Example: Node-Link Protection Configuration

Figure 1: Node-Link Protection Topology Diagram

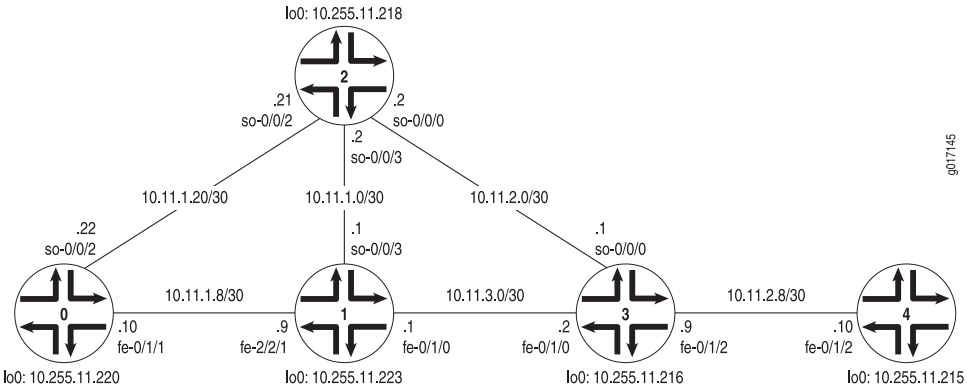

Figure 1 shows an example of how you can implement node-link protection. An LSP is initiated on Router 0 with a strict path travelling through Router 1, Router 2, Router 3, and Router 4. You configure node-link protection within the LSP and link protection on all RSVP interfaces in the path.

On Router 0, configure an LSP to travel across routers 1, 2, 3, and 4. Include the node-link-protection statement in the LSP and configure link protection on outgoing RSVP interface fe-0/1/1. To support the LSP, configure OSPF, MPLS, and RSVP on the needed interfaces.

Router 0

```
[edit]
interfaces {
   fe-0/1/1 {
      unit 0 {
         family inet {
            address 10.11.1.10/30;
         }
         family mpls;
      }
   }
   so-0/0/2 {
      unit 0 {
         family inet {
            address 10.11.1.22/30;
         }
         family mpls;
      }
   }
   lo0 {
      unit 0 {
         family inet {
            address 10.255.11.220/32;
         }
      }
   }
```

```
}
protocols {
    ospf {
        area 0.0.0.0 {
            interface lo0.0 {
                passive;
            }
            interface fe-0/1/1.0;
            interface so-0/0/2.0;
        }
        traffic-engineering;
    }
    mpls {
        statistics {
            file mplsStat.log size 1m;
            interval 30;
            display-id;
        }
        traffic-engineering bgp-igp-both-ribs;
        traceoptions {
            file mpls.log size 5m world-readable;
            flag cspf;
            flag cspf-link;
            flag cspf-node;
            flag state;
            flag error;
        }
        explicit-null;
        label-switched-path test_r0_r4 {
            from 10.255.11.220;
            to 10.255.11.215;
            node-link-protection; # Apply node-link protection to the LSP.
            primary pathP;
        }
        path pathP {# Define the LSP path across routers 1, 2, 3, and 4.
            10.11.1.9 strict;
            10.11.1.2 strict;
            10.11.2.1 strict;
            10.11.2.10 strict;
        }
        interface fe-0/1/1.0;
        interface so-0/0/2.0;
    }
    rsvp {
        traceoptions {
            file rsvp.log size 3m files 12 world-readable;
            flag event;
            flag state;
            flag error;
            flag packets detail;
        }
        interface fe-0/1/1.0 {
            link-protection; # Apply link protection to RSVP interfaces in the LSP path.
        }
        interface so-0/0/2.0;
    }
```

```
}
```

On Router 1, configure link protection on outgoing RSVP interface so-0/0/3. Configure OSPF, MPLS, and RSVP on all transit interfaces.

