

## Test of Discrete Event Systems - 22.10.2014

### Exercise 1

A wireless sensor is powered by a battery of capacity 5 Ah. The sensor can be asked either to acquire a new measurement or to acquire a new measurement and transmit the measurement record via wireless to a data collector. In case of acquisition only, the battery discharge amounts to 1 Ah, whereas in case of both acquisition and transmission, it amounts to 2 Ah<sup>1</sup>. It is assumed that a request is accepted even if the remaining battery capacity is not sufficient to satisfy the request. The lifetimes of both acquisition and transmission are assumed to be negligible. When the battery is too low, it is put on charge. During the charge, the wireless sensor is deactivated (meaning that all requests are rejected). The requests of acquisition arrive every 10 minutes, the requests of both acquisition and transmission arrive every 25 minutes, and the battery charge takes 18 minutes. The battery is initially full.

1. Compute the discharge time of the battery in steady state.
2. Compute the fractions of the two types of requests that are accepted in steady state.

### Exercise 2

A machine can be in one of three states (idle, busy and down). The machine breaks down after 10 hours of operation (i.e. in state “busy”). When the machine breaks down, the ongoing job is lost. Repairing the machine takes 2 hours. After the repair, the machine is idle, waiting for a new job.

1. Define a logical model of the machine.
2. Assuming that: the machine is initially idle; the machine spends in state “idle” 3.0, 0.6, 1.0, 0.8 and 1.2 hours; the first five jobs require 1.8, 2.4, 2.2, 2.6 and 2.5 hours to be completed, determine how many jobs are completed before the machine breaks down for the first time.

### Exercise 3

A doctor’s office has a waiting room with only two chairs. Patients who arrive and find the waiting room full, do not have access to the doctor’s office. Each patient has a maximum time he or she is willing to wait in the waiting room. If the patient is not received by the doctor within this time, he or she gives up and goes away.

1. Taking into account that: the doctor’s office is empty at the opening; the first patient arrives after 2 minutes from the opening, and the others arrive after intervals of 1.5, 1.0, 2.0, 3.0, 3.5 minutes; the visit of the first patient requires 10 minutes; the maximum waiting times acceptable by the patients are 2.0, 6.5, 3.0, 4.0, 5.0, 3.5 minutes, compute how many patients give up during the visit of the first patient.

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<sup>1</sup>These values are not realistic.

