Exercise (SS 2022)

Comunication Systems and Protocols

Institut fuer Technik der Informationsverarbeitung
Dr. Jens Becker, Matthias Stammler M. Sc.

Task 1: Arbitration

4

2

1.1 A system using centralized daisy-chaining is shown in figure 1.1. An exemplary arbitration cycle of the system is shown in figure 1.2. Assign the correct signals of figure 1.1 to the signals shown in the diagram below (figure 1.2). Justify your choice of assignment with a few sentences. What node is sending data at which point in time? Complete the diagram (figure 1.2) accordingly.

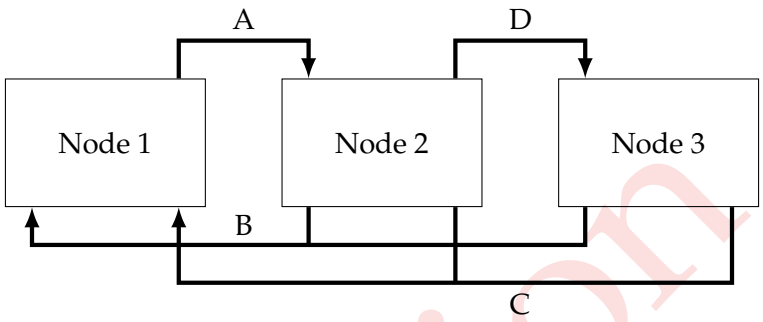

Figure 1.1: Centralized Daisy-chain

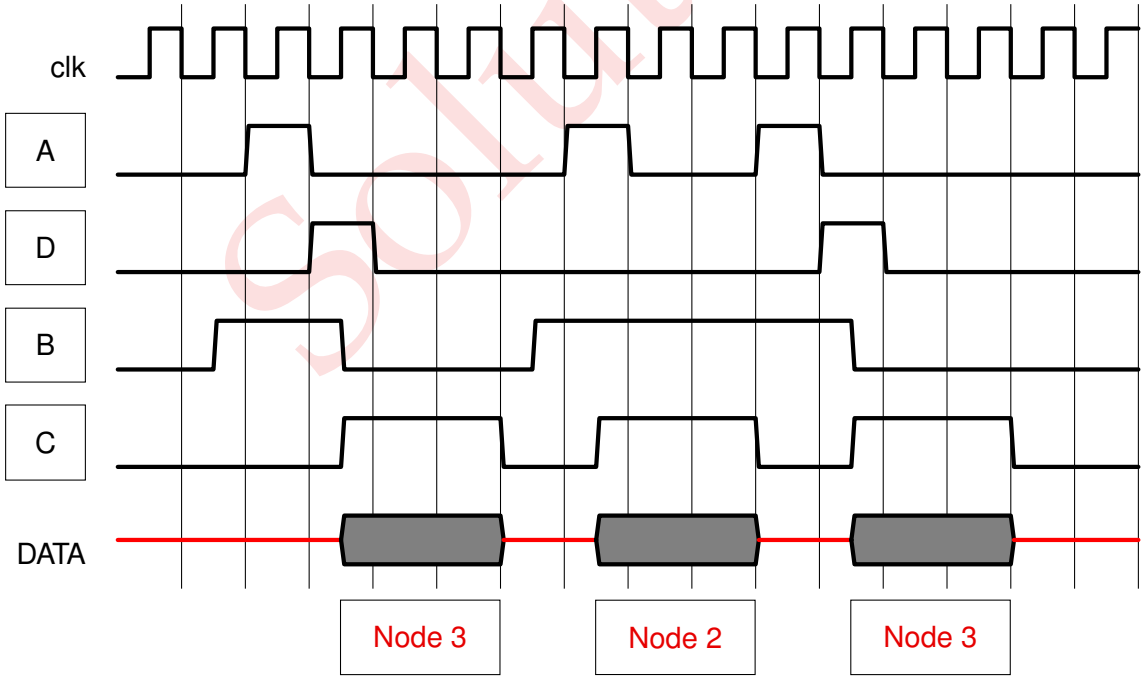

Figure 1.2: Signal flow for Daisy-chain

2

1.2 In the decentralized Daisy-chain shown in figure 1.3 a scheduling should be done. The different nodes will set a request at the times given in table 1.1. Only after successful transmission the nodes will remove their request. A node cannot send data consecutively. The sending of the data always needs exactly one time step. This includes token passing

and the time needed for the arbitration. Complete Table 1.2 according to the specified arbitration scheme.

