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1  |----- MODULE Cure -----|
   | See ICDCS2016: “Cure: Strong Semantics Meets High Availability and Low Latency”. |
6  | EXTENDS Naturals, Sequences |
7  |-----|
8  CONSTANTS
9      Key,           the set of keys, ranged over by  $k \in Key$ 
10     Value,         the set of values, ranged over by  $v \in Value$ 
11     Client,         the set of clients, ranged over by  $c \in Client$ 
12     Partition,      the set of partitions, ranged over by  $p \in Partition$ 
13     Datacenter,     the set of datacenters, ranged over by  $d \in Datacenter$ 
14     Sharding        the mapping from Key to Partition

16  ASSUME Sharding  $\in [Key \rightarrow Partition]$ 
17  |-----|
18  VARIABLES
19      At the client side:
20      cvc, cvc[ $c$ ]: the vector clock of client  $c \in Client$ 
21      At the server side (each for partition  $p \in Partition$  in  $d \in Datacenter$ ):
22      clock, clock[ $p$ ][ $d$ ]: the current clock
23      pvc, pvc[ $p$ ][ $d$ ]: the vector clock
24      css, css[ $p$ ][ $d$ ]: the stable snapshot
25      PMC, PMC[ $p$ ][ $d$ ]: matrix clock
26      store, store[ $p$ ][ $d$ ]: the kv store
27      updates updates[ $p$ ][ $d$ ]: the buffer of updates

29  vars  $\triangleq \langle cvc, clock, pvc, css, PMC, store, updates \rangle$ 
30  |-----|
31  Clock  $\triangleq Nat$ 
32  VC  $\triangleq [Datacenter \rightarrow Clock]$  vector clock with an entry per datacenter  $d \in Datacenter$ 
33  VCInit  $\triangleq [d \in Datacenter \mapsto 0]$ 
34  KVTuple  $\triangleq [key : Key, val : Value, vc : VC]$ 

36  TypeOK  $\triangleq$ 
37       $\wedge cvc \in [Client \rightarrow VC]$ 
38       $\wedge clock \in [Partition \rightarrow [Datacenter \rightarrow Clock]]$ 
39       $\wedge pvc \in [Partition \rightarrow [Datacenter \rightarrow VC]]$ 
40       $\wedge css \in [Partition \rightarrow [Datacenter \rightarrow VC]]$ 
41       $\wedge PMC \in [Partition \rightarrow [Datacenter \rightarrow [Partition \rightarrow VC]]]$ 
42       $\wedge store \in [Partition \rightarrow [Datacenter \rightarrow SUBSET KVTuple]]$ 
43       $\wedge updates \in [Partition \rightarrow [Datacenter \rightarrow Seq(KVTuple)]]$ 
44  |-----|
45  Init  $\triangleq$ 
46       $\wedge cvc = [c \in Client \mapsto VCInit]$ 
47       $\wedge clock = [p \in Partition \mapsto [d \in Datacenter \mapsto 0]]$ 
48       $\wedge pvc = [p \in Partition \mapsto [d \in Datacenter \mapsto VCInit]]$ 
49       $\wedge css = [p \in Partition \mapsto [d \in Datacenter \mapsto VCInit]]$ 

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50       $\wedge PMC = [p \in Partition \mapsto [d \in Datacenter \mapsto [q \in Partition \mapsto VCInit]]]$ 
51       $\wedge store = [p \in Partition \mapsto [d \in Datacenter \mapsto \{\}]]$ 
52       $\wedge updates = [p \in Partition \mapsto [d \in Datacenter \mapsto \langle \rangle]]$ 
53  |-----|
54  | Client operations at client  $c \in Client$ . |
55  |-----|
56  | Server operations at partition  $p \in Partition$  in datacenter  $d \in Datacenter$ . |
57  |-----|
58   $Next \triangleq$ 
59       $\vee \text{UNCHANGED } vars$ 
61   $Spec \triangleq Init \wedge \Box[Next]_{vars}$ 
62  |-----|
63  |-----|

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