

Assignment 5

Drahtlose Kommunikation (Wireless Communications)

Exercise 1

Which disadvantage of the S-MAC protocol is resolved in T-MAC and which new problem occurs?

Problem with S-MAC – energy wasted due to the fixed schedule of sleep and active periods => we have problem with variable load (different sizes of the packets)

This problem is resolved in T-MAC using adaptive scheduling

Problem with T-MAC – early sleeping problem => a node goes to sleep state even if it has something to receive from other node (but it is blocked by the other node)

Exercise 2

Given are three sensor nodes S1, S2 and S3 with following energy consumption values:

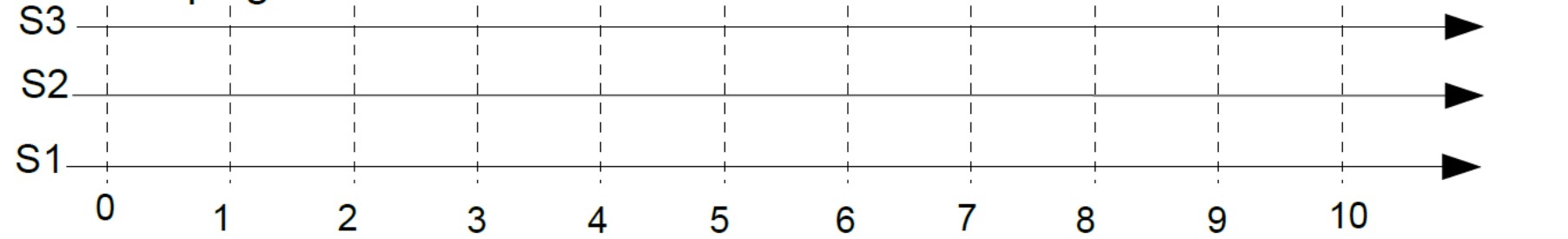
Sleep mode per ms:	0,1 J
Receive mode per ms:	1 J
Data transmission per ms:	2 J

Node S1 wants to send a data packet to node S3. The transmission takes 2ms.

For each of the following MAC protocols and the given time period of 10 ms, draw into the diagrams, how long each node is transmitting data (T), in receive mode (R), sending the preamble (P), or in sleep mode (S). Then calculate the overall energy consumption (in Joule).

a)

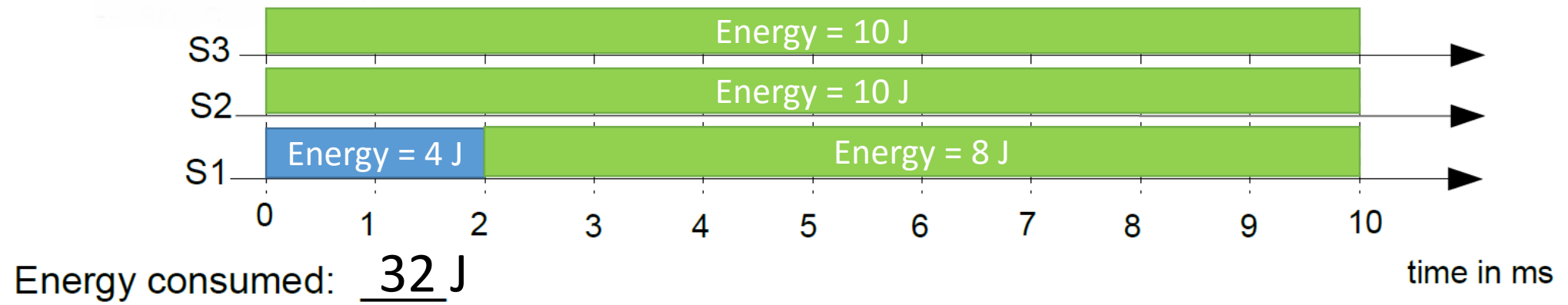
Nodes are not sleeping:



Energy consumed: _____

time in ms

a)



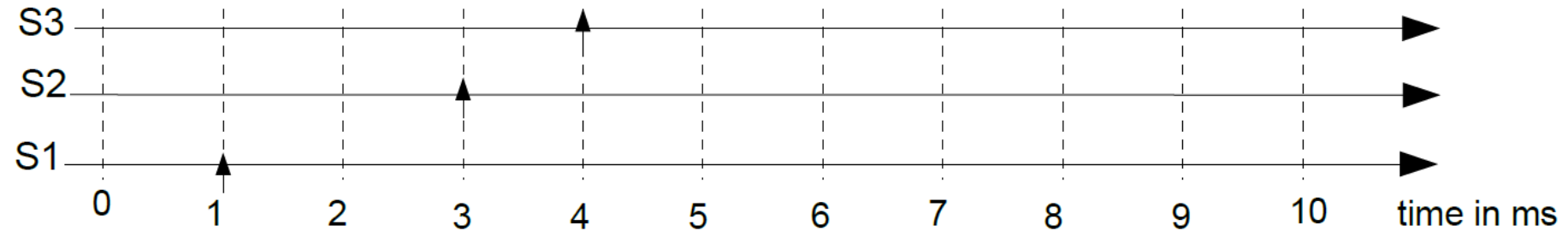
Transmission mode => 2 J / ms

Receive mode => 1 J / ms

b)

For the following MAC protocols the sleep cycle of each node is 5 ms. The arrow \uparrow indicates when the node wakes up from sleep mode for the first time.

