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CONTROL PLANE SHARED RISK (CPSR) FACTOR IN A CONVERGED PACKET-OPTICAL NETWORK

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ABSTRACT

Presented herein is a "control plane type" along with numbers in the calculation of diverse paths for Label Switch Path (LSP) diversity. The control plane type is published along with the Shared Risk Link Group (SRLG) value at the termination endpoint. This helps in determining the source control plane of the SRLG value. The control plane type publication is local to the node/endpoint and does not need any additional signaling.

DETAILED DESCRIPTION

Currently, Label Switch Path (LSP) diversity is generally achieved by creating LSPs with Shared Risk Link Group (SRLG) diverse paths. If a Label Switched Router (LSR) is required to have multiple diversely routed LSPs to another LSR, the path computation should attempt to route the paths so that they do not have any links in common, and such that the path SRLGs are disjoint.

RFC 8001 provides RSVP-TE extension for collecting SRLG across control plane using Resource Reservation Protocol (RSVP) signaling. This helps in finding an SRLG disjoint path across control planes (Multiprotocol Label Switching/Generalized Multiprotocol Label Switching/ Wavelength Switched Optical Network (MPLS/GMPLS/WSON)). In simple terms, SRLG recording across control plane ensures that no common Optical Transport Network (OTN) or WSON link is shared by multiple diverse LSPs. Recording of SRLG is done on numbers (32 bit SRLG value in Interior Gateway Protocol (IGP) extensions). In the end, SRLG diversity is calculated based on numbers only. Currently no method exists to identify the degree of overlap between 2 links if few SRLGs are common.

Presented herein is a "control plane type" along with numbers in the calculation of diverse paths. For example, in case no disjoint path exists, the "Only WSON" overlap will be preferred over "WSON + GMPLS" overlap.

GMPLS protocol reuses and enhances the existing MPLS signaling and Internet routing protocols capabilities to provide a generic efficient scalable and standardized distributed control plane architecture. This concept is applicable to multiple network technologies such as TDM-SC (TDM switch capable) and packet switch capable (PSC) such as routers, Lambda switch capable (LSC) such as Dense Wavelength Division Multiplexed (DWDM) equipment, and fiber switch capable (FSC) interfaces.

This GMPLS suite is targeted at providing:

1. Dynamic neighbor and topology discovery across multi-vendor GMPLS aware transport networks.
2. Automatic LSP provisioning.
3. Ability to dynamically provision, protect, and restore end-to-end LSPs across all above types of transport equipment, within and across multiple layers, eliminating or reducing the need for separate network control planes.

A control plane can be present across several layers independently with each layer confined to its own specific control plane information and unaware of rest of the control plane layers such as WSON, GMPLS, MPLS etc.

Figure 1 below illustrates the multi-layer control planes i.e., Layer 0 DWDM WSON based control plane, Layer-1 OTN GMPLS control plane[2] and layer2/3 MPLS-TE control plane.

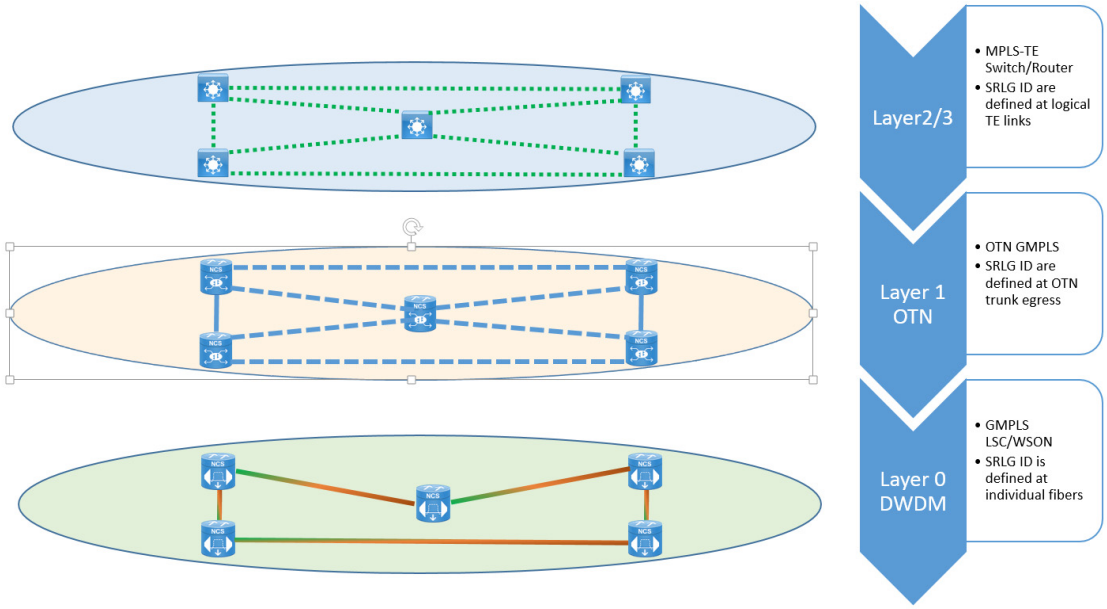


Figure 1

At each layer on each of these control plane above, it is ensured that a given LSP work link and same LSP's backup link always pick diverse path with non-common failure points on the work and backup path. This is done for the obvious reason that main and backup links do not fail at the same time due to a common resource (common fiber or common OTN link or common Traffic Engineering (TE) link).

