CS 350

2.6

Transfer of Information

Transfer of Information

- Inside the machine : busses and bus structures
-
- outside the machine: data communications

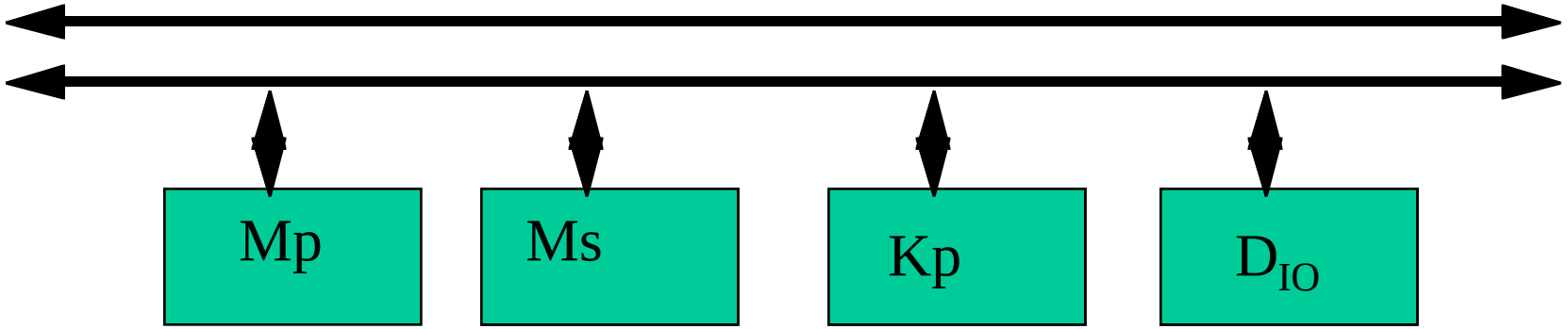
What's a bus?

- Many parallel wires
  - data
  - control
  - address
- Interface circuits
- protocols for gaining control of the bus
- switching functionality
-

