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**Encoding of Objective Functions in Path Computation Element (PCE)  
communication and discovery protocols**

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## Abstract

The computation of one or a series of Traffic Engineering Label Switched Paths (TE LSP) in MultiProtocol Label Switching (MPLS) and Generalized MPLS (GMPLS) networks, is subject to a set of one or more specific optimization criteria(s), referred to as an objective function (e.g. minimum cost path, widest path, etc.). A Path Computation Element (PCE) may support one or multiple objective functions, and it is desired for a Path Computation Client (PCC) to automatically discover the set of objective functions supported by a PCE. Furthermore, it may be useful for a PCC to specify in a path computation request the required objective function used by the PCE to compute a TE LSP or a set of TE LSPs. Thus the aim of this document is to define extensions to the PCE Discovery (PCED) TLV carried within the IS-IS Router Capability TLV and the OSPF Router Information LSA so as to allow a PCC to discover the set of objective functions supported by a PCE. Extensions to the PCE communication Protocol (PCEP) are also specified allowing a PCC to indicate in a path computation request the required objective function and a PCE to indicate in a path computation reply the objective function actually applied.

## 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 [RFC-2119](#).

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## 1. Terminology

### Terminology used in this document

IGP: Interior Gateway Protocol: Either of the two routing protocols Open Shortest Path First (OSPF) or Intermediate System to Intermediate system (IS-IS).

LSR: Label Switching Router.

OF: Objective Function: A set of one or more optimization criteria(s) used for the computation of a single path (e.g. path cost minimization), or the synchronized computation of a set of paths (e.g. aggregate bandwidth consumption minimization, etc.).

PCC: Path Computation Client: Any client application requesting a path computation to be performed by a Path Computation Element.

PCE: Path Computation Element: An entity (component, application, or network node) that is capable of computing a network path or route based on a network graph, and applying computational constraints.

PCED: PCE Discovery: Generic term to refer to a PCE Discovery Mechanism.

IS-IS PCED: IS-IS based PCE Discovery.



OSPF PCED: OSPF based PCE Discovery.

PCEP: Path Computation Element communication Protocol.

TE LSP: Traffic Engineered Label Switched Path.

## 2. Introduction

The PCE-based network architecture [[RFC4655](#)] defines a Path Computation Element (PCE) as an entity capable of computing TE LSP paths based on a network graph, and applying computational constraints. A PCE serves path computation requests sent by Path Computation Clients (PCC).

The PCE communication Protocol (PCEP), defined in [[PCEP](#)], allows for communication between a PCC and a PCE or between two PCEs, in compliance with requirements and guidelines set forth in [[RFC4657](#)]. Such interactions include path computation requests and path computation replies.

The IS-IS based PCE Discovery and OSPF based PCE Discovery mechanisms defined respectively in [[ISIS-PCED](#)] and [[OSPF-PCED](#)], allow a PCC to automatically discover a set of PCEs as well as some information required for PCE selection, in compliance with requirements set forth in [[RFC4674](#)].

The computation of one or a set of TE LSPs is subject to a set of one or more optimization criteria(s), called an objective function. An objective function is used by the PCE, when it computes a path or a set of paths, in order to select the "best" candidate path(s). There is a variety of objective functions: an objective function could apply either to a set of non synchronized path computation requests, or to a set of synchronized path computation requests. In the former case, the objective function refers to an individual path computation request (e.g. computation of the shortest constrained path where the metric is the IGP metric, computation of the least loaded constrained path, etc.). Conversely in the latter case, the objective function applies to a set of path computation requests the computation of which is synchronized (e.g. minimize the aggregate bandwidth consumption of all links, minimize the sum of the delays for two diverse paths, or the delta between those delays, etc.). Moreover, some objective functions relate to the optimization of a single metric and others to the optimization of a set of metrics (organized in a hierarchical manner, using a weighted function, etc.).

