Hierarchical Protocol

Abstract

This example shows how the CP-net from "Simple Protocol" can be turned into a hierarchical CP-net – with separate pages (subnets) for the *Sender*, the *Network* and the *Receiver* part. The protocol is modified to accommodate multiple *Receivers*.

Developed and Maintained by:

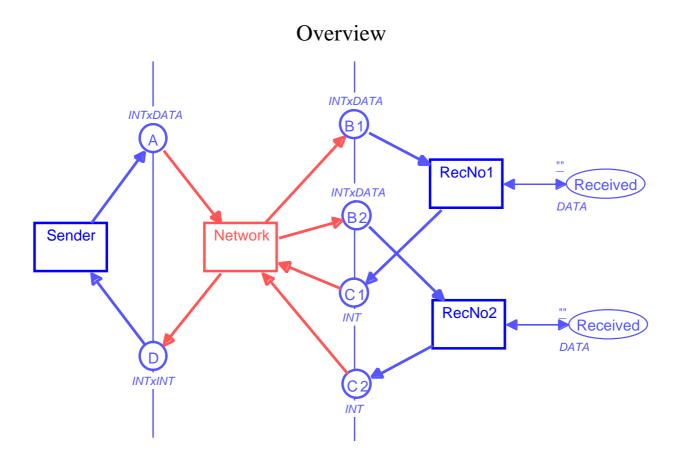
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Graphical Quality

The figures in this document are inserted via PICT format. This is why some of the arcs and place borders look a bit ragged. A postscript printout from Design/CPN (and the screen image in Design/CPN) has much higher graphical quality.

CPN Model

The most abstract page looks as shown below. It tells us that we have a *Sender*, a *Network* and two *Receivers*. The basic idea is that the *Sender* sends messages which the *Network* broadcasts to the two *Receivers*. Analogously, the *Receivers* send acknowledgments which the *Network* transmits to the *Sender*.

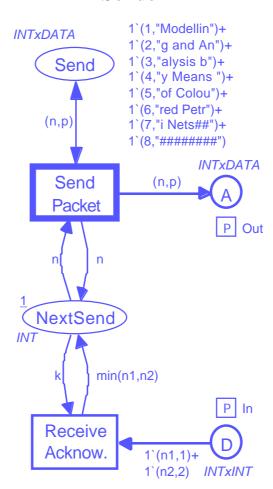


```
color INT = int;
color DATA = string;
color INTxDATA = product INT * DATA;
color INTxINT = product INT * INT;
var n, k, n1, n2 : INT;
var p,str : DATA;
val stop = "#######";

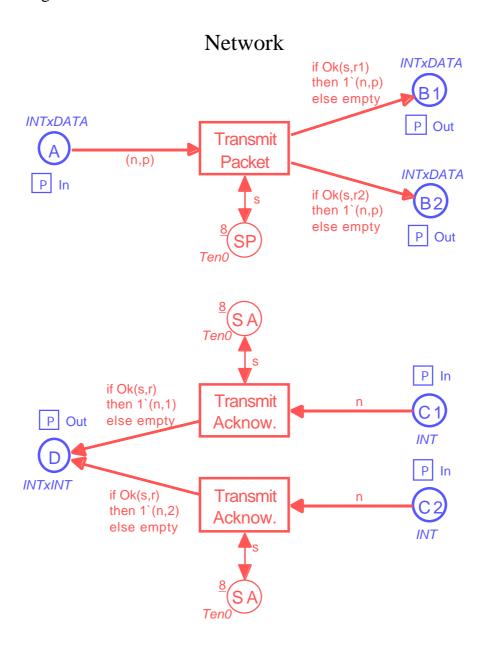
color Ten0 = int with 0..10;
color Ten1 = int with 1..10;
var s : Ten0; var r, r1, r2 : Ten1;
fun Ok(s:Ten0,r:Ten1) = (r<=s);
```

The Sender part is similar to the sender part of the "Simple Protocol". The only difference is that Receive Acknowledgment now needs an acknowledgment from each of the two Receivers in order to become enabled. Each acknowledgment is a pair where the first element is the contents, while the second element indicates whether it came from Receiver one or two. Since packets are sent by means of broadcasts, the Sender needs to wait for the slowest of the two Receivers (or the most unlucky one). Hence Next Send is updated to be the minimum of the two acknowledgment values.

Sender



The *Network* part is similar to the network part of the "Simple Protocol". However, again there are a few differences. *Transmit Packet* produces packets at two different output places B1 and B2. The packets at B1 are for the first *Receiver*, while the packets at B2 are for the second. It should be noted that we use two different variables r1 and r2 to determine whether the packets for B1 and B2 are lost or not. This means that we model a broadcast in which one of the *Receivers* may get a packet while the other does not. If we replace r1 and r2 with a single common variable r, we get a broadcast where the two *Receivers* get exactly the same packets. *Transmit Acknowledgment* is split in two. The upper one handles acknowledgments from the first *Receiver*, while the lower one handles those from the second. Both of them modify the acknowledgment, by adding information telling the *Sender* where the acknowledgment came from.



The *Receiver* part is totally identical to the receiver part of the simple protocol. However, it should be noted that the *Receiver* page is used by two substitution transitions, *RecNo1* and *RecNo2*. This means that we will have two instances of the subnet – during a simulation. The two instances may have different markings and different enabling, otherwise they will be identical. Design/CPN displays one instance at a time. To see another instance, the user applies the **Switch Instance** command in the **Sim** menu.

Receiver