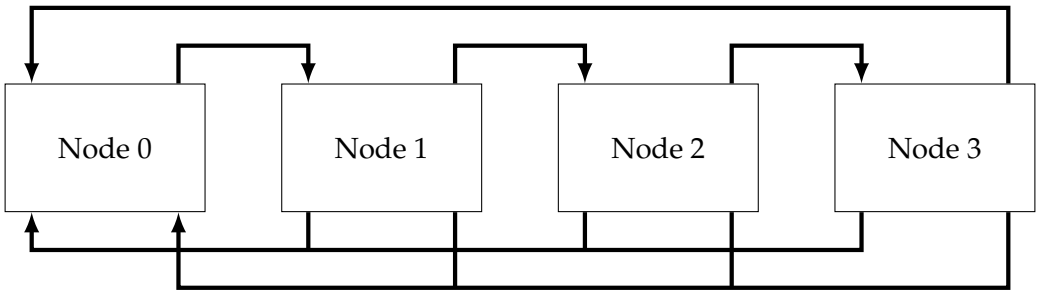

Figure 1.3: Decentralized Daisy-chain

time	Nodes that assert a sending request signal
t_1	Node 2 and Node 3
t_2	Node 1
t_3	Node 0
t_4	Node 0 and Node 1

Table 1.1: Time of sending nodes

time	Sending Node
t_0	Node 0
t_1	Node 2
t_2	Node 3
t_3	Node 0
t_4	Node 1
t_5	Node 0
t_6	Node 1

Table 1.2: Solution of Daisy-chain scheduling

Task 2: Carrier Sense Multiple Access/Collision Resolution (CSMA/CR)

6

A communication system comprises five communication nodes that use CSMA/CR as arbitration scheme. In order to transmit data a node transmits a dominant start bit (‚0') for synchronization purpose. After that a 5 bit message identifier followed and 10 bits of payload data is sent. The message identifiers are unique for each node and all data is sent MSB first. The bus has to cover a maximum distance of $500m$.

2.1 Which requirements have to be fulfilled in order to guaranty a faultless function of the system? What are the implications for the transmission rate? 1

The requirement of simultaneity has to be fulfilled.
The signal propagation time t_s is much smaller compared to the digit length (bit time) t_B:
$\left[t_s = \frac{l}{v}\right] << \left[t_b = \frac{1}{TR}\right]$.

2.2 Calculate the maximum payload data rate of this bus. Assume a propagation velocity of $0.66c$ ($c = 3 \cdot 10^8 \frac{m}{s}$). 2

Transmission rate:
$\left[t_s = \frac{l}{v}\right] << \left[t_b = \frac{1}{TR}\right]$ with $l = 500m$, $v = 0.66 \cdot 3 \cdot 10^8 \frac{m}{s}$

$TR << \frac{v}{l} = \frac{0.66 \cdot 3 \cdot 10^8 \frac{m}{s}}{500m} = 396000 \frac{1}{s}$

Start bit + 5 bit message identifier and 10 bits data:
payload data rate $= \frac{10}{16} \cdot TR = 247500 \frac{1}{s}$

2.3 Figure 2.1 shows a timing diagram for the bus system described above. Indicate the identifiers of the given nodes as far as possible (use Table 2.1). Mark undetermined identifiers bits as X! 2

