Test of Discrete Event Systems - 18.10.2017

One typical question about the event timing dynamics is concerned with what happens when the smallest residual lifetime corresponds to two or more events: how is the next event selected in such a situation? One possible way is to consider priorities between events. These priorities can be set a priori, or arise naturally from the problem description. Exercise 1 deals with the latter case.

The basic algorithm for event timing dynamics proposed in Section 5.2.2. of the textbook, relies on a certain number of assumptions. One of these assumptions is that, when an event which is not possible in the current state, becomes possible in the next state, a new lifetime is taken from the corresponding clock sequence. In other words, a new process underlying the event is started. This may not hold in some practical applications. When an event is interrupted and then becomes possible again, the underlying process might be resumed. Exercise 2 shows an example of this type related to the breakdown of a machine.

The algorithm for event timing dynamics presented in the textbook also assumes that, the next time an event becomes possible after its last occurrence, a new lifetime is taken from the corresponding clock sequence (and the corresponding score is increased by one). This may not hold in some practical applications. An example is round-robin queueing. Another example is given in Exercise 3, where the score of an event is increased according to different rules.

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[1]. 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.

[1]These values are not realistic.

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 opining; 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.

Exercise 1

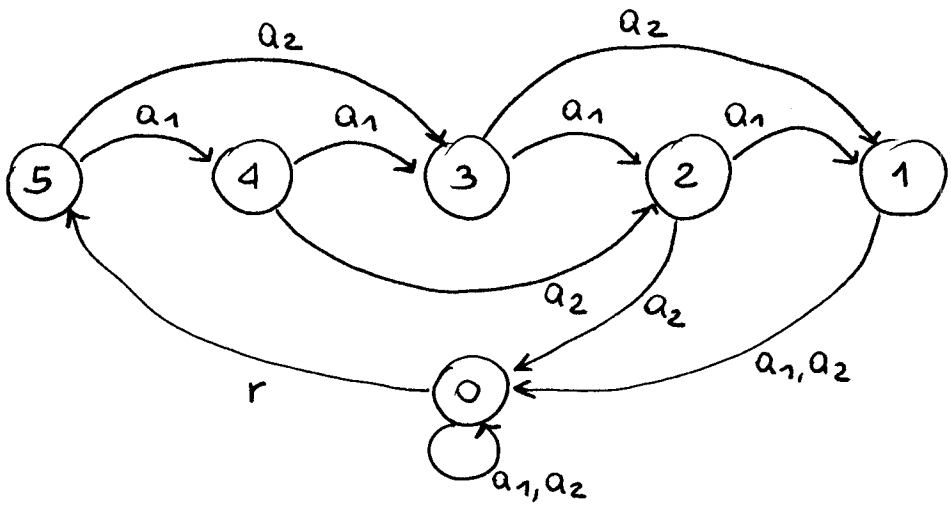
MODEL

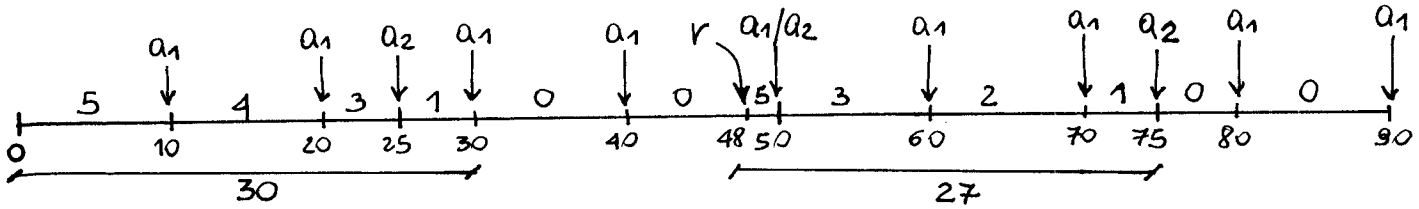
state x = battery capacity ($x=0$ means that the battery is on charge)

