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Requirements for Very Fast Setup of GMPLS LSPs
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Abstract

The Defense Advanced Research Projects Agency (DARPA) Core Optical Networks (CORONET) program has laid out a vision for the next evolution of IP and optical commercial and government networks, with a focus on highly dynamic and resilient multi-terabit core networks. It anticipates the need for rapid (sub-second) setup and SONET/SDH-like restoration times for high-churn (up to tens of requests per second network-wide and one second to one minute holding times) on-demand wavelength, sub-wavelength and packet services for a variety of applications (e.g., grid computing, cloud computing, data visualization, fast data transfer, etc.). This must be done while meeting stringent call blocking requirements, and while minimizing the use of resources such as time slots, switch ports, wavelength conversion and wavelength-km.

This document discusses the requirements for extensions to Generalized Multi-Protocol Label Switching (GMPLS) signaling for expediting the control of Label Switched Paths (LSPs), including sub-wavelengths (e.g., OTN ODUs) and full wavelengths, in order to satisfy application requirements laid out in this program.

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1. Introduction

The Defense Advanced Research Projects Agency (DARPA) Core Optical Networks (CORONET) program [Chiu] has laid out a vision for the next evolution of IP and optical commercial and government networks, with a focus on highly dynamic and resilient multi-terabit core networks. The program anticipates an environment where there are multiple Bandwidth-on-Demand service requests per second, such as might arise

as cloud services proliferate. It includes dynamic services with connection setup requirements that are two to three orders of magnitude faster than possible with current connection setup protocols. The aggregate traffic demand, which is composed of both packet (IP) and circuit (wavelength and sub-wavelength) services,

represents a five to twenty-fold increase over today's traffic levels for the largest of any individual carrier. It is the desired goal of the program to achieve transition of these advances to commercial and government networks in the next few years. Thus, the aggressive requirements must be met with solutions that are scalable, cost effective, and power efficient, while providing the desired quality of service (QoS).

Thus, CORONET anticipates the need for rapid (sub-second) setup and restoration times for high-churn (up to tens of requests per second network-wide and one second to one minute holding times) on-demand wavelength, sub-wavelength and packet services for a variety of applications (e.g., grid computing, cloud computing, data visualization, fast data transfer, etc.). This must be done while meeting stringent call blocking requirements, and while minimizing the use of resources such as time slots, switch ports, wavelength conversion and wavelength-km.

GMPLS protocols and procedures have been developed to enable automated control of Label Switched Paths (LSPs), including setup, teardown, modification, and restoration, for switching technologies extending from layer 2 and layer 3 packets, to time division multiplexing, to wavelength, and to fiber.

However, while the current GMPLS constituent protocols are geared for a wide scope of applications and robust performance, they have not specifically addressed the more aggressive characteristics envisioned here, e.g., applications requiring low connection setup times while maintaining a high success ratio (i.e., low blocking) in a high-churn environment. For example, in Internet2, a network which provides CORONET-like high bandwidth circuit services for the Research & Education community, a circuit is currently established, on average, roughly at a rate of one per hour. In contrast, the CORONET vision is a churn rate of up to tens of circuits per second, over four orders of magnitude greater.

Furthermore, scenarios with highly dynamic connection request activity, where the connection request arrival rate is higher than the TE update rate allowed by OSPF-TE, could lead to unacceptable blocking ratios or low resource utilization. The purpose of this draft is to determine the requirements to augment the GMPLS framework to allow specific applications, or users, to rapidly set up connections over GMPLS networks with minimal delays and a high probability of success.

2. Scope and Motivation

[RFC6163] provides the framework, basic elements, and terminology of wavelength switched optical networks (WSON) and wavelength-based LSPs. These basic elements generally apply to other GMPLS technologies as well, e.g., spectral switching (SSON), sub-wavelength TDM, and L2 LSPs. This draft refers to the same general framework and technologies, but addresses an extension of the general problem space addressed in [RFC6163]. Specifically, this draft addresses the requirements of expediting LSP setup, under heavy connection churn scenarios, while achieving low blocking, under an overall distributed control plane. Once there is agreement on the requirements, further drafts will describe the procedures and signaling contents required to meet the requirements (potentially more than one if separate standard track drafts are found necessary for wavelength and sub-wavelength LSPs). Both single-domain and multi-domain network scenarios are addressed. A connection setup delay is defined here as the time between the arrival of a connection request at an ingress edge switch - or more generally a Label Switch Router (LSR) - and the time at which information can start flowing from that ingress switch over that connection. Note that this definition is more inclusive than the LSP setup time defined in [RFC5814] and [RFC6777], which do not include PCE path computation delays.

