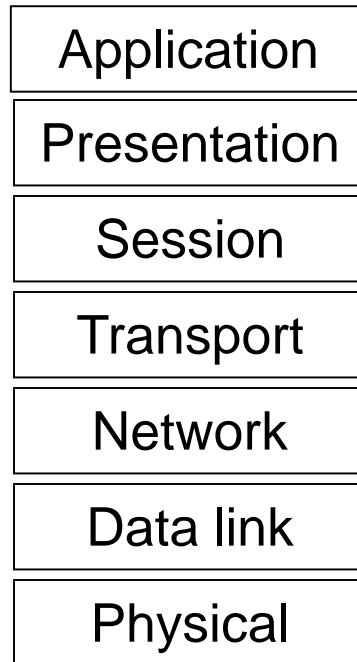


# Networking basics

ID2010

Fredrik Kilander

# OSI



Data types

Authentication  
Session mgmt

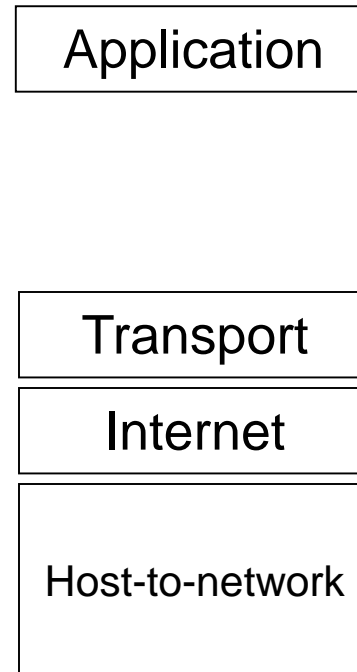
Reliable end-to-end  
data transfer

Routing

Reliable point-to-point  
data transfer

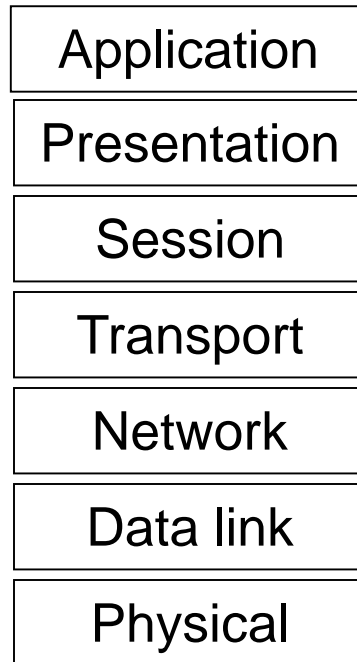
Point-to-point  
bit transfer

# TCP/IP



Shared medium  
access

# OSI



Data types

Authentication  
Session mgmt

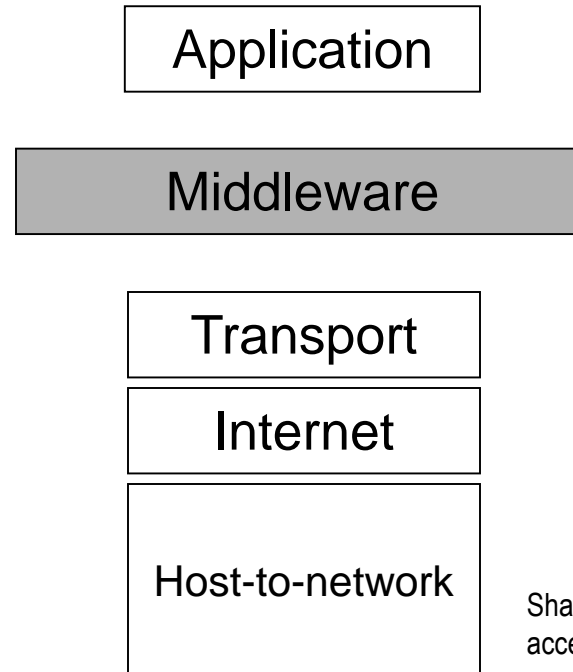
Reliable end-to-end  
data transfer