As spelled out in [[RFC4674](#)], it may be useful for a PCC to discover the set of objective functions supported by a PCE. For that purpose this document specifies PCE Discovery (PCED) extensions in order to allow a PCE advertising a list of supported objective functions.



As spelled out in [[RFC4657](#)], a PCC must be able to indicate in a path computation request a required/desired objective function, as well as optional function parameters. For that purpose this document extends the PCE communication Protocol (PCEP), so as to carry the objective function as well as function parameters. It thus complements the PCEP specification.

Extensions to IS-IS and OSPF based PCE Discovery ([[ISIS-PCED](#)], [OSPF-PCED]) are defined in [section 3](#). A new sub-TLV, the OF-List sub-TLV is defined, to be carried within the PCED TLV. It allows advertising the list of objective functions supported by a PCE.

Extensions to PCEP ([[PCEP](#)]) are defined in [section 4](#). A new PCEP object, the OF object is defined, to be carried within a PCReq message to indicate the required/desired objective function to be applied by a PCE or in a PCRep message to indicate the objective function that was actually applied by the PCE.

A common PCE Objective Function code point registry is defined for both PCEP and PCED protocols, to be managed by IANA.

Six mandatory objective functions that must be supported by PCEP are listed in [[RFC4657](#)]. This document provides a definition of these six mandatory objective functions. Additional objective functions may be defined in other documents.

### 3. PCE Discovery Extensions

#### [3.1. IS-IS PCED Extensions](#)

##### [3.1.1. IS-IS OF-List sub-TLV](#)

The IS-IS Objective Function List (OF-List) sub-TLV is a new sub-TLV carried within the IS-IS PCED sub-TLV defined in [[ISIS-PCED](#)]. It allows advertising the list of objective functions supported by a PCE.

The OF-List sub-TLV is an optional sub-TLV. It MAY be present within the PCED sub-TLV. It MUST NOT be present more than once. If present more than once, all instances except the first one MUST be ignored.

The format of the IS-IS OF-List sub-TLV is the identical to the TLV format used by the Traffic Engineering Extensions to IS-IS [[RFC3784](#)]. That is, the TLV is composed of 1 octet for the type, 1 octet specifying the TLV length, and a value field. The Length field defines the length of the value portion in octets.



The IS-IS OF-List sub-TLV has the following format:

TYPE: To be assigned by IANA (suggested value = 6)  
 LENGTH:  $N * 2$  (where N is the number of objective functions)  
 VALUE: list of 2-bytes objective function code points,  
 identifying the supported objective functions.

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                               OF Code #1                               | OF Code #2                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
//                                                                    //
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                               OF Code  # N                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

OF Code (2 bytes): Objective Function Identifier

The IANA is requested to manage the PCE objective function code point registry (see IANA section).

### **3.1.2. Elements of Procedure**

The OF-List sub-TLV is advertised within an IS-IS PCED sub-TLV defined in [[ISIS-PCED](#)]. As such, elements of procedures are inherited from those defined in [[ISIS-PCED](#)].

The OF-List sub-TLV is OPTIONAL. A PCE MAY include an OF-List sub-TLV within the PCED sub-TLV so as to advertise a set of one or more objective functions. When a PCED sub-TLV does not contain any OF-List sub-TLV this means that the supported objective functions of that PCE are unknown.

## **3.2. OSPF PCED Extensions**

### **3.2.1. OSPF OF-List sub-TLV**

The OSPF Objective Function List (OF-List) sub-TLV is a new sub-TLV carried within the OSPF PCED TLV defined in [[OSPF-PCED](#)]. It allows advertising the objective functions supported by a PCE. It includes a list of 2-bytes objective function identifiers.

The OF-List sub-TLV is an optional TLV. It MAY be present within the PCED TLV. It MUST NOT be present more than once. If present more than once, all instances except the first one MUST be ignored.



