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1  ┌────────────────────────── MODULE TCS ───────────────────────────┐
  See DISC'2018: Multi-Shot Distributed Transaction Commit
5  EXTENDS Naturals, Integers, FiniteSets, Sequences, Functions, TLC
6  ┌────────────────────────────────────────────────────────────────────────┐
7  CONSTANTS
8      Key,           the set of keys, ranged over by  $k \in Key$ 
9      Val,           the set of values, ranged over by  $v \in Val$ 
10     Trans,         the set of transactions, ranged over by  $t \in Trans$ 
11     Shard,         the set of shards, ranged over by  $s \in Shard$ 
12     Client,        the set of clients, ranged over by  $c \in Client$ 
13     TxCoord,        $TxCoord(t)$  is the coordinator of  $t \in Trans$ 
14     KeySharding    $KeySharding(k)$  is the shard that holds  $k \in Key$ 
16      $Slot \triangleq 1 \dots Cardinality(Trans)$ 
18      $NotVal \triangleq \text{CHOOSE } v : v \notin Val$ 
19      $NotTrans \triangleq \text{CHOOSE } t : t \notin Trans$ 
21  ASSUME
22       $\wedge TxCoord \in [Trans \rightarrow Shard]$ 
23       $\wedge KeySharding \in [Key \rightarrow Shard]$ 
24       $\wedge \forall t \in Trans:$ 
25  ┌────────────────────────────────────────────────────────────────────────┐
26      $Op \triangleq [type : \{\text{"read"}, \text{"write"}\}, key : Key, val : Val]$ 
27      $R(k, v) \triangleq [type \mapsto \text{"read"}, key \mapsto k, val \mapsto v]$ 
28      $W(k, v) \triangleq [type \mapsto \text{"write"}, key \mapsto k, val \mapsto v]$ 
30  ASSUME
31       $\wedge Trans \in Seq(Op)$    A transaction is a sequence of operations.
33      $RS(t) \triangleq \{op.key : op \in Range(t)\}$ 
34  ┌────────────────────────────────────────────────────────────────────────┐
35  VARIABLES
36     next,           $next[s] \in Z$  points to the last filled slot
37     txn,            $txn[s][i]$  is the transaction to certify in the  $i$ -th slot
38     vote,           $vote[s][i]$  is the vote for  $txn[s][i]$ 
39     dec,            $dec[s][i]$  is the decision for  $txn[s][i]$ 
40     phase          $phase[s][i]$  is the phase for  $txn[s][i]$ 
42      $vars \triangleq \langle next, txn, vote, dec, phase \rangle$ 
43  ┌────────────────────────────────────────────────────────────────────────┐
44      $TypeOK \triangleq$ 
45      $\wedge next \in [Shard \rightarrow Int]$ 
46      $\wedge txn \in [Shard \rightarrow [Slot \rightarrow Trans \cup \{NotTrans\}]]$ 
47      $\wedge vote \in [Shard \rightarrow [Slot \rightarrow \{\text{"COMMIT"}, \text{"ABORT"}, \text{"NULL"}\}]]$ 
48      $\wedge dec \in [Shard \rightarrow [Slot \rightarrow \{\text{"COMMIT"}, \text{"ABORT"}, \text{"NULL"}\}]]$ 
49      $\wedge phase \in [Shard \rightarrow [Slot \rightarrow \{\text{"START"}, \text{"PREPARED"}, \text{"DECIDED"}\}]]$ 

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50 |-----|
51 Init  $\triangleq$ 
52    $\wedge next = [s \in Shard \mapsto -1]$ 
53    $\wedge txn = [s \in Shard \mapsto [i \in Slot \mapsto NotTrans]]$ 
54    $\wedge vote = [s \in Shard \mapsto [i \in Slot \mapsto "NULL"]]$ 
55    $\wedge dec = [s \in Shard \mapsto [i \in Slot \mapsto "NULL"]]$ 
56    $\wedge phase = [s \in Shard \mapsto [i \in Slot \mapsto "START"]]$ 
57 |-----|
58 Certify(t, s)  $\triangleq$  Cerify transaction t  $\in$  Trans on shard s  $\in$  Shard
59    $\wedge$  FALSE
60 |-----|
61 Next  $\triangleq$  TRUE
63 Spec  $\triangleq$  Init  $\wedge \square[Next]_{vars}$ 
64 |-----|
  \ * Modification History
  \ * Last modified Sat Jun 12 22:14:42 CST 2021 by hengxin
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