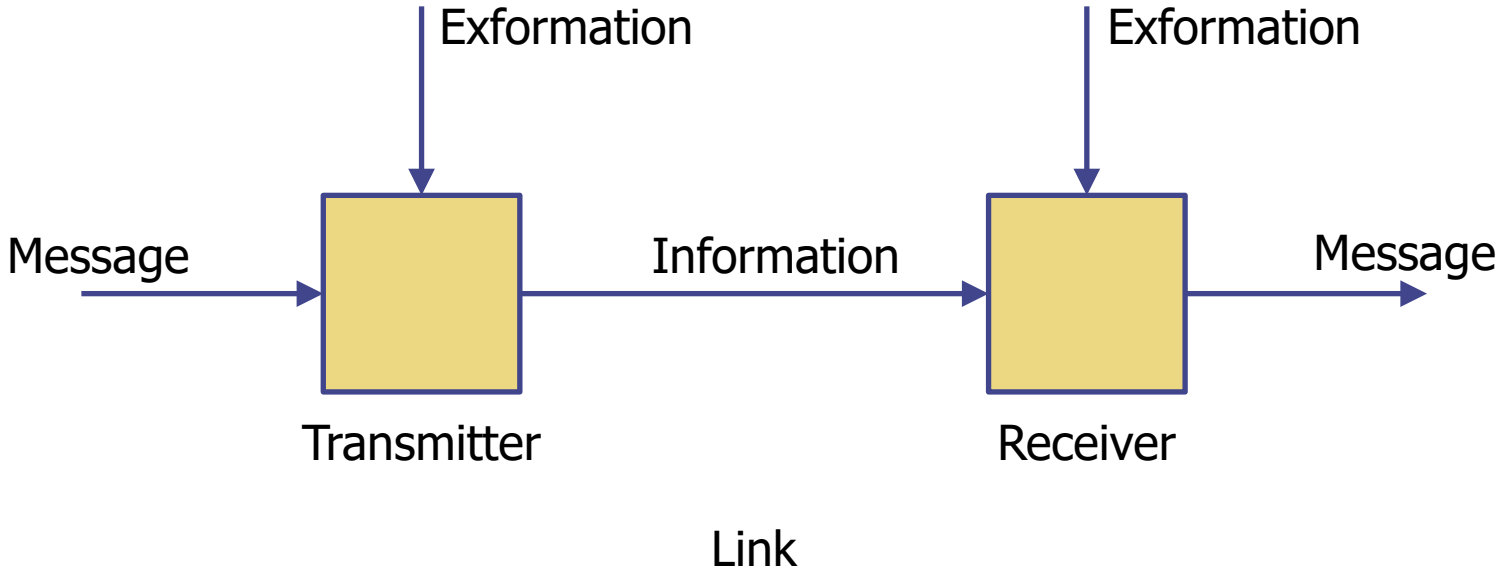
- Little Endian (Intel a.o.)

LSB			MSB



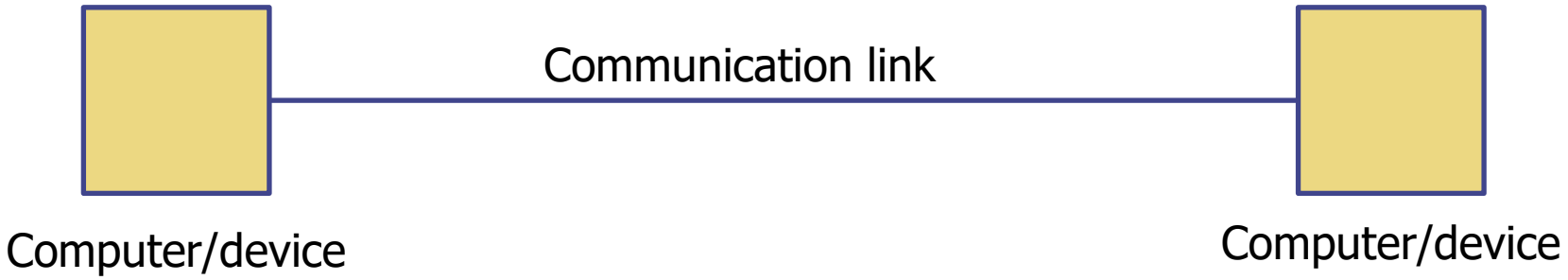


Information and Exformation



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.

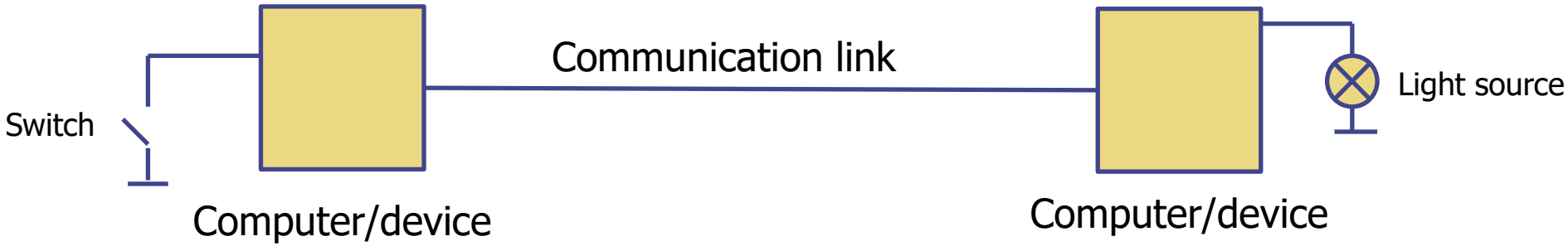
Data Communication



Distributed system / application

We will need an agreement or a protocol.

