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MODULE XJupiter
Specification of the Jupiter protocol described in CSCW'2014 by Xu, Sun, and Li.
EXTENDS StateSpace
VARIABLES
    c2ss,    c2ss[c]: the 2D state space (2ss, for short) at client c ∈ Client
    s2ss     s2ss[c]: the 2D state space maintained by the Server for client c ∈ Client
vars ≜ ⟨intVars, ctxVars, c2ss, s2ss⟩
TypeOK ≜
    ∧  TypeOKInt
    ∧  TypeOKCtx
    ∧  ∀ c ∈ Client : IsSS(c2ss[c]) ∧ IsSS(s2ss[c])
Init ≜
    ∧ InitInt
    ∧ InitCtx
    ∧ c2ss = [c ∈ Client ↦ EmptySS]
    ∧ s2ss = [c ∈ Client ↦ EmptySS]
NextEdge(r, u, ss) ≜  Return the (unique) outgoing edge from u in 2D state space ss.
    CHOOSE e ∈ ss.edge : e.from = u
xForm(r, cop, ss) ≜  Transform cop with an operation sequence in 2D state space ss.
    LET u ≜ Locate(cop, ss)
     cops ≜ ExtractCopSeq(NextEdge, r, u, ss)
    IN   xFormCopCopsSS(cop, cops)
ClientPerform(c, cop) ≜
    LET xform ≜ xForm(c, cop, c2ss[c])  xform: [xcop, xss, lss]
    IN   ∧ c2ss′ = [c2ss EXCEPT ![c] = @ ⊕ xform.xss]
         ∧ SetNewAop(c, xform.xcop.op)
ServerPerform(cop) ≜
    LET c ≜ ClientOf(cop)
    xform ≜ xForm(Server, cop, s2ss[c])  xform: [xcop, xss, lss]
     xcop ≜ xform.xcop
    IN   ∧ s2ss′ = [cl ∈ Client ↦ IF cl = c
                                  THEN s2ss[cl] ⊕ xform.xss
                                  ELSE s2ss[cl] ⊕ xform.lss]
         ∧ SetNewAop(Server, xcop.op)
         ∧ Comm!SSendSame(c, xcop)  broadcast the transformed xcop
DoOp(c, op) ≜
      LET cop ≜ [op ↦ op, oid ↦ [c ↦ c, seq ↦ cseq[c]], ctx ↦ ds[c]]
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        IN    ∧ ClientPerform(c, cop)
              ∧ Comm!CSend(cop)

Do(c) ≜
    ∧ DoInt(DoOp, c)
    ∧ DoCtx(c)
    ∧ UNCHANGED s2ss

Rev(c) ≜
    ∧ RevInt(ClientPerform, c)
    ∧ RevCtx(c)
    ∧ UNCHANGED s2ss

SRev ≜
    ∧ SRevInt(ServerPerform)
    ∧ SRevCtx
    ∧ UNCHANGED c2ss
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Next ≜
    ∨ ∃ c ∈ Client : Do(c) ∨ Rev(c)
    ∨ SRev

Fairness ≜
    WF_vars(SRev ∨ ∃ c ∈ Client : Rev(c))

Spec ≜ Init ∧ □[Next]_vars  ∧ Fairness
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CSSync ≜  Each client c ∈ Client is synchonized with the Server.
    ∀ c ∈ Client : (ds[c] = ds[Server]) ⇒ c2ss[c] = s2ss[c]

THEOREM Spec ⇒ □CSSync
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