

MODULE <i>OpCounter</i>	
EXTENDS <i>Naturals</i>	
CONSTANTS <i>Replica</i>	the set of replicas
VARIABLES <i>c</i> ,	<i>c</i> [<i>r</i>]: current value at <i>r</i> ∈ <i>Replica</i>
<i>d</i> ,	<i>d</i> [<i>r</i>]: buffer of increments at <i>r</i> ∈ <i>Replica</i>
<i>incoming</i>	<i>incoming</i> [<i>r</i>]: incoming channel at replica <i>r</i> ∈ <i>Replica</i>
<i>Msg</i> \triangleq [<i>d</i> : <i>Nat</i>]	message type
<i>vars</i> \triangleq $\langle c, d, incoming \rangle$	
<i>TypeOK</i> \triangleq	
$\wedge c \in [Replica \rightarrow Nat]$	
$\wedge d \in [Replica \rightarrow Nat]$	
$\wedge incoming \in [Replica \rightarrow Msg]$	each incoming channel is represented by a set of message
<i>Init</i> \triangleq	
$\wedge c = [r \in Replica \mapsto 0]$	
$\wedge d = [r \in Replica \mapsto 0]$	
$\wedge incoming = [r \in Replica \mapsto \{\}]$	
<i>Read</i> (<i>r</i>) $\triangleq c[r]$	
<i>Inc</i> (<i>r</i>) \triangleq	
$\wedge c' = [c \text{ EXCEPT } ![r] = @ + 1]$	
$\wedge d' = [d \text{ EXCEPT } ![r] = @ + 1]$	
$\wedge \text{UNCHANGED } \langle incoming \rangle$	
<i>Do</i> (<i>r</i>) $\triangleq Inc(r)$	We ignore <i>Read</i> (<i>r</i>) since it does not modify states.
<i>Send</i> (<i>r</i>) \triangleq	
$\wedge d[r] \neq 0$	
$\wedge d' = [d \text{ EXCEPT } ![r] = 0]$	
$\wedge incoming' = [x \in Replica \mapsto \text{IF } x = r \text{ THEN } incoming[x]$	
$\text{ELSE } incoming[x] \cup [d \rightarrow d[r]]]$	
$\wedge \text{UNCHANGED } \langle c \rangle$	
<i>Deliver</i> (<i>r</i>) \triangleq	
$\wedge incoming[r] \neq \{\}$	
$\wedge \exists m \in incoming[r] :$	choose <i>m</i> from <i>incoming</i> [<i>r</i>] non-deterministically
$\wedge c' = [c \text{ EXCEPT } ![r] = @ + m.d]$	
$\wedge incoming' = [incoming \text{ EXCEPT } ![r] = @ \setminus \{m\}]$	delete <i>m</i>
$\wedge \text{UNCHANGED } \langle d \rangle$	
<i>Next</i> $\triangleq \exists r \in Replica : Do(r) \vee Send(r) \vee Deliver(r)$	
<i>Spec</i> $\triangleq Init \wedge \Box [Next]_{vars}$	

* Modification History
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