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MODULE *ConfigImpl*

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INSTANCE *Naturals*  
 INSTANCE *FiniteSets*  
 INSTANCE *Sequences*  
 LOCAL INSTANCE *TLC*

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This section specifies constant parameters for the model.  
 CONSTANT *LogEnabled*  
 ASSUME *LogEnabled* ∈ BOOLEAN  
 CONSTANT *None*  
 ASSUME *None* ∈ STRING  
 CONSTANT *Node*  
 ASSUME  $\forall n \in \text{Node} : n \in \text{STRING}$   
 CONSTANTS  
     *Change*,  
     *Rollback*  
*Event*  $\triangleq \{ \text{Change}, \text{Rollback} \}$   
 ASSUME  $\forall e \in \text{Event} : e \in \text{STRING}$   
 CONSTANTS  
     *Commit*,  
     *Apply*  
*Phase*  $\triangleq \{ \text{Commit}, \text{Apply} \}$   
 ASSUME  $\forall p \in \text{Phase} : p \in \text{STRING}$   
 CONSTANTS  
     *Pending*,  
     *InProgress*,  
     *Complete*,  
     *Aborted*,  
     *Failed*  
*State*  $\triangleq \{ \text{Pending}, \text{InProgress}, \text{Complete}, \text{Aborted}, \text{Failed} \}$   
*Working*  $\triangleq \{ \text{Pending}, \text{InProgress} \}$

$Finished \triangleq \{Complete, Aborted, Failed\}$

ASSUME  $\forall s \in State : s \in \text{STRING}$

CONSTANT  $Path$

ASSUME  $\forall p \in Path : p \in \text{STRING}$

CONSTANT  $Value$

ASSUME  $\forall v \in Value : v \in \text{STRING}$

$AllValues \triangleq Value \cup \{None\}$

CONSTANT  $NumProposals$

ASSUME  $NumProposals \in Nat$

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This section defines model state variables.

$proposal \triangleq [ i \in 1 \dots Nat \mapsto [$   
 $phase \mapsto Phase,$   
 $change \mapsto [$   
 $values \mapsto Change,$   
 $commit \mapsto State,$   
 $apply \mapsto State],$   
 $rollback \mapsto [$   
 $index \mapsto Nat,$   
 $values \mapsto Change,$   
 $commit \mapsto State,$   
 $apply \mapsto State]]]$

$configuration \triangleq [$   
 $committed \mapsto [$   
 $index \mapsto Nat,$   
 $values \mapsto Change],$   
 $applied \mapsto [$   
 $index \mapsto Nat,$   
 $values \mapsto Change,$   
 $term \mapsto Nat]]]$

$mastership \triangleq [$   
 $master \mapsto \text{STRING},$   
 $term \mapsto Nat,$   
 $conn \mapsto Nat]$

$conn \triangleq [ n \in Node \mapsto [$   
 $id \mapsto Nat,$   
 $connected \mapsto \text{BOOLEAN} ]]$

$target \triangleq [$   
 $id \mapsto Nat,$

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    values  $\mapsto$  Change,
    running  $\mapsto$  BOOLEAN ]
VARIABLE proposal

VARIABLE configuration

VARIABLE mastership

VARIABLE conn

VARIABLE target

VARIABLE history

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

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LOCAL MastershipLog  $\triangleq$  INSTANCE Log WITH
  File  $\leftarrow$  "Mastership.log",
  CurrState  $\leftarrow$  [
    target  $\mapsto$  target,
    mastership  $\mapsto$  mastership,
    conns  $\mapsto$  conn],
  SuccState  $\leftarrow$  [
    target  $\mapsto$  target',
    mastership  $\mapsto$  mastership',
    conns  $\mapsto$  conn'],
  Enabled  $\leftarrow$  LogEnabled

LOCAL ConfigurationLog  $\triangleq$  INSTANCE Log WITH
  File  $\leftarrow$  "Configuration.log",
  CurrState  $\leftarrow$  [
    configuration  $\mapsto$  configuration,
    target  $\mapsto$  target,
    mastership  $\mapsto$  mastership,
    conns  $\mapsto$  conn],
  SuccState  $\leftarrow$  [
    configuration  $\mapsto$  configuration',
    target  $\mapsto$  target',
    mastership  $\mapsto$  mastership',
    conns  $\mapsto$  conn'],
  Enabled  $\leftarrow$  LogEnabled