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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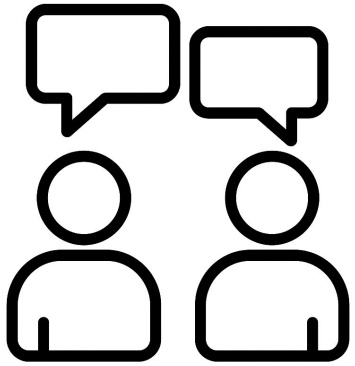
What is a protocol?

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



Discuss which protocols for humans you use?

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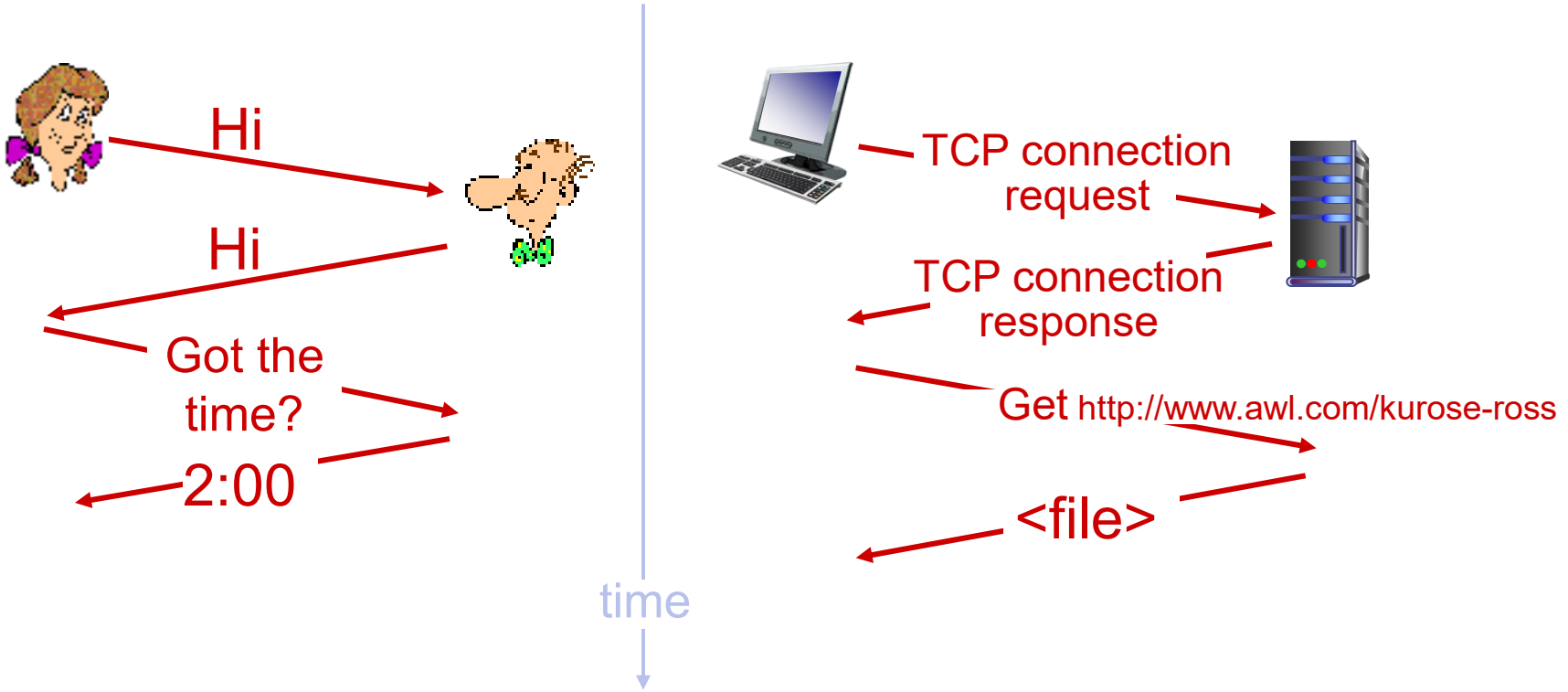
What is a protocol?

a human protocol and a computer network protocol:



Binary / ASCII

Binary	ASCII
0010 0001	0011 1000 = ‘8’
1010 0011	0011 0110 = ‘6’
=	0011 0001 = ‘1’
8611	0011 0001 = ‘1’

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The ASCII table

ASCII Codes:

