

$IsGigraph(G) \triangleq$   $G$  is a record with *node* field and *edge* field

$\wedge G.node \subseteq (\text{SUBSET } Oid)$  each node represents a document state

$\wedge G.edge \subseteq [from : G.node, to : G.node, cop : Cop]$  label: *cop*

$EmptyGraph \triangleq [node \mapsto \{\{\}\}, edge \mapsto \{\}]$

$g \oplus h \triangleq [node \mapsto g.node \cup h.node, edge \mapsto g.edge \cup h.edge]$  union

$xForm(NextEdge(-, -, -), r, cop, g) \triangleq$  Transform *cop* in *g* at replica *r*

LET  $u \triangleq \text{CHOOSE } n \in g.node : n = cop.ctx$   $v \triangleq u \cup \{cop.oid\}$

$xFormHelper(uh, vh, coph, gh) \triangleq$  *gh*: extra digraph produced in *xForm*

IF  $uh = ds[r]$  THEN  $[xcop \mapsto coph, xg \mapsto gh,$

$lg \mapsto [node \mapsto \{vh\}, edge \mapsto \{[from \mapsto uh, to \mapsto vh, cop \mapsto coph]\}]]$

ELSE LET  $e \triangleq NextEdge(r, uh, g)$  specific to *CJupiter* and *XJupiter*

$ecop \triangleq e.cop$   $eu \triangleq e.to$   $ev \triangleq vh \cup \{ecop.oid\}$

$coph2ecop \triangleq COT(coph, ecop)$   $ecop2coph \triangleq COT(ecop, coph)$

IN  $xFormHelper(eu, ev, coph2ecop,$

$gh \oplus [node \mapsto \{ev\},$  union with new *node* and *edge*

$edge \mapsto \{[from \mapsto vh, to \mapsto ev, cop \mapsto ecop2coph],$

$[from \mapsto eu, to \mapsto ev, cop \mapsto coph2ecop]\}])$

IN  $xFormHelper(u, v, cop, [node \mapsto \{v\}, edge \mapsto \{[from \mapsto u, to \mapsto v, cop \mapsto cop]\}])$