LOCAL ProposalLog  $\triangleq$  INSTANCE Log WITH
  File  $\leftarrow$  "Proposal.log",
  CurrState  $\leftarrow$  [
    proposals  $\mapsto$   $[i \in \{i \in \text{DOMAIN } \textit{proposal} : \textit{proposal}[i].\textit{phase} \neq \textit{None}\} \mapsto \textit{proposal}[i]]$ ,

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$$\begin{aligned}
& configuration \mapsto configuration, \\
& target \mapsto target, \\
& mastership \mapsto mastership, \\
& conns \mapsto conn], \\
SuccState \leftarrow [ \\
& proposals \mapsto [i \in \{i \in \text{DOMAIN } proposal' : proposal'[i].phase \neq \text{None}\} \mapsto proposal'[i]], \\
& configuration \mapsto configuration', \\
& target \mapsto target', \\
& mastership \mapsto mastership', \\
& conns \mapsto conn'], \\
Enabled \leftarrow LogEnabled
\end{aligned}$$


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This section models configuration target.

$$\begin{aligned}
StartTarget & \triangleq \\
& \wedge \neg target.running \\
& \wedge target' = [target \text{ EXCEPT } !.id = target.id + 1, \\
& \quad !.running = \text{TRUE}] \\
& \wedge \text{UNCHANGED } \langle proposal, configuration, mastership, conn, history \rangle \\
StopTarget & \triangleq \\
& \wedge target.running \\
& \wedge target' = [target \text{ EXCEPT } !.running = \text{FALSE}, \\
& \quad !.values = [p \in \{\} \mapsto [value \mapsto \text{None}]]] \\
& \wedge conn' = [n \in Node \mapsto [conn[n] \text{ EXCEPT } !.connected = \text{FALSE}]] \\
& \wedge \text{UNCHANGED } \langle proposal, configuration, mastership, history \rangle
\end{aligned}$$


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This section models nodes connection to the configuration target.

$$\begin{aligned}
ConnectNode(n) & \triangleq \\
& \wedge \neg conn[n].connected \\
& \wedge target.running \\
& \wedge conn' = [conn \text{ EXCEPT } ![n].id = conn[n].id + 1, \\
& \quad ![n].connected = \text{TRUE}] \\
& \wedge \text{UNCHANGED } \langle proposal, configuration, mastership, target, history \rangle \\
DisconnectNode(n) & \triangleq \\
& \wedge conn[n].connected \\
& \wedge conn' = [conn \text{ EXCEPT } ![n].connected = \text{FALSE}] \\
& \wedge \text{UNCHANGED } \langle proposal, configuration, mastership, target, history \rangle
\end{aligned}$$


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This section models *mastership* reconciliation.



