

```

sema - available initially
for process 1 and 2
0 : while(true){
1 :   //Non – critical section
2 :   Request(sema)
3 :   //Critical section
4 :   Release(sema)
5 : }

Request(sema){
  while(True){
    if(sema  $\triangleq$  available){
      sema = busy;
      break;
    }
  }
}

//if statement till break is atomic
Release(sema){
  sema = available
}

```

EXTENDS *Integers*
 VARIABLES *s0*, *s1*, *sema*

Init0 \triangleq
 \wedge *sema* = “available”
 \wedge *s0* = 0

Init1 \triangleq
 \wedge *sema* = “available”
 \wedge *s1* = 1

Init \triangleq *Init0* \wedge *Init1*

P01 \triangleq
 \wedge *s0* = 0
 \wedge *s0'* = 1
 \wedge UNCHANGED *sema*

P12 \triangleq
 \wedge *s0* = 1
 \wedge *s0'* = 2
 \wedge UNCHANGED *sema*

P22 \triangleq
 \wedge *s0* = 2

$\wedge s0' = 2$
 $\wedge sema = \text{"busy"}$
 $\wedge sema' = \text{"busy"}$

$P23 \triangleq$
 $\wedge s0 = 2$
 $\wedge s0' = 3$
 $\wedge sema = \text{"available"}$
 $\wedge sema = \text{"busy"}$

$P34 \triangleq$
 $\wedge s0 = 3$
 $\wedge s0' = 4$
 $\wedge \text{UNCHANGED } sema$

$P45 \triangleq$
 $\wedge s0 = 4$
 $\wedge s0' = 5$
 $\wedge sema' = \text{"available"}$

$P50 \triangleq$
 $\wedge s0 = 5$
 $\wedge s0' = 5$
 $\wedge \text{UNCHANGED } sema$

$Next0 \triangleq$
 $\vee P01$
 $\vee P12$
 $\vee P22$
 $\vee P23$
 $\vee P34$
 $\vee P45$
 $\vee P50$

$Q01 \triangleq$
 $\wedge s1 = 0$
 $\wedge s1' = 1$
 $\wedge \text{UNCHANGED } sema$

$Q12 \triangleq$
 $\wedge s1 = 1$
 $\wedge s1' = 2$
 $\wedge \text{UNCHANGED } sema$

$Q22 \triangleq$
 $\wedge s1 = 2$
 $\wedge s1' = 2$

$\wedge \textit{sema} = \text{"busy"}$
 $\wedge \textit{sema}' = \text{"busy"}$

$Q23 \triangleq$
 $\wedge s1 = 2$
 $\wedge s1' = 3$
 $\wedge \textit{sema} = \text{"available"}$
 $\wedge \textit{sema} = \text{"busy"}$

$Q34 \triangleq$
 $\wedge s1 = 3$
 $\wedge s1' = 4$
 $\wedge \text{UNCHANGED } \textit{sema}$

$Q45 \triangleq$
 $\wedge s1 = 4$
 $\wedge s1' = 5$
 $\wedge \textit{sema}' = \text{"available"}$

$Q50 \triangleq$
 $\wedge s1 = 5$
 $\wedge s1' = 5$
 $\wedge \text{UNCHANGED } \textit{sema}$

$Next1 \triangleq$
 $\vee Q01$
 $\vee Q12$
 $\vee Q22$
 $\vee Q23$
 $\vee Q34$
 $\vee Q45$
 $\vee Q50$

$SLOGP \triangleq \text{UNCHANGED } s0$
 $SLOGQ \triangleq \text{UNCHANGED } s1$

$Next \triangleq (Next0 \wedge \text{UNCHANGED } s1) \vee (Next1 \wedge \text{UNCHANGED } s0) \vee SLOGP \vee SLOGQ$

Video 9 for Justice conditions

The terminology in the video is, Weak Fairness (in TLA+ world, not exactly Justice Conditions)

Justice conditions

$J \triangleq$
 $\wedge \neg(s0 = 0)$
 $\wedge \neg(s0 = 3)$
 $\wedge \neg(s0 = 4)$
 $\wedge \neg(s0 = 5)$

$$\begin{aligned}
&\wedge \neg(s1 = 0) \\
&\wedge \neg(s1 = 3) \\
&\wedge \neg(s1 = 4) \\
&\wedge \neg(s1 = 5) \\
&\wedge \neg(s0 = 2 \wedge sema = \text{"available"}) \\
&\wedge \neg(s1 = 2 \wedge sema = \text{"available"})
\end{aligned}$$

but the problem with this is bounded weight need not be satisfied only with the first 10 justice conditions
ie, one process can starve even if we assume fair scheduler

hence we need compassion conditions

$$\begin{aligned}
P0 &\triangleq s0 = 2 \wedge sema = \text{"available"} \\
Q0 &\triangleq s0 \neq 2 \\
P1 &\triangleq s1 = 2 \wedge sema = \text{"available"} \\
Q1 &\triangleq s1 \neq 2
\end{aligned}$$

with this compassion condition, we can show no starvation occurs
i.e if $P0$ wants to enter critical section (i.e it performs $request(sema)$, then
eventually, $P0$ will be allowed in critical section

Similarly for $P1$

\ * Modification History
\ * Last modified *Mon Feb 05 11:40:10 IST 2024* by *neerajkrishnan*
\ * Created *Fri Feb 02 11:35:21 IST 2024* by *neerajkrishnan*