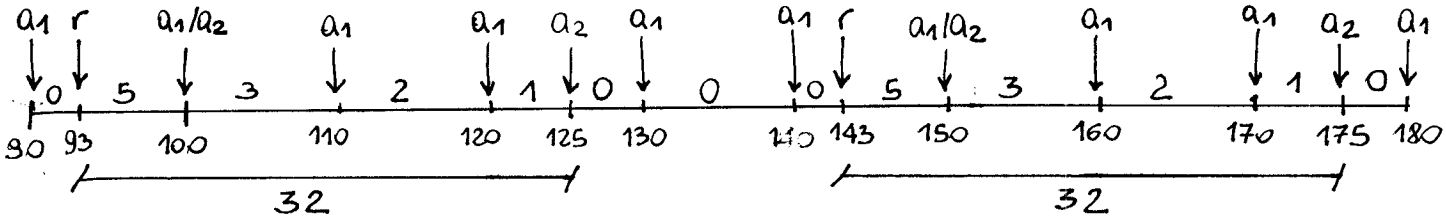
events $\mathcal{E} = \{a_1, a_2, r\}$ → end of battery charge

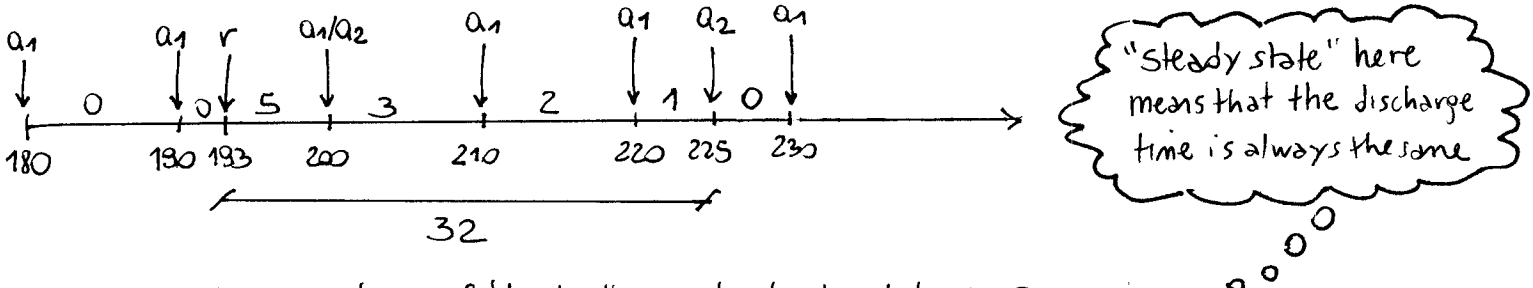
- a_1: request of acquisition only
- a_2: request of both acquisition and transmission

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





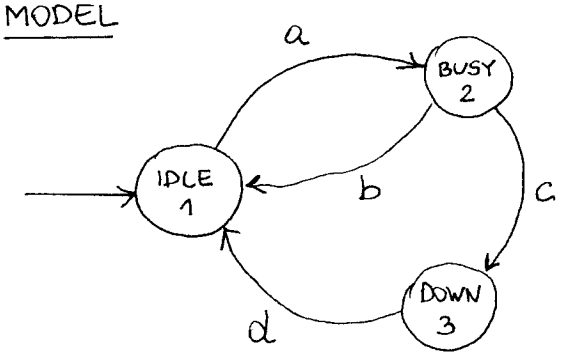




1. The discharge time of the battery at steady state is 32 min.
2. At steady state, all requests a_2 are accepted, while only 60% (fraction $\frac{3}{5}$) of requests a_1 are accepted (we consider that, when a_1 and a_2 occur simultaneously, a_1 is accepted because it is included in a_2).