PH Break busses

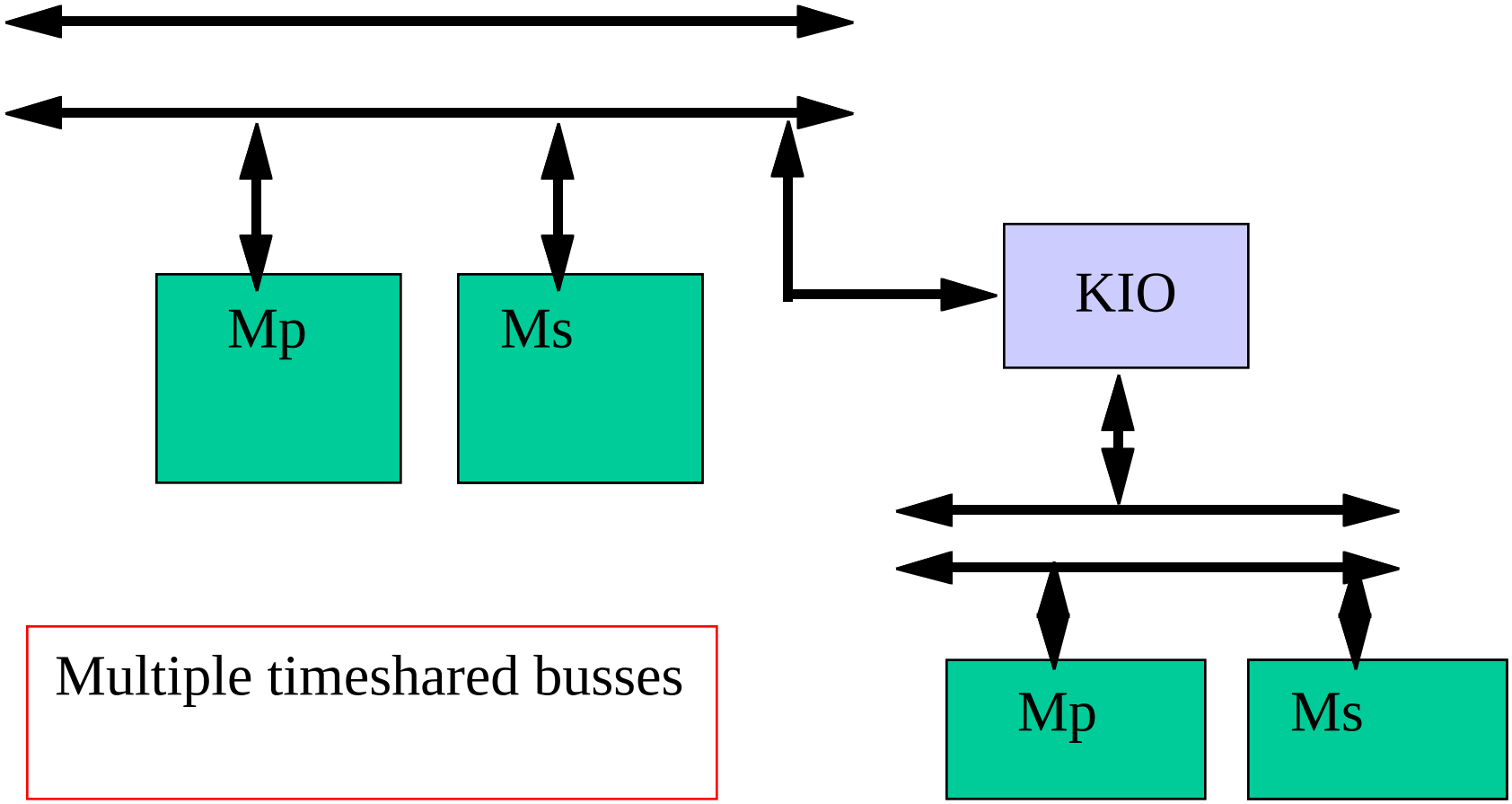
- Section 8.4, text

Some bus architectures



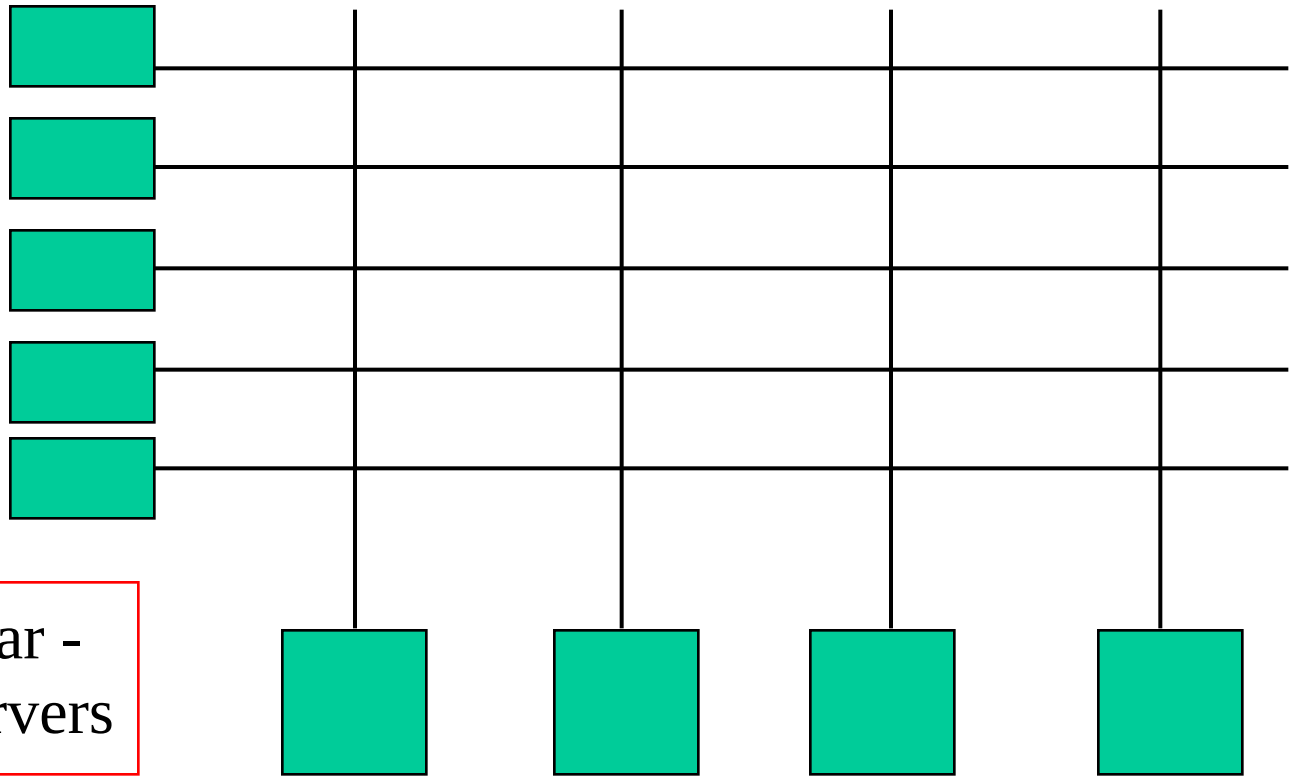
* time-shared bus (time-division multiplexed)
* example: PDP-11 Unibus
* advantages & disadvantages ??

