ERPS Configuration Guide

Application Note

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1. Introduction

This document explains how to setup Ethernet Ring Protection Switching (ERPS) features. Ethernet Ring Protection Switching is defined by the ITU G.8032 standard. This implementation conforms to ITUT-G.8032(V1) and ITUT-G.8032(V2).

The ITU G.8032 standard defines the automatic protection switching (APS) protocol and protection switching mechanisms for Ethernet layer network (ETH) ring topologies. The protection protocol defined in ITU G.8032 enables protected point-to-point, point-to-multipoint and multipoint-to-multipoint connectivity within a ring or interconnected rings, called "multi-ring/ladder network" topology. The ETH ring maps to the physical layer ring structure.

Each Ethernet ring node is connected to adjacent Ethernet ring nodes participating in the same Ethernet ring, using two independent links. A ring link is bounded by two adjacent Ethernet ring nodes and a port for a ring link is called a ring port. The minimum number of Ethernet ring nodes in an Ethernet ring is two.

Loop avoidance in an Ethernet ring is achieved by guaranteeing that, at any time, traffic may flow on all but one of the ring links. This particular link is called the ring protection link (RPL) and under normal conditions this ring link is blocked, i.e., not used for service traffic. One designated Ethernet ring node, the RPL owner node, is responsible for blocking traffic at one end of the RPL. Under an Ethernet ring failure condition, the RPL owner node is responsible for unblocking its end of the RPL, unless the RPL has failed, allowing the RPL to be used for traffic. The other Ethernet ring node adjacent to the RPL, the RPL neighbour node, may also participate in blocking or unblocking its end of the RPL.

The following conditions of the Ethernet ring are supported:

- Signal fail (SF) – When an SF condition is detected on a ring link and it is determined to be a "stable" failure, Ethernet ring nodes adjacent to the failed ring link initiate the protection switching mechanism.
- No request (NR) – The condition when no local protection switching requests are active.

The following administrative commands are supported:

- Forced switch (FS) – This command forces a block on the ring port where the command is issued.
- Manual switch (MS) – In the absence of a failure or FS, this command forces a block on the ring port where the command is issued.
- Clear – The Clear command, at the Ethernet ring node, is used for the following operations.
  - Clearing an active local administrative command (e.g., FS or MS).
  - Triggering reversion before the wait to restore (WTR) or wait to block (WTB) timer expires in the case of revertive operation.
  - Triggering reversion in the case of non-revertive operation.

Revertive and non-revertive switching.

- In revertive operation, after the condition(s) causing a switch has/have cleared, the traffic channel is restored to the working transport entity, i.e., blocked on the RPL. If a defect is cleared, the traffic channel reverts after the expiry of a WTR timer, which is used to avoid toggling protection states in the case of intermittent defects.
- In non-revertive operation, the traffic channel continues to use the RPL, if it has not failed, after a switch condition has cleared.

Protection switching shall be performed when:

- SF is declared on one of the ring links and the detected SF condition has a higher priority than any other local request or far-end request
- the received R-APS message requests to switch and it has a higher priority than any other local request
- initiated by operator control (e.g., FS, MS) if it has a higher priority than any other local request or far-end request.

1.1. ERPS Protocols

ERPS information is carried within the R-APS PDU which is one of a suite of Ethernet OAM PDUs. OAM PDU formats for each type of Ethernet OAM operation are defined in ITU-T Rec. Y.1731.

2. Configuration

In the normal case, an ERPS configuration requires CFM MEP instances to be instantiated in both ends of a protected flow. However, if the ring nodes are connected back-to-back, that is, without going through another network of switches, you may rely on the physical link directly without using a CFM MEP for signal fail. In that case use "sf-trigger link".

