6SENG002W Concurrent Programming

FSP Process Analysis & Design Form

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Date	January 2021

1. FSP Process Attributes

Attribute	Value
Name	PRINTER
Description	This is the primitive process which models the behaviour of the Printer in a Printing System. It can be used to print documents. When the printer runs out of paper, it must be refilled with paper. The printer is modelled for mutual exclusive access to a single user when it is in operation, to prevent the Printer process from data corruption and interference.
Alphabet	alphabet (PRINTER) = { acquireToPrint, acquireToRefill, cannotFill, fill, release }
Number of States	15
Deadlocks (yes/no)	No
Deadlock Trace(s) (if applicable)	Not Applicable

2. FSP Process Code

FSP Process:

```
range PAPER_TRAY = 0..3
const EMPTY_PAPER_TRAY = 0
const FULL_PAPER_TRAY = 3

PRINTER = PRINTER_IN_OPERATION[FULL_PAPER_TRAY],

PRINTER_IN_OPERATION[papersInTray: PAPER_TRAY] =

            if (papersInTray > EMPTY_PAPER_TRAY) // there's paper in the tray

            then
               (acquireToPrint -> release ->
                     PRINTER_IN_OPERATION[papersInTray - 1]

               | acquireToRefill -> cannotFill -> release ->
                     PRINTER_IN_OPERATION[papersInTray])

            else // printer has run out of paper
                (acquireToRefill -> fill -> release ->
                        PRINTER_IN_OPERATION[FULL_PAPER_TRAY]).
```

