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Composite Link Framework in Multi Protocol Label Switching (MPLS)
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Abstract

This document specifies a composite link framework in MPLS network. A composite link consists of a group of homogenous or non-homogenous links that have the same forward adjacency and can be considered as a single TE link or an IP link in routing. The composite link relies on its component links to carry the traffic over composite link. The document specifies composite link model. Applicability is described for a single pair of MPLS-capable nodes, a sequence of MPLS-capable nodes, or a set of layer networks connecting MPLS-capable nodes.

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1. Introduction

Composite link functional requirement are specified in [CL-REQ]. This document specifies a framework of Composite Link in IP/MPLS network to meet the requirements. Single link and link bundle [RFC4201] have been widely used in today's IP/MPLS networks. A link bundle bundles a group of homogeneous links as a TE link to make routing approach more scalable. A composite link allows bundling non-homogenous links together as a single logical link. The motivations for using a composite link are descried in the document [CL-REQ]. This document describes composite link framework in the context of MPLS network with MPLS control plane.

A composite link is a single logical link in MPLS network that contains multiple parallel component links between two routers. Unlike a link bundle [RFC4201], the component links in a composite link can have different properties such as cost or capacity. A composite link can transport aggregated traffic as other physical links from the network perspective and use its component links to carry the traffic internally.

Specific protocol solutions are outside the scope of this document.

2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

2.1. Terminology

Composite Link: a group of component links, which can be considered as a single MPLS TE link or as a single IP link used for MPLS.

Component Link: a physical link (e.g., Lambda, Ethernet PHY, SONET/SDH, OTN, etc.) with packet transport capability, or a logical link (e.g., MPLS LSP, Ethernet VLAN, MPLS-TP LSP, etc.)

Traffic Flow: A set of packets with a common identifier and characteristics that is used by Composite link interior functions to place the set of packets on the same component link. Identifiers can be an MPLS label stack or any combination of IP addresses and protocol types for routing, signaling, and management packets.

Virtual Interface: Composite link is advertised as an interface in IGP

3. Composite Link Framework

A Composite Link in the context of MPLS network is a set of parallel links between two routers that form a single logical link within the network. Composite link model is illustrated in Figure 1, where a composite link is configured between routers R1 and R2. The composite link has three component links. Individual component links in a composite link may be supported by different transport technologies such as wavelength, Ethernet VLAN. Even if the transport technology implementing the component links is identical, the characteristics (e.g., bandwidth, latency) of the component links may differ.

As shown in Figure 1, the composite link may carry LSP traffic flows and control plane packets. A LSP may be established over the link by either RSVP-TE or LDP signaling protocols. All component links in a composite link have the same forwarding adjacency. The composite link forms one routing interface at the composite link end points for MPLS control plane. In other words, two routers connected via a composite link have forwarding adjacency and routing adjacency. Each component link only has significance to the composite link, i.e. it does not appear as a link in the control plane.

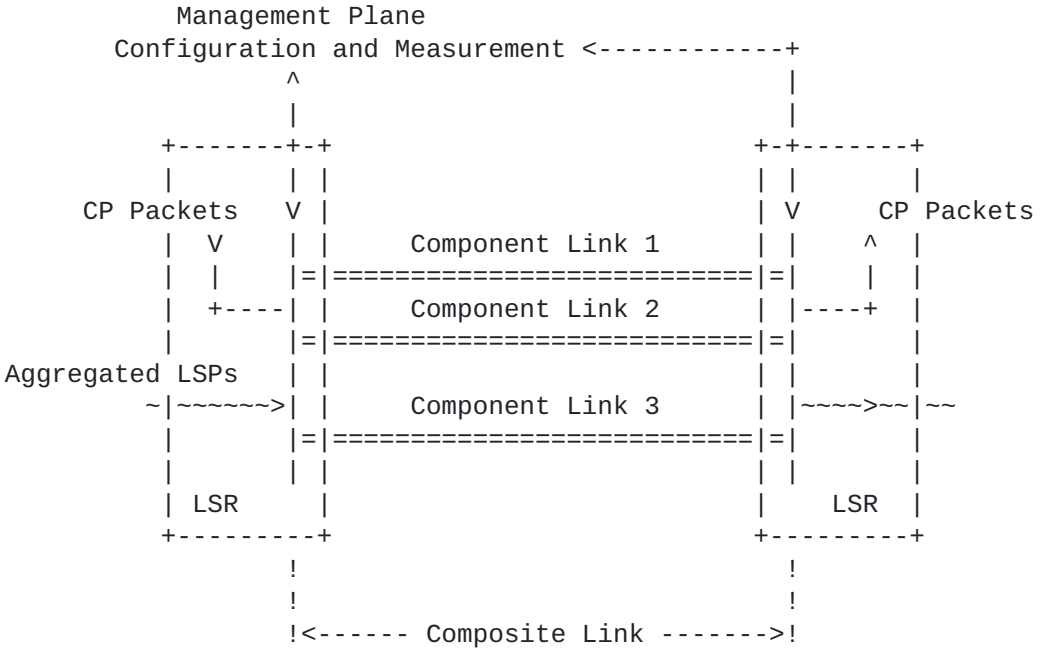

Figure 1 Composite Link Architecture Model

A component link in a composite link may be constructed in different ways.[CL-REQ] Figure 2 shows three common ways that may be deployed in a network.

