

```

|----- 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
* Last modified Sun Feb 20 08:28:04 PST 2022 by jordanhalterman
* Created Sun Feb 20 03:08:25 PST 2022 by jordanhalterman