The format of the OSPF OF-List sub-TLV is the identical to the TLV format used by the Traffic Engineering Extensions to OSPF [[RFC3630](#)]. That is, the TLV is composed of 2 octets for the type, 2 octets specifying the TLV length, and a value field. The Length field defines the length of the value portion in octets. The TLV is padded to four-octet alignment; padding is not included in the Length field (so a two octet value would have a length of two, but the total size of the TLV would be eight octets).

The OSPF OF-List sub-TLV has the following format:

TYPE: To be assigned by IANA (suggested value = 6)  
 LENGTH:  $N * 2$  (where N is the number of objective functions)  
 VALUE: list of 2-bytes objective function code points,  
       identifying the supported objective functions.

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|               OF Code #1               |       OF Code #2       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
//                                         //
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|               OF Code #N               |                       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

OF Code (2 bytes): Objective Function Identifier

The IANA is requested to manage the PCE objective function code point registry (see IANA section).

### **3.2.2. Elements of procedure**

The OF-List sub-TLV is advertised within an OSPF PCED TLV defined in [[OSPF-PCED](#)]. As such, elements of procedures are inherited from those defined in [[OSPF-PCED](#)].

The OF-List sub-TLV is OPTIONAL. A PCE MAY include an OF-List sub-TLV within the PCED TLV so as to advertise a set of one or more objective functions. When a PCED TLV does not contain any OF-List sub-TLV this means that the supported objective functions of that PCE are unknown.

## **4. PCEP Extensions**

This section defines extensions to PCEP ([[PCEP](#)]) so as to support the communication of objective functions. A new PCEP OF (Objective Function) object is defined, to be carried within a PCReq message in order for the PCC to indicate the required/desired objective function

and within a PCRep message in order for the PCE to indicate the objective function that has actually been applied by the PCE. A new

flag is defined in the RP object, so as to indicate in a PCRep message that the inclusion of the objective function actually applied by the PCE is required in the response. Also new PCEP error type and value are defined.

#### **4.1. OF Object**

The PCEP OF (Objective Function) object is optional. It MAY be carried within a PCReq message so as to indicate the desired/required objective function to be applied by the PCE during path computation, or within a PCRep message so as to indicate the objective function that has been actually applied by the PCE.

The OF object format is compliant with the PCEP object format defined in [[PCEP](#)].

The OF Object-Class is to be assigned by IANA (recommended value=18). The OF Object-Types is to be assigned by IANA (recommended value=1).

The format of the OF object body is:

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|Objective Function Code(IANA) |      Reserved      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                                                                 |
//              Optional TLV(s)                                //
|                                                                 |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Objective Function Code (2 bytes): The identifier of the Objective Function. The IANA is requested to manage the PCE objective function code point registry (see IANA section).

Reserved (2 bytes): This field MUST be set to zero on transmission and MUST be ignored on receipt.

Optional TLVs may be defined so as to encode objective function parameters. The IANA is requested to create a registry for this TLVs' name space.

##### **4.1.1. Elements of procedure**

To specify an objective function to be applied by a PCE, a PCC MUST include an OF object in the PCReq message.

A bit flag referred to as the P bit is defined in the common header

of each PCEP object that can be set by a PCC to enforce a PCE to take into account the related information during the path computation. If the objective function is mandatory (required objective function),

the P bit in the OF object MUST be set, else if it is optional (desired objective function) the P bit MUST be cleared.

On receipt of a PCReq message with an OF object, a PCE has to proceed as follows:

- If the OF object is unknown/unsupported, the PCE MUST follow procedures defined in [PCEP], that is if the P bit is set, it sends a PCErr message with error type unknown/unsupported object (type 3 and 4) else if the P bit is cleared it is free to ignore the object.
- If the objective function is unknown / unsupported and the P bit is set, the PCE MUST send a PCErr message with a new PCEP error type "objective function error" and error value "unknown/unsupported objective function" (defined in this document), and the related path computation request MUST be discarded.
- If the objective function is unknown / unsupported and the P bit is cleared, the PCE SHOULD apply another (default) objective function.
- If the objective function is supported but policy does not permit applying it, and the P bit is set, the PCE MUST send a PCErr message with the PCEP error type "policy-violation" (type 5) and a new error value "objective function not allowed" (defined in this document).
- If the objective function is supported but policy does not allow applying it, and the P bit is cleared, the PCE SHOULD apply another (default) objective function.
- If the objective function is supported and policy allows applying it, then if the P bit is set the PCE MUST apply the requested objective function, else if the P bit is cleared the PCE is free to apply any other objective function.

