Temporal Logic -NuSMV

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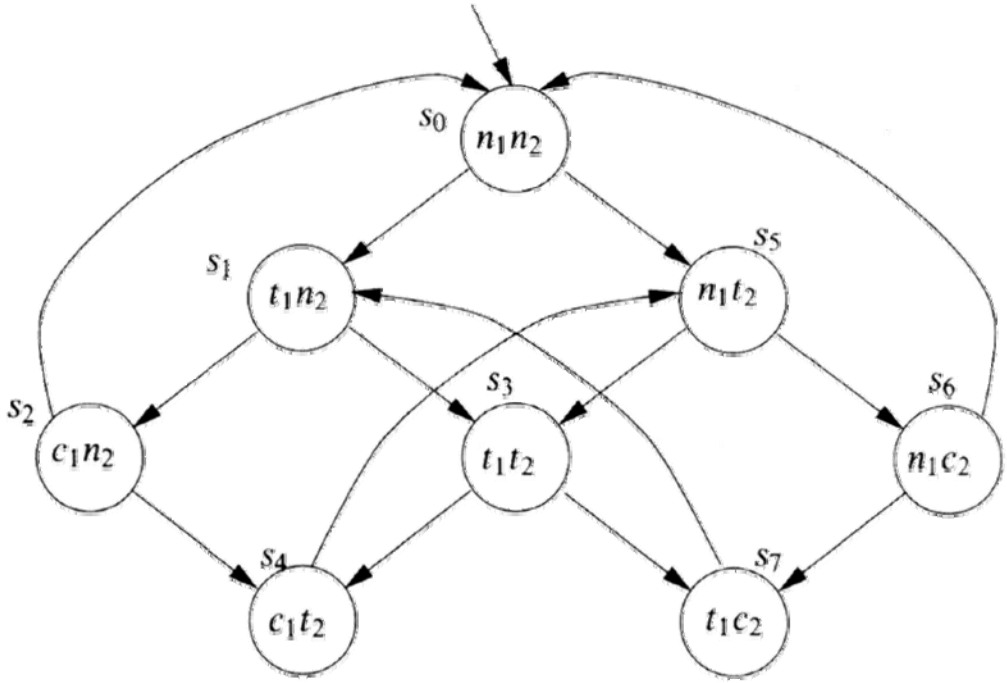
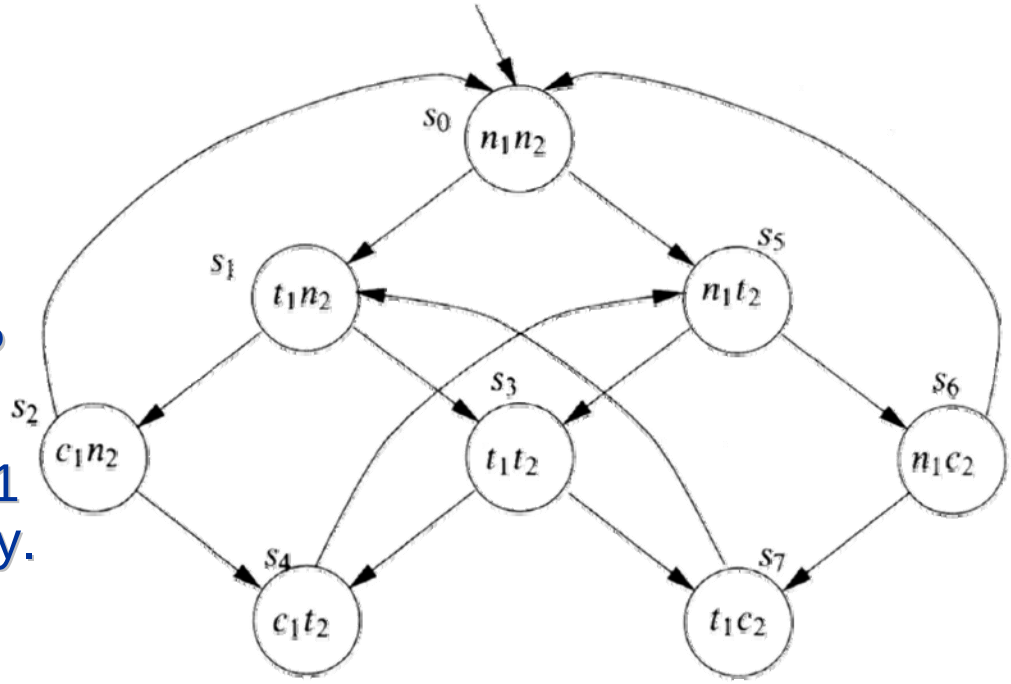
NuSMV specification of the 1st mutual exclusion (1/2)