Routing

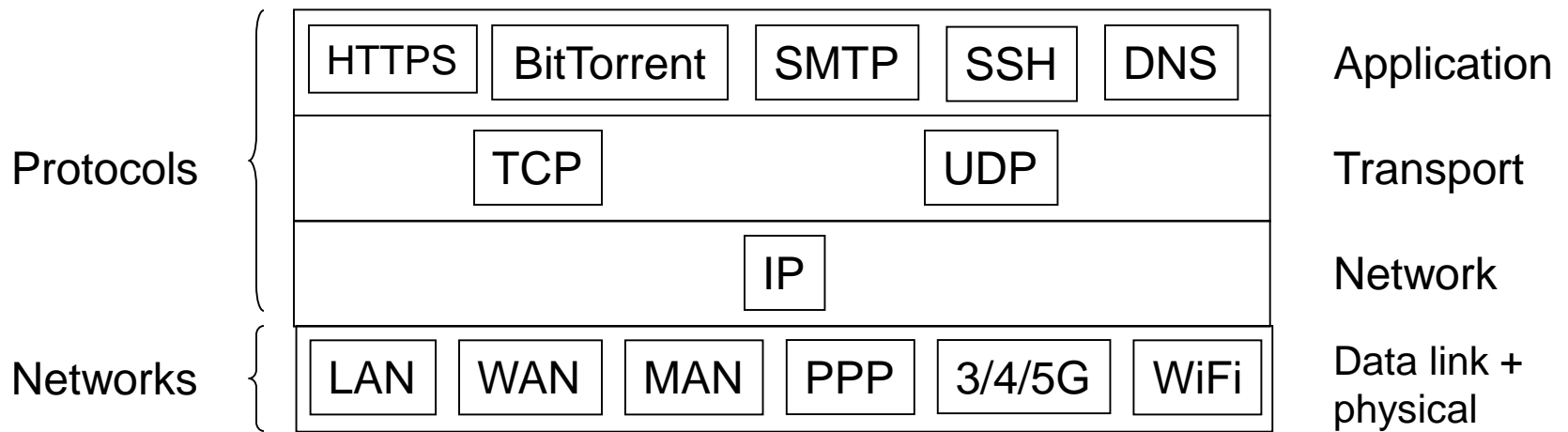
Reliable point-to-point  
data transfer

Point-to-point  
bit transfer

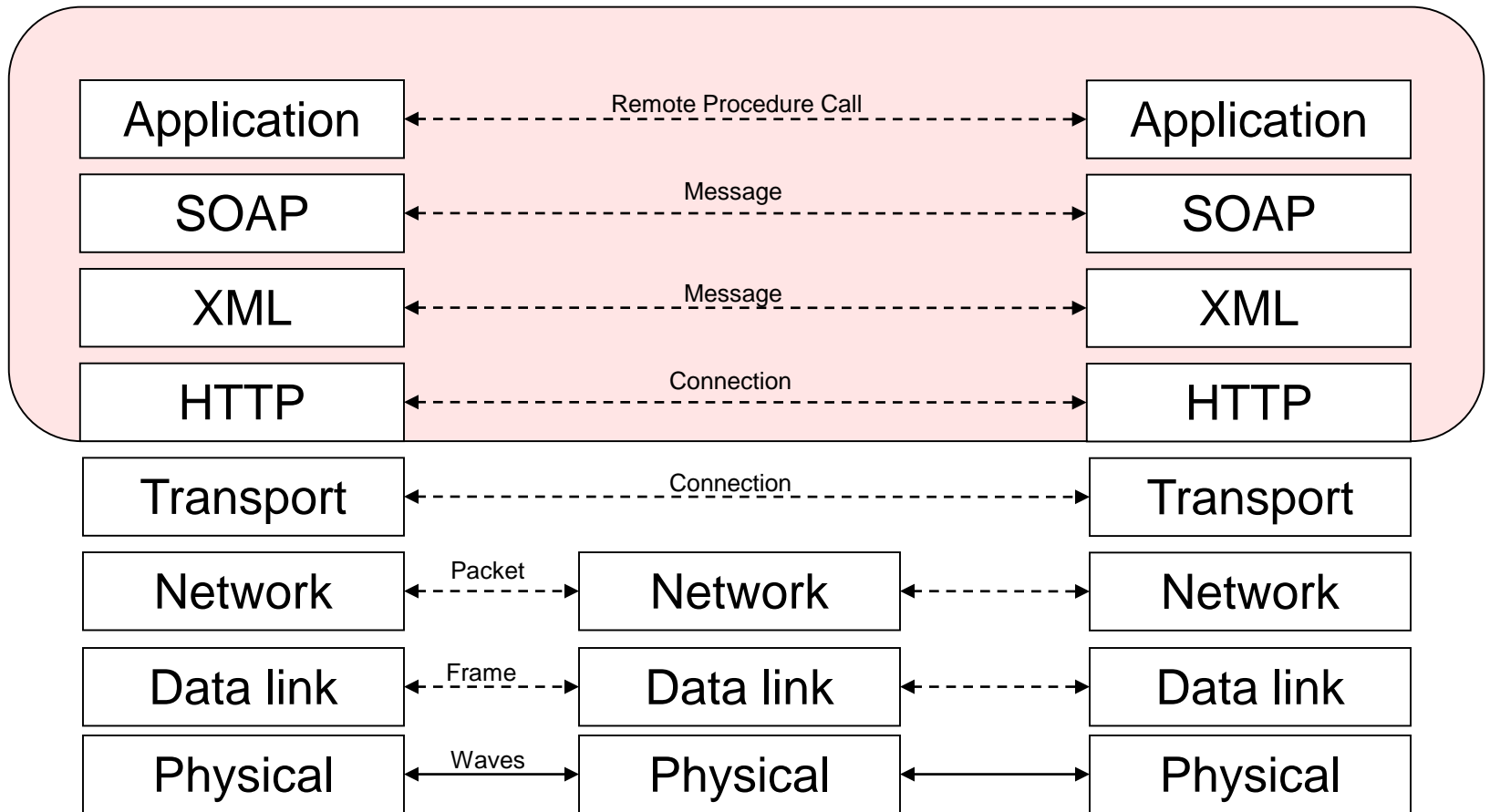
# TCP/IP



Shared medium  
access



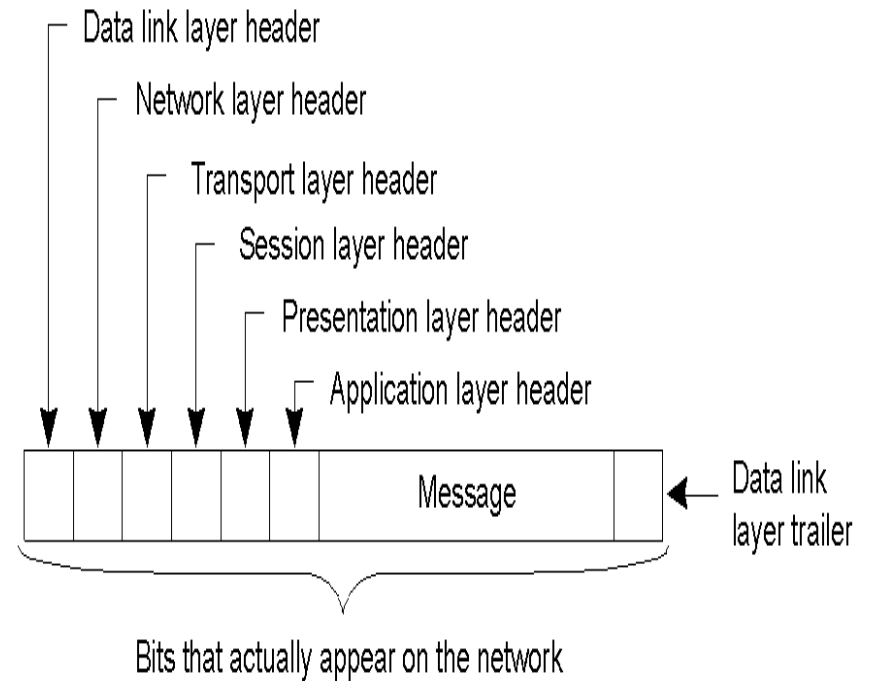
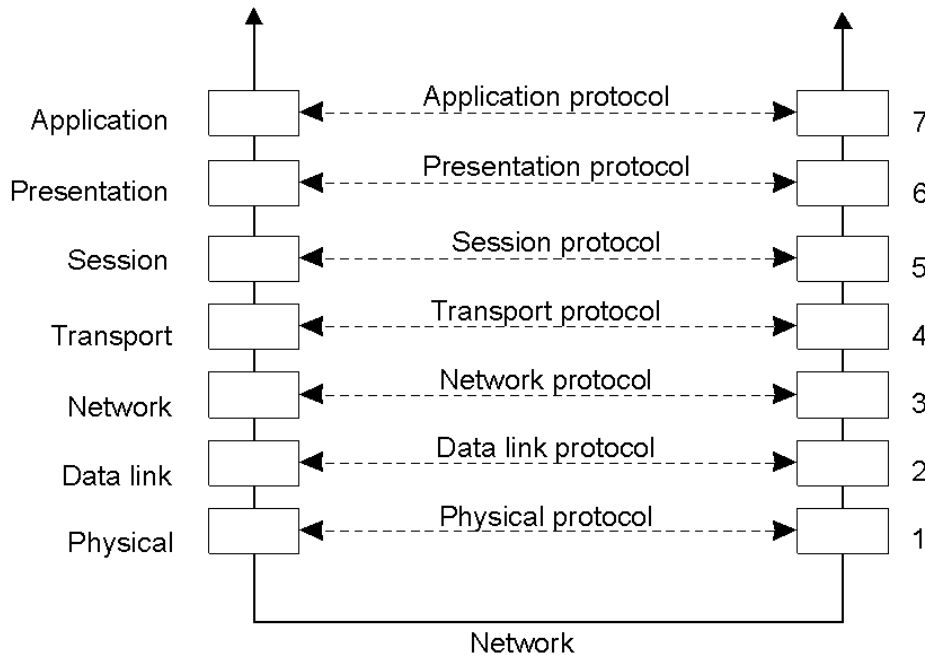
Adapted from A. S. Tanenbaum, Computer Networks, 3rd Ed.

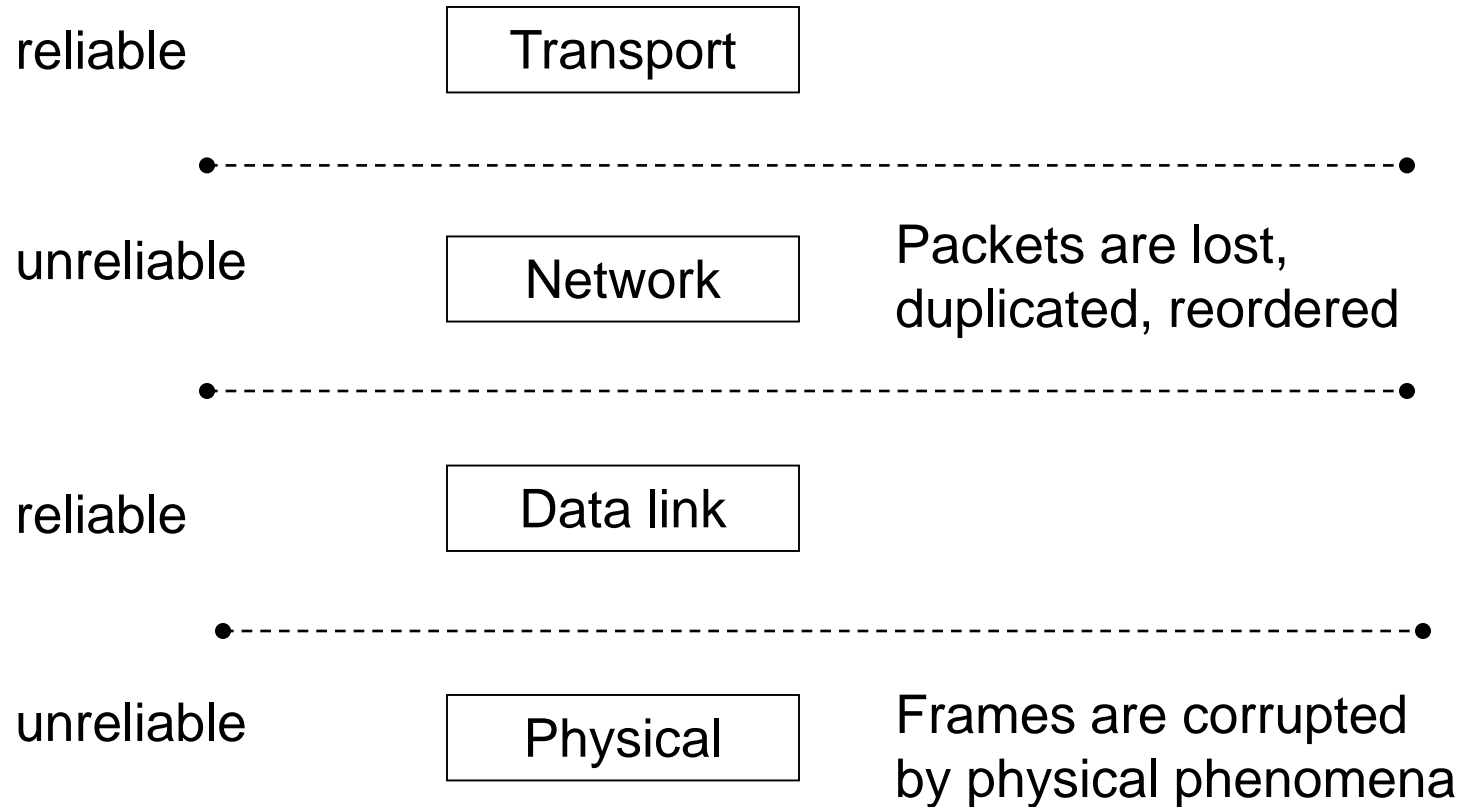


# Communication

Layers, interfaces, and protocols in the OSI (Open Systems Interconnection) reference model.