ASCII	Hex	Symbol
0	0	NUL
1	1	SOH
2	2	STX
3	3	ETX
4	4	EOT
5	5	ENQ
6	6	ACK
7	7	BEL
8	8	BS
9	9	TAB
10	A	LF
11	B	VT
12	C	FF
13	D	CR
14	E	SO
15	F	SI

ASCII	Hex	Symbol
16	10	DLE
17	11	DC1
18	12	DC2
19	13	DC3
20	14	DC4
21	15	NAK
22	16	SYN
23	17	ETB
24	18	CAN
25	19	EM
26	1A	SUB
27	1B	ESC
28	1C	FS
29	1D	GS
30	1E	RS
31	1F	US

ASCII	Hex	Symbol
32	20	(space)
33	21	!
34	22	"
35	23	#
36	24	$
37	25	%
38	26	&
39	27	'
40	28	(
41	29	)
42	2A	*
43	2B	+
44	2C	,
45	2D	-
46	2E	.
47	2F	/

ASCII	Hex	Symbol
48	30	0
49	31	1
50	32	2
51	33	3
52	34	4
53	35	5
54	36	6
55	37	7
56	38	8
57	39	9
58	3A	:
59	3B	;
60	3C	<
61	3D	=
62	3E	>
63	3F	?

ASCII	Hex	Symbol
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4A	J
75	4B	K
76	4C	L
77	4D	M
78	4E	N
79	4F	O

ASCII	Hex	Symbol
80	50	P
81	51	Q
82	52	R
83	53	S
84	54	T
85	55	U
86	56	V
87	57	W
88	58	X
89	59	Y
90	5A	Z
91	5B	[
92	5C	\
93	5D	]
94	5E	^
95	5F	_

ASCII	Hex	Symbol
96	60	`
97	61	a
98	62	b
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k
108	6C	l
109	6D	m
110	6E	n
111	6F	o

ASCII	Hex	Symbol
112	70	p
113	71	q
114	72	r
115	73	s
116	74	t
117	75	u
118	76	v
119	77	w
120	78	x
121	79	y
122	7A	z
123	7B	{
124	7C	|
125	7D	}
126	7E	~
127	7F	

