

## Obligatory Exercise 1 in INF5150 2009 by Erik G. Nilsson

### Problem 2 in the Exam from 2008

#### a) Events

I:

There are 3 events on lifeline u2:

1. Reception of Sms("request t1 TTT 1720 Oslo")
2. Sending of Sms("accept t1")
3. Reception of Sms("Reminder for T1 at 1720")

II:

There are 2 events that may be the first to take place:

1. Sending of Sms("reqltask t1 TTT 1720 Oslo") from lifeline u1
2. Sending of Time(1700) from lifeline timer

These two events are the first events on these two lifelines. For all other lifelines the first event is a reception event, and as sending a message always takes place before reception of the same message, there must be events taking place before these reception events.

III:

There are 4 events that may be the last to take place:

1. Reception of Sms("Reminder for T1 at 1720") in lifeline u2
2. Reception of Sms("You are out of bounds for t1 now") in lifeline u3
3. Reception of Sms("accept t1") in lifeline ts
4. Reception of Sms("reject t1") in lifeline ts

Possible last event must be reception events, so candidates are reception events that are the last events taking place in a lifeline. Event 1 is the last event on lifeline u2. Event 2 is the last event on lifeline u3 if the first branch of the outer xalt is executed (in this case the last event on lifeline ts is a send event). Event 3 is the last event on lifeline ts if the second branch of the outer xalt and the first branch of the inner xalt are executed (in this case the last event on lifeline u3 is a send event). Event 4 is the last event on lifeline ts if the second branch of the outer xalt and the second branch of the inner xalt are executed (in this case the last event on lifeline u3 is a send event). The lifelines timer and u1 will always have send events as their last event in the given sequence diagram.

IV:

There are 3 interaction obligations in the diagram. Initially there is one for the diagram, and one is added for each of the xalt operators (as they each have two branches).

#### b) Traces

I:

The diagram describes negative traces. The reason for this is that there are guards on the branches of the outer xalt operator. Executing these branches when the conditions in the guards are not fulfilled will cause negative traces.

II:

By just considering the part of the diagram above the outer xalt operator, there are a large number of positive traces caused by send events following directly after other send events on one lifeline, and because there are send event as the first event on more than one lifeline. The xalt operators adds two positive traces to all traces that are present before they occur (cf. a) IV above), so by reducing all the traces above the outer xalt operator to one trace will cause exactly 3 positive traces. This is achieved by adding “synchronizing” receive events before the events causing extra traces. This may be done e.g. by adding the following messages (existing messages are numbered from 1 to 13 as they occur from top to bottom on the sequence diagram):

- From u3 to ts below message 2 (the first Sms(“request t1 TTT 1720 Oslo”))
- From ts to u3 below message 4
- From t2 to u1 below message 5
- From u2 to ts below message 7

c) Refinement

I:

One way of changing the diagram into a new one being a narrowing of the original is by adding guards on the inner xalt branches, e.g. [time < 1720] on the first branch and [time >= 1720] on the second branch. Another way of achieving narrowing is to strengthen the guards on the branches of the outer xalt.

II:

No.

If the lifeline u1 and its connected message are removed, all positive traces in the interaction obligation of the diagram will change. This means that all positive traces in the original diagram will become inconclusive in the new diagram. Thus, it is *not* a refinement of the original one. (For the same reason, the original diagram is not a refinement of the new one).

III:

When the guard is removed, some negative behaviour becomes positive, thus the new diagram is more general than the original one. That means that the answer to (A) is no, and the answer to (B) is yes (as some positive behaviour is moved to negative behaviour).