1) All nodes are using the B-MAC protocol:

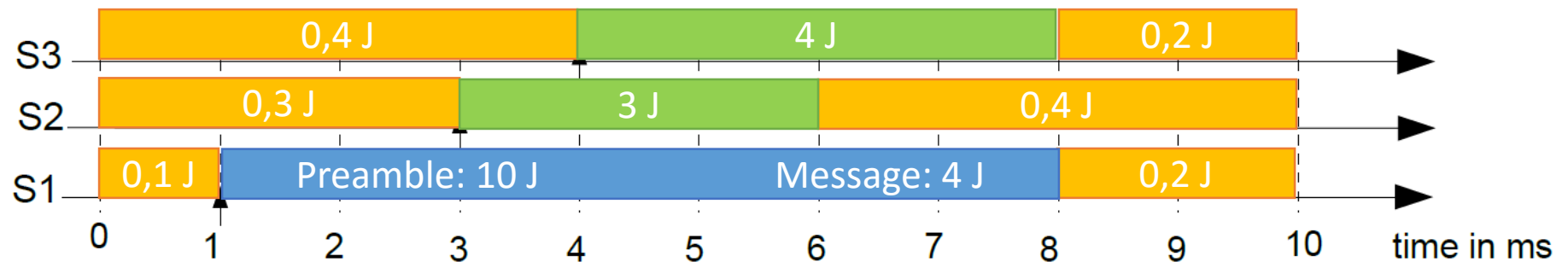


Energy consumed: _____

b)

For the following MAC protocols the sleep cycle of each node is 5 ms. The arrow \uparrow indicates when the node wakes up from sleep mode for the first time.

1) All nodes are using the B-MAC protocol:



Energy consumed: 22,6 J

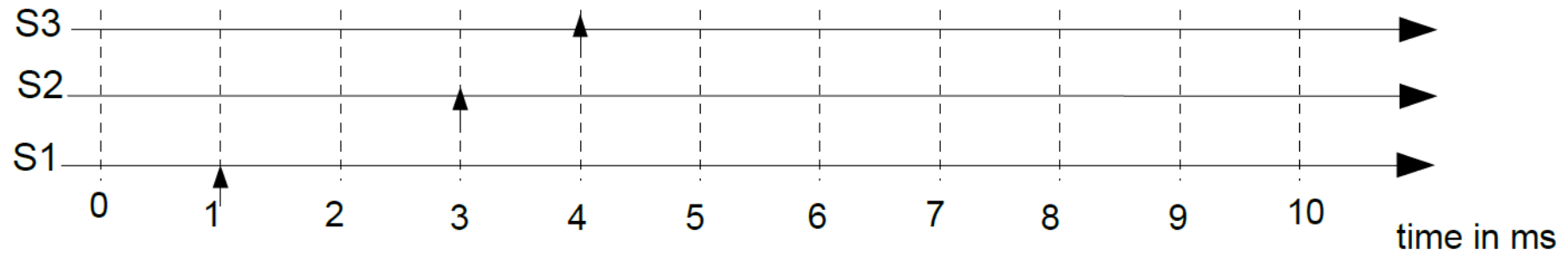
Transmission mode $\Rightarrow 2 \text{ J / ms}$

Receive mode $\Rightarrow 1 \text{ J / ms}$

Sleep mode $\Rightarrow 0,1 \text{ J / ms}$

2) All nodes are using the X-MAC protocol:

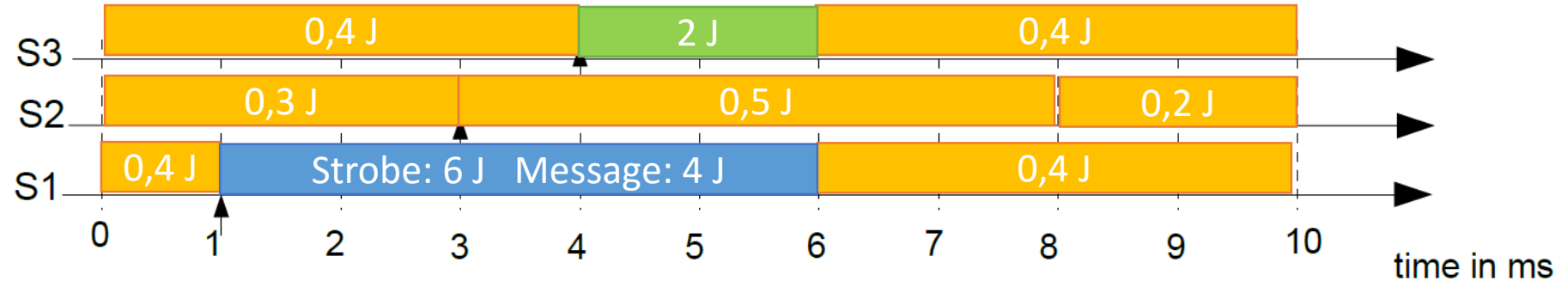
Assume a simplified strobe and acknowledgment length of 0 ms.



