BCS2213 – Formal methods

Teaching assignment 2. TLA specification of Asynchronous Interface.

1. Run TLA+ Toolbox.

2. Develop TLA specification of Asynch Interface, as shown bellow

---- MODULE *AsynchInterface* ----

EXTENDS *Naturals*
CONSTANT *Data*
VARIABLES *val*, *rdy*, *ack*

$$TypeInvariant \triangleq \begin{array}{l} \land\ val \in Data \\ \land\ rdy \in \{0,1\} \\ \land\ ack \in \{0,1\} \end{array}$$

$$Init \triangleq \begin{array}{l} \land\ val \in Data \\ \land\ rdy \in \{0,1\} \\ \land\ ack = rdy \end{array}$$

$$Send \triangleq \begin{array}{l} \land\ rdy = ack \\ \land\ val' \in Data \\ \land\ rdy' = 1 - rdy \\ \land\ \text{UNCHANGED } ack \end{array}$$

$$Rcv \triangleq \begin{array}{l} \land\ rdy \neq ack \\ \land\ ack' = 1 - ack \\ \land\ \text{UNCHANGED } \langle val, rdy \rangle \end{array}$$

$$Next \triangleq Send \lor Rcv$$

$$Spec \triangleq Init \land \Box[Next]_{\langle val, rdy, ack \rangle}$$

THEOREM $Spec \Rightarrow \Box TypeInvariant$

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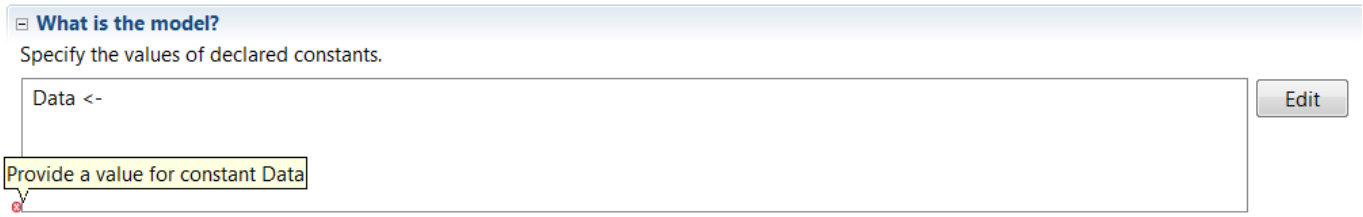
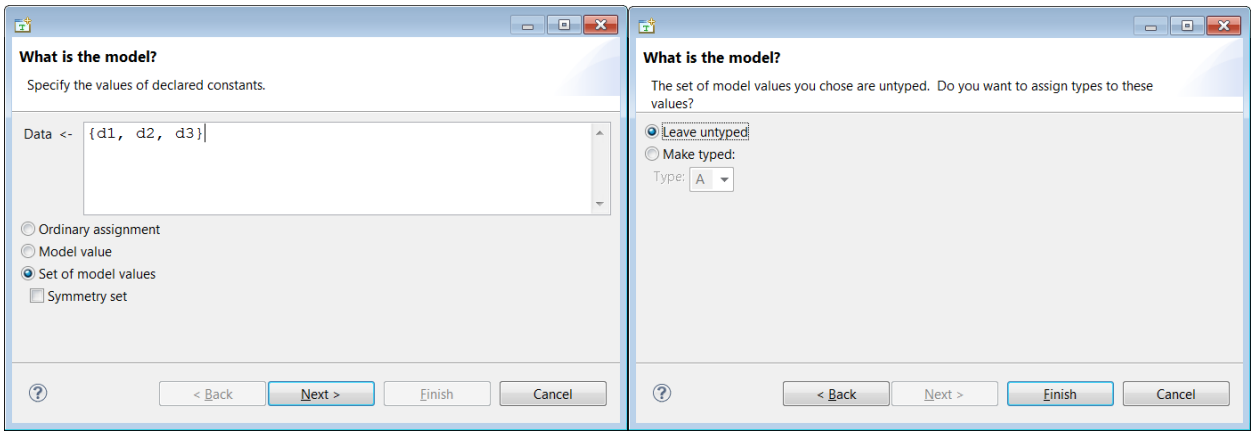
3. To run the model you need provide a value for const Data. Find in the Model Overview page the next window and press "Edit" button.



- Specify the values of declared constants as shown on the next figure and press "Next >"
- Leave values untyped and press "Finish".



As result you will see

4. Analyze the amount of distinct states, generated by TLC.

For it change the size of the Data set (add, delete elements) and see results.

5. What happens if you will specify ***AND*** operation in the next state predicate, linking ***Send*** and ***Rsv*** actions?

Is such the behavior correct? Check it by TLC.

6. Modify the specification to send the values of data, like we do in HourClock, i.e. variable ***val*** should have values 1, 2, 3 … 12, next again start from 1, 2, 3 … 12 etc.

7. TLC allows to print values during module checking.

Operator **Print** is defined in the standard module **TLC**, you need include it by the **EXTENDS** keyword.

TLA definition of Print is

Print(exp1, exp2) == exp2

i.e. the return value of Print(exp1, exp2) is just the expression exp2

To use Print in formulas as **true** assumption we can specify

Print(exp, TRUE)

To print more, than one expression we can use tuple

Print(<<id, exp>>, TRUE)

Modify Send and Rsv actions by adding the print statements:

/\ Print(<<"Send ", val>>, TRUE)

/\ Print(<<"Rcv ", val>>, TRUE)

Analyze the printed output.

8. Modify the protocol in order AsyncInterface has only one line of synchronization – ***ack*** (you can do it on the base of the initial specification or in new file).

Sender send a ***val*** and set value of ***ack*** to 0 (“work done”).

Receiver receive a ***val***, and set the ***ack*** to 1 (“new request”).

9. Submit the TLA specification into Moodle for evaluation.

This assignment will be evaluated in maximum 2% of the general marks.