Shared Risk Link Group: A set of links may constitute a 'shared risk link group' if they share a resource whose failure may affect all links in the set. For example, two fibers in the same conduit would be in the same SRLG. A link may belong to multiple SRLGs. Thus, the SRLG Information describes a list of SRLGs to which the link belongs.

Figure 2 illustrates a current example of how SRLG information is shared across layers (Layer 0 to layer 2/3 in OSI 7 Layer model) in a multi-layer GMPLS/WSON/MPLS situation.

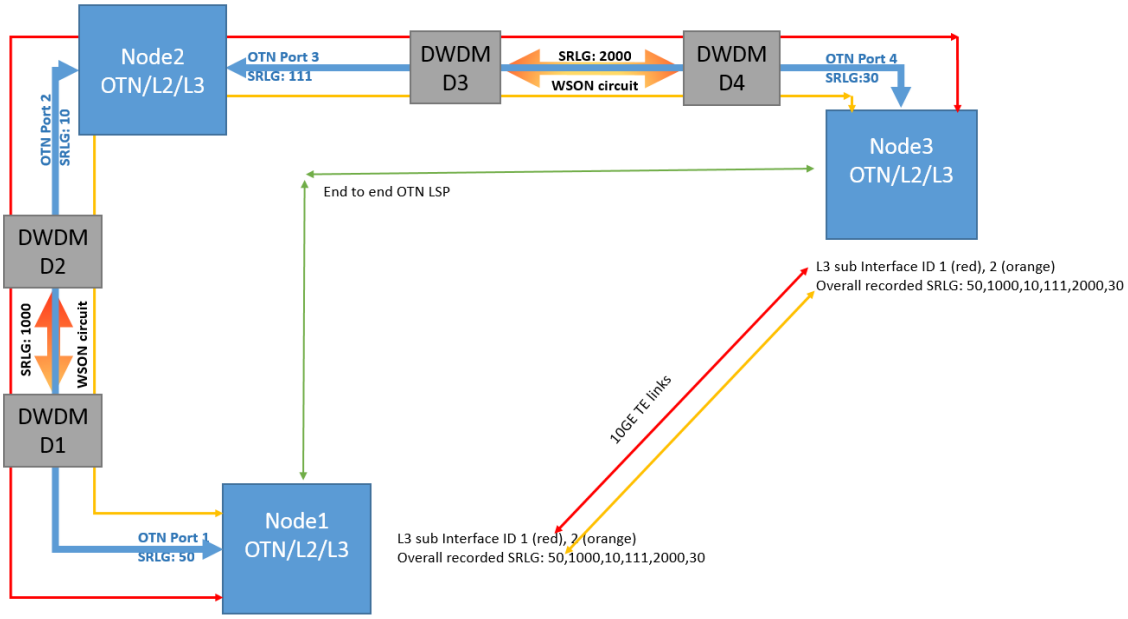


Figure 2

Figure 2 depicts the following SRLG current implementation.

1. DWDM equipment with WSON enabled have SRLG IDs provisioned as 1000 and 2000 on two DWDM links in the example network above.

2. OTN equipment with OTN GMPLS enabled have SRLG IDs provisioned as
Port 1 ========== Port 2 is one OTN Trunk link with SRLG IDs provisioned 50 and 10.
Port 3 ========== Port 4 is second OTN Trunk link with SRLG IDs provisioned 111 and 30.

3. MPLS-TE enabled equipment have two links marked as sub interface ID 1 and sub interface ID 2 link. These links will inherit SRLG from DWDM and OTN layers so as to maintain SRLG diversity across primary and back up LSP on MPLS-TE.

SRLG Recording is a feature which is used to inherit the SRLG IDs from DWDM and OTN layers to L2/L3 layer. While the DWDM LSP is being created, it will record the SRLG values during that creation event in path/RESV Record Route Object (RRO) sub

objects and publish that RRO sub-object containing DWDM SRLG information to OTN layer.

GMPLS at OTN layer will merge the Local OTN link SRLG information with the DWDM SRLG values.

Further, when the GMPLS OTN LSP is being created, it will record the respective SRLG values (Now it is both DWDM and OTN SRLG values) during that creation event in path/RESV RRO sub objects (RFC-8001) and publish that RRO sub-object containing overall SRLG information to L2/L3 layer.

The L2/L3 layer will hence have the complete all layers SRLG information available. This SRLG info is available in numerical format only. Control plane type (WSON or GMPLS) along with SRLG value is not published at the endpoint (Ethernet terminated interface). In the end, SRLG diversity is calculated based on numbers only. Currently, no method exists to identify the degree of overlap between 2 links if few SRLGs are common.