IF  $p \in \text{DOMAIN } \text{configuration.committed.values}$  THEN  
 $\text{configuration.committed.values}[p]$   
 ELSE  
 $[\text{index} \mapsto 0, \text{value} \mapsto \text{None}]$   
 IN  $\text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{rollback.index} = \text{rollbackIndex},$   
 $![i].\text{rollback.values} = \text{rollbackValues},$   
 $![i].\text{change.commit} = \text{InProgress}]$   
 $\vee \text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{change.commit} = \text{Failed}]$   
 $\wedge \text{UNCHANGED } \langle \text{configuration} \rangle$   
 $\wedge \text{UNCHANGED } \langle \text{history} \rangle$   
 $\vee \wedge \text{proposal}[i].\text{change.commit} = \text{InProgress}$   
 $\wedge \vee \wedge \text{configuration.committed.index} \neq \text{configuration.committed.proposal}$   
 $\wedge \text{LET } \text{values} \triangleq [p \in \text{DOMAIN } \text{proposal}[i].\text{change.values} \mapsto$   
 $\text{proposal}[i].\text{change.values}[p] @@ [\text{index} \mapsto i]] @@$   
 $\text{configuration.committed.values}$   
 IN  $\wedge \text{configuration}' = [\text{configuration} \text{ EXCEPT } !.\text{committed.index} = i,$   
 $!.committed.values = \text{values}]$   
 $\wedge \text{history}' = \text{Append}(\text{history}, [\text{type} \mapsto \text{Change}, \text{phase} \mapsto \text{Commit}, \text{index} \mapsto i])$   
 $\wedge \text{UNCHANGED } \langle \text{proposal} \rangle$   
 $\vee \wedge \text{configuration.committed.proposal} = i$   
 $\wedge \text{configuration.committed.index} = i$   
 $\wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{change.commit} = \text{Complete}]$   
 $\wedge \text{UNCHANGED } \langle \text{configuration}, \text{history} \rangle$   
 $\vee \wedge \text{proposal}[i].\text{change.commit} = \text{Failed}$   
 $\wedge \text{configuration.committed.proposal} = i$   
 $\wedge \text{configuration.committed.index} \neq i$   
 $\wedge \text{configuration}' = [\text{configuration} \text{ EXCEPT } !.\text{committed.index} = \text{configuration.committed.index}]$   
 $\wedge \text{UNCHANGED } \langle \text{proposal}, \text{history} \rangle$   
 $\wedge \text{UNCHANGED } \langle \text{mastership}, \text{conn}, \text{target} \rangle$   
 $\text{ApplyChange}(n, i) \triangleq$   
 $\wedge \vee \wedge \text{proposal}[i].\text{change.apply} = \text{Pending}$   
 $\wedge \text{proposal}[i].\text{rollback.apply} = \text{None}$   
 $\wedge \vee \wedge \text{proposal}[i].\text{change.commit} = \text{Complete}$   
 $\wedge \forall j \in \text{DOMAIN } \text{proposal} : j < i \Rightarrow$   
 $\vee \wedge \text{proposal}[j].\text{change.apply} = \text{Complete}$   
 $\wedge \text{proposal}[j].\text{rollback.apply} \notin \text{Working}$   
 $\vee \wedge \text{proposal}[j].\text{change.apply} = \text{Failed}$   
 $\wedge \text{proposal}[j].\text{rollback.apply} = \text{Complete}$   
 $\wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{change.apply} = \text{InProgress}]$   
 $\vee \wedge \text{proposal}[i].\text{change.commit} \in \{\text{Aborted}, \text{Failed}\}$   
 $\wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{change.apply} = \text{Aborted}]$   
 $\wedge \text{UNCHANGED } \langle \text{configuration}, \text{target}, \text{history} \rangle$   
 $\vee \wedge \text{proposal}[i].\text{change.apply} = \text{InProgress}$   
 Verify the applied term is the current *mastership* term to ensure the

