MODULE *Config*

EXTENDS
Northbound,
Proposal,
Configuration,
Mastership,
Southbound

INSTANCE *Naturals*

INSTANCE *FiniteSets*

INSTANCE *Sequences*

LOCAL INSTANCE *TLC*

$vars \triangleq \langle proposal, configuration, mastership, target \rangle$

Formal specification, constraints, and theorems.

$Init \triangleq$
$\land\ InitNorthbound$
$\land\ InitProposal$
$\land\ InitConfiguration$
$\land\ InitMastership$
$\land\ InitSouthbound$

$Next \triangleq$
$\lor\ \land\ NextNorthbound$
$\quad\land$ UNCHANGED $\langle\rangle$
$\lor\ \land\ NextProposal$
$\quad\land$ UNCHANGED $\langle\rangle$
$\lor\ \land\ NextConfiguration$
$\quad\land$ UNCHANGED $\langle proposal \rangle$
$\lor\ \land\ NextMastership$
$\quad\land$ UNCHANGED $\langle proposal, configuration \rangle$
$\lor\ \land\ NextSouthbound$
$\quad\land$ UNCHANGED $\langle proposal, configuration, mastership \rangle$

$Spec \triangleq Init \land \Box[Next]_{vars} \land \mathrm{WF}_{vars}(Next)$

$Order \triangleq$
$\forall\, i \in$ DOMAIN $proposal :$
$\land\ \land\ proposal[i].phase = ProposalCommit$
$\quad\land\ proposal[i].state\ = ProposalInProgress$
$\quad\Rightarrow \neg\exists\, j \in$ DOMAIN $proposal :$

$\land\ j > i$
$\land\ proposal[j].phase = ProposalCommit$
$\land\ proposal[j].state\ = ProposalComplete$
$\land\ \land\ proposal[i].phase = ProposalApply$
$\land\ proposal[i].state\ = ProposalInProgress$
$\Rightarrow \neg\exists\, j \in \text{DOMAIN}\ proposal :$
$\land\ j > i$
$\land\ proposal[j].phase = ProposalApply$
$\land\ proposal[j].state\ = ProposalComplete$

$Consistency \triangleq$

LET

Compute the transaction indexes that have been applied to the target

$targetIndexes \triangleq \{i \in \text{DOMAIN}\ proposal :$
$\land\ proposal[i].phase = ProposalApply$
$\land\ proposal[i].state\ = ProposalComplete$
$\land \neg\exists\, j \in \text{DOMAIN}\ proposal :$
$\land\ j > i$
$\land\ proposal[j].type = ProposalRollback$
$\land\ proposal[j].rollback.index = i$
$\land\ proposal[j].phase = ProposalApply$
$\land\ proposal[j].state\ = ProposalComplete\}$

Compute the set of paths in the target that have been updated by transactions

$appliedPaths \triangleq \text{UNION}\ \{\text{DOMAIN}\ proposal[i].change.values : i \in targetIndexes\}$

Compute the highest index applied to the target for each path

$pathIndexes \triangleq [p \in appliedPaths \mapsto \text{CHOOSE}\ i \in targetIndexes :$
$\forall\, j \in targetIndexes :$
$\land\ i \geq j$
$\land\ p \in \text{DOMAIN}\ proposal[i].change.values]$

Compute the expected target configuration based on the last indexes applied to the target for each path.

$expectedConfig \triangleq [p \in \text{DOMAIN}\ pathIndexes \mapsto proposal[pathIndexes[p]].change.values[p]]$

IN

$target = expectedConfig$

$Safety \triangleq \Box(Order \land Consistency)$

THEOREM $Spec \Rightarrow Safety$

$Terminated(i) \triangleq$
$\land\ i \in \text{DOMAIN}\ proposal$
$\land\ \lor\ \land\ proposal[i].phase = ProposalApply$
$\land\ proposal[i].state\ = ProposalComplete$
$\lor\ proposal[i].state = ProposalFailed$

$Termination \triangleq$

$\forall\, i \in 1 \,..\, Len(proposal) :$
$\quad Terminated(i)$

$Liveness \triangleq \Diamond Termination$

THEOREM $Spec \Rightarrow Liveness$

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