- Divided into 7 layers each deals with one specific aspects of the communication





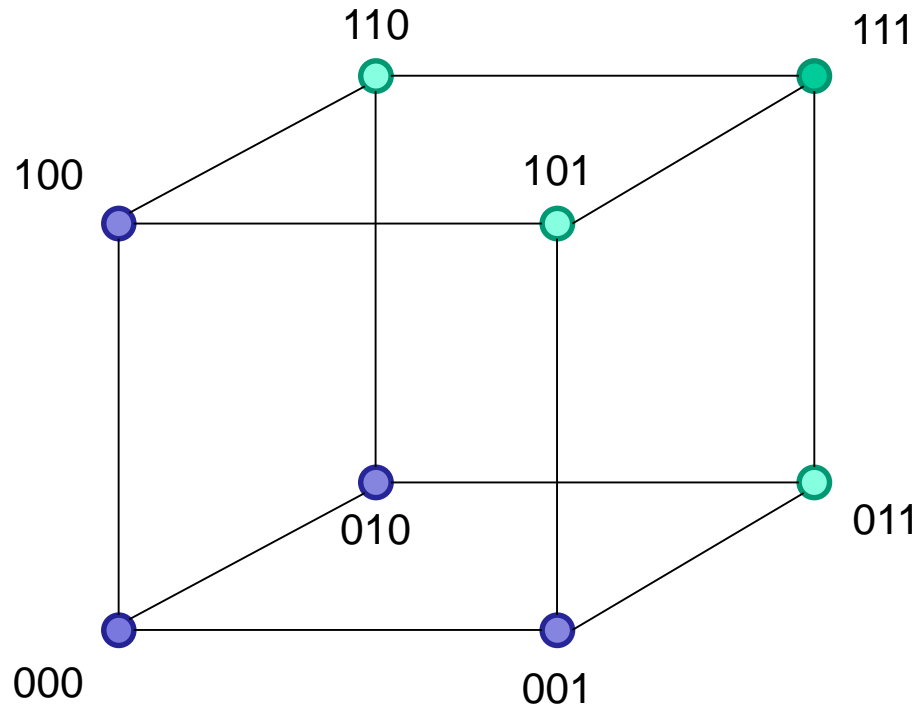
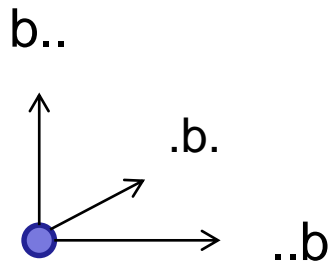
# Reliable data transmission

- Divide data into packets
- Add error-detection/correction to payload
- Add sequence numbers
- Add a timer for each packet sent
- Keep resending packets until they are ack'd.
- Acknowledge received packets
- Reassemble data by sequence numbers



# Error-correcting codes

## 1 bit error



# Block transmission

Bit positions 0 1 2 3 4 5 6 7 8 9 a b c d e **f g h i j** k l m n o p q r s t u v w x y z A B C D

One 5-bit burst error

Arrange bits in a rectangular block by rows

0	1	2	<b>3</b>	4	5	6	7
8	9	a	<b>b</b>	c	d	e	f
g	h	i	<b>j</b>	k	l	m	n
o	p	q	<b>r</b>	s	t	u	v
w	x	y	<b>z</b>	A	B	C	D

Send bits by columns

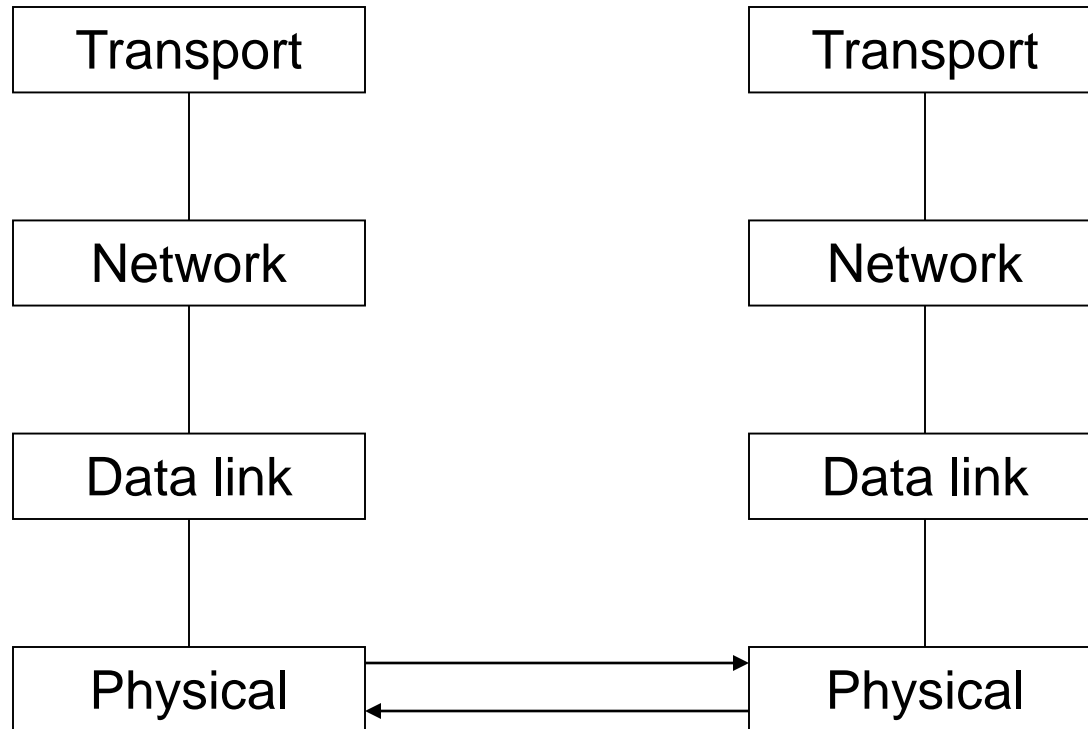
Transmission sequence 0 8 g o w 1 9 h p x 2 a i q y **3 b j r z** 4 c k s A 5 d l t B 6 e m u C 7 f n v D

One 5-bit burst error

0 1 2 **3** 4 5 6 7 8 9 a **b** c d e f g h i **j** k l m n o p q **r** s t u v w x y **z** A B C D