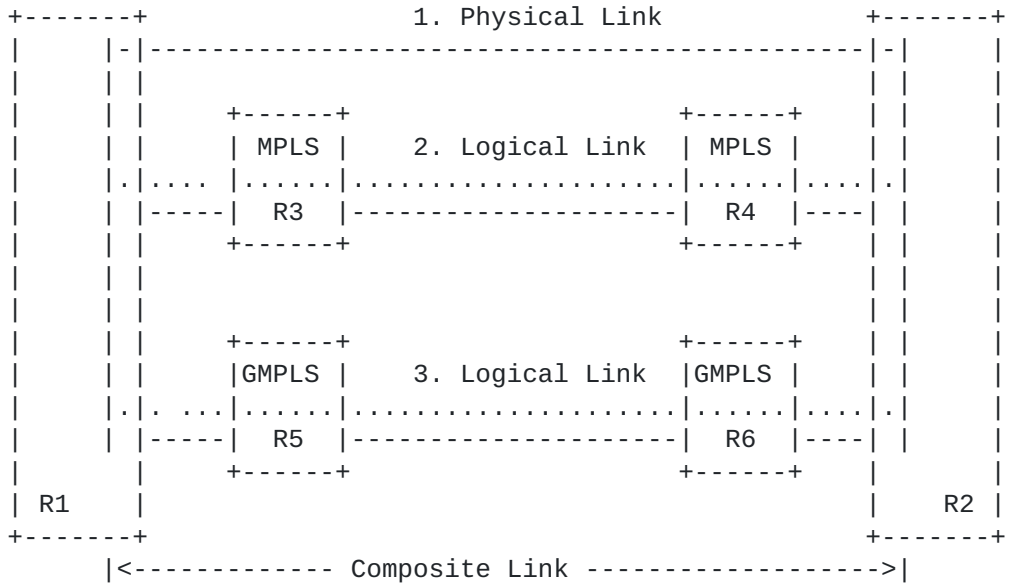

Figure 2 Illustration of Component Link Variances

As shown, the first component link is configured with direct physical media wire. The second component link is a TE tunnel that traverses R3 and R4. Both R3 and R4 are the nodes in the MPLS. The third component link is formed by lower layer network that has GMPLS enabled. In this case, R5 and R6 are not the nodes controlled by the MPLS but provide the connectivity for the component link.

Composite link forms one logical link between connected routers and is used to carry aggregated traffic.[CL-REQ] Composite link relies on its component links to carry the traffic over the composite link. This means that a composite link maps incoming traffic into component links. At the transmitting end (R1 in Figure 1), composite link maps a set of traffic flows including control plane packets to a specific component link. At the receiving end (R2 in Figure 1), composite link receives the packets from its component links and sends them to MPLS forwarding engine like a regular link.

Traffic mapping to component links may be done by control plane, management plane, or data plane.[CL-REQ] The objective is to keep the individual flow packets in sequence and do not overload any component link.[CL-REQ] Operator may have other objectives such as load balance over component links. A flow may be a LSP, or sub-LSP [MLSP], PW, a flow within PW [FAT-PW], entropy flow in LSP [Entropy].

4. Composite Link in Control Plane

A composite Link is advertised as a single logical interface between two connected routers, which forms routing and forwarding adjacency between the routers in IGP. The interface parameters for the composite link can be pre-configured by operator or be derived from

its component links. Composite link advertisement requirements are specified in [CL-REQ].

In IGP-TE, a composite link is advertised as a single TE link between two connected routers. This is similar to a link bundle [RFC4201]. Link bundle applies to a set of homogenous component links. Composite link allows homogenous and non-homogenous component links. The link bundle protocol extension for composite link advertisement is for further study.

Both LDP [RFC5036] and RSVP-TE [RFC3209] can be used to signal a LSP over a composite link. Since composite link capacity is aggregated capacity and is often larger than individual component link capacity, it is possible to signal a LSP whose BW is larger than individual component link capacity.[CL-REQ] Assumption is such LSP carrying an aggregated traffic.

A composite link may contain the set of component links. A component link may be configured by operator or signaled by the control plane. In both cases, it is necessary to convey component link parameters to the composite link.[CL-REQ]

When a component link is supported by lower layer network (third component link in figure 2), the control plane that the composite link resides is able to interoperate with the GMPLS or MPLS-TP control plane that lower layer network uses for component link addition and deletion. [CL-REQ]

5. Composite Link in Data Plane

Composite link may appear as one single interface or multiple interfaces in data plane.

The traffic over composite link is distributed over individual component links. Traffic dissemination may be determined by control plane, management plane, or data plane, and may be changed due to component link status change.[CL-REQ]

A component link in a composite link may fail independently. The composite link functions are able to recognize component link failure and re-assign impacted flows to other active component links in minimal disruptive manner. When a composite link can't recover some impacted flows, it notifies control plane about the flows. When a composite link is not able to transport all flows, it preempts some flows based upon local management configuration and informs the control plane on these preempted flows. This action ensures the remaining traffic is transported properly.

The composite link functions provide component link fault notification and composite link fault notification. Component link fault notification is sent to the management plane. Composite link fault notification is sent to the control plane and management

plane. Composite link allows operator to trace which component link a LSP is assigned to.

6. Security Considerations

For further study.

7. IANA Considerations

IANA actions to provide solutions are for further study.

8. References

8.1. Normative References

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9. Acknowledgments

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