OAM for Network Resource Partition (NRP) in SR

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Motivation

Use existing OAM tools to monitor NRP resource status and rapidly detect faults.

PING[RFC8029] [RFC9259]
TRACEROUTE[RFC8029] [RFC9259]
BFD[RFC5880][RFC5881]
STAMP[RFC8762][RFC9503]

PING

NRP Resource Availability Check via PING:
PING Request with NRP-ID:

- MPLS: MPLS Echo Request includes NRP-ID.
- SRv6: ICMPv6 message with SRH header includes NRP-ID.

NRP Resource Check:

- Intermediate/End Point checks NRP availability.
- If unavailable, responds "NRP resources unavailable" error.
    - MPLS: Extend Return Codes in MPLS Echo Reply.
    - SRv6: Extend Error Code in ICMPv6 Reply.

Successful Check:

- End Point responds with a normal PING Response.

```
1)PING with NRP
---------------------->
           2) Check NRP Not Available
              Reponse Error
<------------
                     3) PING Reponse
<----------------------
+--+      +--+      +--+
|N1+------|N2+------|N3+
+--+      +--+      +--+
```

TRACERT

NRP Resource Availability Check via Traceroute:

Traceroute Request with NRP-ID:

MPLS: MPLS Echo Request with TTL 1 to n.

SRv6: ICMPv6 message with SRH header includes NRP-ID and TTL 1 to n.

NRP Resource Check:

Intermediate/End Point checks NRP availability.

If unavailable, responds with "NRP resources unavailable" error (same error code as PING).

Successful Check:

Proceeds with normal Traceroute, performing hop-by-hop path detection until completion, and outputs results.

```
1)          TRACERT Request with NRP-ID
------------>
          2) TRACERT Reply
<-----------
3) TRACERT Request with NRP-ID
---------------------->

                   4) TRACE Reply
<---------------------
+--+      +--+      +--+
|N1+------|N2+------|N3+
+--+      +--+      +--+
```

BFD

BFD Process for NRP:
Session Initiation:
Initiator includes NRP-ID in the data layer.
NRP Resource Check:
Responder verifies NRP resource availability.
If unavailable: No response, Session failed.
If available: Replies with BFD detection response.

The method of carrying NRP-ID in the data layer is not discussed here.

```
1)           BFD Request with NRP-ID

------------------------>

                    2) BFD Reply

<------------------------

+--+       +--+       +--+
|N1+-------|N2+-------|N3+
+--+       +--+       +--+
```

STAMP

STAMP Process for NRP:

Session-Sender:

Transmits STAMP packets with NRP-ID in the data layer.

Session-Reflector:

Checks NRP resource availability.

If unavailable: Responds with "NRP resources unavailable" error.

If available: Replies with a normal STAMP response.

```
                 1)STAMP Request with NRP-ID
                 ------------------->
                                         2)STAMP Reply
                 <-----------------------
+----------------------+              +-------------------------+
| STAMP Session-Sender | <--- STAMP---> | STAMP Session-Reflector |
+----------------------+              +-------------------------+
```

Round-trip path

When OAM detection is required for the return path of NRP resources:

Method 1:

Head node carries return path's NRP-ID in the control plane.

Sends return NRP-ID to the end-point via OAM message.

End-point retrieves return NRP-ID and uses it for the response message's data plane.

Method 2:

Pre-configure return NRP-ID at the end-point by an administrator.

End-point uses pre-configured return NRP-ID for the response message's data plane.

Implementation details are not within the scope of this document.

Subsequent description of the specific expansion of method 1.

Extend for Round-trip path NRP ID

For MPLS PING and TRACERT, include the return NRP-ID in the Reverse-path Target FEC Stack TLV when sending the Request.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  sub-Type = TBD (NRP-ID)      |          Length = 4           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             NRP-ID                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Reverse-path Target FEC Stack TLV

```
Reverse-path Target FEC Stack TLV
    Sub-TLVs
        LDP IPv4 FEC Sub-TLV
        VPN IPv4 prefix Sub-TLV
        NRP-ID Sub-TLV
```

For STAMP[RFC9503], include the new return NRP-ID in the STAMP Return Path TLV when sending the Request.

```
0                   1                   2                   3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|STAMP TLV Flags|    Type=TBD   |           Length=4            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             NRP-ID                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
Return Path TLV
    Sub-TLVs
        Return Path Control Code Sub-TLV
        Return Address Sub-TLVs
        Return NRP-ID Sub-TLV
```

Extend for Error Code

MPLS echo request/reply[RFC8029]

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Version Number        |         Global Flags          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Message Type |   Reply Mode  |  Return Code  | Return Subcode|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Sender's Handle                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Sequence Number                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    TimeStamp Sent (seconds)                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                TimeStamp Sent (seconds fraction)              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  TimeStamp Received (seconds)                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

MPLS Echo:
New return Code as “NRP resource unavailable” from [RFC8029]3.1

ICMPv6:
New return Code as “NRP resource unavailable” by Type 1(Destination Unreachable)

```
ICMPv6 Packet
  Type: 1(Destination Unreachable)
  Code:
  CheckSum:
  Identifier
```

STAMP:
New return Code as “NRP resource unavailable” from
"STAMP Return Codes"

Next Steps

- Any questions or comments are welcome.

Thanks