configuration has been synchronized following restarts.  
 $\wedge \text{configuration.applied.term} = \text{mastership.term}$   
 Verify the node's connection to the target.  
 $\wedge \text{conn}[n].\text{connected}$   
 $\wedge \text{mastership.conn} = \text{conn}[n].\text{id}$   
 $\wedge \text{target.running}$   
 Model successful and failed target update requests.  
 $\wedge \vee \wedge \text{LET } \text{values} \triangleq [p \in \text{DOMAIN } \text{proposal}[i].\text{change.values} \mapsto$   
 $\quad \text{proposal}[i].\text{change.values}[p] @@ [\text{index} \mapsto i]]$   
 $\quad \text{IN } \wedge \text{target}' = [\text{target} \text{ EXCEPT } !.\text{values} = \text{values} @@ \text{target.values}]$   
 $\quad \wedge \text{configuration}' = [\text{configuration} \text{ EXCEPT } !.\text{applied.index} = i,$   
 $\quad \quad !.\text{applied.values} = \text{values} @@$   
 $\quad \quad \text{configuration.applied.values}]$   
 $\quad \wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{change.apply} = \text{Complete}]$   
 $\quad \wedge \text{history}' = \text{Append}(\text{history}, [\text{type} \mapsto \text{Change}, \text{phase} \mapsto \text{Apply}, \text{index} \mapsto i])$   
 $\vee \wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{change.apply} = \text{Failed}]$   
 $\quad \wedge \text{UNCHANGED } \langle \text{configuration}, \text{target}, \text{history} \rangle$   
 $\wedge \text{UNCHANGED } \langle \text{mastership}, \text{conn} \rangle$   
 $\text{CommitRollback}(n, i) \triangleq$   
 $\wedge \vee \wedge \text{proposal}[i].\text{rollback.commit} = \text{Pending}$   
 $\quad \wedge i + 1 \in \text{DOMAIN } \text{proposal} \Rightarrow \text{proposal}[i + 1].\text{rollback.commit} = \text{Complete}$   
 $\wedge \vee \wedge \text{proposal}[i].\text{change.commit} = \text{Pending}$   
 $\quad \wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{change.commit} = \text{Aborted},$   
 $\quad \quad ![i].\text{rollback.commit} = \text{Complete}]$   
 $\quad \wedge \text{UNCHANGED } \langle \text{configuration} \rangle$   
 $\vee \wedge \text{proposal}[i].\text{change.commit} \neq \text{Pending}$   
 $\quad \wedge \text{configuration.committed.proposal} = i$   
 $\quad \wedge \text{configuration.committed.index} = i$   
 $\quad \wedge \text{configuration}' = [\text{configuration} \text{ EXCEPT } !.\text{committed.proposal} = \text{proposal}[i].\text{rollback.index}]$   
 $\quad \wedge \text{UNCHANGED } \langle \text{proposal} \rangle$   
 $\vee \wedge \text{proposal}[i].\text{change.commit} \neq \text{Pending}$   
 $\quad \wedge \text{configuration.committed.proposal} = \text{proposal}[i].\text{rollback.index}$   
 $\quad \wedge \text{configuration.committed.index} = i$   
 $\quad \wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } ![i].\text{rollback.commit} = \text{InProgress}]$   
 $\quad \wedge \text{UNCHANGED } \langle \text{configuration} \rangle$   
 $\wedge \text{UNCHANGED } \langle \text{history} \rangle$   
 $\vee \wedge \text{proposal}[i].\text{rollback.commit} = \text{InProgress}$   
 $\quad \wedge \vee \wedge \text{configuration.committed.index} \neq \text{configuration.committed.proposal}$   
 $\quad \quad \wedge \text{LET } \text{index} \triangleq \text{proposal}[i].\text{rollback.index}$   
 $\quad \quad \text{values} \triangleq \text{proposal}[i].\text{rollback.values} @@ \text{configuration.committed.values}$   
 $\quad \quad \text{IN } \wedge \text{configuration}' = [\text{configuration} \text{ EXCEPT } !.\text{committed.index} = \text{index},$   
 $\quad \quad \quad !.\text{committed.values} = \text{values}]$   
 $\quad \quad \wedge \text{history}' = \text{Append}(\text{history}, [\text{type} \mapsto \text{Rollback}, \text{phase} \mapsto \text{Commit}, \text{index} \mapsto i])$   
 $\quad \quad \wedge \text{UNCHANGED } \langle \text{proposal} \rangle$





Propose change at index 'i'

$$\begin{aligned}
\text{ProposeChange}(i) &\triangleq \\
&\wedge \text{proposal}[i].\text{phase} = \text{None} \\
&\wedge i - 1 \in \text{DOMAIN } \text{proposal} \Rightarrow \text{proposal}[i - 1].\text{phase} \neq \text{None} \\
&\wedge \exists p \in \text{Path}, v \in \text{AllValues} : \\
&\quad \wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } \begin{array}{ll} ! [i].\text{phase} &= \text{Change}, \\ ! [i].\text{change.values} &= (p :> [value \mapsto v]), \\ ! [i].\text{change.commit} &= \text{Pending}, \\ ! [i].\text{change.apply} &= \text{Pending} \end{array} \\
&\quad \wedge \text{UNCHANGED } \langle \text{configuration}, \text{mastership}, \text{conn}, \text{target}, \text{history} \rangle
\end{aligned}$$

Rollback proposed change at index 'i'

$$\begin{aligned}
\text{ProposeRollback}(i) &\triangleq \\
&\wedge \text{proposal}[i].\text{phase} = \text{Change} \\
&\wedge \text{proposal}' = [\text{proposal} \text{ EXCEPT } \begin{array}{ll} ! [i].\text{phase} &= \text{Rollback}, \\ ! [i].\text{rollback.commit} &= \text{Pending}, \\ ! [i].\text{rollback.apply} &= \text{Pending} \end{array} \\
&\quad \wedge \text{UNCHANGED } \langle \text{configuration}, \text{mastership}, \text{conn}, \text{target}, \text{history} \rangle
\end{aligned}$$


