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26-Apr-02

3C03 Concurrency
Tutorial Session 6 -Work Sheet

1. a) Write a maximum of 50 words on each of the following:
   - The difference between Processes and Threads
   - Critical sections
   - Critical regions
   - Safety properties
   - Liveness
   - Starvation
   - Deadlock
   - Livelock

   b) Use FSP to specify a system of traffic lights for a junction of two roads. Define the system in such a way that there is one traffic light for each of the four directions. Assume that each traffic light is controlled by a separate process. Neglect special lights for pedestrians and cyclists. (16 marks)

   c) Specify safety properties in FSP for the traffic light system above so it can be proven, by way of reachability analysis, that the traffic lights do not cause car accidents. (9 marks)

2.a) Explain the interleaved model of concurrency using the Java thread model. Elaborate on the Java thread life cycle and discuss how the life cycle supports interleaved concurrency. (15 marks)

b) The following is a FSP specification of a one way bridge:

```
const BRIDGE_CAPACITY=5

range T=0..BRIDGE_CAPACITY
DIRECTION=DIRECTION[0],
DIRECTION[i:T]=(
   when (i<BRIDGE_CAPACITY) enter->DIRECTION[i+1]
 | when (i>0)leave->DIRECTION[i-1]
 | going[i]->DIRECTION[i] ).

BRIDGE_CONTROLER=(south.going[s:T] -> north.going[n:T] -> (
   when (n==0) south.enter -> BRIDGE_CONTROLER
 | when (s==0) north.enter -> BRIDGE_CONTROLER)
)+{south.enter,south.going[T], north.enter,north.going[T]}.

||BRIDGE=(north:DIRECTION || south:DIRECTION || BRIDGE_CONTROLER).
```

Design a concurrent implementation of this bridge using UML class diagrams for an implementation that uses Java threads. Give a rationale for the relationships you have chosen. (9 marks)

c) Java method calls are synchronous. This means that a method m that calls another method n is blocked while n is being executed. With an asynchronous model, m would continue to execute as soon as n has accepted the call and m and n synchronise later. Asynchronous behaviour is often desirable in a distributed setting. Explain how Java threads can be used to implement asynchronous method calls. Discuss how the asynchronous call can be made and what options are available for synchronisation. (8 marks)