MODULE *MCSequential*

EXTENDS *Sequential*, *Sequences*, *Naturals*, *TLC*

VARIABLES h

CONSTANTS *Hmax*

$$\begin{aligned} \mathit{TypeOk} \triangleq\ & \land\ op \in \{\text{“r”}, \text{“w”}\} \\ & \land\ arg \in Obj \cup Obj \times Val \\ & \land\ rval \in Val \cup \{Ok\} \cup \text{SUBSET } Obj \\ & \land\ env \in [Obj \to Val] \\ & \land\ ff \in \{Flip, Flop\} \end{aligned}$$

$$\begin{aligned} \mathit{TypeOkH} \triangleq\ & \land\ \mathit{TypeOk} \\ & \land\ h \in Seq([op : \{\text{“r”}, \text{“w”}\},\ obj : Obj,\ val : Val]) \end{aligned}$$

$$\begin{aligned} \mathit{InitH} \triangleq\ & \land\ \mathit{Init} \\ & \land\ h = \langle\rangle \end{aligned}$$

$$\begin{aligned} \mathit{ReadH}(obj,\ val) \triangleq\ & \land\ \mathit{Read}(obj,\ val) \\ & \land\ h' = \mathit{Append}(h,\ [op \mapsto \text{“r”},\ obj \mapsto obj,\ val \mapsto val]) \end{aligned}$$

$$\begin{aligned} \mathit{WriteH}(obj,\ val) \triangleq\ & \land\ \mathit{Write}(obj,\ val) \\ & \land\ h' = \mathit{Append}(h,\ [op \mapsto \text{“w”},\ obj \mapsto obj,\ val \mapsto val]) \end{aligned}$$

$$\mathit{NextH} \triangleq\ \lor \exists\, obj \in Obj,\ val \in Val : \mathit{ReadH}(obj,\ val) \lor \mathit{WriteH}(obj,\ val)$$

$$vh \triangleq \langle op,\ arg,\ rval,\ env,\ ff,\ h\rangle$$
$$\mathit{SpecH} \triangleq \mathit{InitH} \land \Box[\mathit{NextH}]_{vh}$$

The set of writes to **obj**

$$\begin{aligned} \mathit{Wr}(obj) \triangleq\ & \text{LET } evt \triangleq \{h[i] : i \in \text{DOMAIN } h\} \\ & \text{IN}\quad \{e \in evt : e.op = \text{“w”} \land e.obj = obj\} \end{aligned}$$

Most recent value written to **obj**

$$\begin{aligned} \mathit{MRW}(obj) \triangleq\ & \\ & \text{LET } i \triangleq \text{CHOOSE } i \in \text{DOMAIN } h : \\ & \qquad \land\ h[i].op = \text{“w”} \\ & \qquad \land\ h[i].obj = obj \\ & \qquad \land\ \neg\exists\, j \in \text{DOMAIN } h : \land\ h[j].op = \text{“w”} \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ h[j].obj = obj \\ & \qquad\qquad\qquad\qquad\qquad\quad \land\ j > i \\ & \text{IN}\quad h[i].val \end{aligned}$$

If an object was previously written, the read should correspond to the most recent write

$$\begin{aligned} \mathit{ReadLastWrite} \triangleq\ & op = \text{“r”} \Rightarrow \\ & \text{LET } obj \triangleq arg \\ & \qquad val \triangleq rval \end{aligned}$$

IN $Wr(obj) \neq \{\} \Rightarrow MRW(obj) = val$

Successive reads without intervening writes should return the same value

$$
\begin{array}{lll}
SuccessiveReads & \triangleq & \text{LET } obj \triangleq arg \\
& & \quad val \triangleq rval \\
& & \quad IsRd(k,\, o) \triangleq h[k].op = \text{“r”} \ \wedge h[k].obj = o \\
& & \quad IsWr(k,\, o) \triangleq h[k].op = \text{“w”} \ \wedge h[k].obj = o \\
& & \quad NoWrRd(i,\, o) \triangleq IsRd(i,\, o) \wedge \neg \exists\, j \in i+1 \,..\, Len(h)-1 : IsWr(j,\, o) \\
& & \quad j \triangleq \text{CHOOSE } j \in 1 \,..\, Len(h)-1 : NoWrRd(j,\, obj) \\
& & \text{IN } \ (op = \text{“r”} \wedge \exists\, i \in 1 \,..\, Len(h)-1 : NoWrRd(i,\, obj)) \Rightarrow rval = h[j].val
\end{array}
$$

$Symmetry \triangleq Permutations(Obj) \cup Permutations(Val)$

$MaxHistory \triangleq Len(h) \leq Hmax$