```
1  ---------- MODULE TCommit ----------
   This specification is explained in "Transaction Commit", Lecture 5 of the TLA+ Video Course.
6  CONSTANT RM          The set of participating resource managers
8  VARIABLE rmState     rmState[rm] is the state of resource manager rm.
9  ----------
10 TCTypeOK ≜
     The type-correctness invariant
14   rmState ∈ [RM → {"working", "prepared", "committed", "aborted"}]
16 TCInit ≜  rmState = [r ∈ RM ↦ "working"]
     The initial predicate.
21 canCommit ≜ ∀ r ∈ RM : rmState[r] ∈ {"prepared", "committed"}
     True iff all RMs are in the "prepared" or "committed" state.
26 notCommitted ≜ ∀ r ∈ RM : rmState[r] ≠ "committed"
     True iff no resource manager has decided to commit.
30 ----------
   We now define the actions that may be performed by the RMs, and then define the complete
   next-state action of the specification to be the disjunction of the possible RM actions.
36 Prepare(r) ≜ ∧ rmState[r] = "working"
37              ∧ rmState' = [rmState EXCEPT ![r] = "prepared"]
39 Decide(r) ≜ ∨ ∧ rmState[r] = "prepared"
40              ∧ canCommit
41              ∧ rmState' = [rmState EXCEPT ![r] = "committed"]
42            ∨ ∧ rmState[r] ∈ {"working", "prepared"}
43              ∧ notCommitted
44              ∧ rmState' = [rmState EXCEPT ![r] = "aborted"]
46 TCNext ≜ ∃ r ∈ RM : Prepare(r) ∨ Decide(r)
     The next-state action.
50 ----------
51 TCConsistent ≜
     A state predicate asserting that two RMs have not arrived at conflicting decisions. It is an
     invariant of the specification.
56   ∀ r1, r2 ∈ RM : ¬ ∧ rmState[r1] = "aborted"
57                     ∧ rmState[r2] = "committed"
58 ----------
   The following part of the spec is not discussed in Video Lecture 5. It will be explained in Video
   Lecture 8.
63 TCSpec ≜ TCInit ∧ □[TCNext]_rmState
     The complete specification of the protocol written as a temporal formula.
```

69 THEOREM $TCSpec \Rightarrow \Box(TCTypeOK \land TCConsistent)$

This theorem asserts the truth of the temporal formula whose meaning is that the state predicate $TCTypeOK \land TCInvariant$ is an invariant of the specification $TCSpec$. Invariance of this conjunction is equivalent to invariance of both of the formulas $TCTypeOK$ and $TCConsistent$.

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* Modification History
* Last modified *Tue* May 04 13:49:33 *SGT* 2021 by *nurliyana*
* Created *Tue* May 04 12:12:04 *SGT* 2021 by *nurliyana*