An example of an ERPS configuration is shown below, with the associated CFM configuration:

2.1. Configuration of parameters

The syntax for ERPS global level CLI configuration command is:

```
erps <inst>
```

Where:

```
inst              ERPS instance number.
```

The syntax for ERPS level CLI configuration command is:

```
admin-state { enable | disable }
control-vlan <vid> [ pcp <pcp> ]
guard-time <guard_time>
hold-off-time <hold_off>
level <level>
no guard-time <guard_time>
no hold-off-time <hold_off>
no node-id
no port0 smac
no port1 smac
no protected-vlans
no revertive
no rpl
no wait-to-restore <wtr>
node-id <node_id>
port0 interface <port_type> <port>
port0 sf-trigger { link | { mep domain <md_name> service <ma_name> mep-id <mepid> } }
port0 smac <mac>
port1 interface <port_type> <port>
port1 sf-trigger { link | { mep domain <md_name> service <ma_name> mep-id <mepid> } }
port1 smac <mac>
protected-vlans <vlan_list>
revertive
ring-id <ring_id>
ring-type { major | sub-ring [ virtual-channel ] | interconnected-sub-ring {
connected-ring <connected_ring_inst> [ virtual-channel ] [ propagate-topology-change
] } }
rpl { owner | neighbor } { port0 | port1 }
version { v1 | v2 }
wait-to-restore <wtr>
```

Where:

```
admin-state       Enable or disable this ERPS instance
control-vlan      Set the ERPS instance's control VLAN and PCP used in R-APS PDUs
                  transmitted on both ring ports (if applicable).
guard-time        The guard timer is used to prevent ring nodes from acting upon
                  outdated R-APS PDUs upon topology changes.
hold-off-time     When a new (or more severe) defect occurs, the hold-off timer
                  will be started and the event will be reported after the timer
                  expires. Hold-off timer value measured in milliseconds.
                  Must be in multiples of 100 ms. Default value 0.
level             Set the MD/MEG level used in R-APS PDUs. Default is 7.
no                Negate a command or set its defaults.
node-id           Controls the Node ID used inside the R-APS PDUs to uniquely
                  identify this node (switch). Defaults to using the switch's.
port0             Set configuration for ring port0 (East).
port1             Set configuration for ring port1 (West).
interface         Assign an interface to ring port.
sf-trigger        Choose whether the port's interface link state or a MEP installed
                  on port's interface is used as signal-fail trigger.
link              The port's interface link state is used as signal-fail trigger
mep               A MEP installed on the port is used as signal-fail trigger.
protected-vlans   Set the list of VLANs protected by this ERPS instance.
revertive         Set this instance to be revertive, that is, restore to default
                  after the wait-to-restore timer has expired.
ring-id           Controls the Ring ID, which is used in the last byte of the
                  DMAC of R-APS PDUs. Ring IDs of received R-APS PDUs must match
                  the configured Ring ID.
ring-type         Controls whether this is a major ring or a sub-ring. Only major
                  rings are supported if using G.8032v1.
major             Make this a major ring, which always has two ring ports.
sub-ring          Make this a non-interconnected sub-ring, which has two ring ports.
virtual-channel   Configure this interconnected sub-ring with a R-APS virtual
channel,
                  that is, R-APS PDUs are transmitted on the connected ring that this
                  sub-ring connects to.
interconnected-sub-ring Make this an interconnected sub-ring, which has only
                  one ring port (port0), but connects to a major ring.
connected-ring    An interconnected sub-ring points to another ring with two ring
ports
                  (that is, that other ring cannot itself be an interconnected
sub-ring),
                  which receives flush notifications and may carry R-APS PDUs for
the sub-ring.
connected_ring_inst The ERPS instance number of the connected ring that this
interconnected
                  sub-ring connects to.
propagate-topology-change If a topology-change occurs on this interconnected
sub-ring,
                  the connected ring also flushes its FDB. If this keyword is
specified,
                  the connected ring will also send Flush R-APS Event PDU onto its
                  ring ports.
rpl               Controls whether this node holds the Ring Protection Link (RPL),
                  and what role it has in that case. Use the no-form if this node
                  doesn't hold the RPL.
neighbor          This node is RPL neighbor.
```

```
owner             This node is RPL owner.
version           Specify whether to use G.8032v1 or G.8032v2 of the R-APS protocol.
wait-to-restore   Only used in revertive mode. Indicates the number of seconds
                  after a defect has cleared until operation is switched back to
                  the normal condition. Valid range [1-720]. Measured in seconds.
                  Default value 300.
```