Some bus architectures



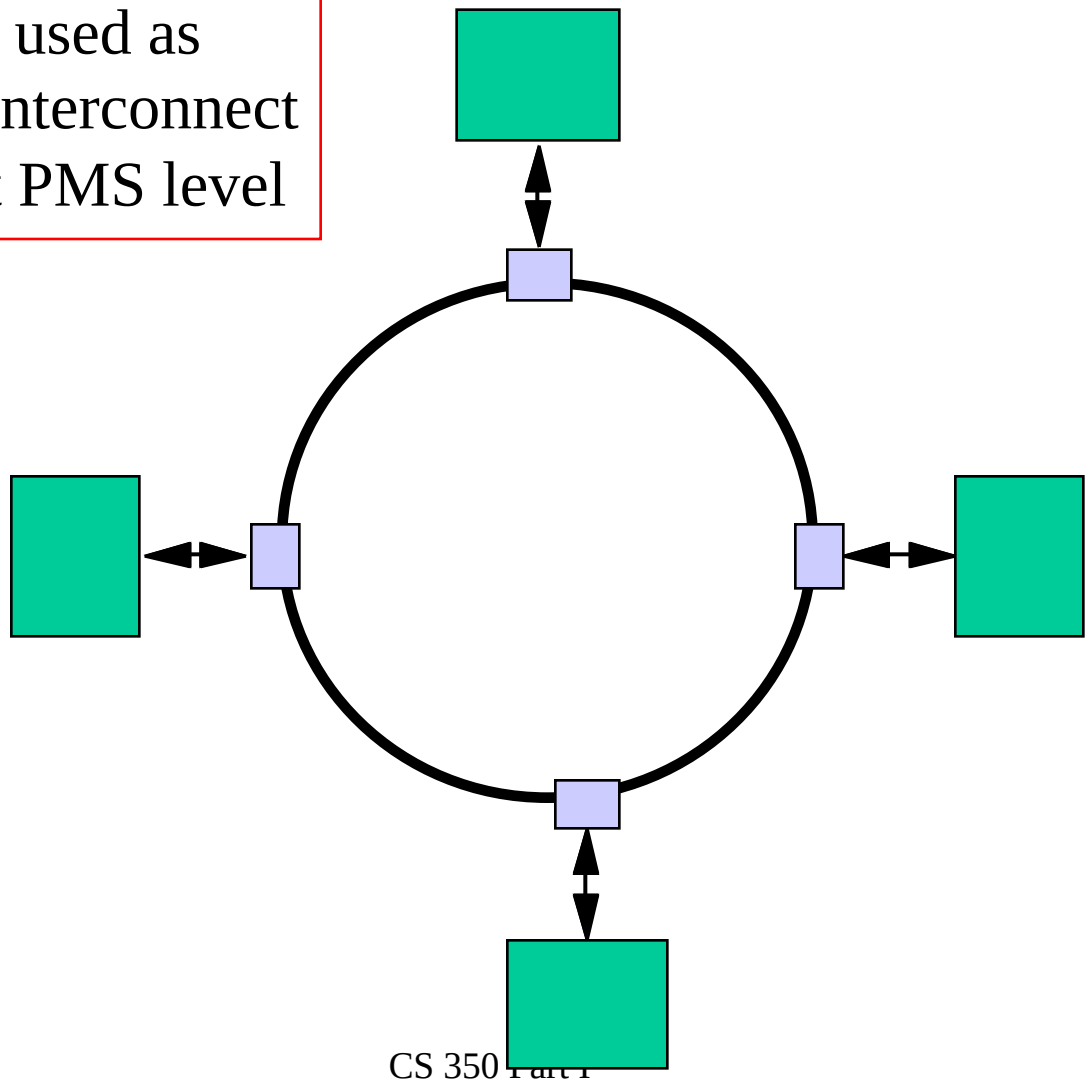
Multiple timeshared busses

Some bus architectures

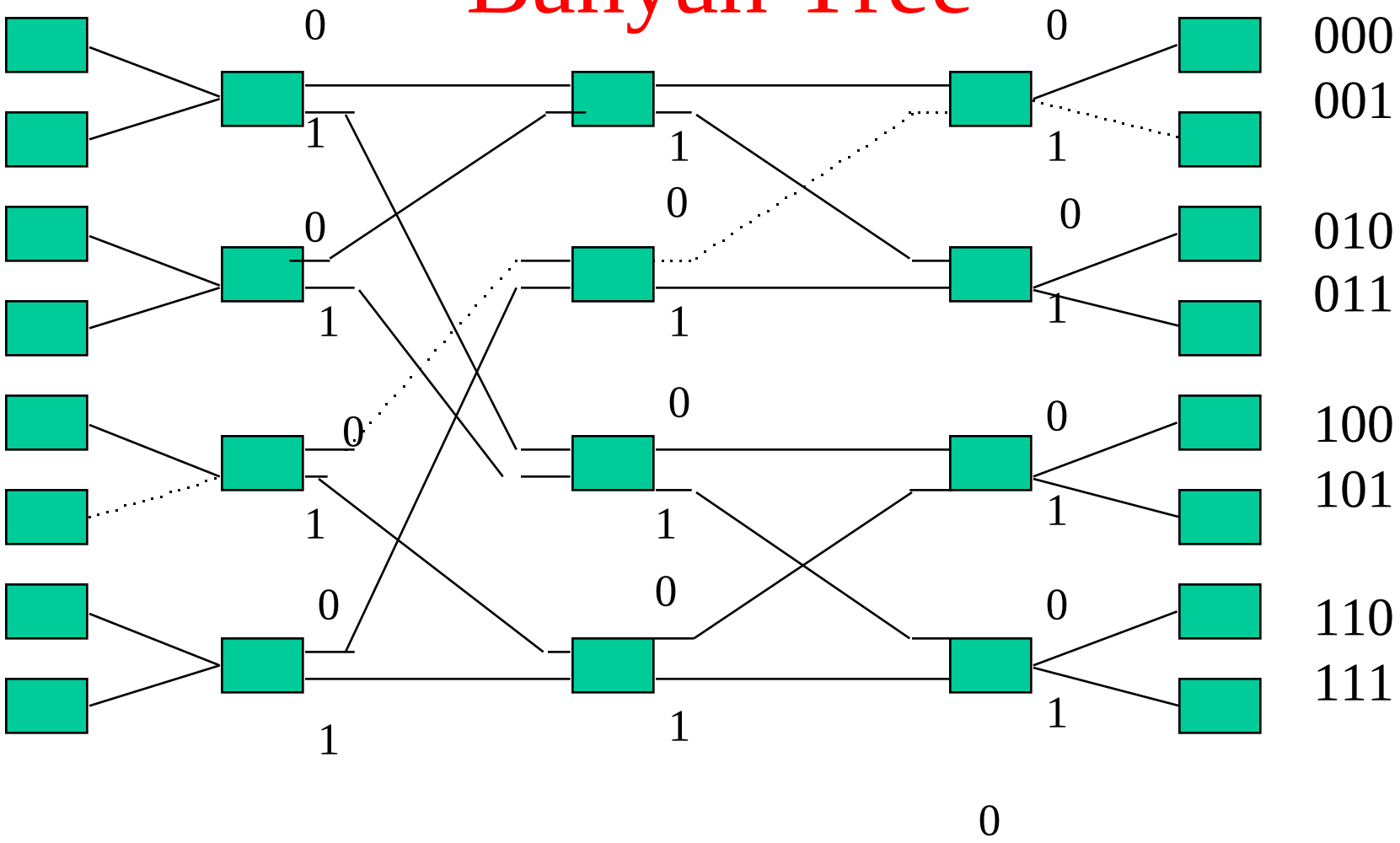


Crossbar - Sun servers

Ring
commonly used as
computer interconnect
not used at PMS level

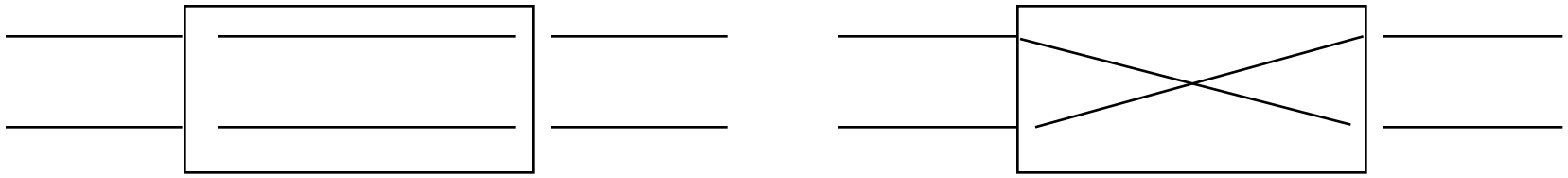


Banyan Tree



Banyan Tree

OR



Basic switching element - Binary switch

2- input permuter

easily fabricated in VLSI

Case Study
pdp-11 Unibus

- Cheap, low-performance, asynchronous bus
- used in 1970s to connect Mp as well as Dio to Kp
- typical of today's peripheral device busses - Dio to Mp, but not used to connect Kp to Mp

Unibus Operation

- Active devices:
  - cpu
  - some I/O devices
- Any active device can:
  - bid for control of the bus
  - communicate with any other active or passive device
  - release the bus
-