Exercise 2

MODEL



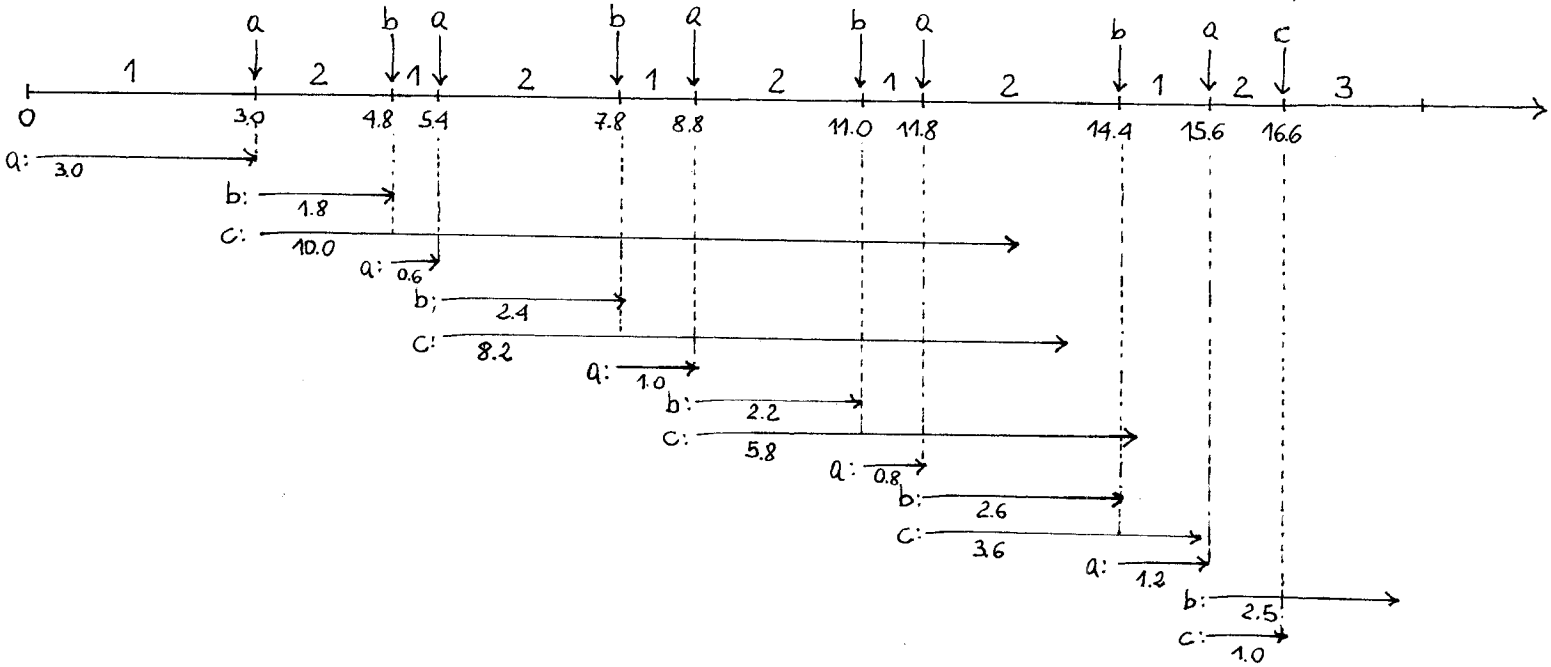
events:

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:

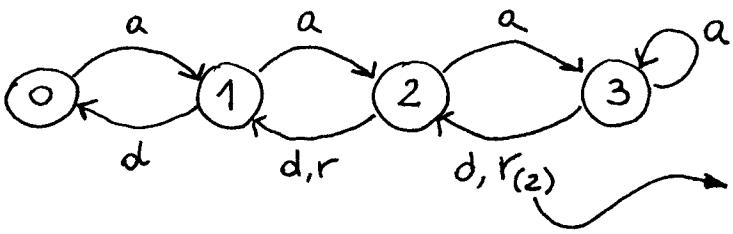
$V_a = \{3.0, 0.6, 1.0, 0.8, 1.2\}$, $V_b = \{1.8, 2.4, 2.2, 2.6, 2.5\}$, $V_c = \{10.0, \ldots\}$, $V_d = \{2.0, \ldots\}$



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

- a: arrival of a patient
- r: patient gives up and goes away
- d: termination of a visit