Router 1

```
[edit]
interfaces {
    fe-0/1/0 {
        unit 0 {
            family inet {
                address 10.11.3.1/30;
            }
            family mpls;
        }
    }
    fe-2/2/1 {
        unit 0 {
            family inet {
                address 10.11.1.9/30;
            }
            family mpls;
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.11.1.1/30;
            }
            family mpls;
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.255.11.223/32;
            }
        }
    }
}
protocols {
    ospf {
        area 0.0.0.0 {
            interface lo0.0 {
                passive;
            }
            interface fe-0/1/0.0;
            interface fe-2/2/1.0;
            interface so-0/0/3.0;
        }
        traffic-engineering;
    }
    mpls {
        traffic-engineering bgp-igp-both-ribs;
        explicit-null;
        interface fe-0/1/0.0;
```

```
    interface fe-2/2/1.0;
    interface so-0/0/3.0;
  }
  rsvp {
    interface fe-0/1/0.0;
    interface fe-2/2/1.0;
    interface so-0/0/3.0 {
      link-protection; # Apply link protection on all RSVP interfaces in the LSP path.
    }
  }
}
```

On Router 2, configure link protection on outgoing RSVP interface so-0/0/0. Configure OSPF, MPLS, and RSVP on all transit interfaces.

Router 2

```
[edit]
interfaces {
  so-0/0/0 {
    unit 0 {
      family inet {
        address 10.11.2.2/30;
      }
      family mpls;
    }
  }
  so-0/0/2 {
    unit 0 {
      family inet {
        address 10.11.1.21/30;
      }
      family mpls;
    }
  }
  so-0/0/3 {
    unit 0 {
      family inet {
        address 10.11.1.2/30;
      }
      family mpls;
    }
  }
  lo0 {
    unit 0 {
      family inet {
        address 10.255.11.218/32;
      }
    }
  }
}
protocols {
  ospf {
    area 0.0.0.0 {
      interface lo0.0 {
        passive;
      }
```

```
        interface so-0/0/0.0;
        interface so-0/0/2.0;
        interface so-0/0/3.0;
      }
      traffic-engineering;
    }
    mpls {
      traffic-engineering bgp-igp-both-ribs;
      explicit-null;
      interface so-0/0/0.0;
      interface so-0/0/2.0;
      interface so-0/0/3.0;
    }
    rsvp {
      interface so-0/0/0.0 {
        link-protection; # Apply link protection to RSVP interfaces in the LSP path.
      }
      interface so-0/0/2.0;
      interface so-0/0/3.0;
    }
  }
```

On Router 3, configure link protection on outgoing RSVP interface fe-0/1/2. Configure OSPF, MPLS, and RSVP on all transit interfaces.

Router 3

```
[edit]
interfaces {
  fe-0/1/0 {
    unit 0 {
      family inet {
        address 10.11.3.2/30;
      }
      family mpls;
    }
  }
  fe-0/1/2 {
    unit 0 {
      family inet {
        address 10.11.2.9/30;
      }
      family mpls;
    }
  }
  so-0/0/0 {
    unit 0 {
      family inet {
        address 10.11.2.1/30;
      }
      family mpls;
    }
  }
  lo0 {
    unit 0 {
      family inet {
        address 10.255.11.216/32;
```

```
        }
      }
    }
  }
  protocols {
    ospf {
      area 0.0.0.0 {
        interface lo0.0 {
          passive;
        }
        interface fe-0/1/0.0;
        interface fe-0/1/2.0;
        interface so-0/0/0.0;
      }
      traffic-engineering;
    }
    mpls {
      traffic-engineering bgp-igp-both-ribs;
      explicit-null;
      interface fe-0/1/0.0;
      interface fe-0/1/2.0;
      interface so-0/0/0.0;
    }
    rsvp {
      interface fe-0/1/0.0;
      interface fe-0/1/2.0 {
        link-protection; # Apply link protection to RSVP interfaces in the LSP path.
      }
      interface so-0/0/0.0;
    }
  }
```

Because Router 4 is the endpoint of the LSP, you can configure interfaces and protocols as usual. There is no need to configure any node-link protection or link protection statements on this router.