5 one-bit errors

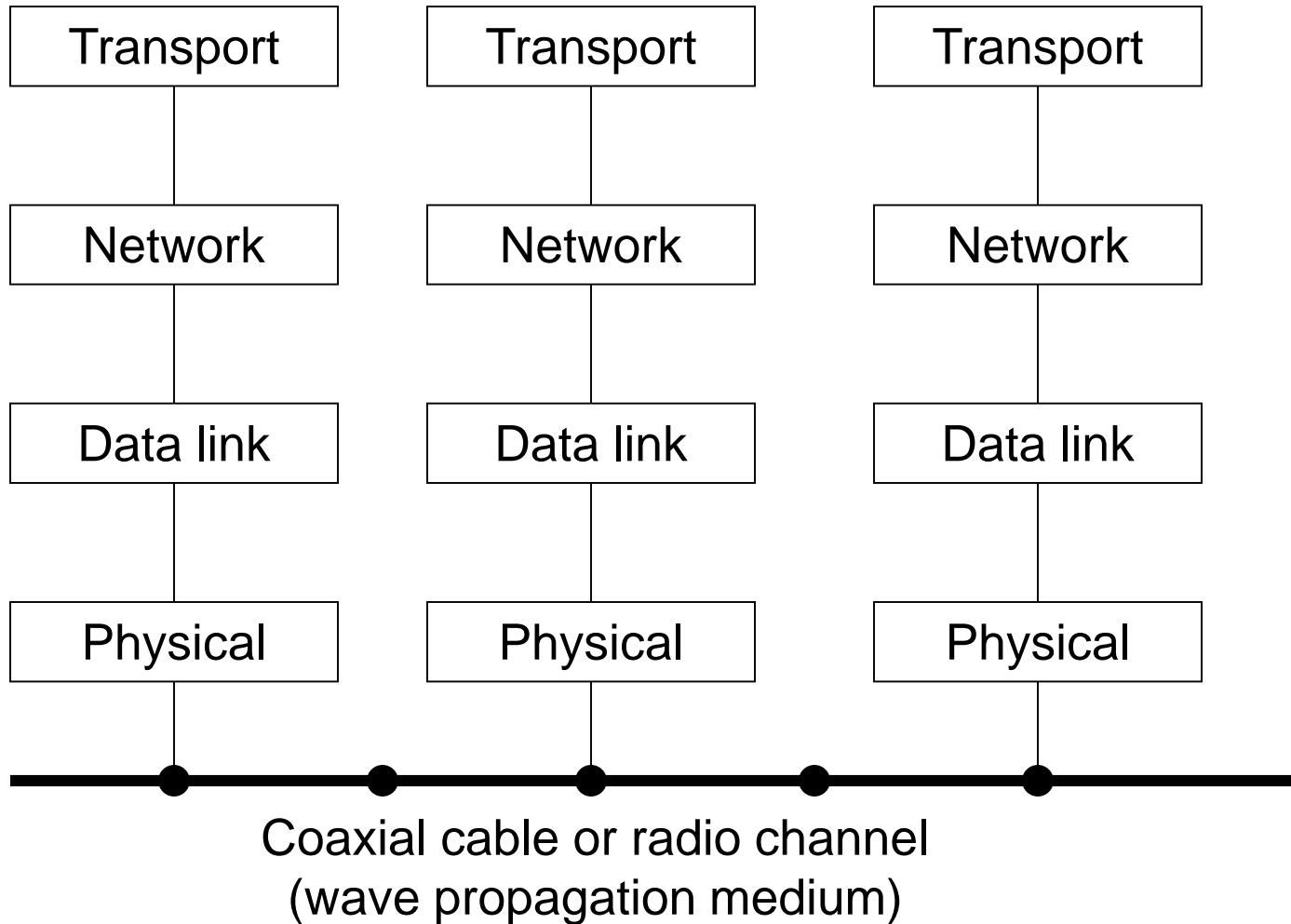
# Point-to-point connection



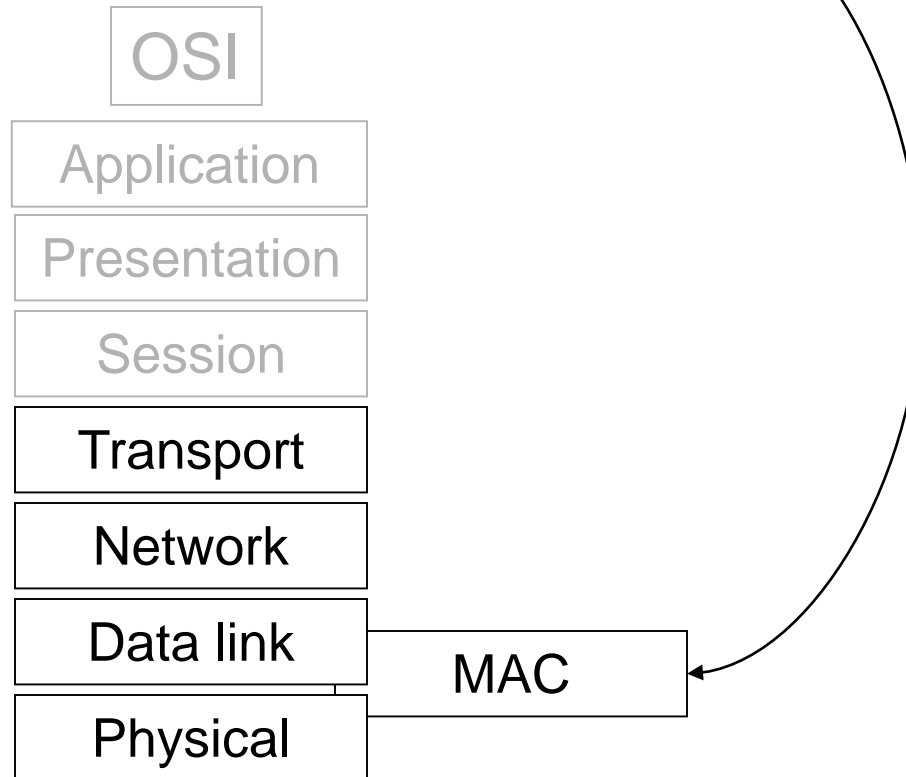
Wire, fibre, beam, field  
(electromagnetism)

For clandestine purposes: air/solids (sound)

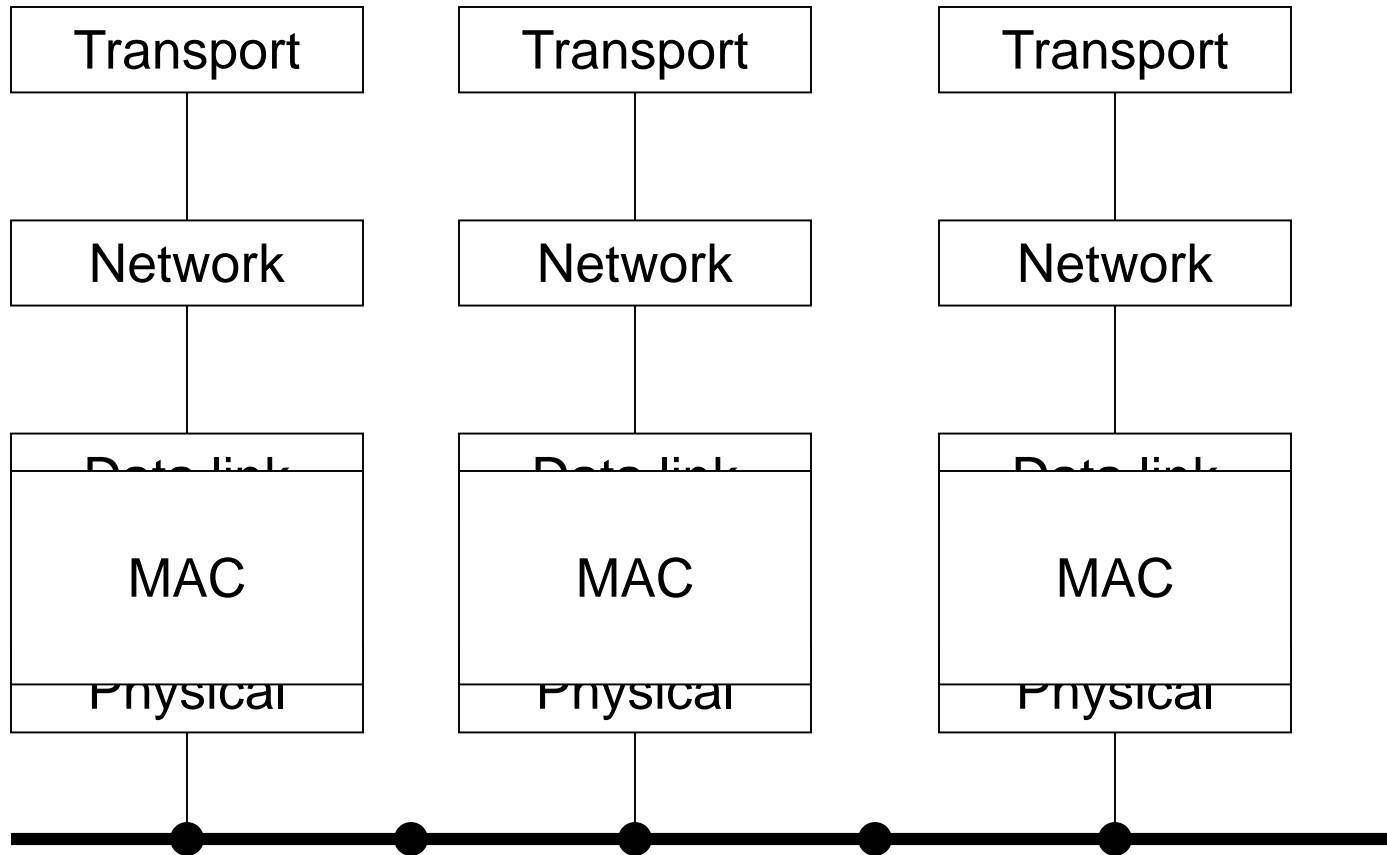
## Common media, no longer point-to-point



