Appendix A

This appendix contains the Concurrency Workbench commands that specify and verify the basic Go-Back-N, the stutter Go-Back-N, and the Asynchronous Retransmission Go-Back-N ARQ protocols for $N = 3$.

```
**********************************************************************
**********************************************************************
**********************************************************************
* The Specification of the Go-Back-N Automatic Repeat Request protocol
* (N=3).
**********************************************************************
**********************************************************************
**********************************************************************

**********************************************************************
* The definition of a realistic communication link (messages may be
* delivered correctly, or may be corrupted by noise, or may be
* discarded entirely by the link)
**********************************************************************

agent Link =
       s0.('r0correct.Link + 'r0error.Link + Link) +
       s1.('r1correct.Link + 'r1error.Link + Link) +
       s2.('r2correct.Link + 'r2error.Link + Link) +
       s3.('r3correct.Link + 'r3error.Link + Link) +
       sack0.('rack0.Link + Link) +
       sack1.('rack1.Link + Link) +
       sack2.('rack2.Link + Link) +
       sack3.('rack3.Link + Link) +
       snak0.('rnak0.Link + Link) +
       snak1.('rnak1.Link + Link) +
       snak2.('rnak2.Link + Link) +
       snak3.('rnak3.Link + Link);



**********************************************************************
* The definition of the Go-Back-N sender (window_size=4 ===> N=3)
**********************************************************************

agent Send0WhenThereAre0UnackMsgs = send.'s0.
      (Send1WhenThereAre1UnackMsgs +
       rack0.Send1WhenThereAre0UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind);
agent Send0WhenThereAre1UnackMsgs = send.'s0.
```

```
      (Send1WhenThereAre2UnackMsgs +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Send1WhenThereAre1UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind);
agent Send0WhenThereAre2UnackMsgs = send.'s0.
      (Send1WhenThereAre3UnackMsgs +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Send1WhenThereAre1UnackMsgs +
       rack2.Send1WhenThereAre2UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind);
agent Send0WhenThereAre3UnackMsgs = send.'s0.
      (rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Send1WhenThereAre1UnackMsgs +
       rack2.Send1WhenThereAre2UnackMsgs +
       rack1.Send1WhenThereAre3UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.Retx1WhenThereAre4UnackMsgsAnd3Behind +
       tau.Retx1WhenThereAre4UnackMsgsAnd3Behind);

agent Send1WhenThereAre0UnackMsgs = send.'s1.
      (Send2WhenThereAre1UnackMsgs +
       rack1.Send2WhenThereAre0UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind);
agent Send1WhenThereAre1UnackMsgs = send.'s1.
      (Send2WhenThereAre2UnackMsgs +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Send2WhenThereAre1UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind);
agent Send1WhenThereAre2UnackMsgs = send.'s1.
      (Send2WhenThereAre3UnackMsgs +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Send2WhenThereAre1UnackMsgs +
       rack3.Send2WhenThereAre2UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind);
agent Send1WhenThereAre3UnackMsgs = send.'s1.
      (rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Send2WhenThereAre1UnackMsgs +
       rack3.Send2WhenThereAre2UnackMsgs +
```

```
        rack2.Send2WhenThereAre3UnackMsgs +
        rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
        rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
        rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind +
        rnak2.Retx2WhenThereAre4UnackMsgsAnd3Behind +
        tau.Retx2WhenThereAre4UnackMsgsAnd3Behind);

agent Send2WhenThereAre0UnackMsgs = send.'s2.
       (Send3WhenThereAre1UnackMsgs +
        rack2.Send3WhenThereAre0UnackMsgs +
        rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind);
agent Send2WhenThereAre1UnackMsgs = send.'s2.
       (Send3WhenThereAre2UnackMsgs +
        rack2.Send3WhenThereAre0UnackMsgs +
        rack1.Send3WhenThereAre1UnackMsgs +
        rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
        rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind);
agent Send2WhenThereAre2UnackMsgs = send.'s2.
       (Send3WhenThereAre3UnackMsgs +
        rack2.Send3WhenThereAre0UnackMsgs +
        rack1.Send3WhenThereAre1UnackMsgs +
        rack0.Send3WhenThereAre2UnackMsgs +
        rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
        rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
        rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind);
agent Send2WhenThereAre3UnackMsgs = send.'s2.
       (rack2.Send3WhenThereAre0UnackMsgs +
        rack1.Send3WhenThereAre1UnackMsgs +
        rack0.Send3WhenThereAre2UnackMsgs +
        rack3.Send3WhenThereAre3UnackMsgs +
        rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
        rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
        rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind +
        rnak3.Retx3WhenThereAre4UnackMsgsAnd3Behind +
        tau.Retx3WhenThereAre4UnackMsgsAnd3Behind);

agent Send3WhenThereAre0UnackMsgs = send.'s3.
       (Send0WhenThereAre1UnackMsgs +
        rack3.Send0WhenThereAre0UnackMsgs +
        rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind);
agent Send3WhenThereAre1UnackMsgs = send.'s3.
       (Send0WhenThereAre2UnackMsgs +
        rack3.Send0WhenThereAre0UnackMsgs +
        rack2.Send0WhenThereAre1UnackMsgs +
        rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
        rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind);
```

```
agent Send3WhenThereAre2UnackMsgs = send.'s3.
      (Send0WhenThereAre3UnackMsgs +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Send0WhenThereAre1UnackMsgs +
       rack1.Send0WhenThereAre2UnackMsgs +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind);
agent Send3WhenThereAre3UnackMsgs = send.'s3.
      (rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Send0WhenThereAre1UnackMsgs +
       rack1.Send0WhenThereAre2UnackMsgs +
       rack0.Send0WhenThereAre3UnackMsgs +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.Retx0WhenThereAre4UnackMsgsAnd3Behind +
       tau.Retx0WhenThereAre4UnackMsgsAnd3Behind);

agent Retx0WhenThereAre1UnackMsgsAnd0Behind = 's0.
      (Send1WhenThereAre1UnackMsgs +
       rack0.Send1WhenThereAre0UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind);
agent Retx0WhenThereAre2UnackMsgsAnd0Behind = 's0.
      (Send1WhenThereAre2UnackMsgs +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Send1WhenThereAre1UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind);
agent Retx0WhenThereAre2UnackMsgsAnd1Behind = 's0.
      (Retx1WhenThereAre2UnackMsgsAnd0Behind +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind);
agent Retx0WhenThereAre3UnackMsgsAnd0Behind = 's0.
      (Send1WhenThereAre3UnackMsgs +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Send1WhenThereAre1UnackMsgs +
       rack2.Send1WhenThereAre2UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind);
agent Retx0WhenThereAre3UnackMsgsAnd1Behind = 's0.
      (Retx1WhenThereAre3UnackMsgsAnd0Behind +
       rack1.Send2WhenThereAre0UnackMsgs +
```

```
       rack0.Send2WhenThereAre1UnackMsgs +
       rack3.Send2WhenThereAre2UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind);
agent Retx0WhenThereAre3UnackMsgsAnd2Behind = 's0.
      (Retx1WhenThereAre3UnackMsgsAnd1Behind +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind);
agent Retx0WhenThereAre4UnackMsgsAnd0Behind = 's0.
      (tau.Retx1WhenThereAre4UnackMsgsAnd3Behind +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Send1WhenThereAre1UnackMsgs +
       rack2.Send1WhenThereAre2UnackMsgs +