Router 4

```
[edit]
interfaces {
  fe-0/1/2 {
    unit 0 {
      family inet {
        address 10.11.2.10/30;
      }
      family mpls;
    }
  }
  lo0 {
    unit 0 {
      family inet {
        address 10.255.11.215/32;
      }
    }
  }
}
protocols {
```

```
    ospf {
      area 0.0.0.0 {
        interface lo0.0 {
          passive;
        }
        interface fe-0/1/2.0;
      }
      traffic-engineering;
    }
    mpls {
      traffic-engineering bgp-igp-both-ribs;
      explicit-null;
      interface fe-0/1/2.0;
    }
    rsvp {
      interface fe-0/1/2.0;
    }
  }
```

Verifying Your Work

To verify proper operation of MPLS LSP node-link protection, use the following commands:

- show mpls lsp extensive
- show route detail
- show rsvp neighbor detail
- show rsvp session detail

The following section shows the output of these commands used with the configuration example.

```
user@router0> show rsvp session detail
Ingress RSVP: 2 sessions
10.255.11.215
  From: 10.255.11.220, LSPstate: Up, ActiveRoute: 5
  LSPname: test_r0_r4, LSPpath: Primary
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 100128
  Resv style: 1 SE, Label in: -, Label out: 100128
  Time left:    -, Since: Thu May  8 13:36:58 2003
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 3 receiver 56517 protocol 0
  Node/Link protection desired
  Type: Node/Link protected LSP
  PATH rcvfrom: localclient
  PATH sentto: 10.11.1.9 (fe-0/1/1.0) 20 pkts
  RESV rcvfrom: 10.11.1.9 (fe-0/1/1.0) 37 pkts
  Explct route: 10.11.1.9 10.11.1.2 10.11.2.1 10.11.2.10
  Record route: <self> 10.11.1.9 10.11.1.2 10.11.2.1 10.11.2.10

10.255.11.218
  From: 10.255.11.220, LSPstate: Up, ActiveRoute: 0
  LSPname: Bypass->10.11.1.9->10.11.1.2 # 2 next hops indicate node-link
```

```
protection.
  Suggested label received: -, Suggested label sent: -
  Recovery label received: -, Recovery label sent: 0
  Resv style: 1 SE, Label in: -, Label out: 0
  Time left:    -, Since: Thu May  8 13:36:58 2003
  Tspec: rate 0bps size 0bps peak Infbps m 20 M 1500
  Port number: sender 1 receiver 56521 protocol 0
  Type: Bypass LSP
    Number of data route tunnel through: 4
    Number of RSVP session tunnel through: 0
  PATH rcvfrom: localclient
  PATH sentto: 10.11.1.21 (so-0/0/2.0) 1 pkts
  RESV rcvfrom: 10.11.1.21 (so-0/0/2.0) 1 pkts
  Explct route: 10.11.1.21
  Record route: <self> 10.11.1.21
Total 2 displayed, Up 2, Down 0

Egress RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0

Transit RSVP: 0 sessions
Total 0 displayed, Up 0, Down 0
```