NuSMV specification of the 1st mutual exclusion (2/2)

- What if there are 3 processes?
  - We need a more realistic compositional model
- Does this way of modeling reflect real implementation?
  - There might be no global scheduler, which allows only 1 process to execute 1 step only.
  - For software process, asynchronous interleaving is more realistic



Revised mutual exclusion model in NuSMV (1/2)

- This code consists of two modules, `main` and `prc`
  - `main`
    - `turn` determines whose turn it is to enter the critical section if both are trying to enter
  - `prc`
    - `st`: the status of a process
    - `other-st`: the status of the other
- `FAIRNESS` ϕ restrict search tree to execution paths along which ϕ is infinitely often true
  - i.e., limit the search space
  - `FAIRNESS running` enforces that the process should execute infinitely often

```
MODULE main
   VAR
      pr1: process prc(pr2.st, turn, 0);
      pr2: process prc(pr1.st, turn, 1);
      turn: boolean;
   ASSIGN
      init(turn) := 0;
   -- safety
   SPEC   G!((pr1.st = c) & (pr2.st = c))
   -- liveness
   SPEC   G((pr1.st = t) ->  F (pr1.st = c))
   SPEC   G((pr2.st = t) ->  F (pr2.st = c))
```

```
MODULE prc(other-st, turn, myturn)
   VAR
      st: {n, t, c};
   ASSIGN
      init(st) := n;
      next(st) :=
         case
            (st = n)                                          : {t,n};
            (st = t) & (other-st = n)                         : c;
            (st = t) & (other-st = t) & (turn = myturn): c;
            (st = c)                                          : {c,n};
            1                                                 : st;
         esac;
      next(turn) :=
         case
            turn = myturn & st = c : !turn;
            1                      : turn;
         esac;
   FAIRNESS running
   FAIRNESS  !(st = c)
```

Revised mutual exclusion model in NuSMV (2/2)

- `FAIRNESS !(st=c)`
  - This prevents a process from staying at critical section forever
    - this prevents to detects silly violation of liveness property due to such situation
- `FAIRNESS running`
  - This prevents a process from executing all the time
    - this prevents to detects silly violation of liveness property due to such situation

```
MODULE main
   VAR
      pr1: process prc(pr2.st, turn, 0);
      pr2: process prc(pr1.st, turn, 1);
      turn: boolean;
   ASSIGN
      init(turn) := 0;
   -- safety
   SPEC   G!((pr1.st = c) & (pr2.st = c))
   -- liveness
   SPEC   G((pr1.st = t) ->  F (pr1.st = c))
   SPEC   G((pr2.st = t) ->  F (pr2.st = c))

MODULE prc(other-st, turn, myturn)
   VAR
      st: {n, t, c};
   ASSIGN
      init(st) := n;
      next(st) :=
         case
            (st = n)                                          : {t,n};
            (st = t) & (other-st = n)                         : c;
            (st = t) & (other-st = t) & (turn = myturn): c;
            (st = c)                                          : {c,n};
            1                                                 : st;
         esac;
      next(turn) :=
         case
            turn = myturn & st = c : !turn;
            1                      : turn;
         esac;
   FAIRNESS running
   FAIRNESS  !(st = c)
```

Transition system