https://www.ascii-code.com/

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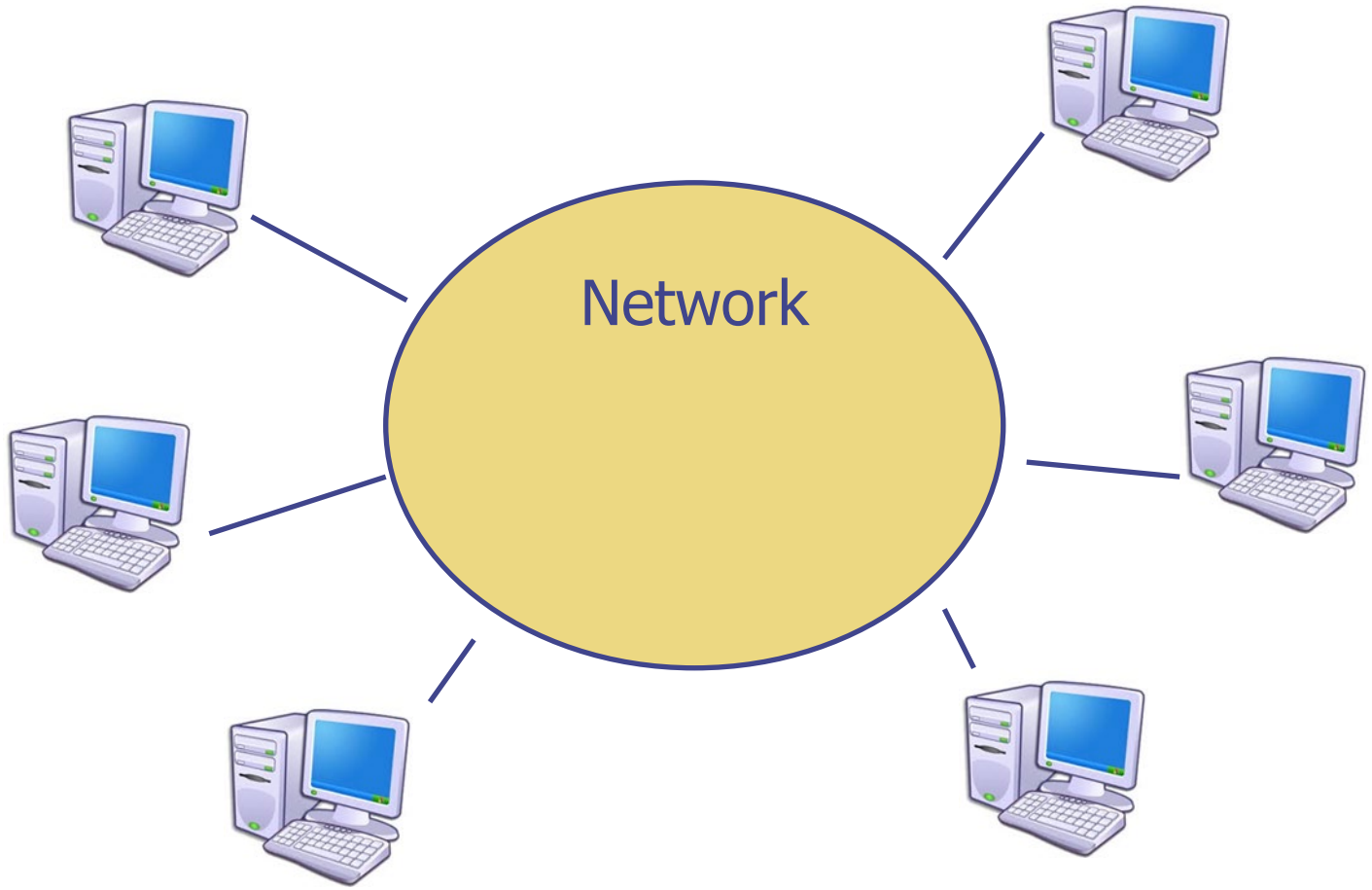
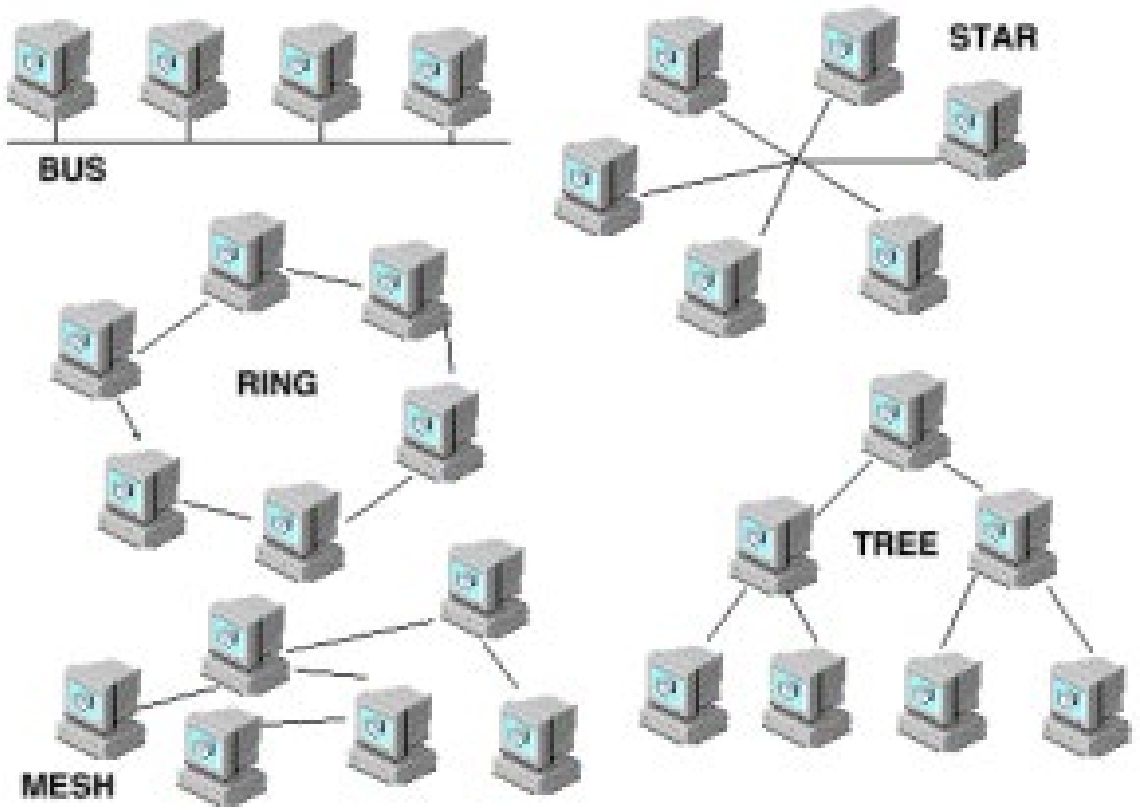
Communicating to more computers/devices.