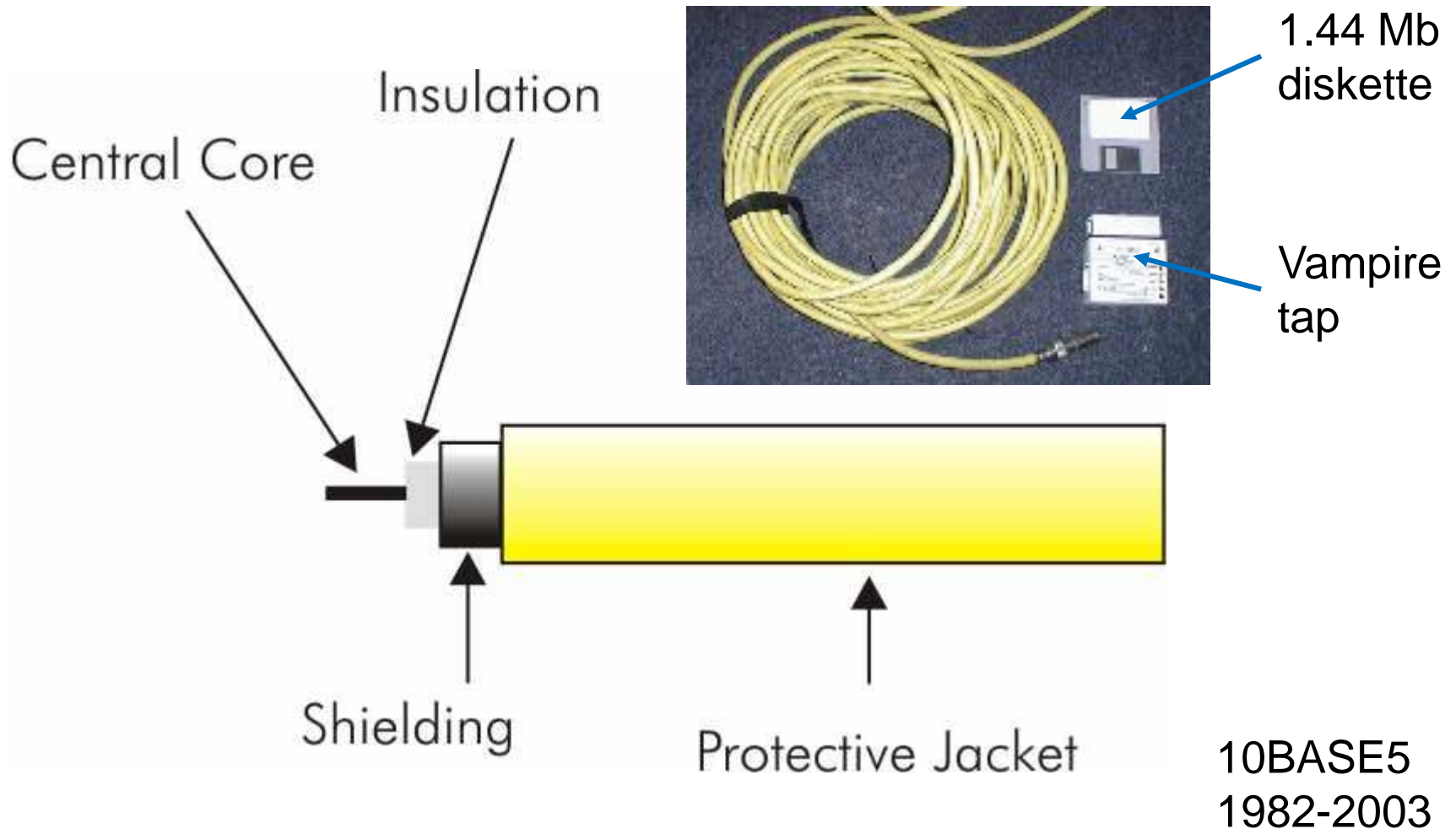
# Medium ACcess Layer



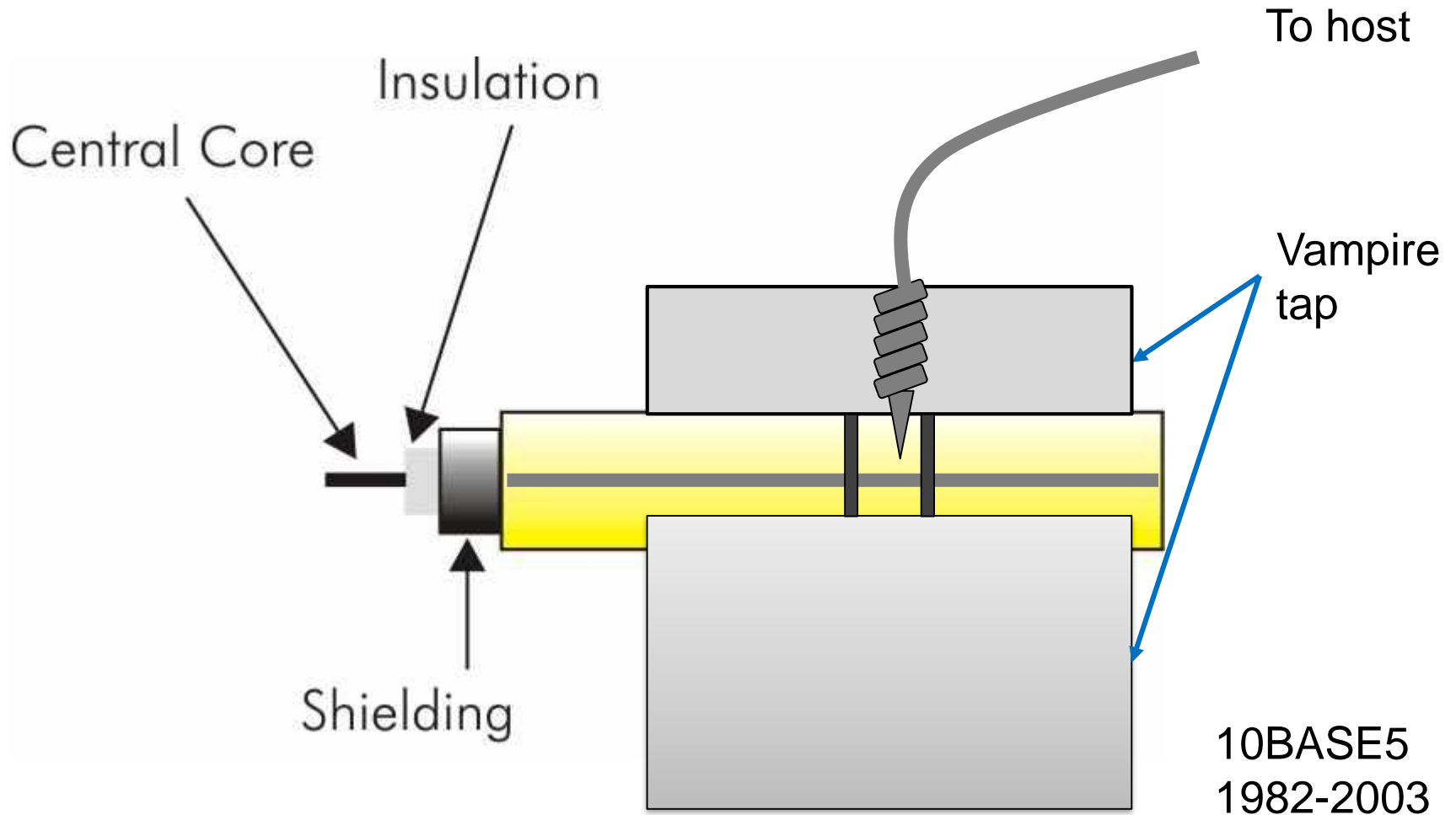
# MAC layer negotiates access to shared medium