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Formal specification, constraints, and theorems.

$$\begin{aligned}
\text{Init} &\triangleq \\
&\wedge \text{proposal} = [ \\
&\quad i \in 1 \dots \text{NumProposals} \mapsto [ \\
&\quad \quad \text{phase} \mapsto \text{None}, \\
&\quad \quad \text{change} \mapsto [ \\
&\quad \quad \quad \text{values} \mapsto [p \in \{\} \mapsto [\text{index} \mapsto 0, \text{value} \mapsto \text{None}]], \\
&\quad \quad \quad \text{commit} \mapsto \text{None}, \\
&\quad \quad \quad \text{apply} \mapsto \text{None}], \\
&\quad \quad \text{rollback} \mapsto [ \\
&\quad \quad \quad \text{index} \mapsto 0, \\
&\quad \quad \quad \text{values} \mapsto [p \in \{\} \mapsto [\text{index} \mapsto 0, \text{value} \mapsto \text{None}]], \\
&\quad \quad \quad \text{commit} \mapsto \text{None}, \\
&\quad \quad \quad \text{apply} \mapsto \text{None}]] \\
&\wedge \text{configuration} = [ \\
&\quad \text{committed} \mapsto [ \\
&\quad \quad \text{proposal} \mapsto 0, \\
&\quad \quad \text{index} \mapsto 0, \\
&\quad \quad \text{values} \mapsto [p \in \{\} \mapsto [\text{index} \mapsto 0, \text{value} \mapsto \text{None}]]], \\
&\quad \text{applied} \mapsto [ \\
&\quad \quad \text{proposal} \mapsto 0, \\
&\quad \quad \text{index} \mapsto 0, \\
&\quad \quad \text{term} \mapsto 0, \\
&\quad \quad \text{target} \mapsto 0, \\
&\quad \quad \text{values} \mapsto [p \in \{\} \mapsto [\text{index} \mapsto 0, \text{value} \mapsto \text{None}]]],
\end{aligned}$$