Energy consumed: _____

2) All nodes are using the X-MAC protocol:

Assume a simplified strobe and acknowledgment length of 0 ms.



Energy consumed: 14,3 J

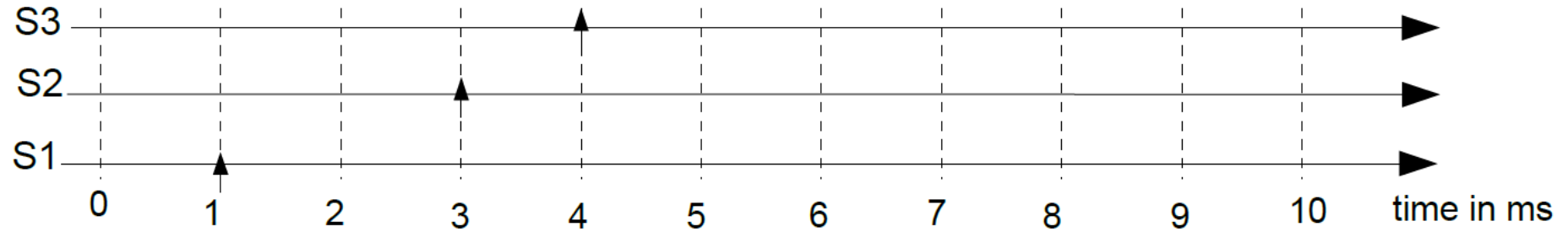
Transmission mode => 2 J / ms

Receive mode => 1 J / ms

Sleep mode => 0,1 J / ms

3) All nodes are using the Wise-MAC protocol:

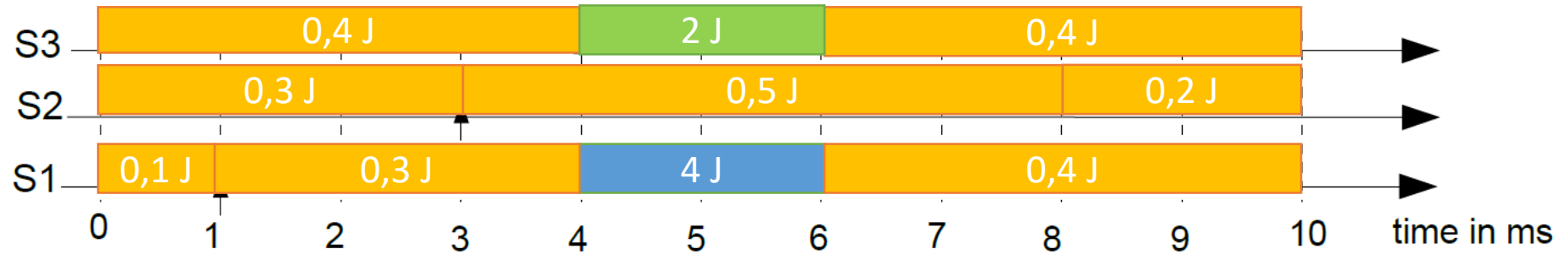
Assume that node S1 already learned the schedule of node S3. Assume a simplified preamble length of 0 ms.



Energy consumed: _____

3) All nodes are using the Wise-MAC protocol:

Assume that node S1 already learned the schedule of node S3. Assume a simplified preamble length of 0 ms.



Energy consumed: 8,6 J

Transmission mode => 2 J / ms

Receive mode => 1 J / ms

Sleep mode => 0,1 J / ms

Exercise 3

Assume a scenario where all nodes have a fixed sleep/wake cycle of Δ . How long is the preamble sent on average when using the following protocols?

a) B-MAC:

On average: Δ

b) X-MAC:

On average: $\Delta/2$

Exercise 4

In the following, parts of the source code of a TinyOS program are shown that uses the components W, X, Y and Z. How many instances are created at runtime for each component? The main component is W.

```
configuration W
{
}
implementation
{
    components X;
    components Z;
    ...
}

configuration Z
{
}
implementation
{
    components X;
    components Y;
    ...
}
```

One instance of
each component

Exercise 5

Given is the following wiring in TinyOS that wires together the components A and B via an interface: A -> B

a) Can A call routines in B? If yes, which type?

Yes, component A can call **commands** from B

b) Can B call routines in A? If yes, which type?

Yes, component B can call **events** from A

Exercise 6

a)

Are event handlers of timers synchronous or asynchronous?

Timer event handlers are synchronous, everything is synchronous by default, asynchronous operation is enabled with keyword ASYNC

b)

What is the impact of the runtime of a task on timers?

Timers can be delayed due to the runtime of the task (which is not interruptible with synchronous).

c)

Name two essential differences between a task and an event handler in TinyOS.

- Event handler is called through the interface, task is set for one component
- Task does not have return value while events have
- Event handler can be called immediately (like a function), tasks are always scheduled