       rack1.Send1WhenThereAre3UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.Retx1WhenThereAre4UnackMsgsAnd3Behind);
agent Retx0WhenThereAre4UnackMsgsAnd1Behind = 's0.
      (Retx1WhenThereAre4UnackMsgsAnd0Behind +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Send2WhenThereAre1UnackMsgs +
       rack3.Send2WhenThereAre2UnackMsgs +
       rack2.Send2WhenThereAre3UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.Retx2WhenThereAre4UnackMsgsAnd3Behind);
agent Retx0WhenThereAre4UnackMsgsAnd2Behind = 's0.
      (Retx1WhenThereAre4UnackMsgsAnd1Behind +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rack3.Retx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.Retx3WhenThereAre4UnackMsgsAnd3Behind);
agent Retx0WhenThereAre4UnackMsgsAnd3Behind = 's0.
      (Retx1WhenThereAre4UnackMsgsAnd2Behind +
       rack3.Send0WhenThereAre0UnackMsgs +
```

```
       rack2.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rack0.Retx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.Retx0WhenThereAre4UnackMsgsAnd3Behind);

agent Retx1WhenThereAre1UnackMsgsAnd0Behind = 's1.
      (Send2WhenThereAre1UnackMsgs +
       rack1.Send2WhenThereAre0UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind);
agent Retx1WhenThereAre2UnackMsgsAnd0Behind = 's1.
      (Send2WhenThereAre2UnackMsgs +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Send2WhenThereAre1UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind);
agent Retx1WhenThereAre2UnackMsgsAnd1Behind = 's1.
      (Retx2WhenThereAre2UnackMsgsAnd0Behind +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind);
agent Retx1WhenThereAre3UnackMsgsAnd0Behind = 's1.
      (Send2WhenThereAre3UnackMsgs +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Send2WhenThereAre1UnackMsgs +
       rack3.Send2WhenThereAre2UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind);
agent Retx1WhenThereAre3UnackMsgsAnd1Behind = 's1.
      (Retx2WhenThereAre3UnackMsgsAnd0Behind +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Send3WhenThereAre1UnackMsgs +
       rack0.Send3WhenThereAre2UnackMsgs +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind);
agent Retx1WhenThereAre3UnackMsgsAnd2Behind = 's1.
      (Retx2WhenThereAre3UnackMsgsAnd1Behind +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
```

```
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind);
agent Retx1WhenThereAre4UnackMsgsAnd0Behind = 's1.
      (tau.Retx2WhenThereAre4UnackMsgsAnd3Behind +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Send2WhenThereAre1UnackMsgs +
       rack3.Send2WhenThereAre2UnackMsgs +
       rack2.Send2WhenThereAre3UnackMsgs +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.Retx2WhenThereAre4UnackMsgsAnd3Behind);
agent Retx1WhenThereAre4UnackMsgsAnd1Behind = 's1.
      (Retx2WhenThereAre4UnackMsgsAnd0Behind +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Send3WhenThereAre1UnackMsgs +
       rack0.Send3WhenThereAre2UnackMsgs +
       rack3.Send3WhenThereAre3UnackMsgs +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.Retx3WhenThereAre4UnackMsgsAnd3Behind);
agent Retx1WhenThereAre4UnackMsgsAnd2Behind = 's1.
      (Retx2WhenThereAre4UnackMsgsAnd1Behind +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rack0.Retx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.Retx0WhenThereAre4UnackMsgsAnd3Behind);
agent Retx1WhenThereAre4UnackMsgsAnd3Behind = 's1.
      (Retx2WhenThereAre4UnackMsgsAnd2Behind +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rack1.Retx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.Retx1WhenThereAre4UnackMsgsAnd3Behind);

agent Retx2WhenThereAre1UnackMsgsAnd0Behind = 's2.
      (Send3WhenThereAre1UnackMsgs +
       rack2.Send3WhenThereAre0UnackMsgs +
```

```
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind);
agent Retx2WhenThereAre2UnackMsgsAnd0Behind = 's2.
      (Send3WhenThereAre2UnackMsgs +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Send3WhenThereAre1UnackMsgs +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind);
agent Retx2WhenThereAre2UnackMsgsAnd1Behind = 's2.
      (Retx3WhenThereAre2UnackMsgsAnd0Behind +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind);
agent Retx2WhenThereAre3UnackMsgsAnd0Behind = 's2.
      (Send3WhenThereAre3UnackMsgs +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Send3WhenThereAre1UnackMsgs +
       rack0.Send3WhenThereAre2UnackMsgs +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind);
agent Retx2WhenThereAre3UnackMsgsAnd1Behind = 's2.
      (Retx3WhenThereAre3UnackMsgsAnd0Behind +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Send0WhenThereAre1UnackMsgs +
       rack1.Send0WhenThereAre2UnackMsgs +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind);
agent Retx2WhenThereAre3UnackMsgsAnd2Behind = 's2.
      (Retx3WhenThereAre3UnackMsgsAnd1Behind +
       rack0.Send0WhenThereAre0UnackMsgs +
       rack3.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind);
agent Retx2WhenThereAre4UnackMsgsAnd0Behind = 's2.
      (tau.Retx3WhenThereAre4UnackMsgsAnd3Behind +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Send3WhenThereAre1UnackMsgs +
       rack0.Send3WhenThereAre2UnackMsgs +
       rack3.Send3WhenThereAre3UnackMsgs +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind +
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```
       rnak3.Retx3WhenThereAre4UnackMsgsAnd3Behind);
agent Retx2WhenThereAre4UnackMsgsAnd1Behind = 's2.
      (Retx3WhenThereAre4UnackMsgsAnd0Behind +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Send0WhenThereAre1UnackMsgs +
       rack1.Send0WhenThereAre2UnackMsgs +
       rack0.Send0WhenThereAre3UnackMsgs +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.Retx0WhenThereAre4UnackMsgsAnd3Behind);
agent Retx2WhenThereAre4UnackMsgsAnd2Behind = 's2.
      (Retx3WhenThereAre4UnackMsgsAnd1Behind +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rack1.Retx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.Retx1WhenThereAre4UnackMsgsAnd3Behind);
agent Retx2WhenThereAre4UnackMsgsAnd3Behind = 's2.
      (Retx3WhenThereAre4UnackMsgsAnd2Behind +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rack3.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rack2.Retx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.Retx2WhenThereAre4UnackMsgsAnd3Behind);

agent Retx3WhenThereAre1UnackMsgsAnd0Behind = 's3.
      (Send0WhenThereAre1UnackMsgs +
       rack3.Send0WhenThereAre0UnackMsgs +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind);
agent Retx3WhenThereAre2UnackMsgsAnd0Behind = 's3.
      (Send0WhenThereAre2UnackMsgs +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Send0WhenThereAre1UnackMsgs +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind);
agent Retx3WhenThereAre2UnackMsgsAnd1Behind = 's3.
      (Retx0WhenThereAre2UnackMsgsAnd0Behind +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Retx0WhenThereAre1UnackMsgsAnd0Behind +
```

```
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind);
agent Retx3WhenThereAre3UnackMsgsAnd0Behind = 's3.
      (Send0WhenThereAre3UnackMsgs +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Send0WhenThereAre1UnackMsgs +
       rack1.Send0WhenThereAre2UnackMsgs +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind);
agent Retx3WhenThereAre3UnackMsgsAnd1Behind = 's3.
      (Retx0WhenThereAre3UnackMsgsAnd0Behind +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Send1WhenThereAre1UnackMsgs +
       rack2.Send1WhenThereAre2UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind);
agent Retx3WhenThereAre3UnackMsgsAnd2Behind = 's3.
      (Retx0WhenThereAre3UnackMsgsAnd1Behind +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rack3.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind);
agent Retx3WhenThereAre4UnackMsgsAnd0Behind = 's3.
      (tau.Retx0WhenThereAre4UnackMsgsAnd3Behind +
       rack3.Send0WhenThereAre0UnackMsgs +
       rack2.Send0WhenThereAre1UnackMsgs +
       rack1.Send0WhenThereAre2UnackMsgs +