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

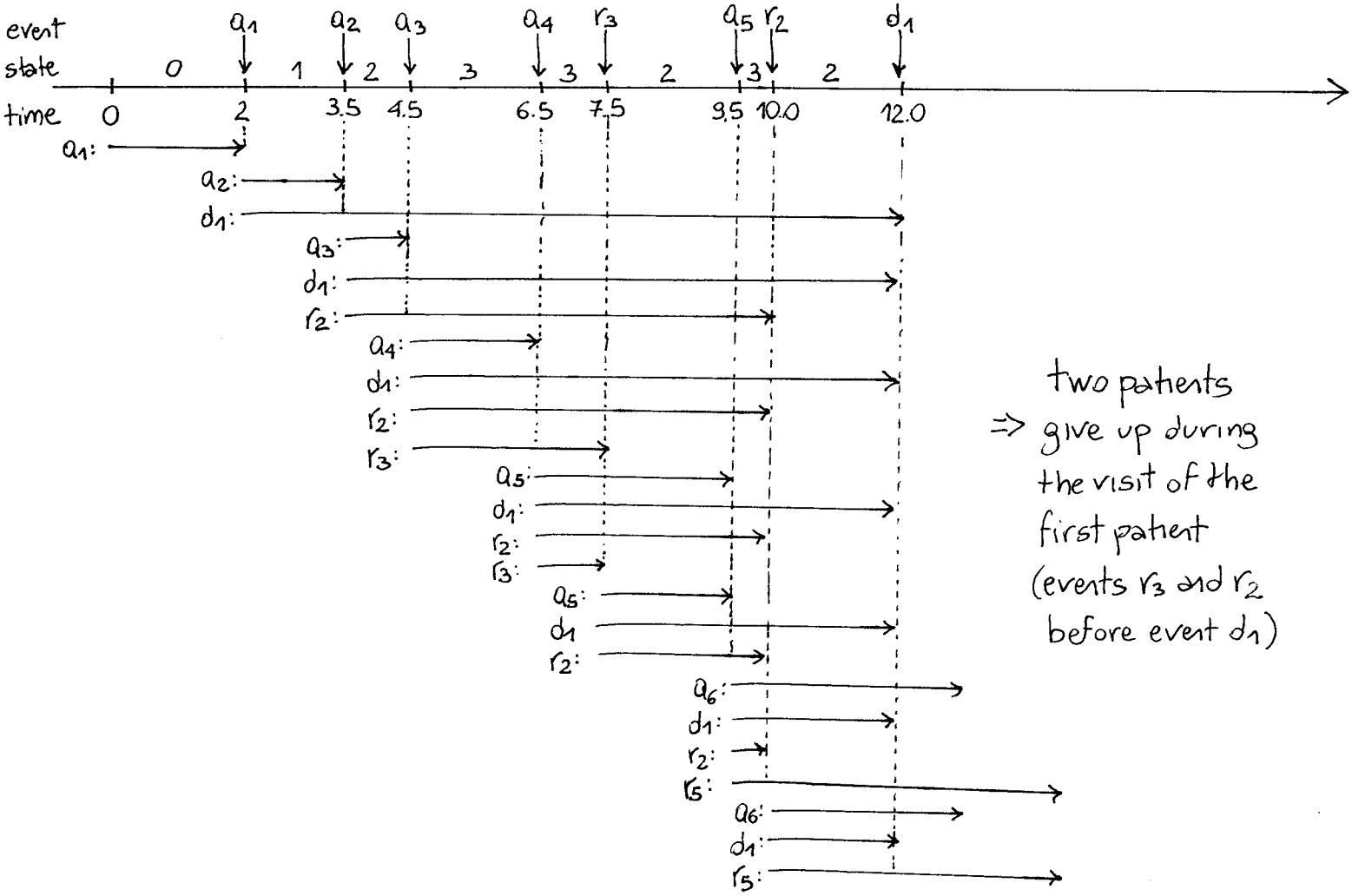
LIFETIMES:

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

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)