MODULE *WoundWait*

EXTENDS *TLC*, *FiniteSets*, *Integers*, *Sequences*

CONSTANT *txs*, *locks*, *actives*
VARIABLE *tStat*, *lStat*, *lOwn*, *waitList*

$Vars \triangleq \langle tStat, lStat, lOwn, waitList \rangle$

$TypeOK \triangleq$
$\quad \land \quad \forall\, t \in txs : tStat[t] \in \{\text{“f”}, \text{“l”}\}$
$\quad \land \quad \forall\, l1 \in locks : lStat[l1] \in \{\text{“f”}, \text{“l”}\}$
$\quad \land \quad \forall\, l2 \in locks : lOwn[l2] \in txs \cup \{0\}$
$\quad \land \quad waitList \subseteq txs$

$Init \triangleq$
$\quad \land\, tStat = [t \in txs \mapsto \text{“f”}]$
$\quad \land\, lStat = [l \in locks \mapsto \text{“f”}]$
$\quad \land\, lOwn = [l \in locks \mapsto 0]$
$\quad \land\, waitList = \{\}$

$Min(L) \triangleq$ CHOOSE $t \in L : \forall\, ts \in L : t \leq ts$

$SignalWait \triangleq$
$\quad$ IF $waitList \neq \{\}$
$\quad\quad$ THEN $waitList' = waitList \setminus \{Min(waitList)\}$
$\quad\quad$ ELSE UNCHANGED $waitList$

$Wait(t) \triangleq \land\, waitList' = waitList \cup \{t\}$

$CanAcquire(t,\, l) \triangleq$
$\quad \lor \quad \land\, lStat[l] = \text{“f”}$
$\quad \lor \quad \land\, lStat[l] = \text{“l”}$
$\quad\quad\quad \land\, lOwn[l] = t$

$AcquireLock(t,\, l) \triangleq$
$\quad \lor \quad \land\, CanAcquire(t,\, l)$
$\quad\quad\quad \land\, lStat' = [lStat$ EXCEPT $![l] = \text{“l”}]$
$\quad\quad\quad \land\, lOwn' = [lOwn$ EXCEPT $![l] = t]$
$\quad\quad\quad \land\, tStat' = [tStat$ EXCEPT $![t] = \text{“l”}]$
$\quad\quad\quad \land$ UNCHANGED $waitList$
$\quad \lor \quad \land\, lStat[l] = \text{“l”}$
$\quad\quad\quad \land\, lOwn[l] \neq t$
$\quad\quad\quad \land$ IF $(t < lOwn[l])$
$\quad\quad\quad\quad$ THEN $\land\, lStat' = [lStat$ EXCEPT $![l] = \text{“l”}]$
$\quad\quad\quad\quad\quad\quad \land\, lOwn' = [lOwn$ EXCEPT $![l] = t]$
$\quad\quad\quad\quad\quad\quad \land\, tStat' = [tStat$ EXCEPT $![lOwn[l]] = \text{“f”}]$

$\land\ tStat' = [tStat \text{ EXCEPT } ![t] = \text{“I”}]$
$\land$ UNCHANGED $waitList$
ELSE $\land\ Wait(t)$
$\land$ UNCHANGED $\langle tStat,\ lStat,\ lOwn\rangle$

$Commit(t,\ l) \triangleq$
$\land\ lOwn[l] = t$
$\land\ lOwn' = [lOwn \text{ EXCEPT } ![l] = 0]$
$\land\ lStat' = [lStat \text{ EXCEPT } ![l] = \text{“f”}]$
$\land\ tStat' = [tStat \text{ EXCEPT } ![t] = \text{“f”}]$
$\land\ t' = t + actives$
$\land\ SignalWait$

$Next \triangleq$
$\exists\, t \in txs : \exists\, l \in locks :$
$\lor\ AcquireLock(t,\ l)$
$\lor\ Commit(t,\ l)$

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

$FairSpec \triangleq$
$Spec \land \forall\, t1 \in txs,\ l1 \in locks :$
$\text{WF}_{Vars}(AcquireLock(t1,\ l1))$
$\land \forall\, t2 \in txs,\ l2 \in locks :$
$\text{WF}_{Vars}(Commit(t2,\ l2))$

$DeadLock \triangleq\ waitList \neq txs$

$Starvation \triangleq$
$\land \forall\, t1 \in txs,\ l1 \in locks :$
$\Box\Diamond(\langle AcquireLock(t1,\ l1)\rangle_{Vars})$
$\land \forall\, t2 \in txs,\ l2 \in locks :$
$\Box\Diamond(\langle Commit(t2,\ l2)\rangle_{Vars})$