$$\begin{aligned}
& \text{status} \mapsto \text{Pending}] \\
& \wedge \text{mastership} = [\text{master} \mapsto \text{None}, \text{term} \mapsto 0, \text{conn} \mapsto 0] \\
& \wedge \text{conn} = [n \in \text{Node} \mapsto [\text{id} \mapsto 0, \text{connected} \mapsto \text{FALSE}]] \\
& \wedge \text{target} = [ \\
& \quad \text{id} \mapsto 0, \\
& \quad \text{values} \mapsto [p \in \{\} \mapsto [\text{index} \mapsto 0, \text{value} \mapsto \text{None}]], \\
& \quad \text{running} \mapsto \text{FALSE}] \\
& \wedge \text{history} = \langle \rangle \\
\text{Next} & \triangleq \\
& \vee \exists i \in 1 \dots \text{NumProposals} : \\
& \quad \vee \text{ProposeChange}(i) \\
& \quad \vee \text{ProposeRollback}(i) \\
& \vee \exists n \in \text{Node}, i \in \text{DOMAIN } \text{proposal} : \\
& \quad \text{ProposalLog! Action}(\text{ReconcileProposal}(n, i), [\text{node} \mapsto n, \text{index} \mapsto i]) \\
& \vee \exists n \in \text{Node} : \\
& \quad \text{ConfigurationLog! Action}(\text{ReconcileConfiguration}(n), [\text{node} \mapsto n]) \\
& \vee \exists n \in \text{Node} : \\
& \quad \text{MastershipLog! Action}(\text{ReconcileMastership}(n), [\text{node} \mapsto n]) \\
& \vee \exists n \in \text{Node} : \\
& \quad \vee \text{ConnectNode}(n) \\
& \quad \vee \text{DisconnectNode}(n) \\
& \vee \text{StartTarget} \\
& \vee \text{StopTarget} \\
\text{Spec} & \triangleq \\
& \wedge \text{Init} \\
& \wedge \Box [\text{Next}]_{\text{vars}} \\
& \wedge \forall i \in 1 \dots \text{NumProposals} : \text{WF}_{\text{vars}}(\text{ProposeChange}(i) \vee \text{ProposeRollback}(i)) \\
& \wedge \forall n \in \text{Node}, i \in 1 \dots \text{NumProposals} : \text{WF}_{\text{vars}}(\text{ReconcileProposal}(n, i)) \\
& \wedge \forall n \in \text{Node} : \text{WF}_{\langle \text{configuration}, \text{mastership}, \text{conn}, \text{target} \rangle}(\text{ReconcileConfiguration}(n)) \\
& \wedge \forall n \in \text{Node} : \text{WF}_{\langle \text{mastership}, \text{conn}, \text{target} \rangle}(\text{ReconcileMastership}(n)) \\
& \wedge \forall n \in \text{Node} : \text{WF}_{\langle \text{conn}, \text{target} \rangle}(\text{ConnectNode}(n) \vee \text{DisconnectNode}(n)) \\
& \wedge \text{WF}_{\langle \text{target} \rangle}(\text{StartTarget}) \\
& \wedge \text{WF}_{\langle \text{target} \rangle}(\text{StopTarget}) \\
\text{Mapping} & \triangleq \text{INSTANCE Config WITH} \\
& \text{proposal} \leftarrow [i \in \text{DOMAIN } \text{proposal} \mapsto [ \\
& \quad \text{phase} \mapsto \text{proposal}[i].\text{phase}, \\
& \quad \text{values} \mapsto [p \in \text{DOMAIN } \text{proposal}[i].\text{change.values} \mapsto \text{proposal}[i].\text{change.values}[p].\text{value}], \\
& \quad \text{change} \mapsto [ \\
& \quad \quad \text{commit} \mapsto \text{IF } \wedge \text{proposal}[i].\text{change.commit} = \text{InProgress} \\
& \quad \quad \quad \wedge \text{configuration.committed.index} = i \\
& \quad \quad \quad \text{THEN Complete} \\
& \quad \quad \quad \text{ELSE } \text{proposal}[i].\text{change.commit}, \\
& \quad \text{apply} \mapsto \text{IF } \wedge \text{proposal}[i].\text{change.apply} = \text{InProgress}
\end{aligned}$$

$$\begin{aligned}
& \wedge \text{configuration.applied.index} = i \\
& \text{THEN } \text{Complete} \\
& \text{ELSE } \text{proposal}[i].\text{change.apply}], \\
\text{rollback} \mapsto [ & \\
& \text{commit} \mapsto \text{IF } \wedge \text{proposal}[i].\text{rollback.commit} = \text{InProgress} \\
& \quad \wedge \text{configuration.committed.index} = \text{proposal}[i].\text{rollback.index} \\
& \quad \text{THEN } \text{Complete} \\
& \quad \text{ELSE } \text{proposal}[i].\text{rollback.commit}, \\
& \text{apply} \mapsto \text{IF } \wedge \text{proposal}[i].\text{rollback.apply} = \text{InProgress} \\
& \quad \wedge \text{configuration.applied.index} = \text{proposal}[i].\text{rollback.index} \\
& \quad \text{THEN } \text{Complete} \\
& \quad \text{ELSE } \text{proposal}[i].\text{rollback.apply}]], \\
\text{configuration} \leftarrow [ & \\
& \text{committed} \mapsto [ & \\
& \quad \text{values} \mapsto \text{configuration.committed.values}, & \\
& \text{applied} \mapsto [ & \\
& \quad \text{term} \mapsto \text{configuration.applied.term}, & \\
& \quad \text{target} \mapsto \text{configuration.applied.target}, & \\
& \quad \text{values} \mapsto \text{configuration.applied.values}, & \\
& \text{status} \mapsto \text{configuration.status}] &
\end{aligned}$$

$\text{Refinement} \triangleq \text{Mapping!Spec}$

$\text{Order} \triangleq \text{Mapping!Order}$

$\text{Consistency} \triangleq \text{Mapping!Consistency}$

$\text{Liveness} \triangleq \text{Mapping!Liveness}$

$\text{Sequential} \triangleq \text{Mapping!Sequential}$

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