The show mpls lsp extensive command provides some useful information about link protection and node-link protection. The protection flag entry indicates a series of values. By adding the values together, you can learn the protection state of an LSP based on the total sum. Significant values for the flags include: 1 = Available (Link Protection), 2 = In Use, and 8 = Node Protection. Thus, a value of 9 means that node protection is available (1 + 8 = 9) and a value of A means that a node protected link is in use (8 + 2 = A, in hexadecimal).

```
user@router0> show mpls lsp extensive
Ingress LSP: 1 sessions

10.255.11.215
  From: 10.255.11.220, State: Up, ActiveRoute: 5, LSPname: test_r0_r4
  ActivePath: pathP (primary)
  Node/Link protection desired
  LoadBalance: Random
  Encoding type: Packet, Switching type: Packet, GPID: IPv4
 *Primary   pathP            State: Up
    OptimizeTimer: 30
    Reoptimization in 13 second(s).
    Computed ERO (S [L] denotes strict [loose] hops): (CSPF metric: 40)
 10.11.1.9 S 10.11.1.2 S 10.11.2.1 S 10.11.2.10 S
    Received RRO (ProtectionFlag 1=Available 2=InUse 4=B/W 8=Node):
          10.11.1.9(flag=9 Label=100128) 10.11.1.2(flag=9 Label=100080)
10.11.2.1(flag=1 Label=100080) 10.11.2.10(Label=0)
   67 May  8 13:46:14 CSPF: computation result ignored[18 times]
   66 May  8 13:37:31 Record Route:  10.11.1.9(flag=9 Label=100128)
10.11.1.2(flag=9 Label=100080) 10.11.2.1(flag=1 Label=100080) 10.11.2.10(Label=0)

   65 May  8 13:37:28 CSPF: computation result ignored
   64 May  8 13:37:07 Record Route:  10.11.1.9(flag=9 Label=100128)
10.11.1.2(flag=1 Label=100080) 10.11.2.1(Label=100080) 10.11.2.10(Label=0)
   63 May  8 13:37:01 Record Route:  10.11.1.9(flag=9 Label=100128)
10.11.1.2(Label=100080) 10.11.2.1(Label=100080) 10.11.2.10(Label=0)
   62 May  8 13:37:01 Link-protection Up
   61 May  8 13:36:58 Selected as active path
   60 May  8 13:36:58 Record Route:  10.11.1.9(Label=100128)
```

```
10.11.1.2(Label=100080) 10.11.2.1(Label=100080) 10.11.2.10(Label=0)
   59 May  8 13:36:58 Up
   58 May  8 13:36:58 Originate Call
   57 May  8 13:36:58 CSPF: computation result accepted
   56 May  8 13:36:29 CSPF failed: no route toward 10.11.2.10[10 times]
   55 May  8 13:32:04 Clear Call
   54 May  8 13:31:40 Deselected as active
   53 May  8 13:31:40 Link-protection Down
   52 May  8 13:31:40 Down
   51 May  8 13:31:36 CSPF failed: no route toward 10.11.2.10[6 times]
   50 May  8 13:29:00 10.11.2.1: Session preempted
   49 May  8 13:28:42 Record Route:  10.11.1.9(flag=9 Label=100064)
10.11.1.2(flag=9 Label=100064) 10.11.2.1(Label=100064) 10.11.2.10(Label=0)
   48 May  8 13:28:40 CSPF failed: no route toward 10.11.2.10
   47 May  8 13:28:35 Link-protection Up
   46 May  8 13:28:35 Link-protection Down
   45 May  8 13:28:30 Link-protection Up
   44 May  8 13:28:30 Link-protection Down
   43 May  8 13:28:10 CSPF failed: no route toward 10.11.2.10
   42 May  8 13:27:44 Link-protection Up
   41 May  8 13:27:44 Link-protection Down
   40 May  8 13:27:42 Link-protection Up
   39 May  8 13:27:42 Record Route:  10.11.1.9(flag=9 Label=100064)
10.11.1.2(flag=9 Label=100064) 10.11.2.1(flag=1 Label=100064) 10.11.2.10(Label=0)

   38 May  8 13:27:41 CSPF failed: no route toward 10.11.2.10[2 times]
   37 May  8 13:27:39 CSPF: link down/deleted
10.11.2.9(eagle.00/10.255.11.216)->0.0.0.0(eagle.04/0.0.0.0)
   36 May  8 13:27:39 Link-protection Down
   35 May  8 13:27:39 Record Route:  10.11.1.9(Label=100064)
10.11.1.2(Label=100064) 10.11.2.1(Label=100064) 10.11.2.10(Label=0)
   34 May  8 13:27:39 CSPF failed: no route toward 10.11.2.10
   33 May  8 13:27:39 CSPF: link down/deleted
0.0.0.0(eagle.04/0.0.0.0)->0.0.0.0(papst.00/10.255.11.215)
   32 May  8 13:27:12 CSPF: computation result ignored[16 times]
   31 May  8 13:19:35 Record Route:  10.11.1.9(flag=9 Label=100064)
10.11.1.2(flag=9 Label=100048) 10.11.2.1(flag=1 Label=100048) 10.11.2.10(Label=0)