# Exercise 1

## MODEL

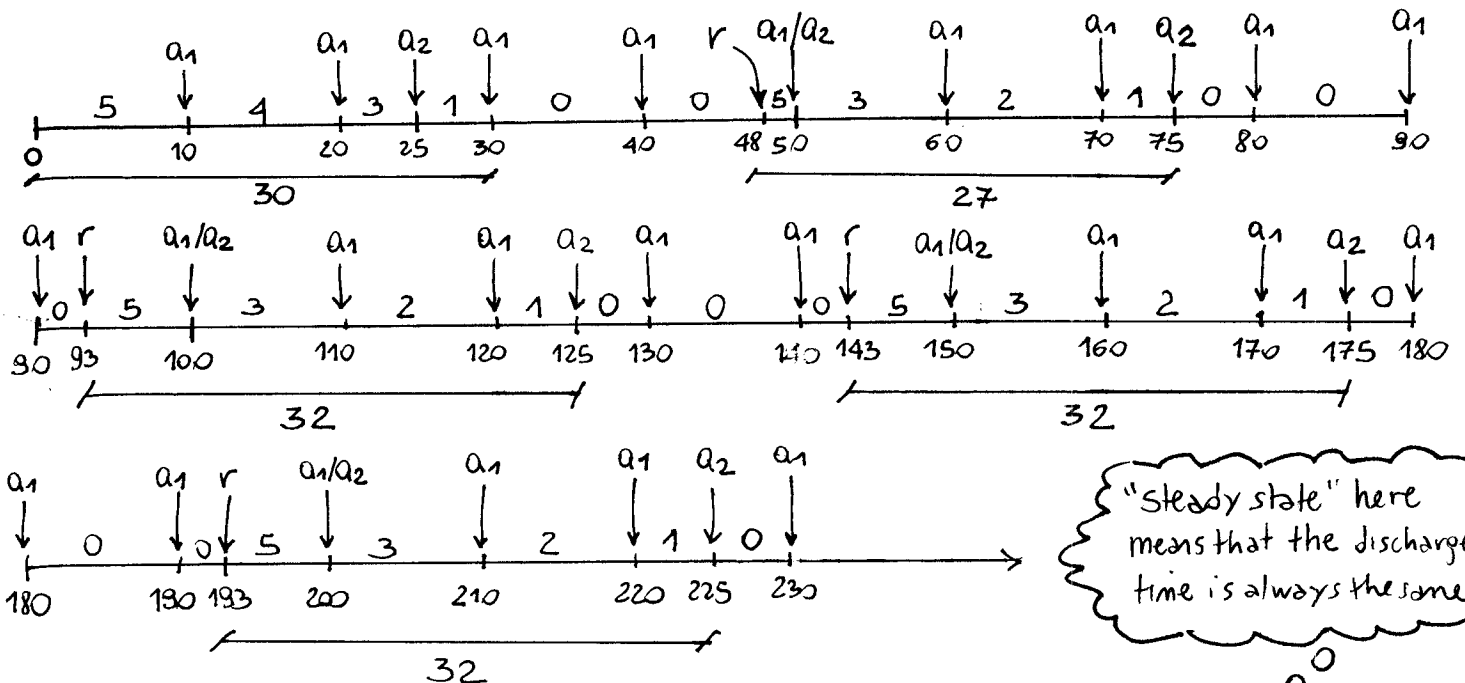
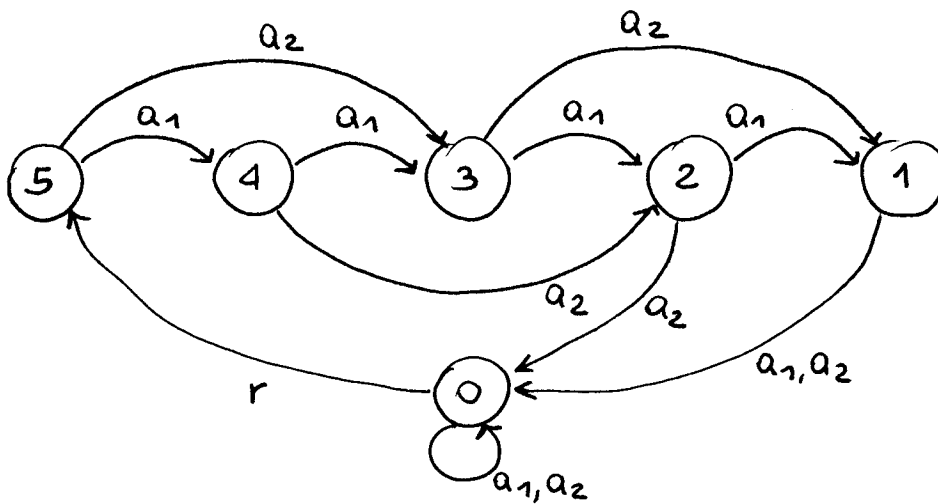
state  $x$  = battery capacity ( $x=0$  means that the battery is on charge)

events  $\mathcal{E} = \{a_1, a_2, r\}$   $\rightarrow$  end of battery charge

request of  
acquisition  
only

request of both  
acquisition and  
transmission

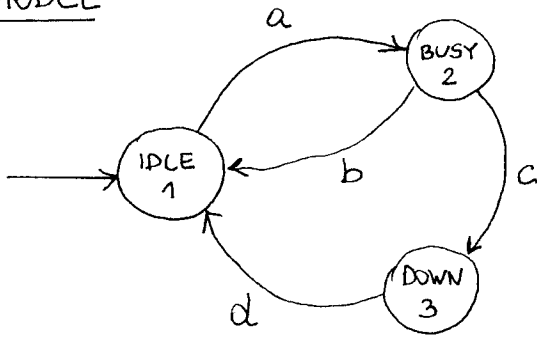
EVENT  $a_2$  "includes" EVENT  $a_1$  if they occur at the same time.



1. The discharge time of the battery at steady state is 32 min.
2. At steady state, all requests  $a_2$  are accepted, while only 60% (fraction  $\frac{3}{5}$ ) of requests  $a_1$  are accepted (we consider that, when  $a_1$  and  $a_2$  occur simultaneously,  $a_1$  is accepted because it is included in  $a_2$ ).

