CONTRIBUTION TO T1 STANDARDS PROJECT

TITLE	**On Shared Risk Link Groups for diversity and risk assessment**	
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ABSTRACT

Shared Risk Link Group (SRLG) is a well-known concept in the Telecommunications world. In this document we provide discussion on how this concept can be used for diverse path computation and risk assessment. The requirements we extract out of this discussion are mapped to the SRLG encoding and protocol requirements.

Key words: SRLG, Diversity, MPLS, Risk assessment

Notice

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1   Introduction

Grouping of links, which share the same risk, is the concept used for many years in the telecommunications industry. Links, which share the same risk, are grouped together to have the same SRLG (Shared Risk Link Group) value.

In this document we revisit the SRLG concept:

- with the new developments in the data world namely MPLS (Multi Protocol Label Switching) technology,
- with the goal of assessing the risk associated with a path,
- with the goal of providing constraint-based diverse paths, and
- extend the definition of SRLG to accommodate logical topologies which share the same risk.

The following are the goals of this work:

- Diversity:
    - o   Capture the link-level and the logical-level diversity.
    - o   Summarizable SRLG notation, which provides ease of and faster computation.
- Risk:
    - o   Assign capabilities to the SRLGs, which in turn help in the risk assessment.
    - o   Facilitate path computation against a given risk type.
- Other:
    - o   Localization of the SRLG allocation.

This document is organized as follows:

- Discussion on diversity in section 2,
- Discussion on risk assessment in section 3,
- Discussion on the requirements on this concept for dynamic and static provisioning in section 4, and
- Conclusions and references in the following sections.

2   Diversity and SRLG

A brief introduction is provided to the need for diversity to set the stage for the discussion. Traffic engineering in IP (Internet Protocol) networks is achieved using MPLS technology as an overlay on the IP networks. With the success of the MPLS TE concept, they are being applied in the Optical Domains as well. By introducing the connection-orientedness in the IP technology, we loose the automatic recovery of the data paths in case of failures. Hence, diverse paths are established between the source and destination MPLS nodes for achieving path resiliency.

The diversity requirements in the transport networks have some different requirements over that in the router (Layer 3 and Layer 2 switching) networks. They are mainly:

- Transport networks provide elaborate protection and restoration mechanisms,
- Transport topologies are not always mesh topologies, as assumed by the router networks, and
- Transport-level protection and restoration mechanisms are not considered in the diverse path computation by the MPLS technology (at least till now).
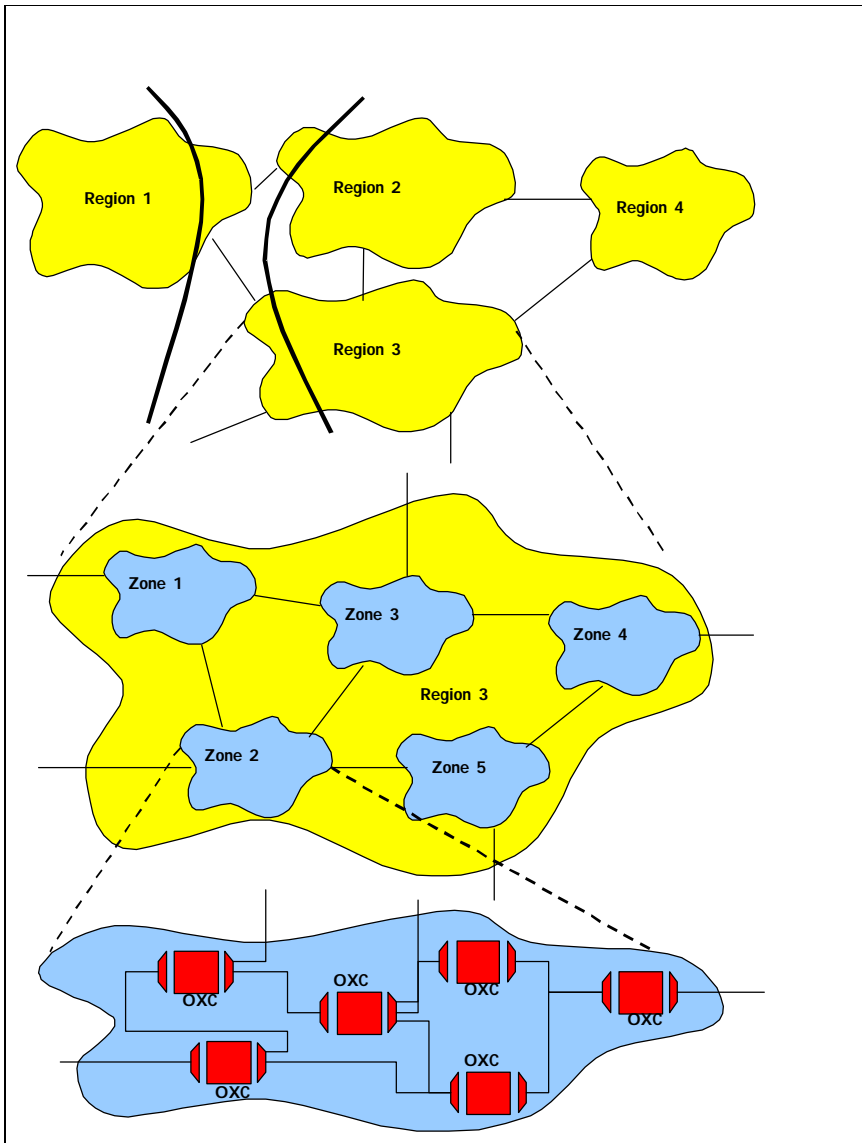
Figure 1 Logical topology representation using SRLG