An example is shown below:

```
(config)# erps 10
(config-erps)#
```

2.2. Using control commands

The syntax for ERPS level CLI command is:

```
erps <inst> clear
erps <inst> switch { force | manual } { port0-to-port1 | port1-to-port0 }
```

Where:

```
inst              ERPS instance number.
clear             Clear a switchover (FS or MS) request and a WTB/WTR condition
                  and force reversion even if not revertive.
switch            Request a switchover from port0 to port1 or vice versa.
                  Use 'erps <inst> clear' to clear the request.
force             Causes a forced switchover.
manual            Causes a switchover if the signal is good and no forced
                  switch is in effect.
port0-to-port1    Blocks port0 and unblocks port1.
port1-to-port0    Blocks port1 and unblocks port0.
```

Example:

```
# erps 10 switch manual port0-to-port1
```

2.3. Show status and statistics

The syntax of the show erps CLI command is:

```
show erps [ <inst_list> ] [ statistics ] [ details ]
```

Where:

```
<inst_list>     List of ERPS instances to show
statistics      Show statistics
details         Provide more details
```

Example show statistics:

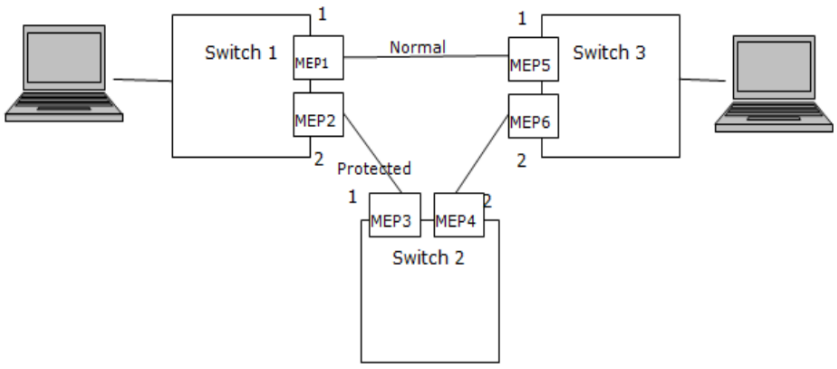
```
# show erps statistics details
Instance: 1
Flushes:  16

Counter        | Port0          | Port1
---------------|----------------|----------------
Rx R-APS NR    |             73 |             62
Rx R-APS NR-RB |              0 |              0
Rx R-APS SF    |              0 |              0
Rx R-APS FS    |              0 |              0
Rx R-APS MS    |              0 |              0
Rx R-APS Event |              0 |              0
Rx Drop Guard  |              1 |              0
Rx Drop Error  |              0 |              0
Rx Own Node ID |              0 |              0
Rx FOP-PM      |              0 |              0
Local SF       |              0 |              2
Tx R-APS NR    |             63 |             63
Tx R-APS NR-RB |             81 |             81
Tx R-APS SF    |             11 |             10
Tx R-APS FS    |              0 |              0
Tx R-APS MS    |              0 |              0
Tx R-APS Event |              0 |              0
#
```