       rack0.Send0WhenThereAre3UnackMsgs +
       rnak3.Retx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.Retx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.Retx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.Retx0WhenThereAre4UnackMsgsAnd3Behind);
agent Retx3WhenThereAre4UnackMsgsAnd1Behind = 's3.
      (Retx0WhenThereAre4UnackMsgsAnd0Behind +
       rack0.Send1WhenThereAre0UnackMsgs +
       rack3.Send1WhenThereAre1UnackMsgs +
       rack2.Send1WhenThereAre2UnackMsgs +
       rack1.Send1WhenThereAre3UnackMsgs +
       rnak0.Retx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.Retx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.Retx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.Retx1WhenThereAre4UnackMsgsAnd3Behind);
```

```
agent Retx3WhenThereAre4UnackMsgsAnd2Behind = 's3.
      (Retx0WhenThereAre4UnackMsgsAnd1Behind +
       rack1.Send2WhenThereAre0UnackMsgs +
       rack0.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rack3.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rack2.Retx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.Retx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.Retx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.Retx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.Retx2WhenThereAre4UnackMsgsAnd3Behind);
agent Retx3WhenThereAre4UnackMsgsAnd3Behind = 's3.
      (Retx0WhenThereAre4UnackMsgsAnd2Behind +
       rack2.Send3WhenThereAre0UnackMsgs +
       rack1.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rack3.Retx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.Retx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.Retx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.Retx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.Retx3WhenThereAre4UnackMsgsAnd3Behind);



*********************************************************************
* The definition of the Go-Back-N receiver (window_size=4 ===> N=3)
*********************************************************************

agent Receive0WhenNoNakSent =
       r0correct.'receive.'sack0.Receive1WhenNoNakSent +
       r0error.'snak0.Receive0WhenNakSent +
       r1correct.'snak0.Receive0WhenNakSent +
       r1error.'snak0.Receive0WhenNakSent +
       r2correct.'snak0.Receive0WhenNakSent +
       r2error.'snak0.Receive0WhenNakSent +
       r3correct.'snak0.Receive0WhenNakSent +
       r3error.'snak0.Receive0WhenNakSent;
agent Receive0WhenNakSent =
       r0correct.'receive.'sack0.Receive1WhenNoNakSent +
       r0error.'snak0.Receive0WhenNakSent +
       r1correct.'snak0.Receive0WhenNakSent +
       r1error.'snak0.Receive0WhenNakSent +
       r2correct.'snak0.Receive0WhenNakSent +
       r2error.'snak0.Receive0WhenNakSent +
       r3correct.'snak0.Receive0WhenNakSent +
       r3error.'snak0.Receive0WhenNakSent +
       tau.'snak0.Receive0WhenNakSent;
```

```
agent Receive1WhenNoNakSent =
       r1correct.'receive.'sack1.Receive2WhenNoNakSent +
       r1error.'snak1.Receive1WhenNakSent +
       r0correct.'snak1.Receive1WhenNakSent +
       r0error.'snak1.Receive1WhenNakSent +
       r2correct.'snak1.Receive1WhenNakSent +
       r2error.'snak1.Receive1WhenNakSent +
       r3correct.'snak1.Receive1WhenNakSent +
       r3error.'snak1.Receive1WhenNakSent;
agent Receive1WhenNakSent =
       r1correct.'receive.'sack1.Receive2WhenNoNakSent +
       r1error.'snak1.Receive1WhenNakSent +
       r0correct.'snak1.Receive1WhenNakSent +
       r0error.'snak1.Receive1WhenNakSent +
       r2correct.'snak1.Receive1WhenNakSent +
       r2error.'snak1.Receive1WhenNakSent +
       r3correct.'snak1.Receive1WhenNakSent +
       r3error.'snak1.Receive1WhenNakSent +
       tau.'snak1.Receive1WhenNakSent;

agent Receive2WhenNoNakSent =
       r2correct.'receive.'sack2.Receive3WhenNoNakSent +
       r2error.'snak2.Receive2WhenNakSent +
       r0correct.'snak2.Receive2WhenNakSent +
       r0error.'snak2.Receive2WhenNakSent +
       r1correct.'snak2.Receive2WhenNakSent +
       r1error.'snak2.Receive2WhenNakSent +
       r3correct.'snak2.Receive2WhenNakSent +
       r3error.'snak2.Receive2WhenNakSent;
agent Receive2WhenNakSent =
       r2correct.'receive.'sack2.Receive3WhenNoNakSent +
       r2error.'snak2.Receive2WhenNakSent +
       r0correct.'snak2.Receive2WhenNakSent +
       r0error.'snak2.Receive2WhenNakSent +
       r1correct.'snak2.Receive2WhenNakSent +
       r1error.'snak2.Receive2WhenNakSent +
       r3correct.'snak2.Receive2WhenNakSent +
       r3error.'snak2.Receive2WhenNakSent +
       tau.'snak2.Receive2WhenNakSent;

agent Receive3WhenNoNakSent =
       r3correct.'receive.'sack3.Receive0WhenNoNakSent +
       r3error.'snak3.Receive3WhenNakSent +
       r0correct.'snak3.Receive3WhenNakSent +
       r0error.'snak3.Receive3WhenNakSent +
```

```
       r1correct.'snak3.Receive3WhenNakSent +
       r1error.'snak3.Receive3WhenNakSent +
       r2correct.'snak3.Receive3WhenNakSent +
       r2error.'snak3.Receive3WhenNakSent;
agent Receive3WhenNakSent =
       r3correct.'receive.'sack3.Receive0WhenNoNakSent +
       r3error.'snak3.Receive3WhenNakSent +
       r0correct.'snak3.Receive3WhenNakSent +
       r0error.'snak3.Receive3WhenNakSent +
       r1correct.'snak3.Receive3WhenNakSent +
       r1error.'snak3.Receive3WhenNakSent +
       r2correct.'snak3.Receive3WhenNakSent +
       r2error.'snak3.Receive3WhenNakSent +
       tau.'snak3.Receive3WhenNakSent;


**********************************************************************
* The definition of the Go-Back-N protocol (window_size=4 ===> N=3)
**********************************************************************
set InternalActions =
     {s0,s1,s2,s3,
      r0correct,r1correct,r2correct,r3correct,
      r0error,r1error,r2error,r3error,
      sack0,sack1,sack2,sack3,
      rack0,rack1,rack2,rack3,
      snak0,snak1,snak2,snak3,
      rnak0,rnak1,rnak2,rnak3};

agent GBN = (Send0WhenThereAre0UnackMsgs | Receive0WhenNoNakSent | Link)
           \ InternalActions;


**********************************************************************
**********************************************************************
**********************************************************************
* The Specification of the Stutter Go-Back-N Automatic Repeat Request
* protocol (N=3).  (Note that the definitions of the link and receiver
* for the Stutter Go-Back-N protocol are the same as those for the
* Go-Back-N protocol.)
**********************************************************************
**********************************************************************
**********************************************************************

**********************************************************************
```

```
* The definition of the Stutter Go-Back-N sender (N=3)
*****************************************************************

agent StutterSend0WhenThereAre0UnackMsgs = send.'s0.
      (StutterSend1WhenThereAre1UnackMsgs +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind);
agent StutterSend0WhenThereAre1UnackMsgs = send.'s0.
      (StutterSend1WhenThereAre2UnackMsgs +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterSend1WhenThereAre1UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind);
agent StutterSend0WhenThereAre2UnackMsgs = send.'s0.
      (StutterSend1WhenThereAre3UnackMsgs +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterSend1WhenThereAre1UnackMsgs +
       rack2.StutterSend1WhenThereAre2UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind);
agent StutterSend0WhenThereAre3UnackMsgs = send.'s0.
      (rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterSend1WhenThereAre1UnackMsgs +
       rack2.StutterSend1WhenThereAre2UnackMsgs +
       rack1.StutterSend1WhenThereAre3UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.StutterRetx1WhenThereAre4UnackMsgsAnd3Behind +
       StutterRetx0WhenThereAre4UnackMsgsAnd0Behind);

agent StutterSend1WhenThereAre0UnackMsgs = send.'s1.
