MODULE *token4s*

EXTENDS *Integers*
CONSTANT N
ASSUME $N \in Nat \setminus \{0, 1\}$
$Procs \triangleq 1 \,..\, (N-1)$

Dijkstra's stabilizing 4 state token ring with processes

```
--algorithm Token4stateRing{
    variable up = [k ∈ 0 .. N ↦ (k%2)], c = [k ∈ 0 .. N ↦ (k%2)] ;
    fair process ( j ∈ Procs )
    { J1: while ( TRUE )
          {
          either
              { await (c[(self − 1)] ≠ c[self]) ;
                  c[self] := c[(self − 1)] ;
                  up[self] := 1 ;    TRUE (Representing TRUE as 1 and FALSE as 0)
               }
          or
              { await ((c[(self + 1)] = c[self]) ∧ up[(self + 1)] = 0 ∧ up[self] = 1) ;
                  up[self] := 0 ;    FALSE
               }
           }
     }
    fair process ( i ∈ {0} )
    { I0: up[0] := 1 ;  process 0's "up" is always 1
      I1: while ( TRUE )
          { await ((c[1] = c[0]) ∧ up[1] = 0) ;
              c[0] :=  (c[0] + 1)%2 ;
           }
     }
    fair process ( z ∈ {N} )
    { Z0: up[self] := 0 ;  process N's "up" is always 0
      Z1: while ( TRUE )
          { await (c[(N − 1)] ≠ c[N]) ;
              c[N] := c[(N − 1)] ;
           }
     }
}
```

BEGIN TRANSLATION

VARIABLES up, c, pc

$vars \triangleq \langle up, c, pc \rangle$

$ProcSet \triangleq (Procs) \cup (\{0\}) \cup (\{N\})$

$Init \triangleq$ Global variables

$\land\ up = [k \in 0\,..\,N \mapsto (k\%2)]$
$\land\ c = [k \in 0\,..\,N \mapsto (k\%2)]$
$\land\ pc = [self \in ProcSet \mapsto \text{CASE } self \in Procs \to \text{“J1”}$
$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad \square\ \ self \in \{0\}\ \to \text{“I0”}$
$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad \square\ \ self \in \{N\} \to \text{“Z0”}]$

$J1(self) \triangleq \land\ pc[self] = \text{“J1”}$
$\qquad\qquad \land\ \lor\ \land\ (c[(self-1)] \neq c[self])$
$\qquad\qquad\qquad\qquad\ \land\ c' = [c \text{ EXCEPT } ![self] = c[(self-1)]]$
$\qquad\qquad\qquad\qquad\ \land\ up' = [up \text{ EXCEPT } ![self] = 1]$
$\qquad\qquad\qquad\quad \lor\ \land\ ((c[(self+1)] = c[self]) \land up[(self+1)] = 0 \land up[self] = 1)$
$\qquad\qquad\qquad\qquad\ \land\ up' = [up \text{ EXCEPT } ![self] = 0]$
$\qquad\qquad\qquad\qquad\ \land\ c' = c$
$\qquad\qquad \land\ pc' = [pc \text{ EXCEPT } ![self] = \text{“J1”}]$

$j(self) \triangleq J1(self)$

$I0(self) \triangleq \land\ pc[self] = \text{“I0”}$
$\qquad\qquad \land\ up' = [up \text{ EXCEPT } ![0] = 1]$
$\qquad\qquad \land\ pc' = [pc \text{ EXCEPT } ![self] = \text{“I1”}]$
$\qquad\qquad \land\ c' = c$

$I1(self) \triangleq \land\ pc[self] = \text{“I1”}$
$\qquad\qquad \land\ ((c[1] = c[0]) \land up[1] = 0)$
$\qquad\qquad \land\ c' = [c \text{ EXCEPT } ![0] = (c[0]+1)\%2]$
$\qquad\qquad \land\ pc' = [pc \text{ EXCEPT } ![self] = \text{“I1”}]$
$\qquad\qquad \land\ up' = up$

$i(self) \triangleq I0(self) \lor I1(self)$

$Z0(self) \triangleq \land\ pc[self] = \text{“Z0”}$
$\qquad\qquad \land\ up' = [up \text{ EXCEPT } ![self] = 0]$
$\qquad\qquad \land\ pc' = [pc \text{ EXCEPT } ![self] = \text{“Z1”}]$
$\qquad\qquad \land\ c' = c$

$Z1(self) \triangleq \land\ pc[self] = \text{“Z1”}$
$\qquad\qquad \land\ (c[(N-1)] \neq c[N])$
$\qquad\qquad \land\ c' = [c \text{ EXCEPT } ![N] = c[(N-1)]]$
$\qquad\qquad \land\ pc' = [pc \text{ EXCEPT } ![self] = \text{“Z1”}]$
$\qquad\qquad \land\ up' = up$

$z(self) \triangleq Z0(self) \lor Z1(self)$

$Next \triangleq (\exists\, self \in Procs : j(self))$
$\qquad\qquad \lor (\exists\, self \in \{0\}\ : i(self))$
$\qquad\qquad \lor (\exists\, self \in \{N\} : z(self))$

$Spec \triangleq \land\ Init \land \Box[Next]_{vars}$

$$\begin{array}{l} \land \forall\, self \in Procs : \mathrm{WF}_{vars}(j(self)) \\ \land \forall\, self \in \{0\} \ : \mathrm{WF}_{vars}(i(self)) \\ \land \forall\, self \in \{N\} : \mathrm{WF}_{vars}(z(self)) \end{array}$$

END TRANSLATION

$$\begin{array}{lll} InvProp & \triangleq & \land (\forall\, k \in 0 \,..\, N : c[k] \leq 1) \\ & & \land (\forall\, k \in 0 \,..\, N : up[k] \leq 1) \\ Stabilization & \triangleq & \Diamond InvProp \end{array}$$

* Modification History
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Project submitted by *Siddharth Krishna Sinha* (*ssinha4@buffalo.edu*)
