MODULE *Northbound*

EXTENDS *Transaction*

INSTANCE *Naturals*

INSTANCE *FiniteSets*

INSTANCE *Sequences*

LOCAL INSTANCE *TLC*

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

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

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

$$
\begin{array}{l}
Changes(s) \triangleq \\
\quad [t \in \{v.target : v \in s\} \mapsto Paths(s,\ t)]
\end{array}
$$

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

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

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

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.

$$
\begin{array}{l}
ValidChanges \triangleq \\
\quad \text{LET } changeSets \triangleq \{s \in \text{SUBSET } ValidTargets : \\
\qquad\qquad\qquad \forall\, t \in \text{DOMAIN } Target\ \ : \\
\qquad\qquad\qquad\quad \forall\, p \in \text{DOMAIN } Target[t].values : \\
\qquad\qquad\qquad\qquad Cardinality(\{v \in s : v.target = t \land v.path = p\}) \leq 1\} \\
\quad \text{IN} \\
\qquad \{c \in \{Changes(s) : s \in changeSets\} : \\
\qquad\quad \text{DOMAIN } c \neq \{\} \land \forall\, t \in \text{DOMAIN } c : \text{DOMAIN } c[t] \neq \{\}\}
\end{array}
$$

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

$$
\begin{array}{l}
\mathit{RequestChange}(c) \triangleq \\
\quad \text{LET } \mathit{index} \triangleq \mathit{Len}(\mathit{transaction}) + 1 \\
\quad \text{IN } \exists\, \mathit{isolation} \in \{\mathit{ReadCommitted}, \mathit{Serializable}\} : \\
\qquad \land\, \mathit{transaction}' = \mathit{transaction} \mathbin{@@} (\mathit{index} :> [\mathit{type} \mapsto \mathit{TransactionChange}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{isolation} \mapsto \mathit{isolation}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{change} \mapsto c, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{targets} \mapsto \{\}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{phase} \mapsto \mathit{TransactionInitialize}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{state} \mapsto \mathit{TransactionInProgress}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{status} \mapsto \mathit{TransactionPending}])
\end{array}
$$

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

$$
\begin{array}{l}
\mathit{RequestRollback}(i) \triangleq \\
\quad \text{LET } \mathit{index} \triangleq \mathit{Len}(\mathit{transaction}) + 1 \\
\quad \text{IN } \exists\, \mathit{isolation} \in \{\mathit{ReadCommitted}, \mathit{Serializable}\} : \\
\qquad \land\, \mathit{transaction}' = \mathit{transaction} \mathbin{@@} (\mathit{index} :> [\mathit{type} \mapsto \mathit{TransactionRollback}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{isolation} \mapsto \mathit{isolation}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{rollback} \mapsto i, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{targets} \mapsto \{\}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{phase} \mapsto \mathit{TransactionInitialize}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{state} \mapsto \mathit{TransactionInProgress}, \\
\qquad\qquad\qquad\qquad\qquad\qquad\quad \mathit{status} \mapsto \mathit{TransactionPending}])
\end{array}
$$

$$
\begin{array}{l}
\mathit{RequestSet} \triangleq \\
\quad \lor\, \exists\, c \in \mathit{ValidChanges} : \\
\qquad \mathit{RequestChange}(c) \\
\quad \lor\, \exists\, i \in \text{DOMAIN } \mathit{transaction} : \\
\qquad \mathit{RequestRollback}(i)
\end{array}
$$

Formal specification, constraints, and theorems.

$$
\mathit{InitNorthbound} \triangleq \text{TRUE}
$$

$$
\begin{array}{l}
\mathit{NextNorthbound} \triangleq \\
\quad \lor\, \mathit{RequestSet}
\end{array}
$$

---

* Modification History
* Last modified Sun *Feb* 20 09:09:26 *PST* 2022 by *jordanhalterman*
* Created Sun *Feb* 20 03:08:25 *PST* 2022 by *jordanhalterman*