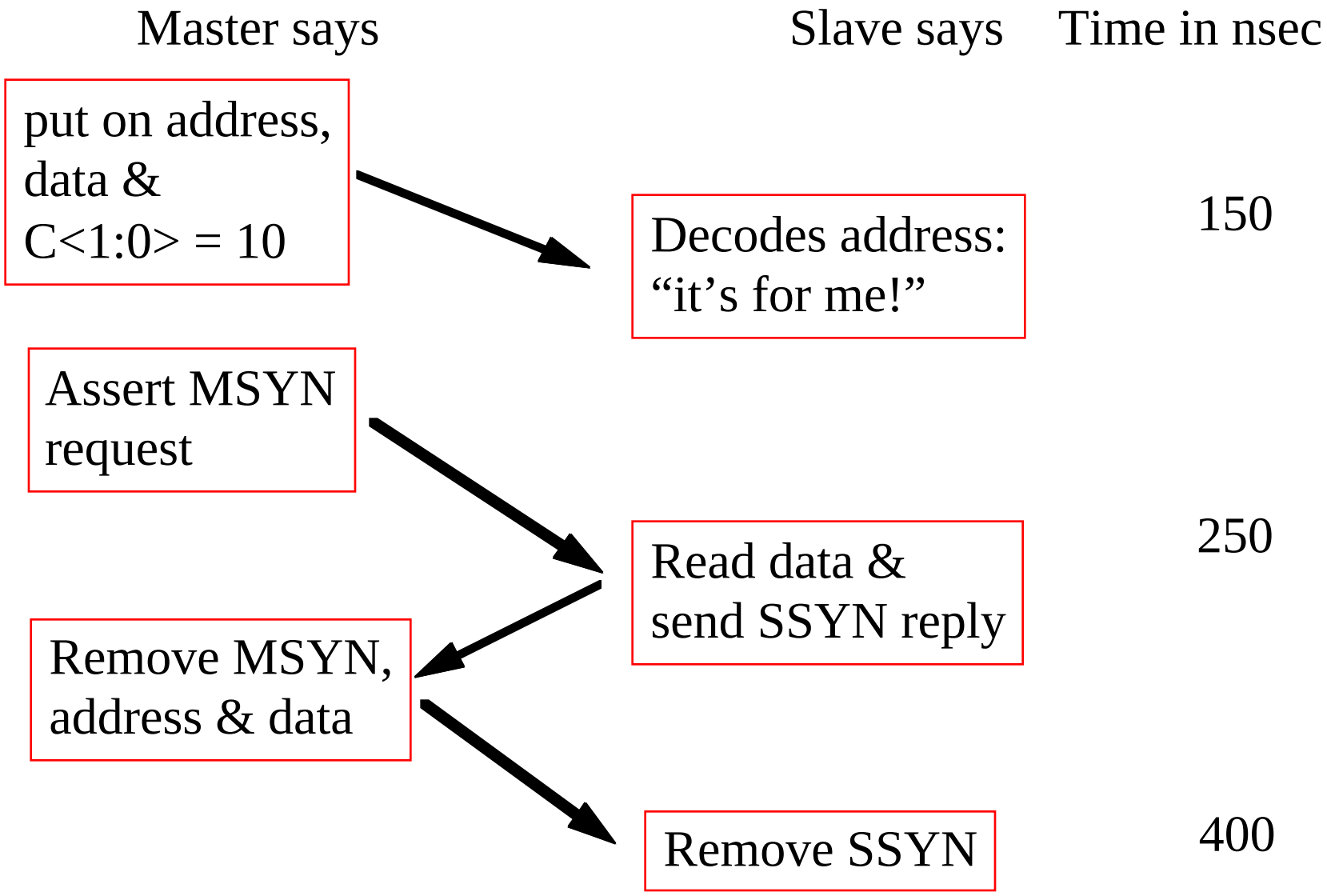
Unibus Operation

- E.g.
  - Kp to Mp
  - disc controller to Mp
  - DMA device to Mp
  -
- Who arbitrates access to the bus?
  - The Bus Master (usually the cpu)

Unibus structure

DATA	D<15:00>	
ADDRESS	A<17:00>	
CONTROL	C<1:0>	
MASTER SYNC	MSYN	} control
SLAVE SYNC	SSYN	
PARITY HI	PB	
PARITY	PA	
BUS REQUEST	BR<7:4>, NPR	} priority
BUS GRANT	BG<7:4>, NPG	
SACK		
BBSY		
INTR		

Data out protocol


Master says
Slave says
Time in nsec
put on address, data & C<1:0> = 10
Decodes address: “it’s for me!”
150
Assert MSYN request
Read data & send SSYN reply
250
Remove MSYN, address & data
Remove SSYN
400

Other Unibus protocols

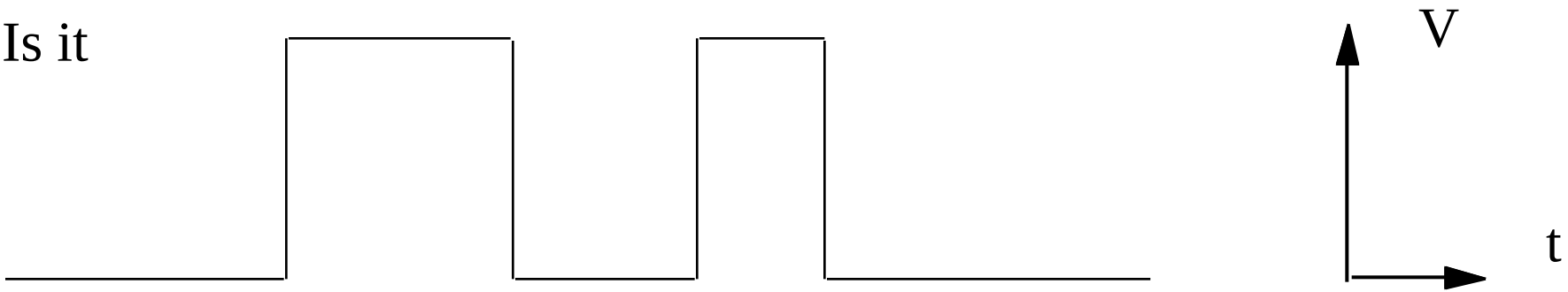
- Get control
-
- Data in C<1:0> = 00
- Non Processor request
- Interrupt

Busses:
Questions to ask

- Performance (measured by probability of blocking, latency, throughput)
-
- cost as a function of size (O(n), $O(n^2)$)
-
- Performance / cost [bang per buck]