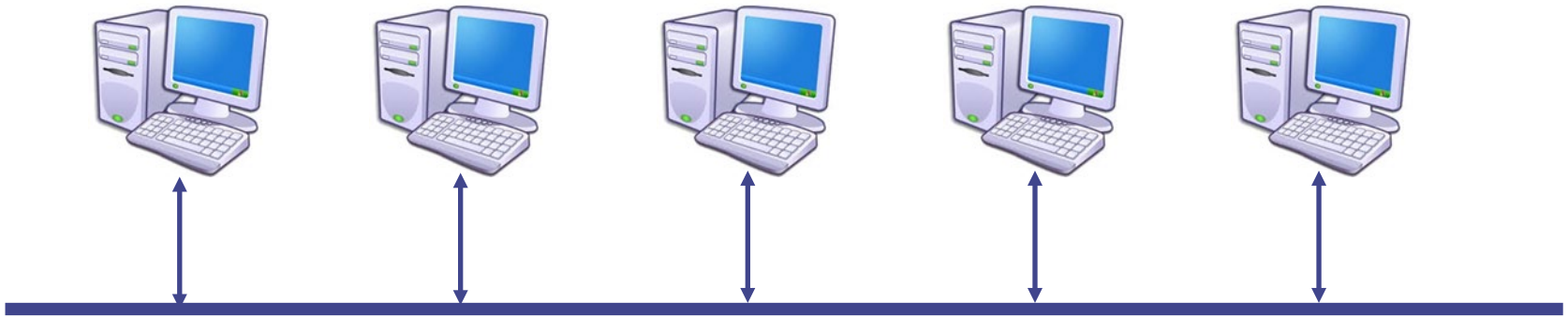
Network topologies



Peer-to-peer / Multidrop

peer-to-peer

Multidrop



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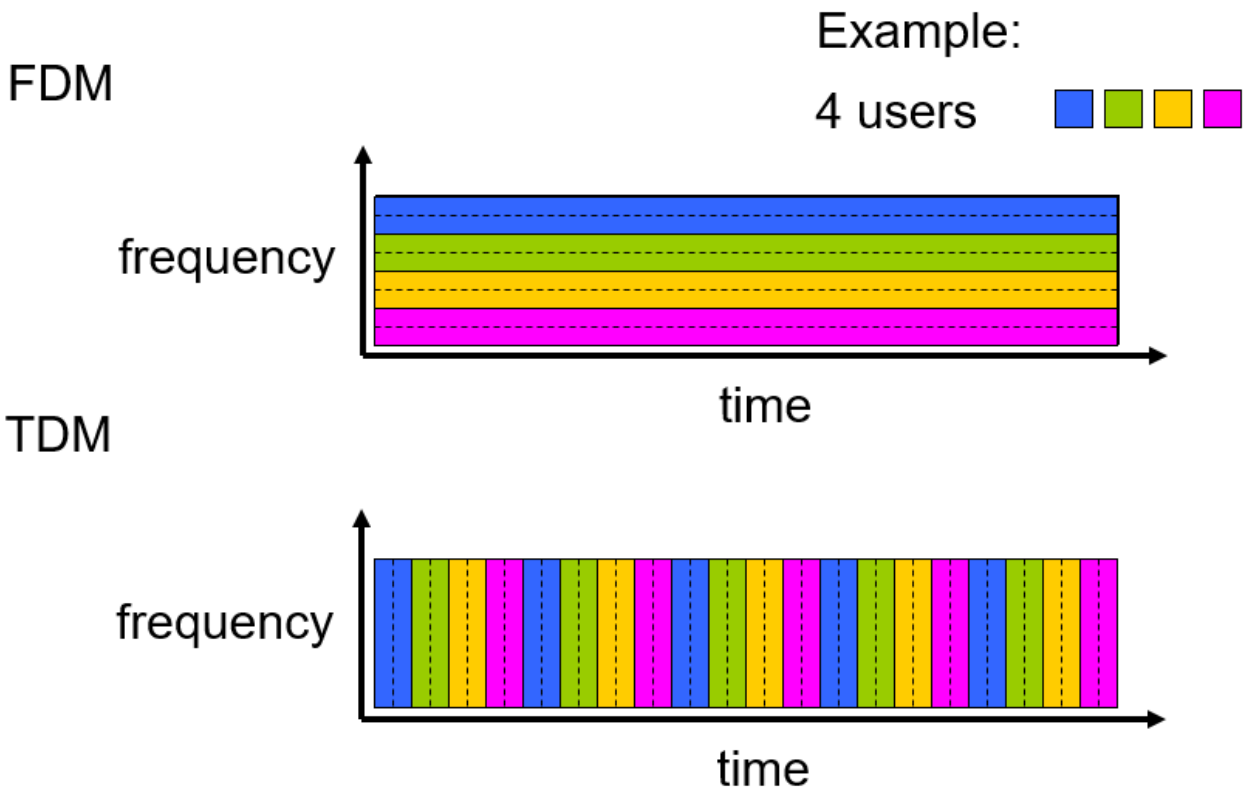
Sharing the communication media - Solutions

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

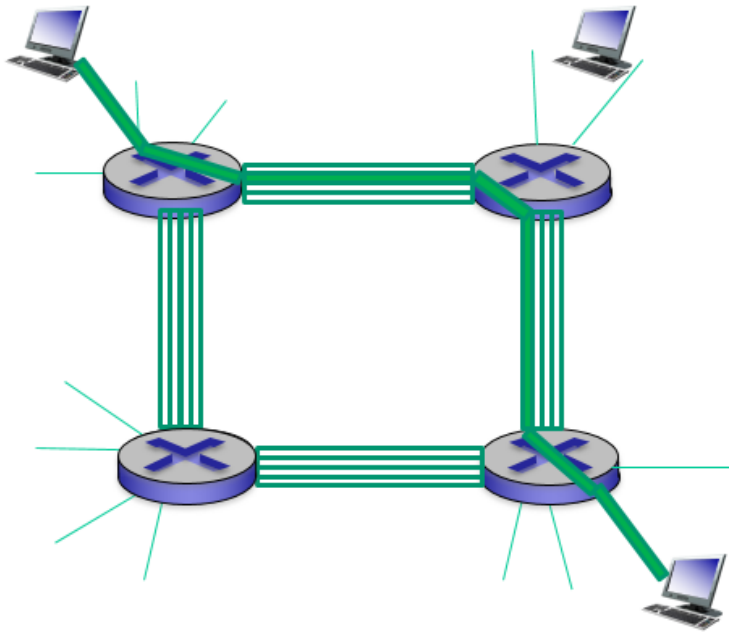
Sharing the communication media - Multiplexing