Example show status:

```
# # show erps details
--------------------------------------------------------------------------------
----
Instance:                 1
Operational state:        Active
Operational warning:      None
Node state:               Idle
Ring type:                Major
Ring ID:                  1
Level:                    7
Control VLAN:             7
Protected VLANs:          1,2
RPL role:                 Owner on port1
Connected ring instance:  N/A
Virtual channel:          N/A
Revertive:                Yes
Command:                  None
FOP-TO:                   No
                             | Tx                | Port0 Rx          | Port1 Rx
-----------------------------|-------------------|-------------------|--------------
----
Interface                    | -                 | Gi 1/1            | Gi 1/2
Blocked                      | -                 | No                | Yes
SF                           | -                 | No                | No
FOP-PM                       | -                 | No                | No
Last R-APS change (secs ago) | 342               | 346               | 346
Version                      | 1 (G.8032v2)      | 1 (G.8032v2)      | 1 (G.8032v2)
R-APS PDU                    | NR, RB, DNF       | NR                | NR
R-APS BPR                    | port1             | port1             | port1
Node ID                      | 00-01-c1-1c-aa-10 | 02-00-c1-9b-af-69 |
02-00-c1-9b-af-69
Source MAC                   | Varies            | 02-00-c1-9b-af-6a |
02-00-c1-9b-af-6b
--------------------------------------------------------------------------------
----
```

2.4. Configure three switch ring example

A simple three switch network is constructed to demonstrate how the ERPS features can be configured. The network is shown below.



The following commands will disable STP and LLDP, enable C-Port on Port 1 and 2 on all 3 switches.

```
#Configure port 1
interface GigabitEthernet 1/1
 #set C-Port
 switchport hybrid port-type c-port
 switchport mode hybrid
 #disable LLDP
 no lldp receive
 no lldp transmit
 #disable Spanning Tree Protocol
 no spanning-tree
!
#Configure port 2
interface GigabitEthernet 1/2
 #set C-Port
 switchport hybrid port-type c-port
 switchport mode hybrid
 #disable LLDP
 no lldp receive
 no lldp transmit
 #disable Spanning Tree Protocol
 no spanning-tree
```

The 3 individual switches are now configured like this:

Configure CFM and ERPS on Switch 1

```
cfm domain MyDomain
 format none
 service MyService
  format icc "ICC000MEG0000"
  mep 1
   interface GigabitEthernet 1/1
   vlan 3001
   remote mep 5
   continuity-check
   admin-state enable
   exit
  mep 2
   interface GigabitEthernet 1/2
   vlan 3001
   remote mep 3
   continuity-check
   admin-state enable
   exit
!
!
erps 1
 rpl owner port1
 port0 interface GigabitEthernet 1/1
 port1 interface GigabitEthernet 1/2
 port0 sf-trigger mep domain MyDomain service MyService mep-id 1
 port1 sf-trigger mep domain MyDomain service MyService mep-id 2
 control-vlan 7 pcp 7
 protected-vlans 1,2
 admin-state enable
```

Configure CFM and ERPS on Switch 2

```
cfm domain MyDomain
 format none
 service MyService
  format icc "ICC000MEG0000"
  mep 3
   interface GigabitEthernet 1/1
   vlan 3001
   remote mep 2
   continuity-check
   admin-state enable
   exit
  mep 4
   interface GigabitEthernet 1/2
   vlan 3001
   remote mep 6
   continuity-check
   admin-state enable
   exit
!
erps 1
 rpl neighbor port0
 port0 interface GigabitEthernet 1/1
 port1 interface GigabitEthernet 1/2
 port0 sf-trigger mep domain MyDomain service MyService mep-id 3
 port1 sf-trigger mep domain MyDomain service MyService mep-id 4
 control-vlan 7 pcp 7
 protected-vlans 1,2
 admin-state enable
```

Configure CFM and ERPS on Switch 3

```
cfm domain MyDomain
 format none
 service MyService
  format icc "ICC000MEG0000"
  mep 5
   interface GigabitEthernet 1/1
   vlan 3001
   remote mep 1
   continuity-check
   admin-state enable
   exit
  mep 6
   interface GigabitEthernet 1/2
   vlan 3001
   remote mep 4
   continuity-check
   admin-state enable
   exit
!
erps 1
 port0 interface GigabitEthernet 1/1
 port1 interface GigabitEthernet 1/2
 port0 sf-trigger mep domain MyDomain service MyService mep-id 5
 port1 sf-trigger mep domain MyDomain service MyService mep-id 6
 control-vlan 7 pcp 7
 protected-vlans 1,2
 admin-state enable
```