Transfer of information Outside the computer - data communications

- Is it
-

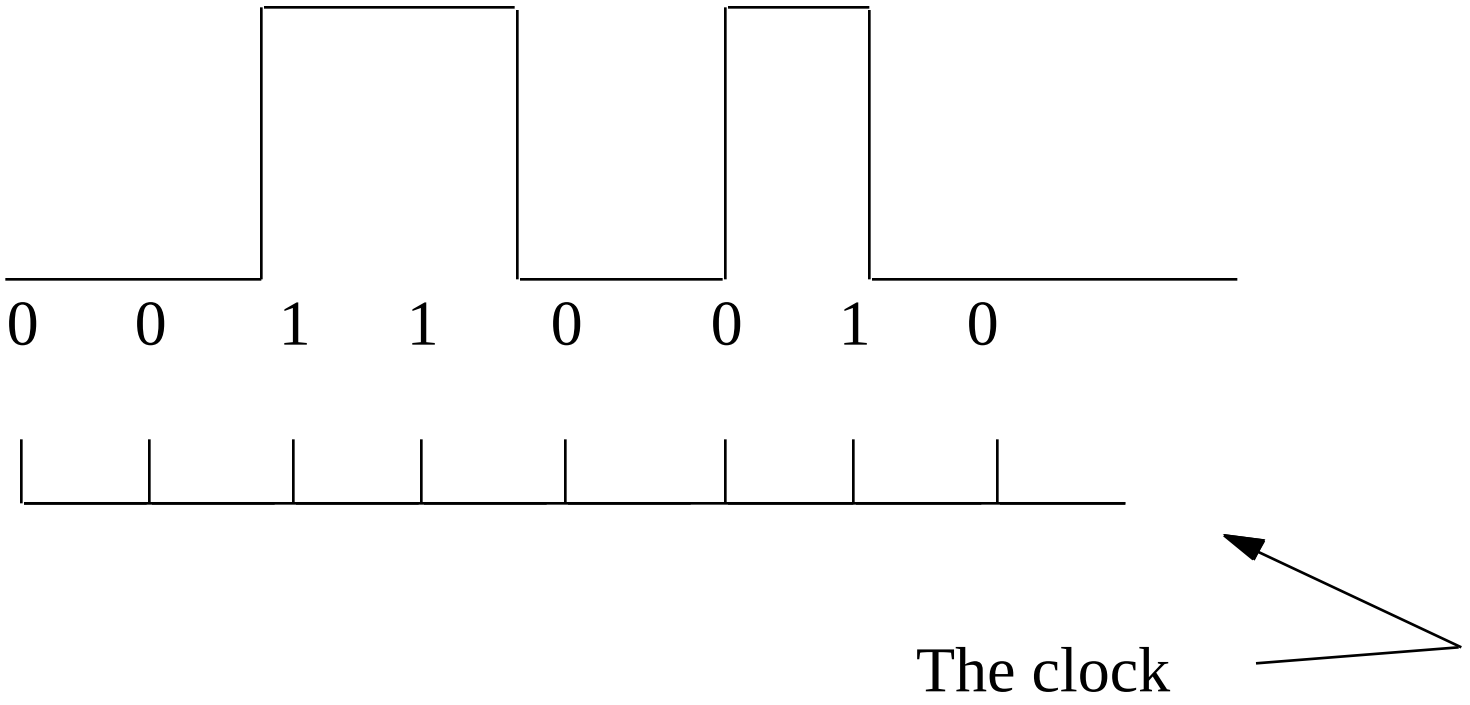


0 0 1 1 0 1 0 0 0

Or is it

0 0 1 0 0 1 0 0 ? ?

The answer:



Which raises two more questions:

- When was T =0 ?
-
- How fast does the clock tick?

Ways to answer these questions:

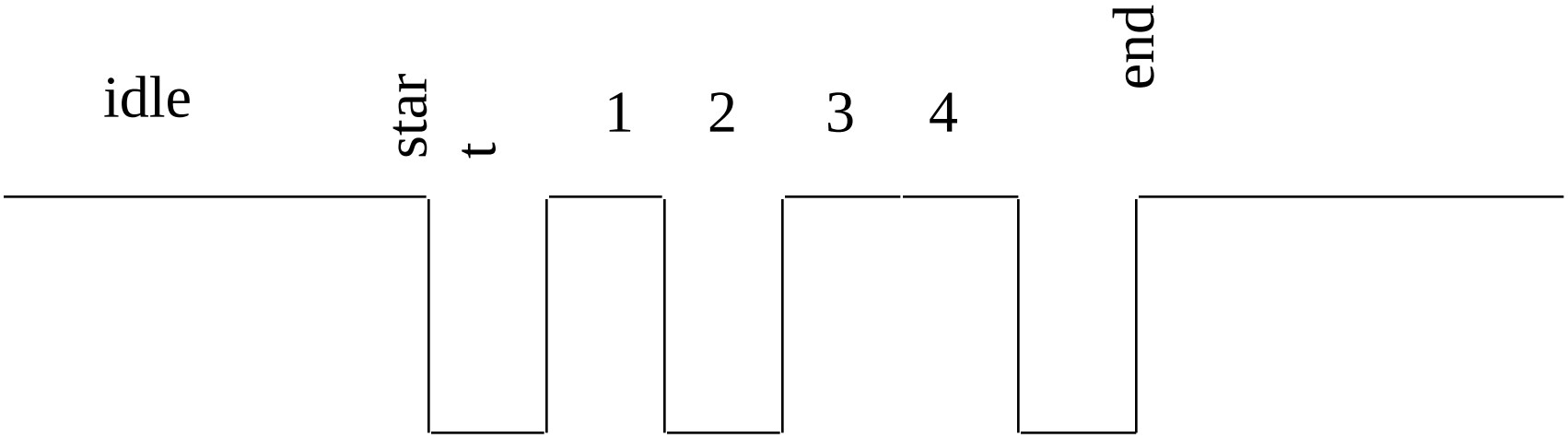
-
- synchronous - by - character transmission
-
- synchronous - by - block transmission
-

synchronous - by - character transmission

(misnamed “asynchronous transmission”)