The motivation for GMPLS extensions as described here is the anticipated need for rapid setup while maintaining low blocking, on-demand, of large bandwidth connections (in the form of sub-wavelengths, e.g., OTN ODUx, and wavelengths, e.g., OTN OCh) for a variety of applications including grid computing, cloud computing,

data visualization, and intra- and inter-datacenter communications. The ability to setup circuit-like LSPs for large bandwidth flows and with low setup delays provides an alternative to packet-based solutions implemented over static circuits that may require tying up more expensive and power-consuming resources (e.g., router ports). Reducing the LSP setup delay will reduce the minimum bandwidth threshold at which a GMPLS approach is preferred over a layer 3 (e.g., IP) approach. Dynamic circuit and virtual circuit switching intrinsically provide guaranteed bandwidth, guaranteed low-latency and jitter, and faster restoration, all of which are very hard to provide in a packet-only networks. Again, a key element in achieving these benefits is enabling the fastest possible circuit setup times.

Future applications are expected to require setup times as fast as 100 ms in highly dynamic, national-scale network environments while meeting stringent blocking requirements and minimizing the use of resources such as switch ports, wavelength converters/regenerators, wavelength-km, and other network design parameters. Of course, the

benefits of low setup delay diminish for connections with long holding times.

The need for rapid setup for specific applications may override and thus get traded off against some other features currently provided in GMPLS, e.g., robustness against setup errors.

With the advent of data centers, cloud computing, video, gaming, mobile and other broadband applications, it is anticipated that connection request rates may increase, even for connections with longer holding times, either during limited time periods (such as during the restoration from a data center failure) or over the longer term, to the point where the current GMPLS maximum frequency of TE information updates is not sufficient to provide adequate path computation and resource allocation, as network conditions and resource attributes may be changing faster than can be reflected in OSPF-TE updates.

Thus, GMPLS and routing protocol traffic engineering (e.g. OSPF-TE) extensions are also needed to address heavy churn of connection requests (i.e., high connection request arrival rate) in networks with high traffic loads, even for connections with relatively longer

holding times.

3. Requirements for Very Fast Setup of GMPLS LSPs

This section lists the requirements for very fast setup of GMPLS LSPs in order to provide the services described in the previous sections. They will be the basis for future standards-track drafts to satisfy these requirements. Some of these requirements may be implementation-dependent to some extent, but they may also have LSP signaling protocol dependencies as well.

R1 Protocol extensions must be backward compatible with existing GMPLS control plane protocols.

R2 Use of GMPLS protocol extensions for this application must be selectable by provisioning or configuration.

R3 Must support the use of PCE for path computation, and in particular the PCE-based approach for multi-domain LSPs in [RFC5441].

R4 Must have an LSP setup time less than or equal to 100 ms for intra-continental LSPs, and less than or equal to 250 ms for transcontinental LSPs, including PCE path computation delays.

R5 Must support LSP holding times of one second to one minute.

R6 While there are implementation-dependent aspects of supporting high LSP setup rates, the protocol aspects of LSP signaling must not preclude LSP request rates of tens per second. A possible example of a protocol aspect is the ability to update the IGP TE database to accurately reflect resource availability at all times. Note that LSP request rates may be dependent on LSP bandwidth, where very high bandwidth LSPs (such as for an entire wavelength) could be less frequent than lower-rate LSPs (such as an ODUx connection).

R7 Must support restoration for all cases of single node or link failures.

R8 At most one blocked LSP setup request per 1000 requests.

4. IANA Considerations

This memo includes no request to IANA.

5. Security Considerations

Being able to support very fast setup and a high churn rate of GMPLS LSPs is not expected to adversely affect the underlying security issues associated with existing GMPLS signaling, and potentially could improve GMPLS' resistance against denial of service attacks that attempt to deny service through the use of a high frequency of GMPLS LSP setup requests.

6. Acknowledgements

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7. References

7.1. Normative References

[RFC5441] Vasseur, JP., Zhang, R., Bitar, N., and JL. Le Roux, "A Backward-Recursive PCE-Based Computation (BRPC) Procedure to Compute Shortest Constrained Inter-Domain Traffic Engineering Label Switched Paths", RFC 5441, April 2009.

[RFC5814] Sun, W. and G. Zhang, "Label Switched Path (LSP) Dynamic Provisioning Performance Metrics in Generalized MPLS Networks", RFC 5814, March 2010.

[RFC6163] Lee, Y., Bernstein, G., and W. Imajuku, "Framework for GMPLS and Path Computation Element (PCE) Control of Wavelength Switched Optical Networks (WSONs)", RFC 6163, April 2011.

[RFC6777] Sun, W., Zhang, G., Gao, J., Xie, G., and R. Papneja, "Label Switched Path (LSP) Data Path Delay Metrics in Generalized MPLS and MPLS Traffic Engineering (MPLS-TE)

Networks", RFC 6777, November 2012.

7.2. Informative References

[Chiu] A. Chiu, et al, "Architectures and Protocols for Capacity Efficient, Highly Dynamic and Highly Resilient Core Networks", Journal of Optical Communications and Networking vol. 4, No. 1, pp. 1-14, January 2012, <http://dx.doi.org/10.1364/JOCN.4.000001>.

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