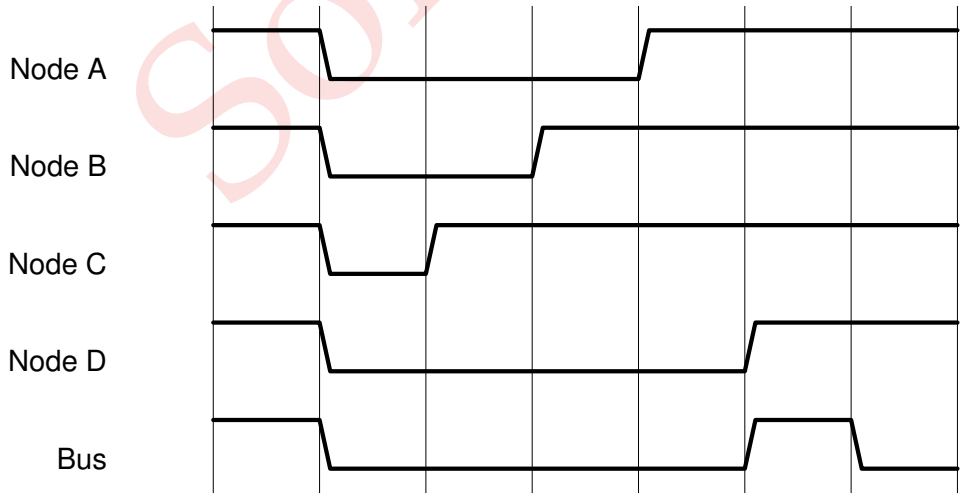

Figure 2.1: Bus Access

Node	Bit 4 (MSB)	Bit 3	Bit 2	Bit 1	Bit 0 (LSB)
A	0	0	1	X	X
B	0	1	X	X	X
C	1	X	X	X	X
D	0	0	0	1	1

Table 2.1: Identifiers of the nodes

2.4 Which node is granted exclusive access to the bus? 1

Node E (five nodes are mentioned in the task) is able to send data.
OR: No one of the four nodes A-D is allowed to send data.

Task 3: Carrier Sense Multiple Access/Collision Detection (CSMA/CD)

2

In this task we have a look at a bus system with arbitration that is derived from CSMA/CD. The following rules apply:

- All nodes want to send as many messages as possible. The length of each message is given in Table 3.1.
- A node is not allowed to send twice in a row. After each successful transmission it has to wait until another node has finished its transmission. The values of the assigned waiting times for each node are given in Table 3.1.
- If a node willing to send detects that the bus is occupied it withdraws and waits for the time specified in Table 3.1 (waiting time) until it will retry to transmit. Any ongoing transmission is not influenced.
- If two or more nodes want to start a transmission on the free bus at the same time there is a collision. All involved nodes withdraw from the bus and wait for the time given in Table 3.1. If a node was already waiting before, its waiting time will be doubled. The waiting time is only reset to the initial value after a successful transmission of the respective node.

Node	Packet length	Waiting time
A	2	1
B	2	2
C	2	3

Table 3.1: Specification of nodes

3.1 Fill in the signal sequence of the bus nodes, resulting from the specification as given above (use Figure 3.1). Mark waiting times and collisions that occur.

2

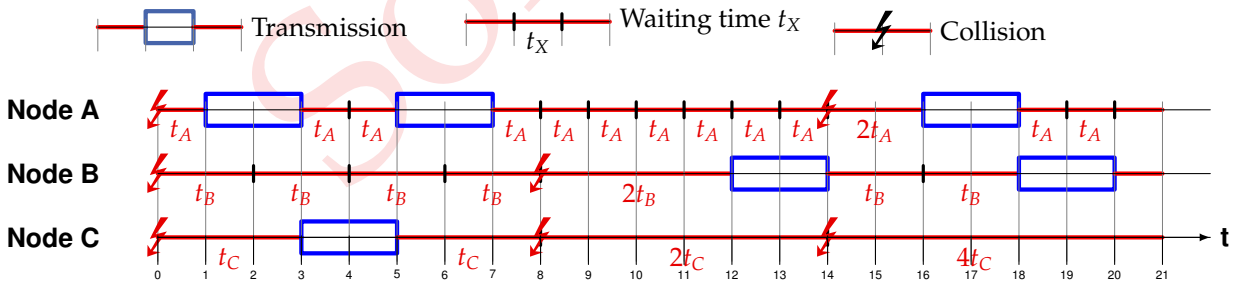

Figure 3.1: Signal sequence