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Requirements for PCE applied
in Time-Division Multiplexing (TDM) Networks

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Abstract

This document describes the special requirements for applying the Path Computation Element (PCE) in Time-Division Multiplexing (TDM) networks, including Synchronous Optical Network (SONET), Synchronous Digital Hierarchy (SDH), and Digital Wrapper (G.709 ODUk).

The material presented in this document is collected here for analysis. The intention is to separate this material into separate documents on generic GMPLS requirements, generic GMPLS extensions, and TDM-specific requirements and extensions.

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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](#)].

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[1.](#) Introduction

As defined in [[RFC4655](#)], a Path Computation Element (PCE) is an entity that is capable of computing a network path or route based on a network graph, and of applying computational constraints during the computation. Any node in the network can act as a Path Computation Client (PCC) and request PCE to compute a path that satisfies the set of constraints. When it finishes computing, the PCE will respond with the path to the PCC. The communication protocol between PCE and PCC has been described in [[PCEP](#)].

The main work for PCE so far has been its application in MPLS networks that are already stable and mature. However, the application of PCE to GMPLS in packet and non-packet networks has also been considered. GMPLS has more technology-specific and generic traffic engineering constraints, and some of these, for TDM networks, need further extensions to PCEP.

First, the properties of the LSP being computed should be fed to the

PCE from the PCC. These properties include the switching capabilities (e.g., TDM, lambda, LSC, etc.), the encoding type (e.g., SDH/Sonet, Digital Wrapper, lambda, etc.), and the signaling type (e.g., VC12, VC3, ODUk, etc.). This information is very important for the PCE to

compute a required Path. These properties are parameters are added to PCEP in [[PCEP-Layer](#)].

Second, the reliability of the network is very important for transport networks. So the PCE should get information about required level of protection for the LSP from the PCC. In TDM networks, there are abundant protection types to satisfy different demand for the service, for example, 1+1 protection, 1:1 protection, 1: n protection, full rerouting, shared-mesh restoration, and segment recovery, etc. This information is really important for PCE to compute the corresponding work LSP and protection LSP correctly on operating the traffic engineering database (TED). In addition, the link protection also should be taken into account for PCE path computation. The requirements for LSP protection type and link protection type are addressed briefly in [[PCE-App-Req](#)].

Third, in TDM networks (e.g., SDH/OTN networks), a client service can be transmitted by various connection(s) of TDM with different connection type. For example, in the SDH networks, if the client service which is 100M Ethernet is required to be transported over the SDH networks, the Ethernet service can be provided by a VC4 connection, and it can also be provided by three concatenated VC3 connections (Contiguous or Virtual Concatenation). So this information about connection type is vital for PCE to compute the correct LSP(s) to transport the service traffic.

The above three requirements are very important for PCE to compute the desirable paths when PCE applied in the TDM networks. However, the first two requirements are addressed partially in [[PCEP-Layer](#)] and [[PCE-App-Req](#)], so this document focuses on the third requirement.

1.1. Disposition of this Document

The material presented in this document is collected here for analysis. The intention is to separate this material into separate documents as follows:

- Generic GMPLS requirements for PCEP will be merged into a single document working with the authors of [[PCE-App-Req](#)].
- A new document will be created to provide generic GMPLS extensions to PCEP to address the generic requirements.
- This document will be reduced to contain the TDM-specific requirements (If needed, we can use one document to cover the

TDM-specific requirements and extensions).

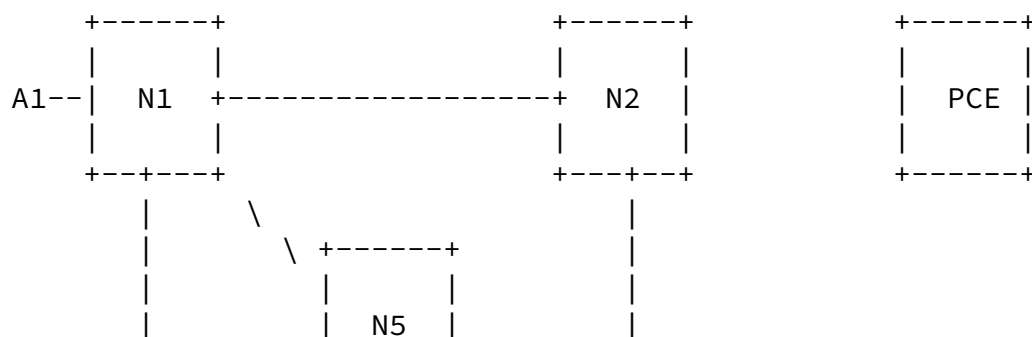
[2. Terminology](#)

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](#)].

[3. PCE Applications](#)

The TDM networks are usually responsible for transmitting data for the client layer. These TDM networks can provide different types of connections for customer services based on different service bandwidth requests.

The applications and the corresponding additional requirements for applying PCE in TDM networks are described below. In order to simplify the description, this document just discusses the scenario in SDH networks as an example. The scenarios in SONET or G.709 ODUK layer networks are similar.