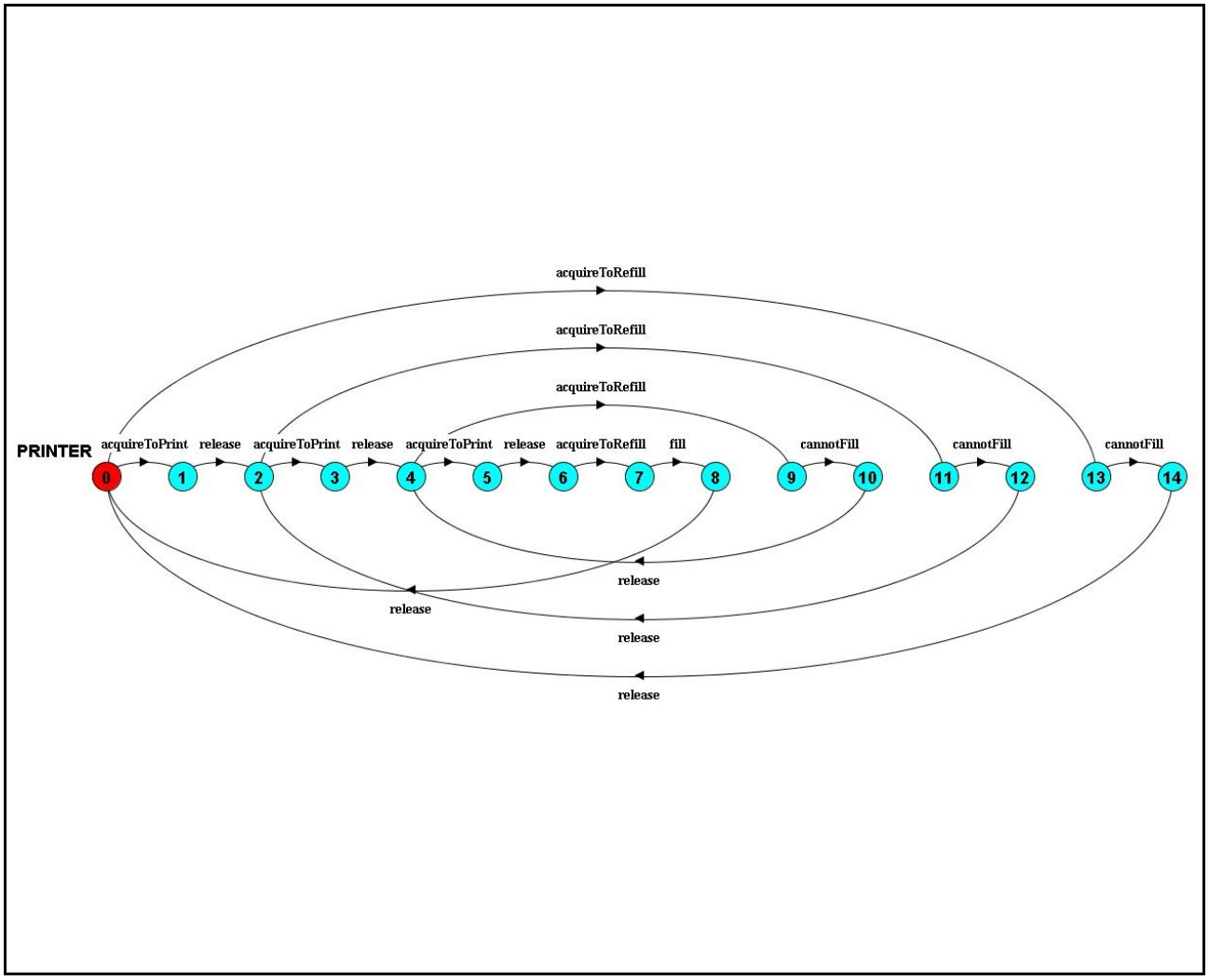
3. Actions Description

A description of what each of the FSP process' actions represents, i.e. is modelling. In addition, indicate if the action is intended to be synchronised (shared) with another process or asynchronous (not shared). (Add rows as necessary.)

Actions	Represents	Synchronous or Asynchronous
acquireToPrint	Acquiring the lock on the printer for mutual exclusive access, to print a document.	Synchronous
acquireToRefill	Acquiring the lock on the printer for mutual exclusive access, to refill the paper tray.	Synchronous
release	Releasing the lock on the printer, or rather mutual exclusive access to the printer.	Synchronous
cannotFill	Indicates to the user that the paper tray of the printer cannot be filled, when the paper tray IS NOT empty.	Synchronous
fill	Fill the paper tray of the printer with paper when the paper tray is empty	Synchronous

4. FSM/LTS Diagrams of FSP Process

Note that if there are too many states, more than 64, then the LTSA tool will not be able to draw the diagram. In this case draw small diagrams of the most important parts of the complete diagram.



5. LTS States

A description of what each of the FSP process' states represents, i.e. is modelling. If there are a large number of states then you can group similar states together &/or only include the most important ones. For example, identify any states related to mutual exclusion (ME) & the associated critical section (CS), e.g. waiting to enter the CS state, in the CS state(s), left the CS state. (Add rows as necessary.)

State	Represents
0	Waiting to enter CS state The Printer is ready to be acquired. Paper Tray is full at this point (3 papers in tray)
1	ME The Printer is currently acquired by a user who has mutually exclusive access to the printer, where they may execute an action that reduces the paper tray level (critical section). Nonetheless when considering the Printer, it can be released at this point.
2	Left the CS state, Waiting to enter CS state The user who acquired the printer previously (State 0) have let go of (released) their mutually exclusive access to the printer and thus left the CS state. Again, the printer is ready to be acquired. Paper Tray level is at 2 pages at this point.
3	ME Same as State 1.
4	Left the CS state, Waiting to enter CS state Same as State 2. Paper Tray level is at 1 page at this point.
5	ME Same as States 1 and 3.
6	Left the CS state, Waiting to enter CS state The user who acquired the printer previously (State 4) have let go of their mutually exclusive access to the printer and thus left the CS state. However, at this state the printer has run out of paper. Thus, it must be refilled before it can be acquired and used to print again.

7	ME A user has acquired the lock on the printer to refill the paper tray.
8	CS The user who acquired the lock on the printer in the previous state was able to refill the paper tray with paper since it was empty. The user has filled the paper tray to the maximum level (3).
9	ME A user has acquired the printer to refill the paper tray. The Paper Tray level is 1 at this point,
10	This state indicates to the user that the printer cannot be refilled at this time since it is not empty (current paper tray level is 1 as indicated above).
11	Same as State 9. However, the Paper Tray level is 2 at this point.
12	Same as State 10. However, the Paper Tray level is 2 at this point.
13	Same as State 9, 11. However, the Paper Tray Level is 3 at this point.
14	Same as State 10, 12. However, Paper Tray Level is 3 at this point.

6. Trace Tree for FSP Process

The trace tree for the process. Use the conventions given in the lecture notes and add explanatory notes if necessary.