- Channel has two states
  - +V <=> logic “1”
  - 0V <=> logic “0”
- Xmtr emits continuous “1” when nothing to send
- “0” denotes start of character
- return to continuous “1” denotes end-of-char

synchronous - by - character



Sending a 4-bit character

Pros & Cons

- Pro:
  - cheap clocks (need to maintain sync for 1 character time
  -
  - small buffers (1 char)
  -
- Con:
  - inefficient use of (expensive?) telecom channel

Used

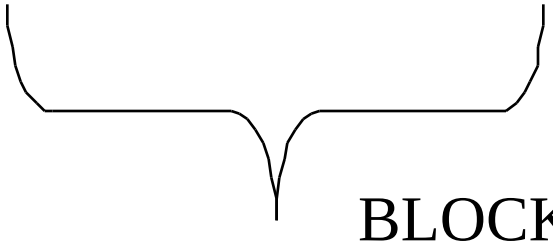
- To connect cheap terminals
  - cash registers
  - Point of Sale terminals
  - data collection terminals
  - interactive computer terminals
  - banking and airline res’n terminals
- to hosts via slow lines

Synchronous by block

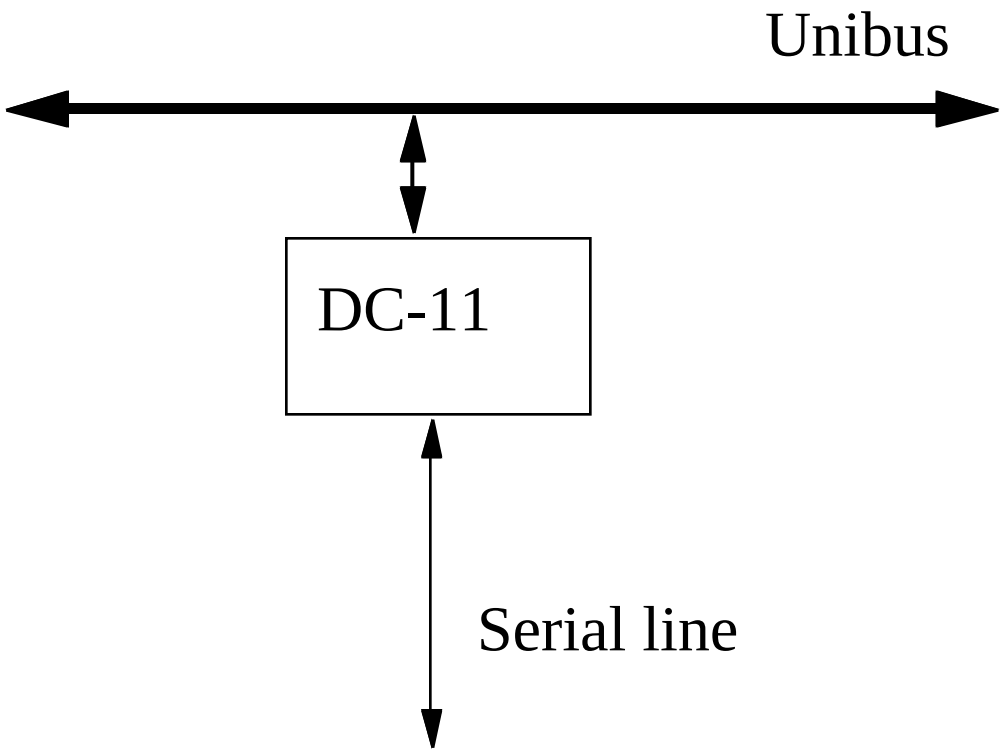
- Tx & Rx clocks resynchronized once per *block* (e.g. 1000 chars *)* instead of once per char
- Expensive clocks
- big buffers (eg 1 000 chars)
- better utilization of the line
- standard technique for computer-computer connection
-

Block sync

- A unique symbol (“SYN”) sent continuously on the idle line
-
- SYN SYN SYN ABCDEFG .. Z SYN SYN



Async Product
DEC DC-11



DC - 11

- Price: $300 US
- speeds: 100 - 300 bps
- package: 4 logic cards
- registers:

Rcvr status

Bit	means
15	enable cpu interrupt
12	error
10,9	char length - 1 of 5,6,7,8
7	done. Char available in buffer
3,4	select speed

DC - 11

- Transmitter : like receiver
-
- date: 1970
-
- DLV-11 1978 version - 1 card.
- Today: little used - too slow, poor line utilization

DEC DP - 11
Synchronous line driver

- Cost : $1200 US
- package: 8 (eight) logic cards
- programmable SYN char, size of data chars
- t = o (block sync) from end of SYN SYN
- clock rate (bit sync) from bit stream

DEC DP - 11
Synchronous line driver

- 8-bit parallel transmission
- interrupt raised on each character sent or received (!)
- data rate up to 50 000 b/s