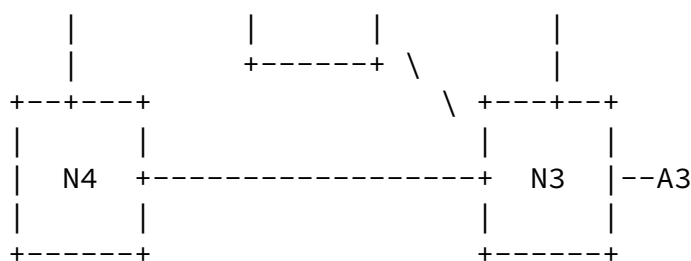


Figure 1: A simple SDH network

Figure 1 shows a simple network topology, where N1, N2, N3, N4, and N5 are all SDH switches. Assume that one Ethernet service with 100M

bandwidth is required from A1 to A3 over this network. The client Ethernet service could be provided by a VC4 connection from N1 to N3, and it could also be provided by three concatenated VC3 connections (Contiguous or Virtual concatenation) from N1 to N3.

The type of connectivity that is required (one VC4 or three concatenated VC3) needs to be specified by PCC (e.g., N1 or NMS), but could also be determined by PCE automatically based on policy, configuration, or network capabilities. This is related to the policies which can be implemented per [RFC5394]. The next section lists requirements described according to different the policies that are applied.

[4. Requirements](#)

[4.1. Requirements when PCC Specifies the Connection Type](#)

In this case, when receiving the service request from A1 to A3 from client layer, the PCC (e.g., N1) specifies the transport scheme for the service based on the requested bandwidth and the transport policies pre-configured, and then requests the PCE to compute the corresponding path. For example, the node N1 specifies that it needs three virtual concatenated VC3 connections in the Path Computation Request message to the PCE. Therefore, the following information should be specified by PCC in the PCReq message:

- (1) Signal Type: Indicates the type of elementary signal that constitutes the requested LSP. A lot of signal types with different granularity have been defined in SONET/SDH and G.709

ODUk, such as VC11, VC12, VC2, VC3 and VC4 in SDH, and ODU1, ODU2 and ODU3 in G.709 ODUk. See [[RFC4606](#)] and [[RFC4328](#)] (Note that switching capability and encoding type should also be specified which are described in [[PCE-App-Req](#)]).

- (2) Concatenation Type: In SDH/ SONET and G.709 ODUk networks, two kinds of concatenation modes are defined: contiguous concatenation which requires co-router for each member signal and requires all the interfaces along the path to support this capability, and virtual concatenation which allows diverse routes for the member signals and only requires the ingress and egress interfaces to support this capability. Note that for the virtual concatenation, it also may specify co-routed or separated-routed. See [[RFC4606](#)] and [[RFC4328](#)] about Concatenation information.

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- (3) Concatenation Number: Indicates the number of signals that are requested to be contiguously or virtually concatenated. Also see [[RFC4606](#)] and [[RFC4328](#)].

When receiving the PCReq message, PCE computes the path that satisfies the set of constraints in the PCReq message. If successful, the corresponding path will be returned to PCC in the PCRep message. Note that the PCE should return the above information (Signal type, Concatenation type, Concatenation number) in the PCRep message to tell PCC how to create the corresponding connections.

In the case of virtual concatenation, when separate-routed paths are required, it is necessary for the PCE to indicate that how many member signals are needed in each route. For example, in Figure 1, if the node N1 requests a virtual concatenation connection with four VC4 signals and these four VC4 member signals should be separated-routed, the result of path computation may be two VC4 signals along the route N1-N2-N3 and another two VC4 signal along the route N1-N5-N3.

[4.2](#). Requirements when PCE Determines the Connection Type

In this case, when receiving the request for a service from A1 to A3 from the client layer, the PCC (e.g., N1) sends the PCReq message to the PCE. The message contains the information about requested bandwidth, as described in [[PCEP](#)].

When receiving the PCReq message, the PCE determines the transport

scheme for the service based on the requested bandwidth and the pre-configured transport policies, and then computes the path. If successful, the information of the corresponding paths will be sent to the PCC in the PCRep message.

In order that the PCC can set up the corresponding path, the PCE should tell the PCC the transport scheme, i.e., the connection type. So the PCRep message should contain the information described below:

- (1) Signal Type: Same as described in [Section 4.1](#).
- (2) Concatenation Type: Same as described in [Section 4.1](#).
- (3) Concatenation Number: Same as described in [Section 4.1](#).

In the case of virtual concatenation when separated routed paths are returned, it is also necessary for the PCE to indicate that how many

member signals are needed in each route, which is the same as described in [Section 4.1](#).

[5](#). Security Considerations

This document just focuses on the requirements when PCE is applied in the TDM networks, so there is no additional security introduced. Possible security issues should be considered when it need extend PCEP to support these requirements.

[6](#). IANA Considerations

There is no IANA request in this document.

[7](#). Acknowledgments

TBD.

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[9](#). Authors' Addresses

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