Exercise 1 – LSC Syntax

Consider the Live Sequence Chart in Figure 1.

Figure 1: A Live Sequence Chart.

(i) Provide the set of locations $L$ (including their temperature). Make sure to clearly indicate where in the chart which element of $L$ occurs.

*Hint: Note that all locations in a coregion obtain the same temperature from the relevant instance line segment adjacent to the whole coregion.*

(ii) Give the partial order relation $\preceq$ for the locations on instance lines $I_1$ and $I_2$.

*Hint: Only direct predecessors/successors need to be given, the full relation is then the transitive, reflexive closure of those.*

(iii) Give one example element each from the simultaneity relation $\sim$, the set of messages $\text{Msg}$, the set of local invariants $\text{LocInv}$, and the set of conditions $\text{Cond}$ (the latter three including their temperature).
Exercise 2 – LSC Semantics (7/20 Points)

(i) Construct the Büchi automaton for the body of the chart in Figure 1.

Show the steps of your construction by writing down the cuts that need to be considered (incl. their temperature), their direct successor relation via fired-sets, and point out which state in the automaton each cut corresponds to. For the three smallest cuts, note down all locations that the cut comprises, and for all other cuts only note down their front locations.

Hint: For instantaneous messages $F$ from $J_1$ to $J_2$, you may use the shorthand notations $F_{J_1,J_2}$ and $F_{J_1,J_2} \land F_{J_2,J_2}$ for $F_{J_1,J_2} \land F_{J_2,J_2}$ and $(F_{J_1,J_2} \lor F_{J_2,J_2})$, respectively. Note that $F_{J_1,J_2}$ is not equivalent to $\neg F_{J_1,J_2}$.

(ii) Consider the following computation path $\pi_1$:

$$\pi_1 = \sigma_0 \xrightarrow{c_0} \sigma_1 \xrightarrow{A^{\lambda_1 \lambda_2}} \sigma_2 \xrightarrow{A^{\lambda_1 \lambda_2}} \sigma_3 \xrightarrow{\sim c_2} \sigma_4 \xrightarrow{\sim c_2} \sigma_5 \xrightarrow{c_2} \cdots$$

a) Does $\pi_1$ satisfy LSC $\mathcal{L}$ or does it violate the chart? (1)

Hint: Argue your result on the automaton from the previous task.

b) For each of the following three cases, provide a computation path that is an example for the case. Use the example to explain the concept covered by the case in your own words (for example, for the case in the middle, explain the concept of satisfaction without legal exit and how this concept is visible in your example):

- Path violates chart.
- Path satisfies chart by taking a legal exit.
- Path (activates and) satisfies chart without taking a legal exit.

You may re-use path $\pi_1$ from the previous task if it matches one of the three cases. (2)

Exercise 3 – Use Cases and Use Case Diagrams (0/20 Points + 2 Bonus)

Assume that the table in Figure 2 is provided together with LSC $\mathcal{L}$ as a proper use case. What would be the use case diagram for this use case? Explain. (2 Bonus)

Exercise 4 – Class and Object Diagrams (7/20 Points)

Recall the Wireless Fire Alarm System (WFAS) from the lectures on requirements. A cornerstone of the design is the idea that for each sensor, there is a so-called master to monitor the sensor and take notifications (like indications of smoke or high temperatures). If the system is operational (not in maintenance mode), each sensor must have a link to exactly one master, and the sensor-master links must be reciprocal, i.e. the master’s link includes all sensors who have a link to this master.

Figure 3 shows an abstract model of this design idea.

(i) Provide the abstract syntax of the diagram. (2)

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1The notation with boxes below states (or configurations) indicates which atomic propositions we assume to be satisfied in the labelled state. For example, $\sigma_0$ is any state in which $c_0$ is satisfied (while we do not care about the satisfaction of $c_1$ and $c_2$). State $\sigma_1$ is any state in which condition $c_1$ is satisfied and $c_2$ not (and about $c_0$ we do not care).

2Which keeps track of a received signal strength indicator (RSSI)
Table: Example Use Case.

<table>
<thead>
<tr>
<th>name</th>
<th>handle situation $c_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>goal</td>
<td>get system back into safe mode</td>
</tr>
<tr>
<td>precondition</td>
<td>system in situation $c_0$</td>
</tr>
<tr>
<td>postcondition</td>
<td>safe mode reached (indicated by message $D$), optional: user confirmation $E$ acknowledged with $F$</td>
</tr>
<tr>
<td>actors</td>
<td>user (main actor, instance line $I_1$ in $L$)</td>
</tr>
<tr>
<td>open questions</td>
<td>none</td>
</tr>
<tr>
<td>normal case</td>
<td>see LSC $L$ (without legal exit)</td>
</tr>
<tr>
<td>exception case</td>
<td>see LSC $L$ (legal exit)</td>
</tr>
<tr>
<td></td>
<td>see LSC $L$ (cold cut)</td>
</tr>
</tbody>
</table>

Figure 2: Example Use Case.

Figure 3: WFAS masters and slaves.

(ii) Clarify the intended usage of the data-structure as described in the introductory text to this exercise; use at least three own (i.e., not from the lecture, not from an exercise) non-trivial system states (over the Class Diagram from Figure 3 and structure $D$ with $D(\mathbb{Z}) = \mathbb{Z}$ and $D(\mathcal{C})$ of your choice) shown as Object Diagrams.

- One system state that models a typical configuration in operational mode. (2)
- One system state that is not allowed in operational mode. (1)
- One system state that models a corner-case configuration, i.e., which may be (dis)allowed by the wording above but which seems questionable from the WFAS context. (1)

*Hint: Note that the task asks for ‘clarification’, i.e., a set of system states alone is not a solution to this task.*

(iii) For one of your Object Diagrams from Task (ii), which includes at least one Sensor-object, provide the underlying system state in function notation. (1)