Diversity in the router world is achieved as follows:

- Request: Given the (physical and logical) topology, link capabilities, and constraints calculate 1 to N diverse path between two points in the network.
- Input:
  o Topology:
    ▪ Physical topology is always meshed.
    ▪ Areas and autonomous systems achieve logical topology.
  o Capability:
    ▪ Only link capabilities are propagated.
  o Constraints:
    ▪ Inclusive requirements: Such as a preferred links (color).

- ▪ Exclusive requirements: Such as avoiding a node (node-level diversity, link-level diversity).
- ▪ Limiting requirements: Such as bandwidth.
  - – Output:
    - o Paths available or not.
    - o If paths are available then provide the strict or loose paths.
      - ▪ Strict paths can be provided if the physical topology is known between the source and destination.
      - ▪ Loose paths are provided if the end-to-end physical topology is not known (or for other reasons).

Diversity in the transport world is achieved as follows:

- – Request: Given the (physical and logical) topology, link capabilities, **domain capabilities** and constraints calculate 1 to N diverse path between two points in the network.
- – Input:
  - o Topology:
    - ▪ Physical topology is flexible (**Rings, Meshes, Ring-Mesh inter connected**).
    - ▪ **Domains** (or islands) are used to achieve logical topology. Note: These domains may not map onto areas and autonomous systems.
  - o Capability:
    - ▪ Both link (or span) and domain capabilities need to be propagated.
  - o Constraints:
    - ▪ Inclusive requirements: Such as preferred links and preferred link, node and **domain** capabilities.
    - ▪ Exclusive requirements: Such as avoiding a link, node or **domain**.
    - ▪ Limiting requirements: Such as bandwidth.
- – Output:
  - o Paths available or not.
  - o If paths are available then provide the strict or loose paths.
    - ▪ Strict paths can be provided if the physical topology is known between the source and destination.
    - ▪ Loose paths are provided if the end-to-end physical topology is not known or cannot be interpreted such as in ring topologies (or for other reasons).

Discussion:

The following observations can be made between the diverse path setup mechanisms in the router world and in the transport world:

- – Sharing risk is not only the property of the links, but it can be extended to the nodes and the domains (from exclusive constraints). That an SRLG can be associated with the links, nodes and domains.
- – Also, for example, domain capabilities can be associated with the domain SRLG to achieve inclusive constraints. For example a BLSR ring can have an SRLG with the ring capabilities associated with it.

As a precursor to achieve such constraints we propose to extend the SRLG notion to represent the logical topologies also, as shown in **Figure 1**. As shown in the figure, a logical topology can be constructed based on the regions, zones and finally nodes. By assigning SRLGs in a hierarchical fashion (to a region, a zone and nodes), we can capture the capabilities, and risks associated with them. An extensive discussion on this subject is provided in [IETF-SRLG].

Note 1: A domain may be mapped onto a region or a zone.

Note 2: Here we can debate the name SRLG, which has the term 'Link' in it to say this is applicable only for the link.

> "A typical trans-atlantic fiber can contain 100s of SRLGs."
>
> – John Strand, AT&T.

Considering the above practical knowledge of the real world scenarios, it is essential (to reduce the computation time) to reduce the number of SRLGs by some means of encoding. Also, we need to observe that the amount of configuration can be reduced, from 100s on a link for the 100s of links, by distributing it. This poses the following requirements:

- Need a mechanism to encode (and hence summarizable) SRLG to group represent a link or node or domain wide individual SRLGs.
- Need to modify the path computation algorithms (such as CSPF) for accommodating the new encoding scheme.
- Need to enhance the path computation mechanisms to work with the logical topologies (or domains)
- Need to propagate the logical topologies (or domains) via the routing protocols.