## Exercise 2

### MODEL



events:

a = start of a job

b = end of a job

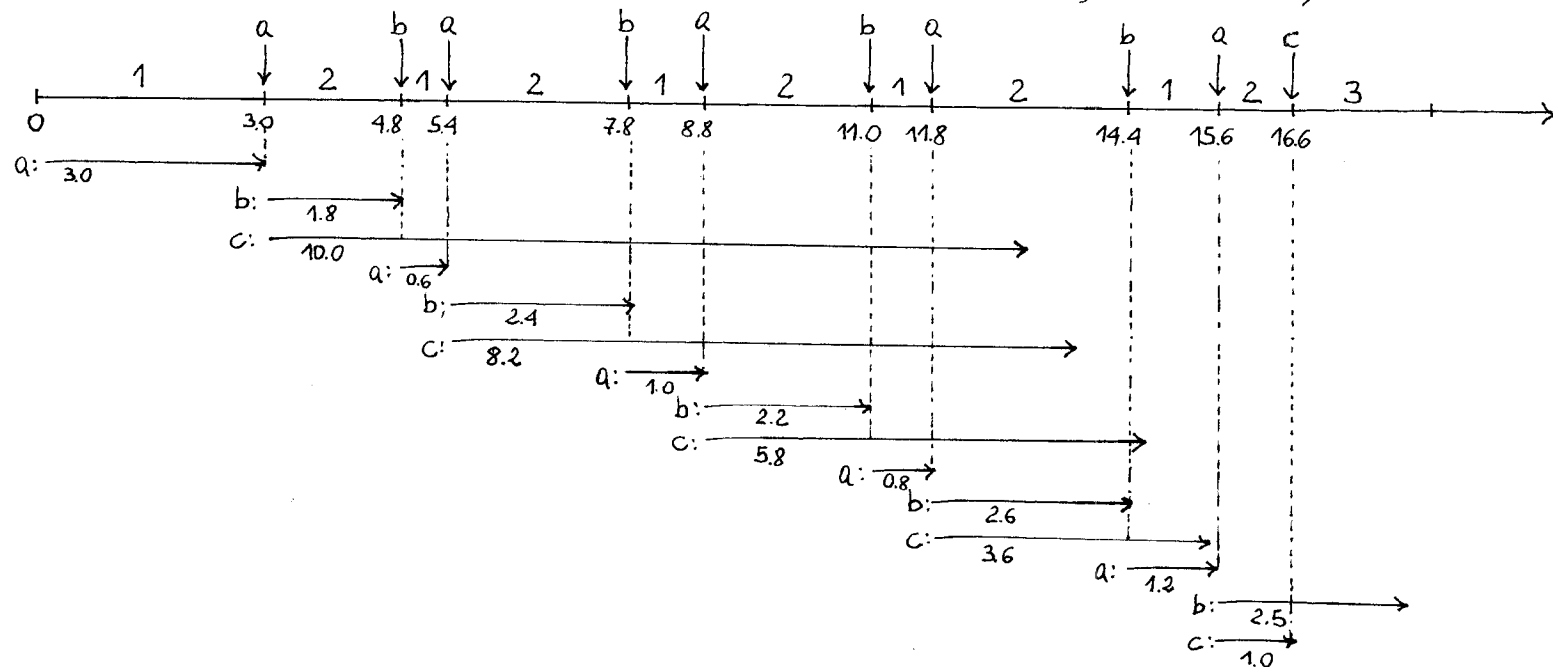
c = break down

d = end of repair

WARNING: the clock of event 'c' is restarted in state BUSY and stopped in state IDLE; moreover, the clock of event 'c' is reset to zero in state DOWN.

LIFETIMES:

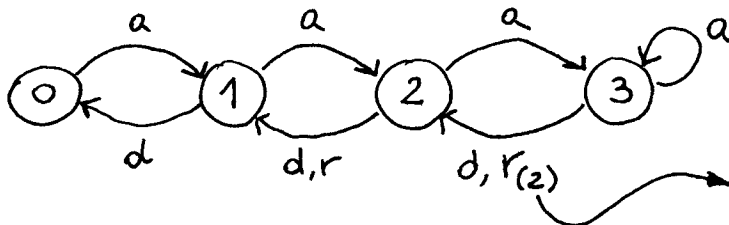
$$V_a = \{3.0, 0.6, 1.0, 0.8, 1.2\}, V_b = \{1.8, 2.4, 2.2, 2.6, 2.5\}, V_c = \{10.0, \dots\}, V_d = \{2.0, \dots\}$$



Four jobs are completed (events 'b') before the machine breaks down for the first time (event 'c').