# Ethernet history – thick cable

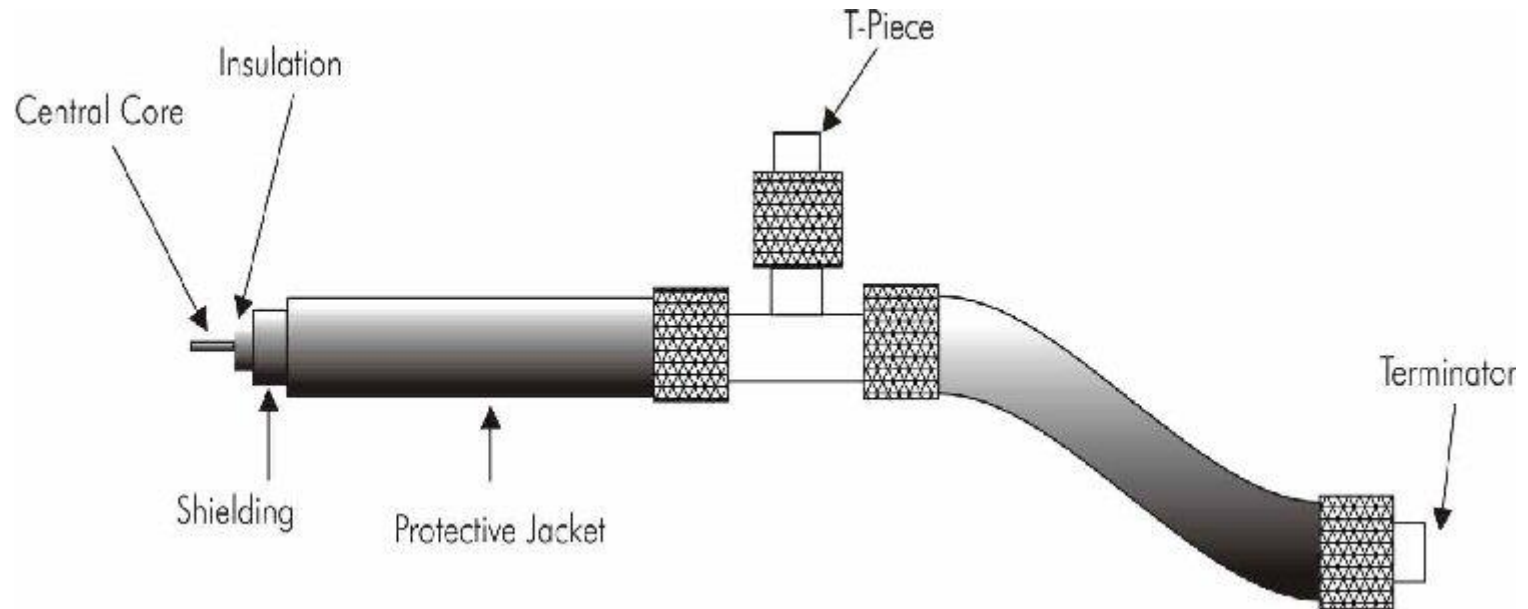


# Ethernet history – thick cable





# Ethernet history – thinwire



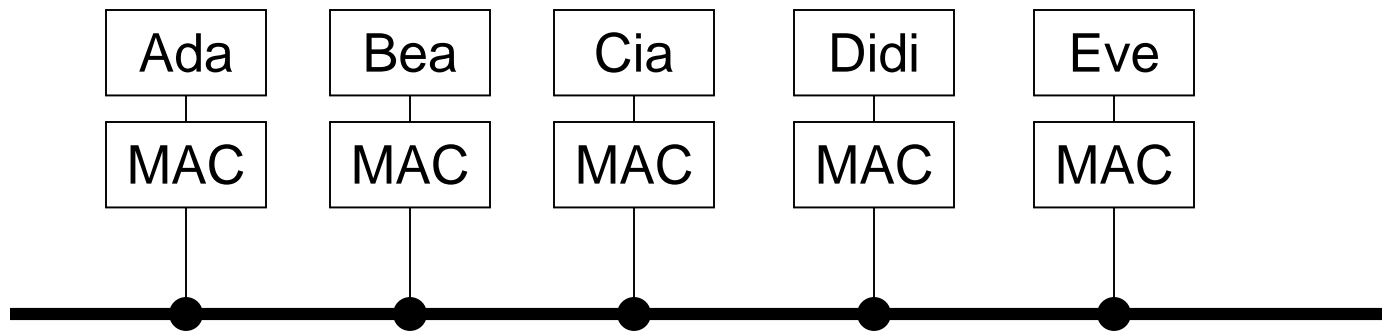
10BASE2  
1985-2011

# Ethernet history – CAT6/WiFi



# Stations share the broadcast medium

Only one station may send - all listen



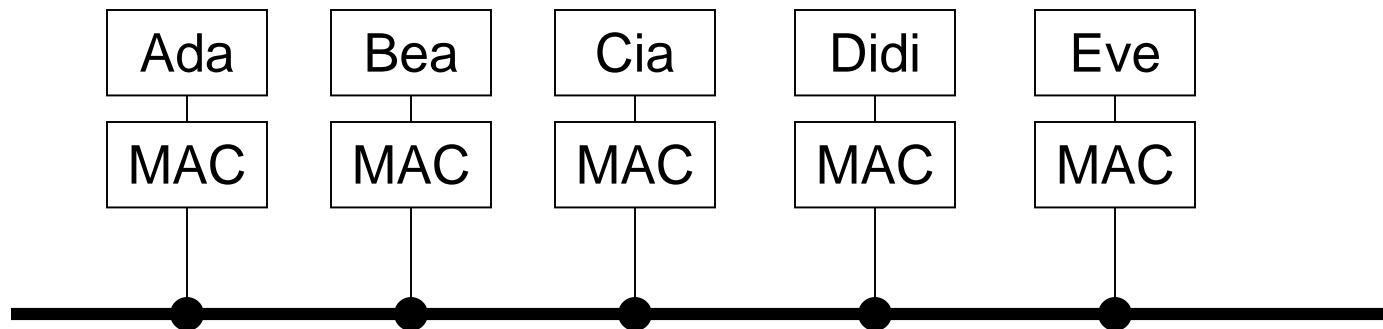
Transmissions are addressed

- to an interface (unicast)
- or to a group (multicast)
- or to all (broadcast)

# Stations share the broadcast medium

The MAC-address depends on the medium

00:1F:3B:BF:CA:35



Ethernet

48 bits vv:vv:vv:ss:ss:ss

BlueTooth

48 bits NAP(16)UAP(8)LAP(24)