      (StutterSend2WhenThereAre1UnackMsgs +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind);
agent StutterSend1WhenThereAre1UnackMsgs = send.'s1.
      (StutterSend2WhenThereAre2UnackMsgs +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterSend2WhenThereAre1UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind);
agent StutterSend1WhenThereAre2UnackMsgs = send.'s1.
      (StutterSend2WhenThereAre3UnackMsgs +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterSend2WhenThereAre1UnackMsgs +
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```
       rack3.StutterSend2WhenThereAre2UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind);
agent StutterSend1WhenThereAre3UnackMsgs = send.'s1.
      (rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterSend2WhenThereAre1UnackMsgs +
       rack3.StutterSend2WhenThereAre2UnackMsgs +
       rack2.StutterSend2WhenThereAre3UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.StutterRetx2WhenThereAre4UnackMsgsAnd3Behind +
       StutterRetx1WhenThereAre4UnackMsgsAnd0Behind);

agent StutterSend2WhenThereAre0UnackMsgs = send.'s2.
      (StutterSend3WhenThereAre1UnackMsgs +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind);
agent StutterSend2WhenThereAre1UnackMsgs = send.'s2.
      (StutterSend3WhenThereAre2UnackMsgs +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterSend3WhenThereAre1UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind);
agent StutterSend2WhenThereAre2UnackMsgs = send.'s2.
      (StutterSend3WhenThereAre3UnackMsgs +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterSend3WhenThereAre1UnackMsgs +
       rack0.StutterSend3WhenThereAre2UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind);
agent StutterSend2WhenThereAre3UnackMsgs = send.'s2.
      (rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterSend3WhenThereAre1UnackMsgs +
       rack0.StutterSend3WhenThereAre2UnackMsgs +
       rack3.StutterSend3WhenThereAre3UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.StutterRetx3WhenThereAre4UnackMsgsAnd3Behind +
       StutterRetx2WhenThereAre4UnackMsgsAnd0Behind);

agent StutterSend3WhenThereAre0UnackMsgs = send.'s3.
      (StutterSend0WhenThereAre1UnackMsgs +
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       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind);
agent StutterSend3WhenThereAre1UnackMsgs = send.'s3.
      (StutterSend0WhenThereAre2UnackMsgs +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterSend0WhenThereAre1UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind);
agent StutterSend3WhenThereAre2UnackMsgs = send.'s3.
      (StutterSend0WhenThereAre3UnackMsgs +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterSend0WhenThereAre1UnackMsgs +
       rack1.StutterSend0WhenThereAre2UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind);
agent StutterSend3WhenThereAre3UnackMsgs = send.'s3.
      (rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterSend0WhenThereAre1UnackMsgs +
       rack1.StutterSend0WhenThereAre2UnackMsgs +
       rack0.StutterSend0WhenThereAre3UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.StutterRetx0WhenThereAre4UnackMsgsAnd3Behind +
       StutterRetx3WhenThereAre4UnackMsgsAnd0Behind);

agent StutterRetx0WhenThereAre1UnackMsgsAnd0Behind = 's0.
      (StutterSend1WhenThereAre1UnackMsgs +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind);
agent StutterRetx0WhenThereAre2UnackMsgsAnd0Behind = 's0.
      (StutterSend1WhenThereAre2UnackMsgs +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterSend1WhenThereAre1UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind);
agent StutterRetx0WhenThereAre2UnackMsgsAnd1Behind = 's0.
      (StutterRetx1WhenThereAre2UnackMsgsAnd0Behind +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind);
agent StutterRetx0WhenThereAre3UnackMsgsAnd0Behind = 's0.
      (StutterSend1WhenThereAre3UnackMsgs +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
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```
       rack3.StutterSend1WhenThereAre1UnackMsgs +
       rack2.StutterSend1WhenThereAre2UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx0WhenThereAre3UnackMsgsAnd1Behind = 's0.
      (StutterRetx1WhenThereAre3UnackMsgsAnd0Behind +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterSend2WhenThereAre1UnackMsgs +
       rack3.StutterSend2WhenThereAre2UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx0WhenThereAre3UnackMsgsAnd2Behind = 's0.
      (StutterRetx1WhenThereAre3UnackMsgsAnd1Behind +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx0WhenThereAre4UnackMsgsAnd0Behind = 's0.
      (tau.StutterRetx1WhenThereAre4UnackMsgsAnd3Behind +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterSend1WhenThereAre1UnackMsgs +
       rack2.StutterSend1WhenThereAre2UnackMsgs +
       rack1.StutterSend1WhenThereAre3UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.StutterRetx1WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx0WhenThereAre4UnackMsgsAnd1Behind = 's0.
      (StutterRetx1WhenThereAre4UnackMsgsAnd0Behind +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterSend2WhenThereAre1UnackMsgs +
       rack3.StutterSend2WhenThereAre2UnackMsgs +
       rack2.StutterSend2WhenThereAre3UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.StutterRetx2WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx0WhenThereAre4UnackMsgsAnd2Behind = 's0.
      (StutterRetx1WhenThereAre4UnackMsgsAnd1Behind +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
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```
       rack3.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.StutterRetx3WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx0WhenThereAre4UnackMsgsAnd3Behind = 's0.
      (StutterRetx1WhenThereAre4UnackMsgsAnd2Behind +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rack0.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.StutterRetx0WhenThereAre4UnackMsgsAnd3Behind);

agent StutterRetx1WhenThereAre1UnackMsgsAnd0Behind = 's1.
      (StutterSend2WhenThereAre1UnackMsgs +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind);
agent StutterRetx1WhenThereAre2UnackMsgsAnd0Behind = 's1.
      (StutterSend2WhenThereAre2UnackMsgs +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterSend2WhenThereAre1UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind);
agent StutterRetx1WhenThereAre2UnackMsgsAnd1Behind = 's1.
      (StutterRetx2WhenThereAre2UnackMsgsAnd0Behind +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind);
agent StutterRetx1WhenThereAre3UnackMsgsAnd0Behind = 's1.
      (StutterSend2WhenThereAre3UnackMsgs +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterSend2WhenThereAre1UnackMsgs +
       rack3.StutterSend2WhenThereAre2UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx1WhenThereAre3UnackMsgsAnd1Behind = 's1.
      (StutterRetx2WhenThereAre3UnackMsgsAnd0Behind +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterSend3WhenThereAre1UnackMsgs +
       rack0.StutterSend3WhenThereAre2UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
```

```
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx1WhenThereAre3UnackMsgsAnd2Behind = 's1.
      (StutterRetx2WhenThereAre3UnackMsgsAnd1Behind +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx1WhenThereAre4UnackMsgsAnd0Behind = 's1.
      (tau.StutterRetx2WhenThereAre4UnackMsgsAnd3Behind +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterSend2WhenThereAre1UnackMsgs +
       rack3.StutterSend2WhenThereAre2UnackMsgs +
       rack2.StutterSend2WhenThereAre3UnackMsgs +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.StutterRetx2WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx1WhenThereAre4UnackMsgsAnd1Behind = 's1.
      (StutterRetx2WhenThereAre4UnackMsgsAnd0Behind +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterSend3WhenThereAre1UnackMsgs +
       rack0.StutterSend3WhenThereAre2UnackMsgs +