#### **4.2. Carrying the OF object in a PCEP message**

The OF object MAY be carried within a PCReq message. An OF object specifying an objective function that applies to a set of synchronized path computation requests MUST be carried just after the corresponding SVEC object, and MUST NOT be repeated for each elementary request.

An OF object specifying an objective function that applies to an individual path computation request (non synchronized case) MUST



follow the RP object for which it applies.

The format of the PCReq message is updated as follows:

```
<PCReq Message> ::= <Common Header>
                    [<SVEC-list>]
                    <request-list>

where:
    <svec-list> ::= <SVEC>
                   [<OF>]
                   [<svec-list>]

    <request-list> ::= <request> [<request-list>]

    <request> ::= <RP>
                 <END-POINTS>
                 [<OF>]
                 [<LSPA>]
                 [<BANDWIDTH>]
                 [<metric-list>]
                 [<RRO>]
                 [<IRO>]
                 [<LOAD-BALANCING>]

where:

    <metric-list> ::= <METRIC> [<metric-list>]
```

The OF object MAY be carried within a PCRep message to indicate the objective function that was actually applied by the PCE.

The format of the PCRep message is updated as follows:

```
<PCRep Message> ::= <Common Header>
                    <response-list>

where:
    <response-list> ::= <response> [<response-list>]

    <response> ::= <RP>
                  [<NO-PATH>]
                  [<path-list>]

    <path-list> ::= <path> [<path-list>]

    <path> ::= <ERO>
              [<OF>]
              [<LSPA>]
              [<BANDWIDTH>]
              [<metric-list>]
```

[<IRO>]

where:

<metric-list>::=<METRIC>[<metric-list>]

### **4.3. New RP object flag**

In some cases, where no objective function is specified in the request, or an optional objective function is desired (P bit cleared in the OF object header) but the PCE does not follow the recommendation, the PCC may desire to know the objective function actually applied by the PCE. For that purpose, a new flag is defined in the RP object, the OF flag, allowing a PCC to request for the inclusion in the reply of the objective function actually applied by the PCE.

The following new bit flag of the RP object is defined:

Objective Function (OF) flag (1 bit): 0x200 (suggested value, to be assigned by IANA). When set in a PCReq message, this indicates that the PCE must provide the applied objective function (should a path satisfying the constraints be found) in the PCRep message. When set in a PCRep message this indicates that the Objective Function applied by the PCE is included.

#### **4.3.1. Elements of procedure**

If the PCC wants to know the objective function actually applied by a PCE for a given request, it MUST set the OF flag in the RP object.

On receipt of a PCReq message with the OF flag in the RP object set, the PCE has to proceed as follows:

- If policy permits it MUST include in the PCRep message an OF object indicating the objective function it actually applied.
- If policy does not permit, it MUST send a PCErr message with the PCEP error code "policy-violation" (type 5) and a new error value "objective function indication not allowed" (defined in this document).

### **5. Objective Functions definition**

Six objective functions that must be supported by PCEP are listed in [\[RFC4657\]](#). Objective function codes should be assigned by IANA and are suggested below.

