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1  |----- MODULE CSComm -----|
   | Specification of communication in a Client-Server system model.
5  | EXTENDS Naturals, Op
7  | CONSTANTS
8      Client,      the set of clients
9      Server       the (unique) server
11 | VARIABLES
12     cincoming,    cincoming[c]: incoming channel at the client c ∈ Client
13     sincoming     incoming channel at the Server
14 |-----|
15 | vars ≜ ⟨cincoming, sincoming⟩
16 |-----|
   | Messages between the Server and the Clients. There are two kinds of messages according to their
   | destinations. TODO: Abstraction from the concrete representation of messages.
22 | Msg ≜ [c : Client, ack : Nat, op : Op] ∪ messages sent to the Server from a client c ∈ Client
23 |      [ack : Nat, op : Op] messages broadcast to Clients from the Server
24 |-----|
25 | TypeOK ≜ ∧ cincoming ∈ [Client → Seq(Msg)]
26 |      ∧ sincoming ∈ Seq(Msg)
27 |-----|
   | The initial predicate.
31 | Init ≜ ∧ cincoming = [c ∈ Client ↦ ⟨⟩]
32 |      ∧ sincoming = ⟨⟩
33 |-----|
   | A client sends a message msg to the Server.
37 | CSend(msg) ≜
38 |     ∧ sincoming' = Append(sincoming, msg)
39 |     ∧ UNCHANGED cincoming
   | A client receives a message from the Server.
43 | CRev(c) ≜
44 |     ∧ cincoming[c] ≠ ⟨⟩ there are messages to handle with
45 |     ∧ cincoming' = [cincoming EXCEPT ![c] = Tail(@)] consume a message
46 |     ∧ UNCHANGED sincoming
47 |-----|
   | SRev and SSend below will be used together in one subaction. Therefore, there are no UNCHANGED
   | sub-formulas in their definitions.
   | The Server receives a message from some client c ∈ Client.
56 | SRev ≜
57 |     ∧ sincoming ≠ ⟨⟩ there are messages for the Server to handle with
58 |     ∧ sincoming' = Tail(sincoming) consume a message
   | The Server broadcasts messages to the Clients other than c ∈ Client. The “ack” parts of the
   | messages [ack : Nat, op : Op] broadcast are determined by the parameter “acks”.

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65  $SSend(c, acks, xop) \triangleq$ 
66    $\wedge cincoming' = [cl \in Client \mapsto$ 
67     IF  $cl = c$ 
68       THEN  $cincoming[cl]$ 
69       ELSE  $Append(cincoming[cl], [ack \mapsto acks[cl], op \mapsto xop])]$ 
70 |-----|
71 |-----|
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