# Exercise 3

model



to recall that there are two patients who might give up before the visit

EVENTS:  $\mathcal{E} = \{a, r, d\}$

arrival of a patient

patient gives up and goes away

termination of a visit

STATE:  $x = \#$  patients in the doctor's office

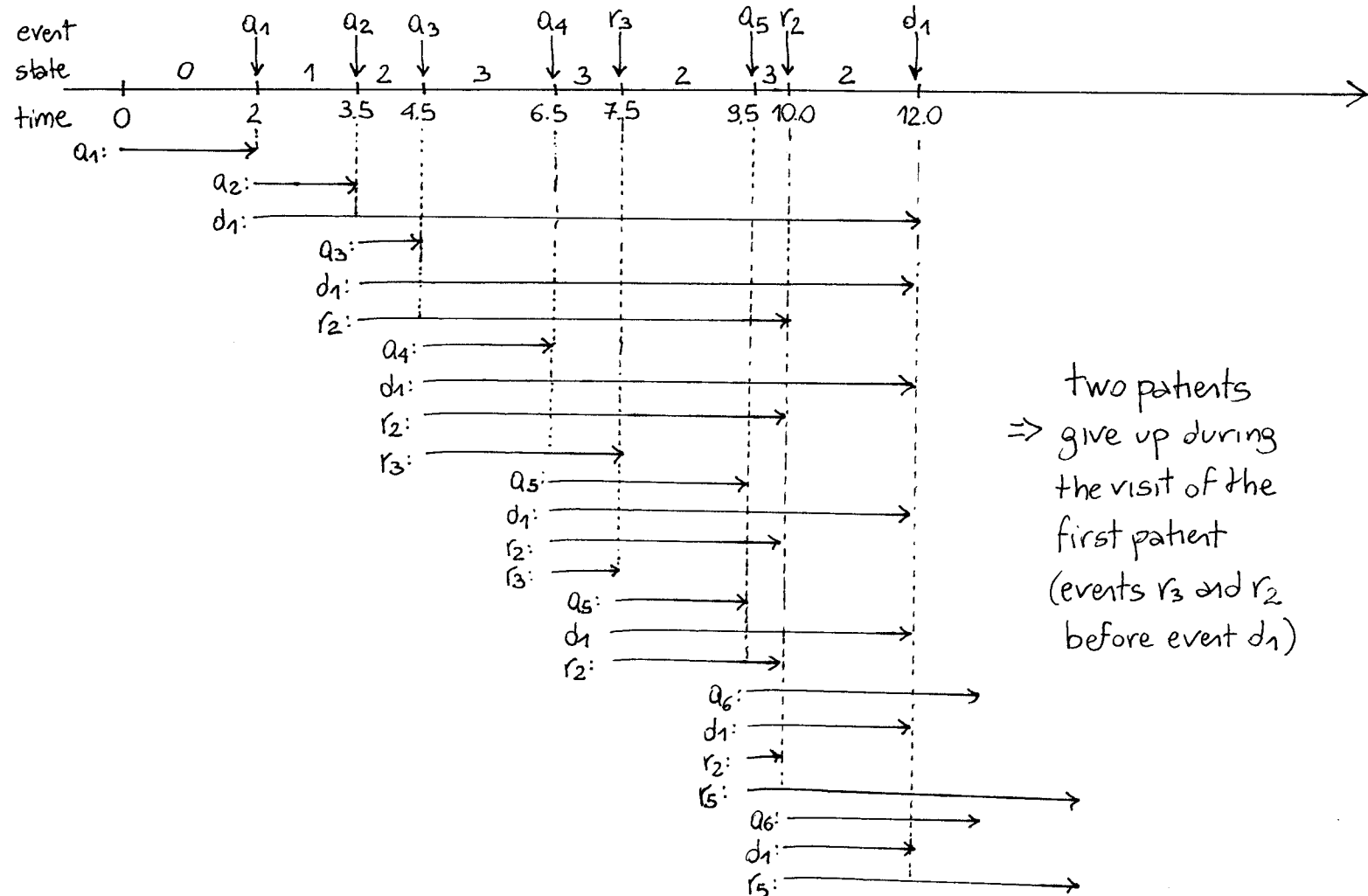
LIFETIMES:

$V_a = \{2.0, 1.5, 1.0, 2.0, 3.0, 3.5\}$ , 
  $V_r = \{2.0, 6.5, 3.0, 4.0, 5.0, 3.5\}$ , 
  $V_d = \{10.0, \dots\}$

$a_i$ : arrival of the  $i$ -th patient

$r_i$ :  $i$ -th patient gives up and goes away

$d_i$ : termination of the visit of the  $i$ -th patient



two patients  
 $\Rightarrow$  give up during  
 the visit of the  
 first patient  
 (events  $r_3$  and  $r_2$   
 before event  $d_1$ )