

```

1  |----- MODULE XJupiterImplCJupiter -----|
   | We show that XJupiter (XJupiterExtended) implements CJupiter. |
5  | EXTENDS XJupiterExtended |
   | Variables for defining refinement mapping from XJupiter to CJupiter. |
9  | VARIABLES |
10 |   op2ss,   a function from an operation (represented by its Oid) |
11 |             to the part of 2D state space produced while the operation is transformed |
12 |   c2ssX    c2ssX[c]: redundant (eXtra) 2D state space maintained for client c ∈ Client |
14 | varsImpl  $\triangleq$   $\langle \textit{varsEx}, \textit{op2ss}, \textit{c2ssX} \rangle$  |
15 |-----|
16 | TypeOKImpl  $\triangleq$  |
17 |    $\wedge$  TypeOKEx |
18 |    $\wedge \forall \textit{oid} \in \text{DOMAIN } \textit{op2ss} : \textit{oid} \in \textit{Oid} \wedge \textit{IsSS}(\textit{op2ss}[\textit{oid}])$  |
19 |    $\wedge \forall c \in \textit{Client} : \textit{IsSS}(\textit{c2ssX}[c])$  |
20 |-----|
21 | InitImpl  $\triangleq$  |
22 |    $\wedge$  InitEx |
23 |    $\wedge \textit{op2ss} = \langle \rangle$  |
24 |    $\wedge \textit{c2ssX} = [c \in \textit{Client} \mapsto \textit{EmptySS}]$  |
25 |-----|
   | Ignore the lr field in edges of 2D state space ss. |
29 | IgnoreDir(ss)  $\triangleq$  |
30 |    $[ss \text{ EXCEPT } !.edge = \{[from \mapsto e.from, to \mapsto e.to, cop \mapsto e.cop] : e \in @\}]$  |
31 |-----|
32 | DoImpl(c)  $\triangleq$  |
33 |    $\wedge$  DoEx(c) |
34 |    $\wedge$  UNCHANGED  $\langle \textit{op2ss}, \textit{c2ssX} \rangle$  |
36 | RevImpl(c)  $\triangleq$  |
37 |    $\wedge$  RevEx(c) |
38 |    $\wedge$  LET cop  $\triangleq$  Head(cincoming[c]) |
39 |       IN c2ssX' = [c2ssX EXCEPT ![c] = @  $\oplus$  op2ss[cop.oid]] |
40 |    $\wedge$  UNCHANGED  $\langle \textit{op2ss} \rangle$  |
42 | SRevImpl  $\triangleq$  |
43 |    $\wedge$  SRevEx |
44 |    $\wedge$  LET cop  $\triangleq$  Head(sincoming) |
45 |       c  $\triangleq$  cop.oid.c |
46 |       xform  $\triangleq$  xForm(cop, s2ss[c], cur[Server], Remote) | TODO: performance!!! |
47 |       ss  $\triangleq$  xform[1] |
48 |       IN op2ss' = op2ss @@ (cop.oid := [node  $\mapsto$  ss.node, edge  $\mapsto$  ss.edge]) |
49 |    $\wedge$  UNCHANGED  $\langle \textit{c2ssX} \rangle$  |
50 |-----|
51 | NextImpl  $\triangleq$ 

```

```

52    $\vee \exists c \in Client : DoImpl(c) \vee RevImpl(c)$ 
53    $\vee SRevImpl$ 
54
55    $SpecImpl \triangleq InitImpl \wedge \Box [NextImpl]_{varsImpl}$ 
56    $\wedge WF_{varsImpl}(SRevImpl \vee \exists c \in Client : RevImpl(c))$ 
57
58   CJ  $\triangleq$  INSTANCE CJupiter
59       WITH cincoming  $\leftarrow$  cincomingCJ, sincoming needs no substitution
60           css  $\leftarrow [r \in Replica \mapsto$ 
61               IF  $r = Server$ 
62                   THEN IgnoreDir(SetReduce( $\oplus$ , Range(s2ss), EmptySS))
63                   ELSE IgnoreDir(c2ss[r]  $\oplus$  c2ssX[r])]
64
65 THEOREM SpecImpl  $\Rightarrow$  CJ!Spec
66 └──────────────────────────────────────────────────────────────────────────────────┘
    /* Modification History
    /* Last modified Fri Nov 16 14:54:12 CST 2018 by hengrin
    /* Created Fri Oct 26 15:00:19 CST 2018 by hengrin

```