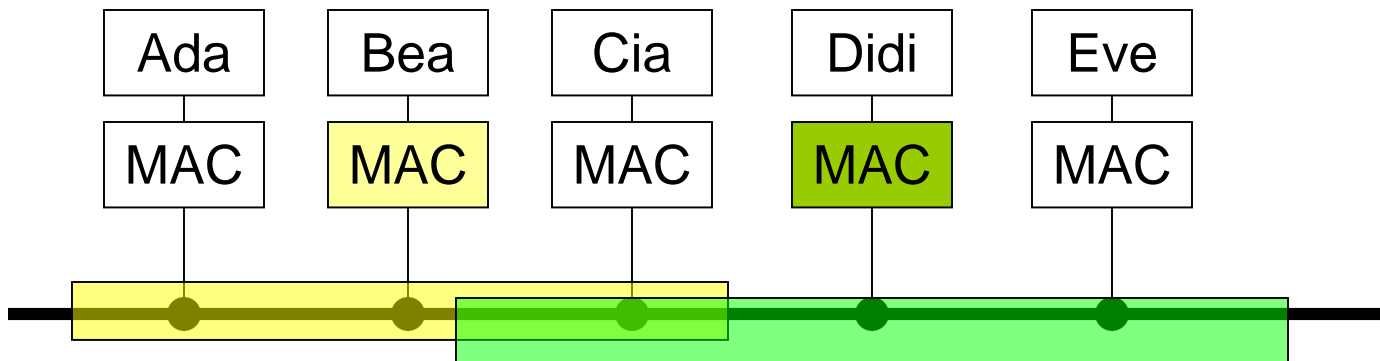
NAP:Non-significant address portion

LAP:Lower address portion

UAP:Upper address portion

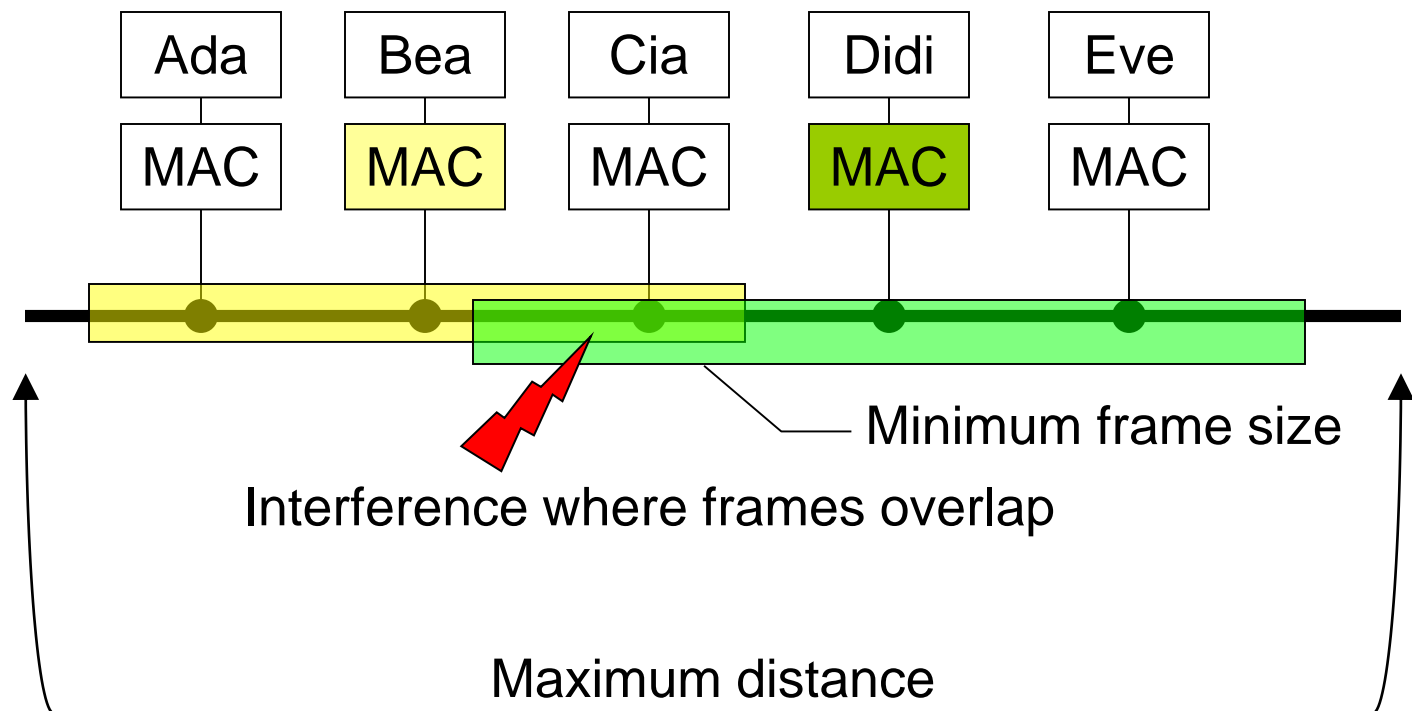
Stations share the broadcast medium

Simultaneous broadcasts leads to collisions



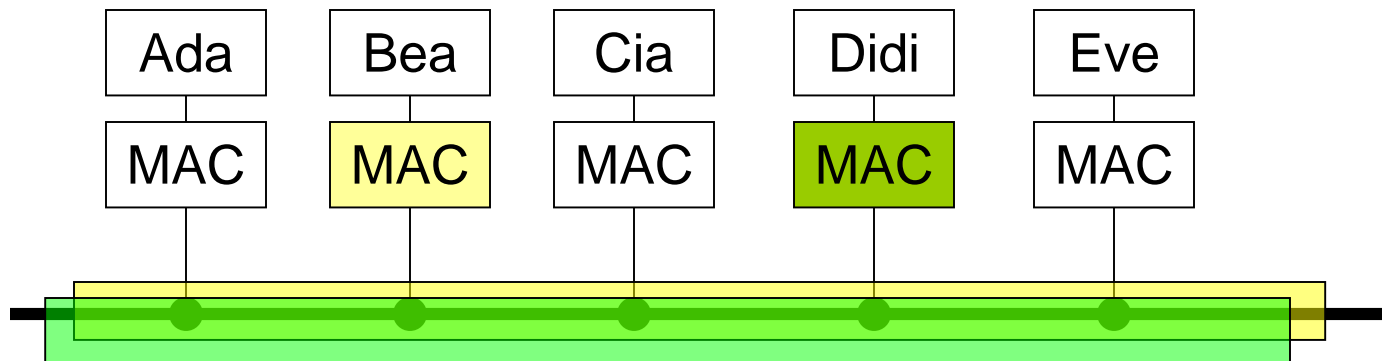
Stations share the broadcast medium

Simultaneous broadcasts leads to collisions



Stations share the broadcast medium

Simultaneous broadcasts leads to collisions




Listen while transmitting – detect collision

Wait random time and try again

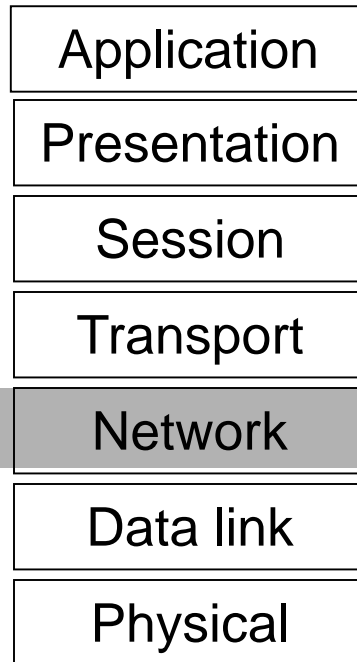
Ca 30% max throughput

# Wi-Fi and 802.11\*

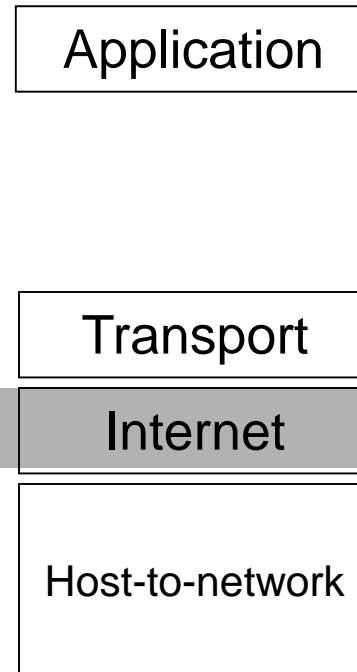
- The medium consists of shared radio channels
- Sending saturates the receiver
- Collision Avoidance instead of Collision Detect
- The hidden station problem 
- RTS/CTS – Request To Send, Clear To Send