       rack3.StutterSend3WhenThereAre3UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.StutterRetx3WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx1WhenThereAre4UnackMsgsAnd2Behind = 's1.
      (StutterRetx2WhenThereAre4UnackMsgsAnd1Behind +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rack0.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.StutterRetx0WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx1WhenThereAre4UnackMsgsAnd3Behind = 's1.
      (StutterRetx2WhenThereAre4UnackMsgsAnd2Behind +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rack1.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind +
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       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.StutterRetx1WhenThereAre4UnackMsgsAnd3Behind);

agent StutterRetx2WhenThereAre1UnackMsgsAnd0Behind = 's2.
      (StutterSend3WhenThereAre1UnackMsgs +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind);
agent StutterRetx2WhenThereAre2UnackMsgsAnd0Behind = 's2.
      (StutterSend3WhenThereAre2UnackMsgs +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterSend3WhenThereAre1UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind);
agent StutterRetx2WhenThereAre2UnackMsgsAnd1Behind = 's2.
      (StutterRetx3WhenThereAre2UnackMsgsAnd0Behind +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind);
agent StutterRetx2WhenThereAre3UnackMsgsAnd0Behind = 's2.
      (StutterSend3WhenThereAre3UnackMsgs +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterSend3WhenThereAre1UnackMsgs +
       rack0.StutterSend3WhenThereAre2UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx2WhenThereAre3UnackMsgsAnd1Behind = 's2.
      (StutterRetx3WhenThereAre3UnackMsgsAnd0Behind +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterSend0WhenThereAre1UnackMsgs +
       rack1.StutterSend0WhenThereAre2UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx2WhenThereAre3UnackMsgsAnd2Behind = 's2.
      (StutterRetx3WhenThereAre3UnackMsgsAnd1Behind +
       rack0.StutterSend0WhenThereAre0UnackMsgs +
       rack3.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx2WhenThereAre4UnackMsgsAnd0Behind = 's2.
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      (tau.StutterRetx3WhenThereAre4UnackMsgsAnd3Behind +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterSend3WhenThereAre1UnackMsgs +
       rack0.StutterSend3WhenThereAre2UnackMsgs +
       rack3.StutterSend3WhenThereAre3UnackMsgs +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.StutterRetx3WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx2WhenThereAre4UnackMsgsAnd1Behind = 's2.
      (StutterRetx3WhenThereAre4UnackMsgsAnd0Behind +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterSend0WhenThereAre1UnackMsgs +
       rack1.StutterSend0WhenThereAre2UnackMsgs +
       rack0.StutterSend0WhenThereAre3UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.StutterRetx0WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx2WhenThereAre4UnackMsgsAnd2Behind = 's2.
      (StutterRetx3WhenThereAre4UnackMsgsAnd1Behind +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rack1.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.StutterRetx1WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx2WhenThereAre4UnackMsgsAnd3Behind = 's2.
      (StutterRetx3WhenThereAre4UnackMsgsAnd2Behind +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rack3.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rack2.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.StutterRetx2WhenThereAre4UnackMsgsAnd3Behind);

agent StutterRetx3WhenThereAre1UnackMsgsAnd0Behind = 's3.
      (StutterSend0WhenThereAre1UnackMsgs +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind);
agent StutterRetx3WhenThereAre2UnackMsgsAnd0Behind = 's3.
      (StutterSend0WhenThereAre2UnackMsgs +
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       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterSend0WhenThereAre1UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind);
agent StutterRetx3WhenThereAre2UnackMsgsAnd1Behind = 's3.
      (StutterRetx0WhenThereAre2UnackMsgsAnd0Behind +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind);
agent StutterRetx3WhenThereAre3UnackMsgsAnd0Behind = 's3.
      (StutterSend0WhenThereAre3UnackMsgs +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterSend0WhenThereAre1UnackMsgs +
       rack1.StutterSend0WhenThereAre2UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx3WhenThereAre3UnackMsgsAnd1Behind = 's3.
      (StutterRetx0WhenThereAre3UnackMsgsAnd0Behind +
       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterSend1WhenThereAre1UnackMsgs +
       rack2.StutterSend1WhenThereAre2UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx3WhenThereAre3UnackMsgsAnd2Behind = 's3.
      (StutterRetx0WhenThereAre3UnackMsgsAnd1Behind +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rack3.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind);
agent StutterRetx3WhenThereAre4UnackMsgsAnd0Behind = 's3.
      (tau.StutterRetx0WhenThereAre4UnackMsgsAnd3Behind +
       rack3.StutterSend0WhenThereAre0UnackMsgs +
       rack2.StutterSend0WhenThereAre1UnackMsgs +
       rack1.StutterSend0WhenThereAre2UnackMsgs +
       rack0.StutterSend0WhenThereAre3UnackMsgs +
       rnak3.StutterRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.StutterRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.StutterRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.StutterRetx0WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx3WhenThereAre4UnackMsgsAnd1Behind = 's3.
      (StutterRetx0WhenThereAre4UnackMsgsAnd0Behind +
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       rack0.StutterSend1WhenThereAre0UnackMsgs +
       rack3.StutterSend1WhenThereAre1UnackMsgs +
       rack2.StutterSend1WhenThereAre2UnackMsgs +
       rack1.StutterSend1WhenThereAre3UnackMsgs +
       rnak0.StutterRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.StutterRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.StutterRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.StutterRetx1WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx3WhenThereAre4UnackMsgsAnd2Behind = 's3.
      (StutterRetx0WhenThereAre4UnackMsgsAnd1Behind +
       rack1.StutterSend2WhenThereAre0UnackMsgs +
       rack0.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rack3.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rack2.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.StutterRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.StutterRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.StutterRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.StutterRetx2WhenThereAre4UnackMsgsAnd3Behind);
agent StutterRetx3WhenThereAre4UnackMsgsAnd3Behind = 's3.
      (StutterRetx0WhenThereAre4UnackMsgsAnd2Behind +
       rack2.StutterSend3WhenThereAre0UnackMsgs +
       rack1.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rack3.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.StutterRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.StutterRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.StutterRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.StutterRetx3WhenThereAre4UnackMsgsAnd3Behind);


*********************************************************************
* The definition of the Stutter Go-Back-N protocol (N=3).  (Note that
* the definitions of the link and receiver for the Stutter Go-Back-N
* protocol are the same as those for the Go-Back-N protocol.)
*********************************************************************
agent StutterGBN = (StutterSend0WhenThereAre0UnackMsgs |
                    Receive0WhenNoNakSent | Link) \ InternalActions;


*********************************************************************
*********************************************************************
*********************************************************************
* The Specification of the Asynchronous Retransmission Go-Back-N
* Automatic Repeat Request protocol (N=3).  (Note that the definitions
```