This solution proposes to publish the control plane type along with the SRLG value at the termination endpoint. This helps in determining the source control plane of the SRLG value. The control plane type publication is local to the node/endpoint and does not need any additional signaling. WSON endpoint (lambda), GMPLS endpoint (OTUk) and terminated Ethernet interface belongs to the same port. Thus, publication is easy and local to the node. GMPLS LSP and WSON LSP will also be local to the node (head or tail node). For example, in the below diagram, the SRLG value is published in the below format for the first link of Bundle#1.

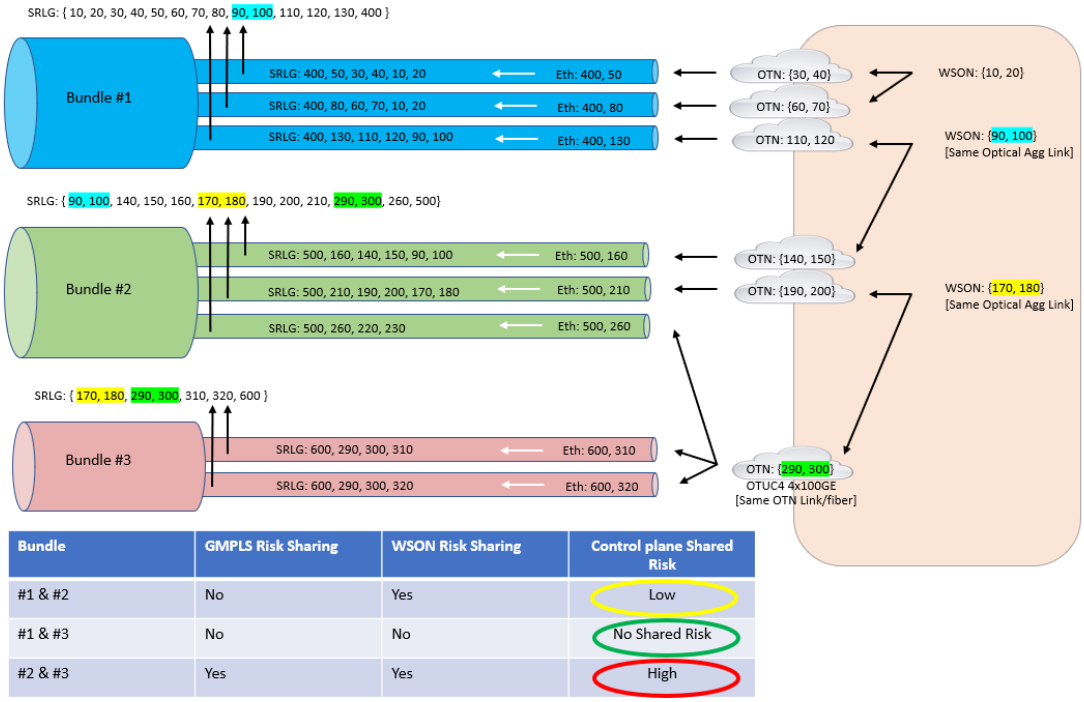
- WSON: 10,20
- GMPLS: 30, 40
- LOCAL: 400, 50

The overall SRLG value of Bundle may be as shown below. The JavaScript Object Notation (JSON) format is selected only for the illustration. The actual data structure will be system-specific.

Bundle#1:
{
"Local": [50, 80, 130, 400],
"Inherited": {
"WSON": [10, 20, 90, 100],
"GMPLS": [30, 40, 60, 70, 110, 120]
}
}
Bundle#2:
{
"Local": [160, 210, 260, 500],
"Inherited": {
"WSON": [90, 100, 170, 180],
"GMPLS": [140, 150, 190, 200]
}
}
Bundle#3:
{
"Local": [310, 320, 600],
"Inherited": {
"WSON": [170, 180],
"GMPLS": [290, 300]
}
}

Figure 3 below illustrates the overall process. Control Plane Shared Risk (CPSR) factor is calculated based on the published "SRLG value + control plane-type". Assume the system needs 2 diverse LSPs for any specific application. The first LSP is routed via Bundle#2. Now the system has no diverse path available with respect to Bundle#2. Both bundles #1 and #3 have some degree of SRLG overlap. Bundle #2 & #1 has "WSON overlap" while Bundle #2 & #3 has "WSON + GMPLS" overlap. In this case, CPSR will

be used for the interface selection. As the only one control overlap will have less risk and overlap, Bundle#1 will be chosen as the backup or diverse path.



Bundle	GMPLS Risk Sharing	WSON Risk Sharing	Control plane Shared Risk
#1 & #2	No	Yes	Low
#1 & #3	No	No	No Shared Risk
#2 & #3	Yes	Yes	High

Figure 3

In summary, presented herein is a "control plane type" along with numbers in the calculation of diverse paths for LSP diversity. The control plane type is published along with the SRLG value at the termination endpoint. This helps in determining the source control plane of the SRLG value. The control plane type publication is local to the node/endpoint and does not need any additional signaling.