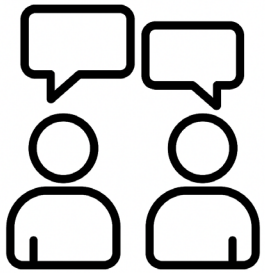


Circuit Switching

end-end resources allocated to, reserved for "call" between source & dest:

- in diagram, each link has four circuits.
  - call gets 2nd circuit in top link and 1st circuit in right link.
- dedicated resources: no sharing
  - circuit-like (guaranteed) performance
- circuit segment idle if not used by call *(no sharing)*
- commonly used in traditional telephone networks





Why is circuit switching not used for the internet?

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Packet Switching

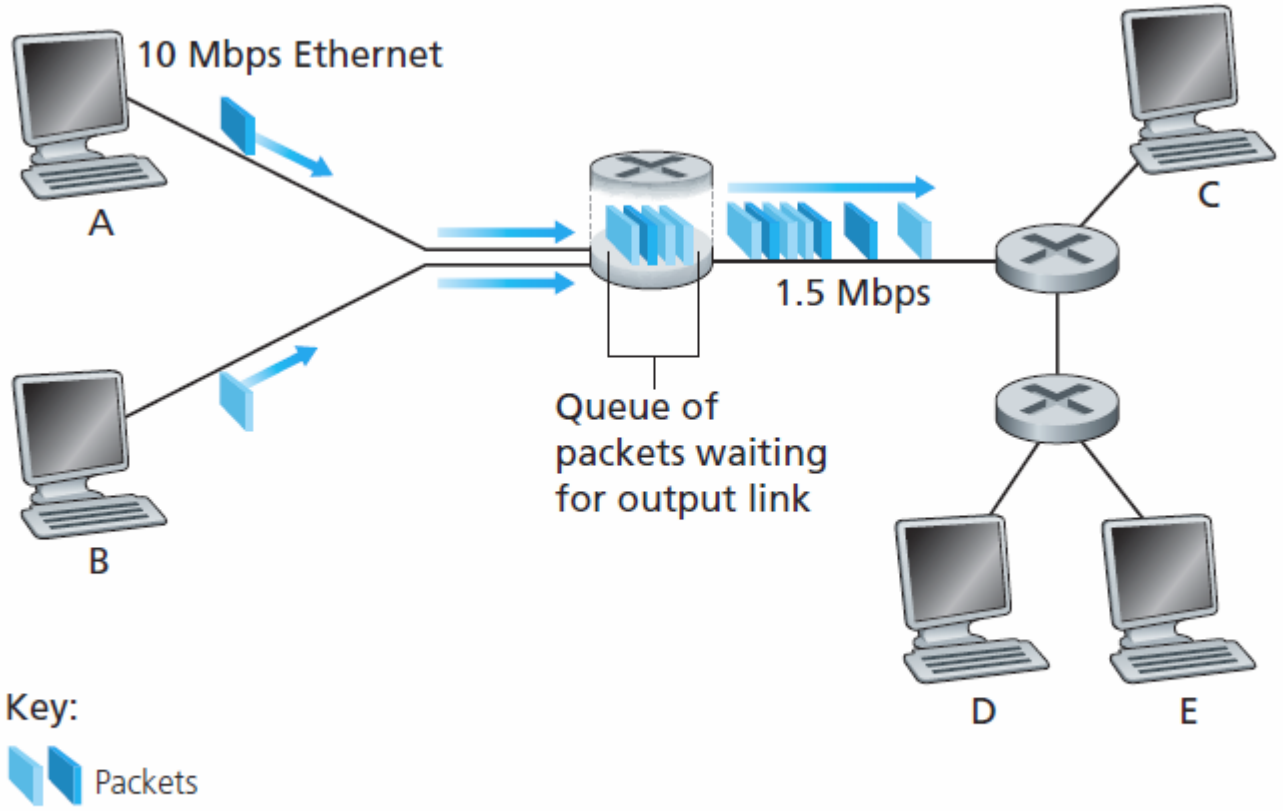
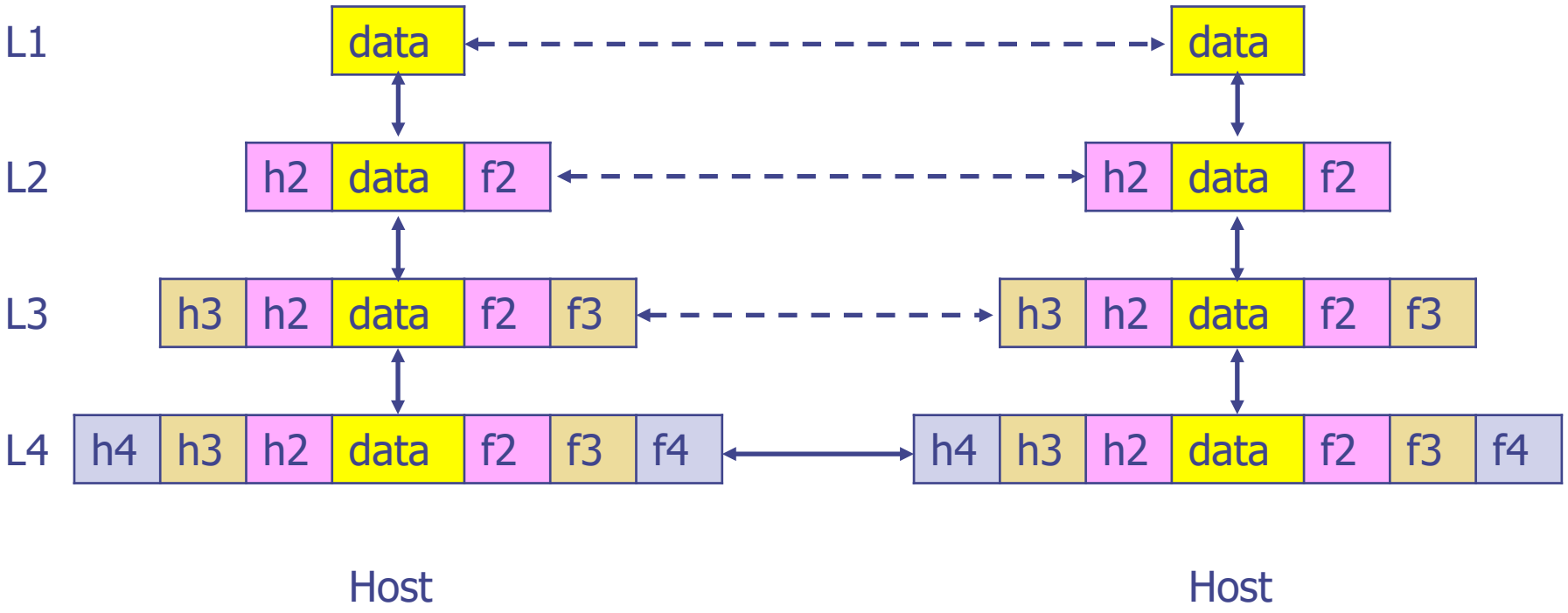
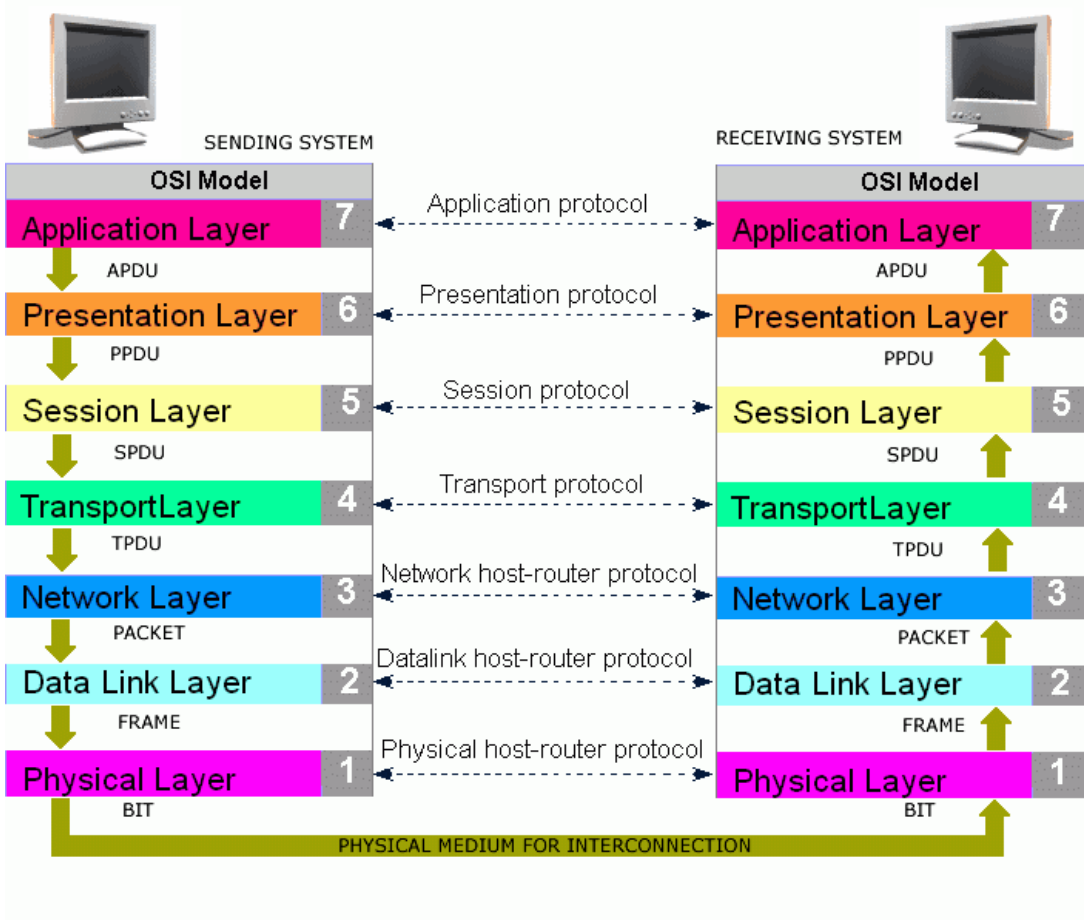