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* of the link and receiver for the Asynchronous Retransmission
* Go-Back-N protocol are the same as those for the Go-Back-N protocol.)
*********************************************************************
*********************************************************************
*********************************************************************

*********************************************************************
* The definition of the Asynchronous Retransmission Go-Back-N sender
* (N=3)
*********************************************************************

agent AsynRetransSend0WhenThereAre0UnackMsgs = send.'s0.
      (AsynRetransSend1WhenThereAre1UnackMsgs +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind);
agent AsynRetransSend0WhenThereAre1UnackMsgs = send.'s0.
      (AsynRetransSend1WhenThereAre2UnackMsgs +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransSend1WhenThereAre1UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransSend0WhenThereAre2UnackMsgs = send.'s0.
      (AsynRetransSend1WhenThereAre3UnackMsgs +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransSend1WhenThereAre1UnackMsgs +
       rack2.AsynRetransSend1WhenThereAre2UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransSend0WhenThereAre3UnackMsgs = send.'s0.
      (rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransSend1WhenThereAre1UnackMsgs +
       rack2.AsynRetransSend1WhenThereAre2UnackMsgs +
       rack1.AsynRetransSend1WhenThereAre3UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.AsynRetransRetx1WhenThereAre4UnackMsgsAnd3Behind +
      (AsynRetransRetx0WhenThereAre4UnackMsgsAnd0Behind +
       AsynRetransRetx3WhenThereAre4UnackMsgsAnd1Behind +
       AsynRetransRetx2WhenThereAre4UnackMsgsAnd2Behind +
       AsynRetransRetx1WhenThereAre4UnackMsgsAnd3Behind));

agent AsynRetransSend1WhenThereAre0UnackMsgs = send.'s1.
      (AsynRetransSend2WhenThereAre1UnackMsgs +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
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       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind);
agent AsynRetransSend1WhenThereAre1UnackMsgs = send.'s1.
      (AsynRetransSend2WhenThereAre2UnackMsgs +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransSend2WhenThereAre1UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransSend1WhenThereAre2UnackMsgs = send.'s1.
      (AsynRetransSend2WhenThereAre3UnackMsgs +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransSend2WhenThereAre1UnackMsgs +
       rack3.AsynRetransSend2WhenThereAre2UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransSend1WhenThereAre3UnackMsgs = send.'s1.
      (rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransSend2WhenThereAre1UnackMsgs +
       rack3.AsynRetransSend2WhenThereAre2UnackMsgs +
       rack2.AsynRetransSend2WhenThereAre3UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.AsynRetransRetx2WhenThereAre4UnackMsgsAnd3Behind +
      (AsynRetransRetx1WhenThereAre4UnackMsgsAnd0Behind +
       AsynRetransRetx0WhenThereAre4UnackMsgsAnd1Behind +
       AsynRetransRetx3WhenThereAre4UnackMsgsAnd2Behind +
       AsynRetransRetx2WhenThereAre4UnackMsgsAnd3Behind));

agent AsynRetransSend2WhenThereAre0UnackMsgs = send.'s2.
      (AsynRetransSend3WhenThereAre1UnackMsgs +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind);
agent AsynRetransSend2WhenThereAre1UnackMsgs = send.'s2.
      (AsynRetransSend3WhenThereAre2UnackMsgs +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransSend3WhenThereAre1UnackMsgs +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransSend2WhenThereAre2UnackMsgs = send.'s2.
      (AsynRetransSend3WhenThereAre3UnackMsgs +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransSend3WhenThereAre1UnackMsgs +
       rack0.AsynRetransSend3WhenThereAre2UnackMsgs +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
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       rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransSend2WhenThereAre3UnackMsgs = send.'s2.
      (rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransSend3WhenThereAre1UnackMsgs +
       rack0.AsynRetransSend3WhenThereAre2UnackMsgs +
       rack3.AsynRetransSend3WhenThereAre3UnackMsgs +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.AsynRetransRetx3WhenThereAre4UnackMsgsAnd3Behind +
      (AsynRetransRetx2WhenThereAre4UnackMsgsAnd0Behind +
       AsynRetransRetx1WhenThereAre4UnackMsgsAnd1Behind +
       AsynRetransRetx0WhenThereAre4UnackMsgsAnd2Behind +
       AsynRetransRetx3WhenThereAre4UnackMsgsAnd3Behind));

agent AsynRetransSend3WhenThereAre0UnackMsgs = send.'s3.
      (AsynRetransSend0WhenThereAre1UnackMsgs +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind);
agent AsynRetransSend3WhenThereAre1UnackMsgs = send.'s3.
      (AsynRetransSend0WhenThereAre2UnackMsgs +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransSend0WhenThereAre1UnackMsgs +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransSend3WhenThereAre2UnackMsgs = send.'s3.
      (AsynRetransSend0WhenThereAre3UnackMsgs +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransSend0WhenThereAre1UnackMsgs +
       rack1.AsynRetransSend0WhenThereAre2UnackMsgs +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransSend3WhenThereAre3UnackMsgs = send.'s3.
      (rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransSend0WhenThereAre1UnackMsgs +
       rack1.AsynRetransSend0WhenThereAre2UnackMsgs +
       rack0.AsynRetransSend0WhenThereAre3UnackMsgs +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.AsynRetransRetx0WhenThereAre4UnackMsgsAnd3Behind +
      (AsynRetransRetx3WhenThereAre4UnackMsgsAnd0Behind +
       AsynRetransRetx2WhenThereAre4UnackMsgsAnd1Behind +
       AsynRetransRetx1WhenThereAre4UnackMsgsAnd2Behind +
       AsynRetransRetx0WhenThereAre4UnackMsgsAnd3Behind));
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agent AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind = 's0.
      (AsynRetransSend1WhenThereAre1UnackMsgs +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind);
agent AsynRetransRetx0WhenThereAre2UnackMsgsAnd0Behind = 's0.
      (AsynRetransSend1WhenThereAre2UnackMsgs +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransSend1WhenThereAre1UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind = 's0.
      (AsynRetransRetx1WhenThereAre2UnackMsgsAnd0Behind +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransRetx0WhenThereAre3UnackMsgsAnd0Behind = 's0.
      (AsynRetransSend1WhenThereAre3UnackMsgs +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransSend1WhenThereAre1UnackMsgs +
       rack2.AsynRetransSend1WhenThereAre2UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx0WhenThereAre3UnackMsgsAnd1Behind = 's0.
      (AsynRetransRetx1WhenThereAre3UnackMsgsAnd0Behind +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransSend2WhenThereAre1UnackMsgs +
       rack3.AsynRetransSend2WhenThereAre2UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind = 's0.
      (AsynRetransRetx1WhenThereAre3UnackMsgsAnd1Behind +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx0WhenThereAre4UnackMsgsAnd0Behind = 's0.
      (tau.AsynRetransRetx1WhenThereAre4UnackMsgsAnd3Behind +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransSend1WhenThereAre1UnackMsgs +
       rack2.AsynRetransSend1WhenThereAre2UnackMsgs +
```