-
- DU - 11 (1976)
  - same, on one card
- DQ-11 (1976)
  - DU-11 plus DR-11B DMA
-

- (1995)
  - DU-11 plus DR-11B plus HDLC on one chip
- (1996)
  - all of the above plus ethernet access on one chip

–

DP-11 operation

- Receive

- load SYN character
- load char size
- go
- DP-11 scans incoming stream for SYN SYN

Receive

- DP-11 sets SYNC flag
- each char received generates an interrupt
- cpu has 1 character time to copy char

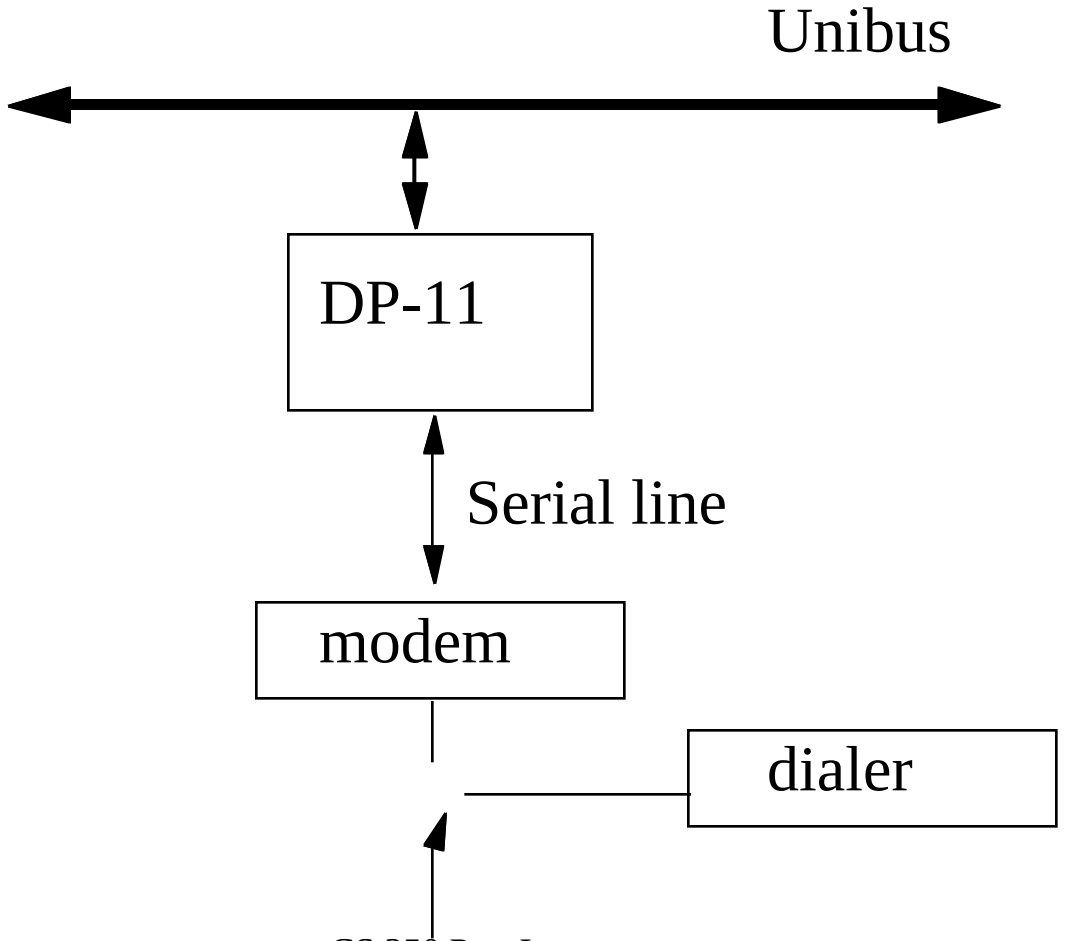
Send

- Load char into transmit buffer
- set go bit
- interrupt on char sent
- load next char . . .

Synchronous uses today

- Driving remote peripheral devices (line printers)
-
- as HDLC LAP-B, basis for ethernet and token ring Local Area Networks

Synchronous line over switched voice network



Other telecom chores

- Speed & code conversion
- terminal mothering
- polling
- multiplex / demultiplex
- data network interface (X.25, Frame Relay)

K_{tel}

- I/O Processor for Remote I/O
  - large number of slow, long lines
  - used to interface mainframes to remote terminals
  - being supplanted by internet-connected PCs
  - typical processor:
    - 32K words Mp
    - operating system
    - $100 000

Telecommunications transmission media

- Wire or terrestrial microwave:
  - BER = 10^{-3}
  - Latency = 100 bits
  - data rate: 50 kb/s to 10 Mb/s

Telecommunications transmission media

- Optical fibre
  - BER = 10^{-12}
  -
  - Latency = megabits
  -
  - rates: 155 Mb/s, 620 Mb/s, 1.2 Gb/s, 2.4 Gb/s
  -
  -
-

Telecommunications

- Switching:
-
  - circuits
  -
  - packets or cells

Convergence

- Telephone networks
- cable TV networks
- Internet
- computing industry