
MODULE *crond*

EXTENDS *Naturals, FiniteSets*

CONSTANTS *MAXAPROGS, PROGS*
 ASSUME *MAXAPROGS* \in *Nat* \wedge *MAXAPROGS* > 0

VARIABLES *crontab, timers, now, aprocs*

nullp \triangleq CHOOSE $x : x \notin PROGS$
TypeInv \triangleq \wedge *timers* $= [n \in Nat \rightarrow [t \rightarrow now, l \rightarrow 0, r \rightarrow \text{"no"}]]$
 \wedge *IsFiniteSet*(*aprocs*)
 \wedge *crontab* $\in [Nat \rightarrow [time : Nat,$
 $\quad prog : PROGS \cup nullp,$
 $\quad status : \{\text{"none"}, \text{"no"}, \text{"yes"}, \text{"run"}\}]]$
 $\wedge now \in Nat$
Ts \triangleq INSTANCE *Timers*
av \triangleq $\langle crontab, timers, aprocs, now \rangle$
sv \triangleq $\langle crontab, timers, aprocs \rangle$

Init $\triangleq Ts!TInit$

AddJob(*t, p, i*) \triangleq \wedge *crontab*[*i*].*status* = "none"
 $\wedge p \in PROGS$
 $\wedge t > 0$
 $\wedge Ts!Set(i, t)$
 $\wedge crontab' = [crontab \text{ EXCEPT}$
 $\quad ![i] = [time \rightarrow t, prog \rightarrow p, status \rightarrow \text{"no"}]]$
 \wedge UNCHANGED $\langle now, aprocs \rangle$

Start(*i*) \triangleq \wedge *crontab*[*i*].*status* = "no"
 $\wedge Ts!Start(i)$
 $\wedge crontab' = [crontab \text{ EXCEPT}$
 $\quad ![i] = [time \rightarrow @.time, prog \rightarrow @.prog, status \rightarrow \text{"yes"}]]$
 \wedge UNCHANGED $\langle aprocs, now \rangle$

Sched(*i*) \triangleq \wedge *crontab*[*i*].*status* = "yes"
 $\wedge Ts!Timeout(i)$
 $\wedge crontab' = [crontab \text{ EXCEPT}$
 $\quad ![i] = [time \rightarrow @.time, prog \rightarrow @.prog, status \rightarrow \text{"run"}]]$
 \wedge UNCHANGED $\langle aprocs, now \rangle$

Exec(*i*) \triangleq \wedge *crontab*[*i*].*status* = "run"
 \wedge *Cardinality*(*aprocs*) $< MAXAPROGS$
 $\wedge crontab' = [crontab \text{ EXCEPT}$
 $\quad ![i] = [time \rightarrow @.time, prog \rightarrow @.prog, status \rightarrow \text{"no"}]]$
 $\wedge aprocs' = aprocs \cup \{ crontab[i].prog \}$
 \wedge UNCHANGED $\langle timers, now \rangle$

$$\begin{array}{l}
\text{RemoveJob}(i) \triangleq \wedge \vee \wedge \text{crontab}[i].\text{status} = \text{"yes"} \\
\quad \wedge Ts! \text{Stop}(i) \\
\quad \wedge \text{UNCHANGED} \langle \text{aprocs}, \text{now} \rangle \\
\quad \vee \wedge \text{crontab}[i].\text{status} = \text{"no"} \\
\quad \wedge \text{UNCHANGED} \langle \text{aprocs}, \text{now}, \text{timers} \rangle \\
\quad \wedge \text{crontab}' = [\text{crontab} \text{ EXCEPT} \\
\quad \quad ![i] = [\text{time} \rightarrow 0, \text{prog} \rightarrow \text{nullp}, \text{status} \rightarrow \text{"none"}]] \\
\hline
\text{Next} \triangleq \exists i \in \text{Nat} : \vee \text{Start}(i) \vee \text{Sched}(i) \vee \text{Exec}(i) \vee \text{RemoveJob}(i) \\
\quad \vee (\exists t \in \text{Nat}, p \in \text{PROGS} : \text{AddJob}(t, p, i)) \\
\text{Spec} \triangleq \text{Init} \wedge \Box [\text{Next}]_{sv} \wedge (\forall i \in \text{Nat} : \text{WF}_{av}(\text{Start}(i)) \wedge \text{SF}_{av}(\text{Exec}(i))) \\
\hline
\text{THEOREM } \text{Spec} \Rightarrow \Box \text{TypeInv} \\
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\end{array}$$