   30 May  8 13:19:22 Link-protection Up
   29 May  8 13:19:22 Record Route:  10.11.1.9(flag=9 Label=100064)
10.11.1.2(flag=9 Label=100048) 10.11.2.1(Label=100048) 10.11.2.10(Label=0)
   28 May  8 13:19:22 Up
   27 May  8 13:19:22 Link-protection Down
   26 May  8 13:19:22 CSPF: computation result accepted
   25 May  8 13:19:16 Link-protection Up
   24 May  8 13:19:16 Link-protection Down
   23 May  8 13:18:54 CSPF failed: no route toward 10.11.2.1
   22 May  8 13:18:54 CSPF: link down/deleted
0.0.0.0(eagle.04/0.0.0.0)->0.0.0.0(papst.00/10.255.11.215)
   21 May  8 13:18:53 CSPF failed: no route toward 10.11.2.1[2 times]
   20 May  8 13:18:46 CSPF: link down/deleted
10.11.2.9(eagle.00/10.255.11.216)->0.0.0.0(eagle.04/0.0.0.0)
   19 May  8 13:18:35 Record Route:  10.11.1.9(flag=9 Label=100032)
10.11.1.2(flag=9 Label=100032) 10.11.2.1(Label=100016) 10.11.2.10(Label=0)
   18 May  8 13:18:35 Record Route:  10.11.1.9(flag=9 Label=100032)
10.11.1.2(Label=100032) 10.11.2.1(Label=100016) 10.11.2.10(Label=0)
  Created: Thu May  8 13:13:28 2003
Total 1 displayed, Up 1, Down 0
Egress LSP: 0 sessions
Total 0 displayed, Up 0, Down 0
Transit LSP: 0 sessions
```

```
Total 0 displayed, Up 0, Down 0

user@router0>  show rsvp neighbor detail
RSVP neighbor: 2 learned
Address: 10.11.1.9 via: fe-0/1/1.0 status: Up
  Last changed time: 33:02, Idle: 5 sec, Up cnt: 1, Down cnt: 0
  Message received: 130
  Hello: sent 221, received: 221, interval: 9 sec
  Remote instance: 0x66368e80, Local instance: 0x643f57b5
  Refresh reduction: incomplete
    Remote end: enabled, Ack-extension: disabled

Address: 10.11.1.21 via: so-0/0/2.0 status: Up
  Last changed time: 32:41, Idle: 10 sec, Up cnt: 1, Down cnt: 0
  Message received: 78
  Hello: sent 218, received: 218, interval: 9 sec
  Remote instance: 0x74b57f2a, Local instance: 0x66341d2f
  Refresh reduction:  operational
    Remote end: enabled, Ack-extension: enabled

user@router0>  show route 10.255.11.215 detail
inet.0: 33 destinations, 34 routes (31 active, 0 holddown, 2 hidden)
10.255.11.215/32 (2 entries, 1 announced)
        State: <FlashAll>
        *RSVP   Preference: 7
                Next hop: 10.11.1.9 via fe-0/1/1.0 weight 1, selected
                Label-switched-path test_r0_r4
                Label operation: Push 100128, selfID=RSVP-7
                 Next hop: via so-0/0/2.0 weight 20001
                 Label-switched-path Bypass->10.11.1.9->10.11.1.2
                Label operation: Push 100080, selfID=RSVP-7, parentID=RSVP-8
                State: <Active Int>
                Local AS:    69
                Age: 13:14      Metric: 40
                Task: RSVP
                Announcement bits (2): 0-KRT 3-Resolve inet.0
                AS path: I
         IS-IS  Preference: 18
                Level: 2
                Next hop: 10.11.1.9 via fe-0/1/1.0, selected
                State: <Int>
                Inactive reason: Route Preference
                Local AS:    69
                Age: 13:20      Metric: 40
                Task: IS-IS
                AS path: I
inet.3: 2 destinations, 2 routes (2 active, 0 holddown, 0 hidden)
10.255.11.215/32 (1 entry, 1 announced)
        State: <FlashAll>
        *RSVP   Preference: 7
                Next hop: 10.11.1.9 via fe-0/1/1.0 weight 1, selected
                Label-switched-path test_r0_r4
                Label operation: Push 100128, selfID=RSVP-7
                Next hop: via so-0/0/2.0 weight 20001
                Label-switched-path Bypass->10.11.1.9->10.11.1.2
                Label operation: Push 100080, selfID=RSVP-7, parentID=RSVP-8
                State: <Active Int>
                Local AS:    69
                Age: 13:14      Metric: 40
                Task: RSVP
```

```
                    Announcement bits (1): 1-Resolve inet.0
                    AS path: I
```

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