```
       rack1.AsynRetransSend1WhenThereAre3UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.AsynRetransRetx1WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx0WhenThereAre4UnackMsgsAnd1Behind = 's0.
      (AsynRetransRetx1WhenThereAre4UnackMsgsAnd0Behind +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransSend2WhenThereAre1UnackMsgs +
       rack3.AsynRetransSend2WhenThereAre2UnackMsgs +
       rack2.AsynRetransSend2WhenThereAre3UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.AsynRetransRetx2WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx0WhenThereAre4UnackMsgsAnd2Behind = 's0.
      (AsynRetransRetx1WhenThereAre4UnackMsgsAnd1Behind +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rack3.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.AsynRetransRetx3WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx0WhenThereAre4UnackMsgsAnd3Behind = 's0.
      (AsynRetransRetx1WhenThereAre4UnackMsgsAnd2Behind +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rack0.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.AsynRetransRetx0WhenThereAre4UnackMsgsAnd3Behind);

agent AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind = 's1.
      (AsynRetransSend2WhenThereAre1UnackMsgs +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind);
agent AsynRetransRetx1WhenThereAre2UnackMsgsAnd0Behind = 's1.
      (AsynRetransSend2WhenThereAre2UnackMsgs +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransSend2WhenThereAre1UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind);
```

```
agent AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind = 's1.
      (AsynRetransRetx2WhenThereAre2UnackMsgsAnd0Behind +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransRetx1WhenThereAre3UnackMsgsAnd0Behind = 's1.
      (AsynRetransSend2WhenThereAre3UnackMsgs +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransSend2WhenThereAre1UnackMsgs +
       rack3.AsynRetransSend2WhenThereAre2UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx1WhenThereAre3UnackMsgsAnd1Behind = 's1.
      (AsynRetransRetx2WhenThereAre3UnackMsgsAnd0Behind +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransSend3WhenThereAre1UnackMsgs +
       rack0.AsynRetransSend3WhenThereAre2UnackMsgs +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind = 's1.
      (AsynRetransRetx2WhenThereAre3UnackMsgsAnd1Behind +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx1WhenThereAre4UnackMsgsAnd0Behind = 's1.
      (tau.AsynRetransRetx2WhenThereAre4UnackMsgsAnd3Behind +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransSend2WhenThereAre1UnackMsgs +
       rack3.AsynRetransSend2WhenThereAre2UnackMsgs +
       rack2.AsynRetransSend2WhenThereAre3UnackMsgs +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.AsynRetransRetx2WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx1WhenThereAre4UnackMsgsAnd1Behind = 's1.
      (AsynRetransRetx2WhenThereAre4UnackMsgsAnd0Behind +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransSend3WhenThereAre1UnackMsgs +
       rack0.AsynRetransSend3WhenThereAre2UnackMsgs +
       rack3.AsynRetransSend3WhenThereAre3UnackMsgs +
```

```
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.AsynRetransRetx3WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx1WhenThereAre4UnackMsgsAnd2Behind = 's1.
      (AsynRetransRetx2WhenThereAre4UnackMsgsAnd1Behind +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rack1.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rack0.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.AsynRetransRetx0WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx1WhenThereAre4UnackMsgsAnd3Behind = 's1.
      (AsynRetransRetx2WhenThereAre4UnackMsgsAnd2Behind +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rack1.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.AsynRetransRetx1WhenThereAre4UnackMsgsAnd3Behind);

agent AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind = 's2.
      (AsynRetransSend3WhenThereAre1UnackMsgs +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind);
agent AsynRetransRetx2WhenThereAre2UnackMsgsAnd0Behind = 's2.
      (AsynRetransSend3WhenThereAre2UnackMsgs +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransSend3WhenThereAre1UnackMsgs +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind = 's2.
      (AsynRetransRetx3WhenThereAre2UnackMsgsAnd0Behind +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransRetx2WhenThereAre3UnackMsgsAnd0Behind = 's2.
      (AsynRetransSend3WhenThereAre3UnackMsgs +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransSend3WhenThereAre1UnackMsgs +
       rack0.AsynRetransSend3WhenThereAre2UnackMsgs +
```

```
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx2WhenThereAre3UnackMsgsAnd1Behind = 's2.
      (AsynRetransRetx3WhenThereAre3UnackMsgsAnd0Behind +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransSend0WhenThereAre1UnackMsgs +
       rack1.AsynRetransSend0WhenThereAre2UnackMsgs +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind = 's2.
      (AsynRetransRetx3WhenThereAre3UnackMsgsAnd1Behind +
       rack0.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack3.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx2WhenThereAre4UnackMsgsAnd0Behind = 's2.
      (tau.AsynRetransRetx3WhenThereAre4UnackMsgsAnd3Behind +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransSend3WhenThereAre1UnackMsgs +
       rack0.AsynRetransSend3WhenThereAre2UnackMsgs +
       rack3.AsynRetransSend3WhenThereAre3UnackMsgs +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak3.AsynRetransRetx3WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx2WhenThereAre4UnackMsgsAnd1Behind = 's2.
      (AsynRetransRetx3WhenThereAre4UnackMsgsAnd0Behind +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransSend0WhenThereAre1UnackMsgs +
       rack1.AsynRetransSend0WhenThereAre2UnackMsgs +
       rack0.AsynRetransSend0WhenThereAre3UnackMsgs +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.AsynRetransRetx0WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx2WhenThereAre4UnackMsgsAnd2Behind = 's2.
      (AsynRetransRetx3WhenThereAre4UnackMsgsAnd1Behind +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rack2.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rack1.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
```

```
      rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
      rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind +
      rnak1.AsynRetransRetx1WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx2WhenThereAre4UnackMsgsAnd3Behind = 's2.
     (AsynRetransRetx3WhenThereAre4UnackMsgsAnd2Behind +
      rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
      rack0.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
      rack3.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
      rack2.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind +
      rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
      rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
      rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind +
      rnak2.AsynRetransRetx2WhenThereAre4UnackMsgsAnd3Behind);

agent AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind = 's3.
     (AsynRetransSend0WhenThereAre1UnackMsgs +
      rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
      rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind);
agent AsynRetransRetx3WhenThereAre2UnackMsgsAnd0Behind = 's3.
     (AsynRetransSend0WhenThereAre2UnackMsgs +
      rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
      rack2.AsynRetransSend0WhenThereAre1UnackMsgs +
      rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
      rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind = 's3.
     (AsynRetransRetx0WhenThereAre2UnackMsgsAnd0Behind +
      rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
      rack3.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
      rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
      rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind);
agent AsynRetransRetx3WhenThereAre3UnackMsgsAnd0Behind = 's3.
     (AsynRetransSend0WhenThereAre3UnackMsgs +
      rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
      rack2.AsynRetransSend0WhenThereAre1UnackMsgs +
      rack1.AsynRetransSend0WhenThereAre2UnackMsgs +
      rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
      rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
      rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx3WhenThereAre3UnackMsgsAnd1Behind = 's3.
     (AsynRetransRetx0WhenThereAre3UnackMsgsAnd0Behind +
      rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
      rack3.AsynRetransSend1WhenThereAre1UnackMsgs +
      rack2.AsynRetransSend1WhenThereAre2UnackMsgs +
      rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
      rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
      rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind);
```

