

VARIABLES $c2ss$, $c2ss[c]$: the 2D digraph maintained at client c
 $s2ss$ $s2ss[c]$: the 2D digraph maintained by the *Server* for client c

$NextEdge(-, u, g) \triangleq \text{CHOOSE } e \in g.edge : e.from = u$

$Do(c, op) \triangleq \text{LET } cop \triangleq [op \mapsto op, oid \mapsto [c \mapsto c, seq \mapsto cseq[c]], ctx \mapsto ds[c]]$
 $u \triangleq ds[c] \quad v \triangleq u \cup \{cop.oid\}$
 IN $\wedge c2ss' = [c2ss \text{ EXCEPT } ![c] =$
 $\quad @ \oplus [node \mapsto \{v\}, edge \mapsto \{[from \mapsto u, to \mapsto v, cop \mapsto cop]\}]]$
 $\wedge \text{apply } op \text{ to } list[c]; \text{ send } cop \text{ to the } Server$

$Rev(c, cop) \triangleq \text{LET } xform \triangleq xForm(NextEdge, c, cop, c2ss[c]) \quad xform: [xcop, xg, lg]$
 IN $\wedge c2ss' = [c2ss \text{ EXCEPT } ![c] = @ \oplus xform.xg]$
 $\wedge \text{apply } xform.xcop.op \text{ to } list[c]$

$SRev(cop) \triangleq$
 $\text{LET } c \triangleq ClientOf(cop)$
 $xform \triangleq xForm(NextEdge, Server, cop, s2ss[c]) \quad xform: [xcop, xg, lg]$
 IN $\wedge s2ss' = [cl \in Client \mapsto \text{IF } cl = c \text{ THEN } s2ss[cl] \oplus xform.xg$
 $\quad \quad \quad \text{ELSE } s2ss[cl] \oplus xform.lg]$
 $\wedge \text{apply } xform.xcop.op \text{ to } list[Server]$
 $\wedge \text{broadcast the transformed operation } xform.xcop \text{ to clients other than } c$