
MODULE *Northbound*

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

An empty constant
 CONSTANT *Nil*

Transaction type constants
 CONSTANTS
 Change,
 Rollback

Transaction isolation constants
 CONSTANTS
 ReadCommitted,
 Serializable

Phase constants
 CONSTANTS
 Initialize,
 Validate,
 Abort,
 Commit,
 Apply

Status constants
 CONSTANTS
 InProgress,
 Complete,
 Failed

State constants
 CONSTANTS
 Pending,
 Validated,
 Committed,
 Applied,
 Aborted

Target is the set of all targets and their possible paths and values.

Example:

$$\begin{aligned} \text{Target} &\triangleq \\ &[\text{target1} \mapsto \\ &\quad [\text{persistent} \mapsto \text{FALSE}, \text{values} \mapsto [\\ &\quad \quad \text{path1} \mapsto \{\text{"value1"}, \text{"value2"}\}, \\ &\quad \quad \text{path2} \mapsto \{\text{"value2"}, \text{"value3"}\}]], \\ &\text{target2} \mapsto \\ &\quad [\text{persistent} \mapsto \text{TRUE}, \text{values} \mapsto [\\ &\quad \quad \text{path2} \mapsto \{\text{"value3"}, \text{"value4"}\}, \\ &\quad \quad \text{path3} \mapsto \{\text{"value4"}, \text{"value5"}\}]]] \end{aligned}$$

CONSTANT *Target*

A transaction log. Transactions may either request a set of changes to a set of targets or rollback a prior change.

VARIABLE *transaction*

This section models configuration changes and rollbacks. Changes are appended to the transaction log and processed asynchronously.

$$\begin{aligned} \text{Value}(s, t, p) &\triangleq \\ \text{LET } \text{value} &\triangleq \text{CHOOSE } v \in s : v.\text{target} = t \wedge v.\text{path} = p \\ \text{IN} & \\ &[\text{value} \mapsto \text{value.value}, \\ &\quad \text{delete} \mapsto \text{value.delete}] \end{aligned}$$

$$\begin{aligned} \text{Paths}(s, t) &\triangleq \\ &[p \in \{v.\text{path} : v \in \{v \in s : v.\text{target} = t\}\} \mapsto \text{Value}(s, t, p)] \end{aligned}$$

$$\begin{aligned} \text{Changes}(s) &\triangleq \\ &[t \in \{v.\text{target} : v \in s\} \mapsto \text{Paths}(s, t)] \end{aligned}$$

$$\begin{aligned} \text{ValidValues}(t, p) &\triangleq \\ \text{UNION } &\{[\text{value} \mapsto v, \text{delete} \mapsto \text{FALSE}] : v \in \text{Target}[t].\text{values}[p]\}, \{[\text{value} \mapsto \text{Nil}, \text{delete} \mapsto \text{TRUE}]\} \} \end{aligned}$$

$$\begin{aligned} \text{ValidPaths}(t) &\triangleq \\ \text{UNION } &\{\{v @@@ [\text{path} \mapsto p] : v \in \text{ValidValues}(t, p)\} : p \in \text{DOMAIN } \text{Target}[t].\text{values}\} \end{aligned}$$

$$\begin{aligned} \text{ValidTargets} &\triangleq \\ \text{UNION } &\{\{p @@@ [\text{target} \mapsto t] : p \in \text{ValidPaths}(t)\} : t \in \text{DOMAIN } \text{Target}\} \end{aligned}$$

The set of all valid sets of changes to all targets and their paths.

The set of possible changes is computed from the *Target* model value.

$$\begin{aligned} \text{ValidChanges} &\triangleq \\ \text{LET } \text{changeSets} &\triangleq \{s \in \text{SUBSET } \text{ValidTargets} : \\ &\quad \forall t \in \text{DOMAIN } \text{Target} : \\ &\quad \quad \forall p \in \text{DOMAIN } \text{Target}[t].\text{values} : \end{aligned}$$

$$Cardinality(\{v \in s : v.target = t \wedge v.path = p\}) \leq 1\}$$

IN

$$\{c \in \{Changes(s) : s \in changeSets\} : \\ \text{DOMAIN } c \neq \{\} \wedge \forall t \in \text{DOMAIN } c : \text{DOMAIN } c[t] \neq \{\}\}$$

Add a set of changes 'c' to the transaction log

$$RequestChange(c) \triangleq$$

LET $index \triangleq Len(transaction) + 1$

IN $\exists isolation \in \{ReadCommitted, Serializable\} :$

$$\wedge transaction' = transaction @@ (index :> [type \mapsto Change, \\ isolation \mapsto isolation, \\ change \mapsto c, \\ targets \mapsto \{\}, \\ phase \mapsto Initialize, \\ state \mapsto InProgress, \\ status \mapsto Pending])$$

Add a rollback of transaction 't' to the transaction log

$$RequestRollback(i) \triangleq$$

LET $index \triangleq Len(transaction) + 1$

IN $\exists isolation \in \{ReadCommitted, Serializable\} :$

$$\wedge transaction' = transaction @@ (index :> [type \mapsto Rollback, \\ isolation \mapsto isolation, \\ rollback \mapsto i, \\ targets \mapsto \{\}, \\ phase \mapsto Initialize, \\ state \mapsto InProgress, \\ status \mapsto Pending])$$

$$RequestSet \triangleq$$

$$\vee \exists c \in ValidChanges : \\ RequestChange(c) \\ \vee \exists i \in \text{DOMAIN } transaction : \\ RequestRollback(i)$$

Formal specification, constraints, and theorems.

$Init \triangleq \text{TRUE}$

$Next \triangleq$
 $\vee RequestSet$

* Modification History
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