3   Risk assessment and SRLG

Risk (the complementary of availability) assessment is defined as the evaluation of the potential risk associated to the inclusion of a given resource (this resource belongs to a given resource type located within a given logical structure such as a geographical location) in a given path.

A brief discussion for the motivation of the risk assessment capabilities of SRLG is provided here. Consider the following example, where the client device makes the following requests to the optical network:

- Request (either through signaling protocols or using an SLA) for a persistent connection with 99.999 % (widely known 5 9s) of availability or equally a down time less than X minutes per year.
- Request a high-protection for a portion of the traffic (at the expense of more charging) compared to other low-priority traffic.

Such requirements will be translated into constraints in the path computation. Such constraints can be grouped into path selection constraints and path characterization constraints.

- Path selection constraints:

    o   These typically dictate which physical path should be taken to achieve the availability requirements of the client. These requirements are typically the logical and physical diversity.

- Path characterization constraints:

o   Path characterization requirements typically dictate the protection mechanisms as requested by the client. This can be achieved in the form of optical rings, meshed protection mechanisms, etc. These constraints can be used in using the link, node, and domain capabilities as discussed in the previous section on diversity.

The components that need formalization in this example are:

–   Step 1. Specification of the user requirements (such as the example above)
–   Step 2. Configuring the network that helps in assessing the features such as the availability
–   Step 3. Propagating the above-configured information.
–   Step 4. Using the above-propagated information.

Step 1 of specifying the requirements is not in the scope of this document. Steps 2 - 4 are discussed below.

Discussion:

A simple way to achieve risk assessment is by associating a conditional risk value to each of the SRLGs, as discussed in [IETF-SRLG]. Also by associating a weight factor to the SRLG, we can increase the choice of selecting specific SRLGs. This call for configuring:

–   Risk factor per SRLG
–   Weight factor per SRLG

The above values in addition to the SRLG capabilities, as discussed before can be propagated via routing protocols. These routing requirements are discussed in the following section.

With the help of the above two configuration parameters, using typical CSPF algorithm to compute the path can be extended to assess the risk associated with it. For example, if a path is traversing through SRLGs 1, 3, 5, then we can infer the risk with the path as (Risk 1 x Risk 3 x Risk 5).

4   Requirements and extensions

The following requirements can be derived form the above discussions:

–   Encoding:
    o   Logical and physical structure: A logical and physical encoding of SRLGs should be proposed to reduce the number of SRLGs from the scalability point-of-view. This also helps in hiding the topology in many cases and helps in loose path computation.
–   Capability assignment
    o   Domain, node, and link capability: Domain capability such as transport network level diversity provided by the domain can be associated with the SRLG. This helps in deciding the logical and physical topologies of the choice for the path.
    o   Risk assessment parameters: Risks can be associated with both the logical and physical SRLGs to assess the possible risk associate to a path.
    o   Preferential route selection: By associating weights to the SRLGs, one can make the automatic path selection algorithms to choose certain SRLG path.
–   Routing protocol extensions to propagate them

- o Given the region-level and zone-level decomposition of the physical topology of the optical network, the link semantics should be extended to accommodate the inter-region and inter-zonal links. Moreover, this concept helps in constructing the logical-level topologies at the region-level and zone-level abstraction, which in turn can be used in the SRLG summarization and loose-path computation.
- o Propagate these additional (region and zonal) links using the IGP routing protocols for intra- and inter-area routing purposes.
- o To reduce the amount of the flooded information and hence lightpath route computation complexity, the flooding scope of the information propagation is extended to accommodate region-level and zone-level.
- o Propagate the capability, risk assessment, and preferential route selection parameters per SRLG.
- − CSPF to use this path
  - o Extend the constraint-based path computation to accommodate the extensions due to the above mechanisms.

Extensions:

- − Encoding:
  - o Logical and physical structure (refer to [IETF-SRLG])
- − Capability assignment [IETF-SRLG-PROTO-EXT]
  - o Domain capability
  - o Node capability
  - o Link capability
  - o Conditional probability
  - o Weight of selection
- − Routing protocol extensions to propagate them
  - o (SRLG, Capability) propagation, which means new TE information
- − CSPF to use this path
  - o Path computation extension with optimization on risk

5 Conclusions

In this document, we demonstrated SRLG uses in diverse path computation and risk assessments. Discussed relevant example to derive the requirements to the encoding mechanisms, capability assignment, CSPF algorithms and routing protocol extensions.

6 References

[IETF-SRLG] D. Papadimitriou et al., "Inference of Shared Risk Link Groups," draft-many-inference-srlg-00.txt, IETF draft (work in progress).

[IETF-SRLG-PROTO-EXT] S. Dharanikota et al., "SRLG related protocol extensions for diversity and risk assessment," IETF draft (work in progress).