

MODULE *Hour*

This module is part of the trivial example from Section 5 of the paper “Auxiliary Variables in TLA+”. The other modules in that example are *HourMin* and *Stuttering*.

The module begins by defining a trivial specification *Spec* of a 24-hour clock that begins with  $h = 0$  and cycles through the integers mod 24.

EXTENDS *Integers*

VARIABLE  $h$

$TypeOK \triangleq h \in 0 \dots 24$

$Init \triangleq h = 0$

$Next \triangleq h' = (h + 1) \% 24$

$Spec \triangleq Init \wedge \Box [Next]_h$

We now add a stuttering variable  $s$  that adds 59 stuttering steps before each *Next* step, using the *PreStutter* operator of module *Stuttering*. The set Sigma of possible values  $s.val$  for the stuttering variable will be  $1 \dots 59$ , taking  $>$  as the “less-than” ordering on Sigma. Thus, the minimal value bot of Sigma is 59, the initial value  $s.val$  is set to is 1, and the decrement operator maps a value  $i$  to  $i + 1$ . The following assumption and theorem are the correctness conditions for adding stuttering steps to *Next*.

THEOREM  $Spec \Rightarrow \Box [Next \Rightarrow (1 \in 1 \dots 59)]_h$

$vars \triangleq h$

VARIABLE  $s$

INSTANCE *Stuttering*

This is the constant condition that is required for  $s$  to be an auxiliary variable.

ASSUME *StutterConstantCondition*( $1 \dots 59, 59, \text{LAMBDA } j : j + 1$ )

$TypeOKS \triangleq \wedge TypeOK$   
 $\wedge s \in \{top\} \cup [id : \{\text{“Next”}\}, ctxt : \{\text{“”}\}, val : 1 \dots 59]$

$InitS \triangleq Init \wedge (s = top)$

$NextS \triangleq PreStutter(Next, TRUE, \text{“Next”}, \text{“”}, 59, 1, \text{LAMBDA } j : j + 1)$

$SpecS \triangleq InitS \wedge \Box [NextS]_{\langle vars, s \rangle}$

The following INSTANCE statement and theorem show that *SpecS* implements *Spec* of module *HourMin* under a suitable refinement mapping, showing that  $\exists s : SpecS$  is equivalent to *Spec*.

$HM \triangleq \text{INSTANCE } HourMin \text{ WITH } m \leftarrow \text{IF } s = top \text{ THEN } 0 \text{ ELSE } s.val$

THEOREM  $SpecS \Rightarrow HM!Spec$

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