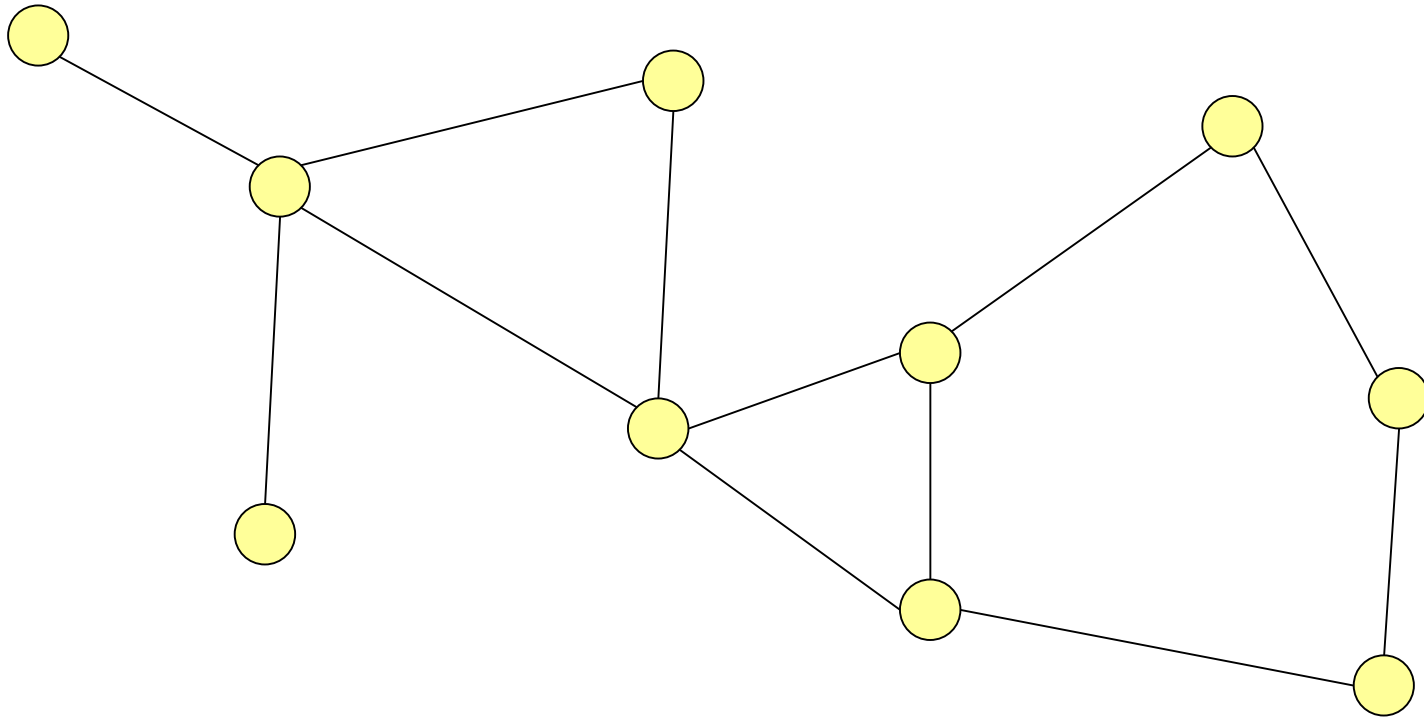
## OSI



## TCP/IP

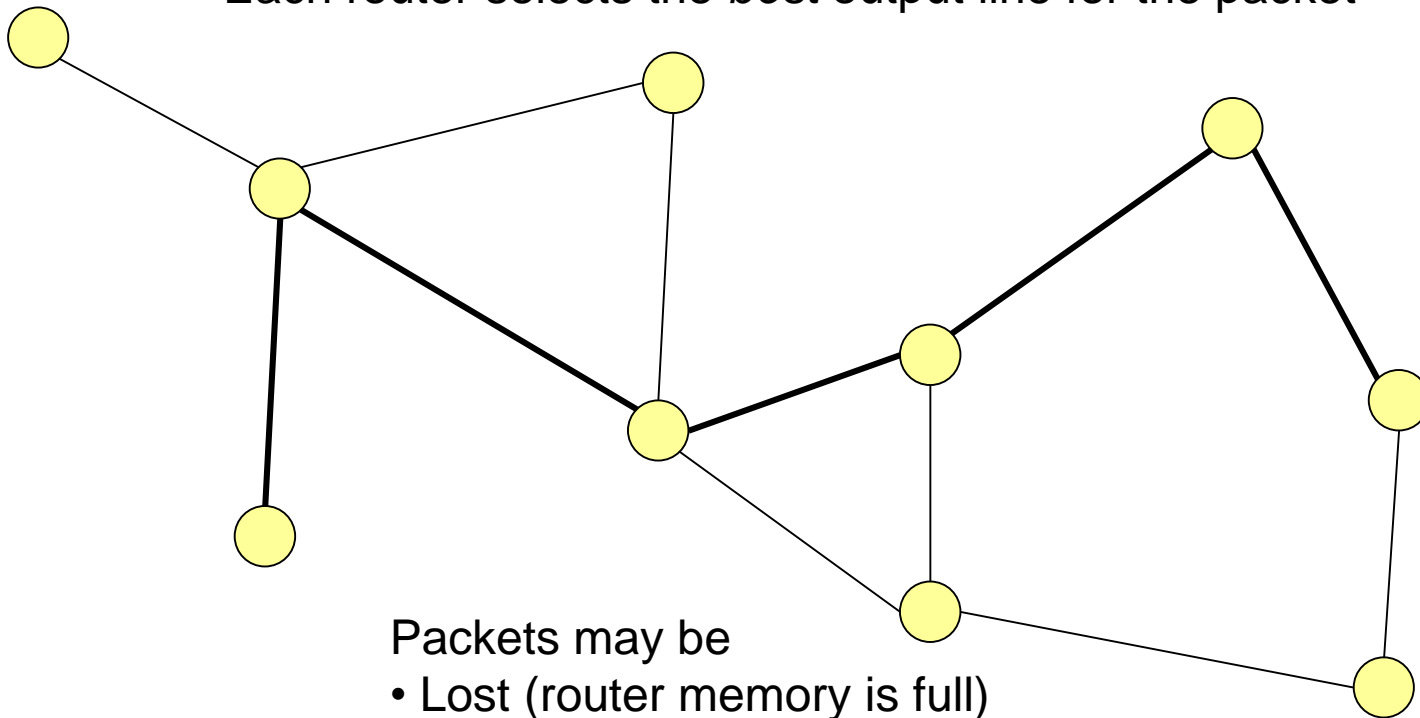


# Data network: routers and links



# Network/Internet layer – routing of packets

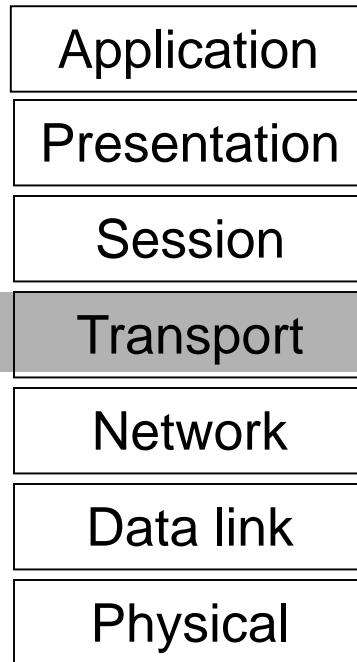
Each router selects the *best* output line for the packet



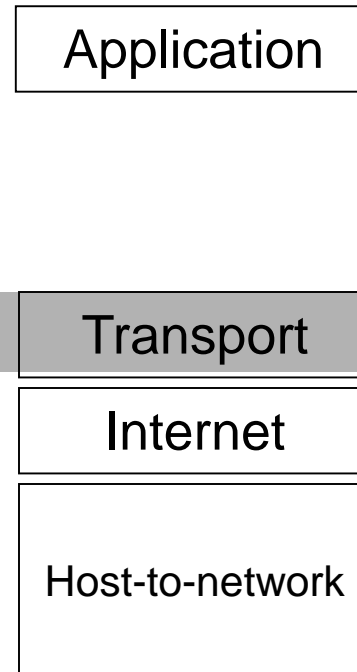
Packets may be

- Lost (router memory is full)
- Reordered (go separate paths)
- Delayed (queued)

## OSI

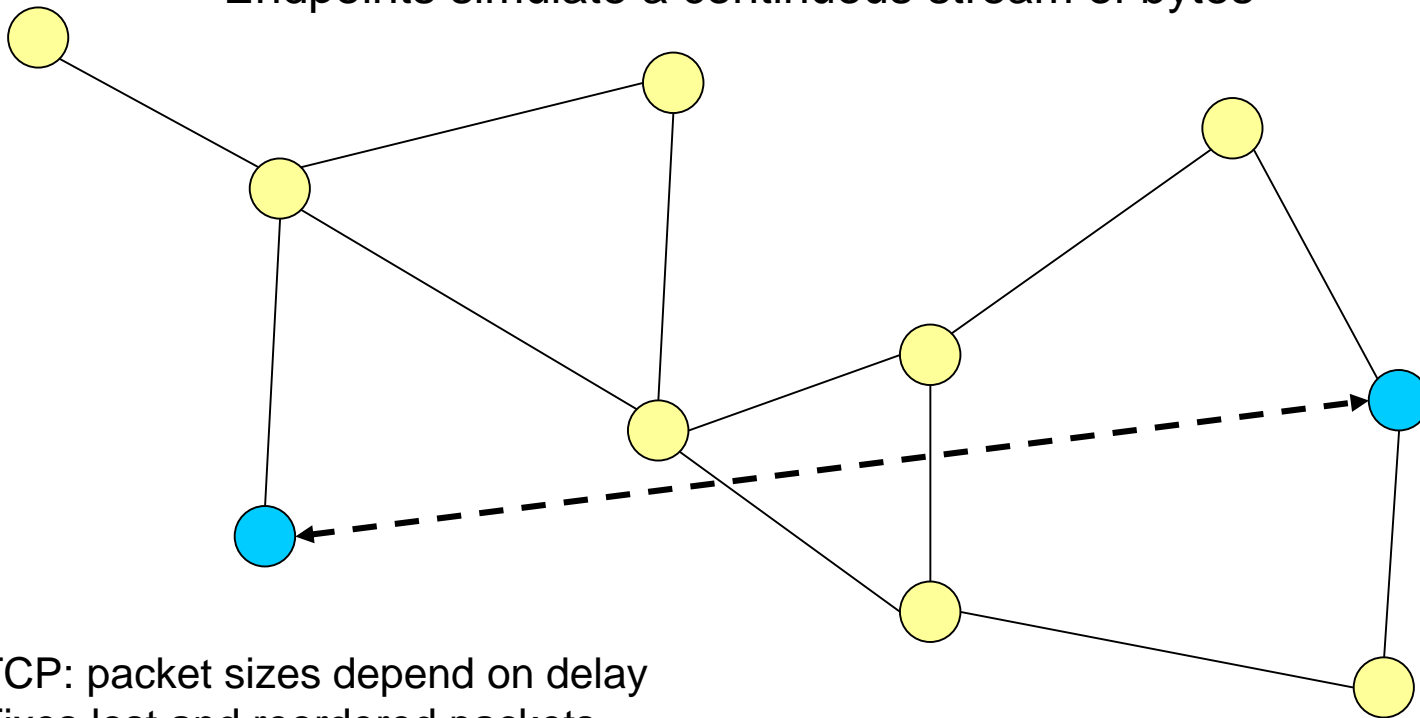


## TCP/IP



# Transport layer – virtual connection

Endpoints simulate a continuous stream of bytes



TCP: packet sizes depend on delay  
Fixes lost and reordered packets

The End