Figure 1.12 ♦ Packet switching

Layering and encapsulation



The OSI Reference Model



Open **S**ystems **I**nterconnection
xPDU: x Procotol Data Unit

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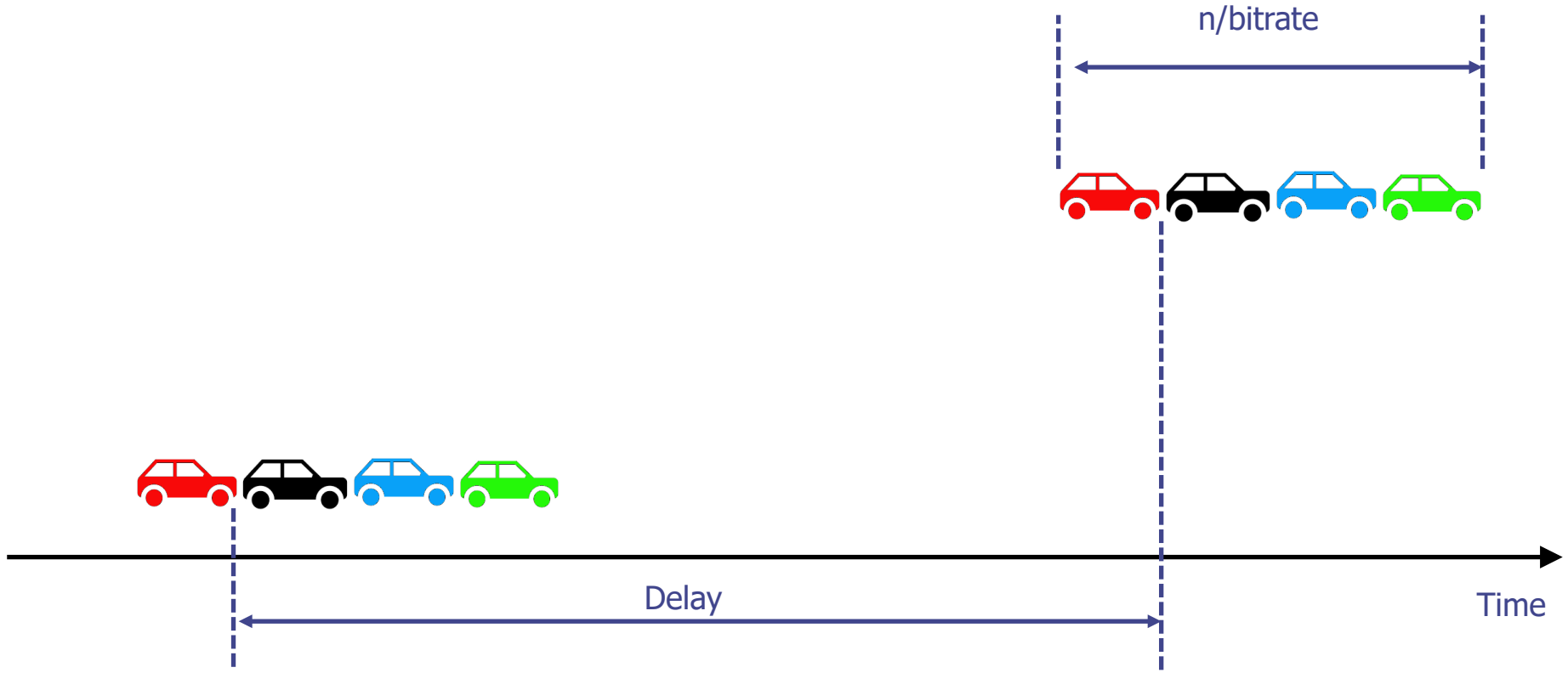
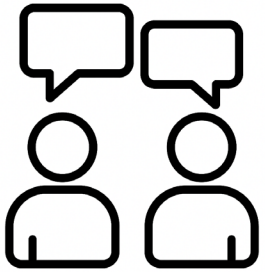
Communication speed
Bitrate vs. delay





Which applications on the internet are affected (most) by which factor?

Other Communication Options

- Serial communication
  - RS 232 – Old but still used
  - RS 485 – E.g. industrial communication such as MODBUS RTU
  - SPI communication – e.g. Microcontrollers and peripheral chips
  - I^2C communication – Can consists of multi-master and multi-slave setups
- Important principles in the book
- Self-study encouraged

Next Time

- We talk about Computer Networks and the Internet
- Related reading is Chapter 1 (page 31-96)
- Bring your computer (obviously ☺) for Lab exercises