```
agent AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind = 's3.
      (AsynRetransRetx0WhenThereAre3UnackMsgsAnd1Behind +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rack3.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind);
agent AsynRetransRetx3WhenThereAre4UnackMsgsAnd0Behind = 's3.
      (tau.AsynRetransRetx0WhenThereAre4UnackMsgsAnd3Behind +
       rack3.AsynRetransSend0WhenThereAre0UnackMsgs +
       rack2.AsynRetransSend0WhenThereAre1UnackMsgs +
       rack1.AsynRetransSend0WhenThereAre2UnackMsgs +
       rack0.AsynRetransSend0WhenThereAre3UnackMsgs +
       rnak3.AsynRetransRetx3WhenThereAre1UnackMsgsAnd0Behind +
       rnak2.AsynRetransRetx2WhenThereAre2UnackMsgsAnd1Behind +
       rnak1.AsynRetransRetx1WhenThereAre3UnackMsgsAnd2Behind +
       rnak0.AsynRetransRetx0WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx3WhenThereAre4UnackMsgsAnd1Behind = 's3.
      (AsynRetransRetx0WhenThereAre4UnackMsgsAnd0Behind +
       rack0.AsynRetransSend1WhenThereAre0UnackMsgs +
       rack3.AsynRetransSend1WhenThereAre1UnackMsgs +
       rack2.AsynRetransSend1WhenThereAre2UnackMsgs +
       rack1.AsynRetransSend1WhenThereAre3UnackMsgs +
       rnak0.AsynRetransRetx0WhenThereAre1UnackMsgsAnd0Behind +
       rnak3.AsynRetransRetx3WhenThereAre2UnackMsgsAnd1Behind +
       rnak2.AsynRetransRetx2WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.AsynRetransRetx1WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx3WhenThereAre4UnackMsgsAnd2Behind = 's3.
      (AsynRetransRetx0WhenThereAre4UnackMsgsAnd1Behind +
       rack1.AsynRetransSend2WhenThereAre0UnackMsgs +
       rack0.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rack3.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rack2.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak1.AsynRetransRetx1WhenThereAre1UnackMsgsAnd0Behind +
       rnak0.AsynRetransRetx0WhenThereAre2UnackMsgsAnd1Behind +
       rnak3.AsynRetransRetx3WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.AsynRetransRetx2WhenThereAre4UnackMsgsAnd3Behind);
agent AsynRetransRetx3WhenThereAre4UnackMsgsAnd3Behind = 's3.
      (AsynRetransRetx0WhenThereAre4UnackMsgsAnd2Behind +
       rack2.AsynRetransSend3WhenThereAre0UnackMsgs +
       rack1.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rack0.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
       rack3.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind +
       rnak2.AsynRetransRetx2WhenThereAre1UnackMsgsAnd0Behind +
       rnak1.AsynRetransRetx1WhenThereAre2UnackMsgsAnd1Behind +
```

```
      rnak0.AsynRetransRetx0WhenThereAre3UnackMsgsAnd2Behind +
      rnak3.AsynRetransRetx3WhenThereAre4UnackMsgsAnd3Behind);


*********************************************************************
* The definition of the Asynchronous Retransmission Go-Back-N protocol
* (N=3). (Note that the definitions of the link and receiver for the
* Asynchronous Retransmission Go-Back-N protocol are the same as those
* for the Go-Back-N protocol.)
*********************************************************************
agent AsynRetransGBN = (AsynRetransSend0WhenThereAre0UnackMsgs |
                        Receive0WhenNoNakSent | Link) \ InternalActions;



*********************************************************************
*********************************************************************
*********************************************************************

*********************************************************************
* The definitions of the temporal operators which are used for
* checking properties of the protocols
*********************************************************************

prop Can(a) = <<a>>T;
prop Bx(P) = max(Z.P & [-]Z);



*********************************************************************
* Check some properties of the protocols
*********************************************************************

cp (GBN, Bx ((Can (send)) | (Can ('receive))));
fd GBN;

cp (StutterGBN, Bx ((Can (send)) | (Can ('receive))));
fd StutterGBN;

cp (AsynRetransGBN, Bx ((Can (send)) | (Can ('receive))));
fd AsynRetransGBN;

eq (GBN, StutterGBN);
eq (GBN, AsynRetransGBN);
eq (AsynRetransGBN, StutterGBN);
```

```
cong (GBN, StutterGBN);
cong (GBN, AsynRetransGBN);
cong (AsynRetransGBN, StutterGBN);

mayeq (GBN, StutterGBN);
mayeq (GBN, AsynRetransGBN);
mayeq (AsynRetransGBN, StutterGBN);

musteq (GBN, StutterGBN);
musteq (GBN, AsynRetransGBN);
musteq (AsynRetransGBN, StutterGBN);

testeq (GBN, StutterGBN);
testeq (GBN, AsynRetransGBN);
testeq (AsynRetransGBN, StutterGBN);
```

Appendix B

This appendix contains output generated by the Concurrency Workbench response to the commands in Appendix A.

```
[Major collection...
[Increasing heap to 13276k]
 76% used (4868800/6337256), 420 msec]

[Increasing heap to 14472k]

[Major collection... 69% used (5117084/7407676), 410 msec]

[Increasing heap to 15032k]

[Major collection... 66% used (5123824/7693296), 440 msec]

[Increasing heap to 15056k]

[Major collection... 66% used (5117904/7712432), 440 msec]

[Major collection... 66% used (5110220/7719704), 430 msec]
true
[Major collection... 65% used (5012664/7705268), 460 msec]

No such agents.

[Major collection... 69% used (5397504/7735192), 490 msec]
```

```
[Increasing heap to 15964k]

[Major collection... 96% used (7901964/8183260), 780 msec]

[Increasing heap to 23284k]

[Major collection... 71% used (8499044/11922364), 780 msec]

[Increasing heap to 25004k]
true
[Major collection... 66% used (8491116/12798468), 790 msec]

No such agents.

[Major collection... 80% used (10377056/12930248), 1070 msec]

[Increasing heap to 30948k]

[Major collection... 75% used (12035116/15865928), 1170 msec]

[Increasing heap to 35372k]
true
No such agents.

[Major collection... 75% used (13943136/18408668), 1390 msec]

[Increasing heap to 41884k]

[Major collection... 96% used (20676668/21441032), 2250 msec]

[Increasing heap to 60696k]
true
[Major collection... 74% used (23098536/31074424), 2510 msec]

[Increasing heap to 67836k]
truetrue
[Major collection... 58% used (20377624/34744936), 2090 msec]
truetrue
[Major collection... 59% used (20693172/34750972), 2100 msec]
truetruetrue
[Major collection... 56% used (19719100/34730056), 2050 msec]
truetruetruetrue
[Major collection... 53% used (18630236/35060544), 1980 msec]
truetruetrue
```