Objective functions are formulated using the following terminology:

- a network comprises a set of N links  $\{L_i, (i=1 \dots N)\}$
- a path P is a list of K links  $\{L_{pi}, (i=1 \dots K)\}$
- Metric of link L is noted  $M(L)$ , this can be the IGP metric the TE metric or any other metric.
- The cost of a path P is noted  $C(P)$ ,  
$$C(P) = \sum \{M(L_{pi}), (i=1 \dots K)\}.$$

- Residual bandwidth on link  $L$  is noted  $R(L)$
- Speed of link  $L$  is noted  $B(L)$

There are three objective functions that apply to the computation of a single path:

Objective Function Code: 1 (suggested value, to be assigned by IANA)  
Name: Minimum Cost Path (MCP)  
Description: Find a path  $P$  such that  $C(P)$  is minimized.

Objective Function Code: 2 (suggested value, to be assigned by IANA)  
Name: Minimum Load Path (MLP)  
Description: Find a path  $P$  such that  $(\text{Max } \{B(L_{pi}) - R(L_{pi})\} / B(L_{pi}), i=1 \dots K)$  is minimized

Objective Function Code: 3 (suggested value, to be assigned by IANA)  
Name: Maximum residual Bandwidth Path (MBP)  
Description: Find a path  $P$  such that  $(\text{Min } \{R(L_{pi}), i=1 \dots K\})$  is maximized.

There are three objective functions that apply to a set of path computation requests the computation of which is synchronized:

Objective Function Code: 4 (suggested value, to be assigned by IANA)  
Name: Minimize aggregate Bandwidth Consumption (MBC)  
Description: Find a set of paths such that  $(\text{Sum } \{B(L_i) - R(L_i), i=1 \dots N\})$  is minimized.

Objective Function Code: 5 (suggested value, to be assigned by IANA)  
Name: Minimize the Load of the most loaded Link (MLL)  
Description: Find a set of paths such that  $(\text{Max } \{B(L_i) - R(L_i)\} / B(L_i), i=1 \dots N)$  is minimized.

Objective Function Code: 6 (suggested value, to be assigned by IANA)  
Name: Minimize the Cumulative Cost of a set of paths (MCC)  
Description: Find a set of paths  $\{P_1 \dots P_m\}$  such that  $(\text{Sum } \{C(P_i), i=1 \dots m\})$  is minimized.

Other objective functions may be defined in separate documents.



## **6. IANA Considerations**

### **6.1. PCE Objective Function registry**

This document defines a 16-bit PCE Objective Function identifier to be carried within the PCEP OF object, as well as the ISIS and OSPF OF-List sub-TLVs.

The IANA is requested to create and manage the 16-bit "PCE Objective Function" code point registry, starting from 1 and continuing through 32767, as follows:

- Objective Function code point value
- Objective Function name
- Defining RFC

The same registry is applicable to the PCEP OF object and the ISIS and OSPF OF-List sub-TLVs defined in this document.

The guidelines (using terms defined in [[RFC2434](#)]) for the assignment of objective function code point values are as follows:

- Function code value 0 is reserved.
- Function code value in the range 1-32767 are to be assigned as follows:
  - Function code values 1 through 1023 are to be assigned by IANA using the "IETF Consensus" policy.
  - Function code values 1024 through 32767 are to be assigned by IANA, using the "First Come First Served" policy.
- Function code values in the range 32768-65535 are for "Private Use".

Six objective functions are defined in [section 5](#) of this document and should be assigned by IANA:

Code Point	Name	Defining RFC
1	MCP	this doc
2	MLP	this doc
3	MBP	this doc
4	MBC	this doc
5	MLL	this doc
6	MCC	this doc





## **[6.2.](#) PCEP code points**

### **[6.2.1.](#) OF Object**

The IANA has been requested to manage the PCEP Objects code point registry (see [[PCEP](#)]).

This document defines a new PCEP object, the OF object, to be carried in PCReq and PCRep messages. The IANA is requested to make the following allocation (suggested value):

Object Class	Name	Object Type	Name	Reference
18	OF	1	Objective Function	(this document)

### **[6.2.2.](#) OF Object TLV Space**

The new PCEP OF object referenced above includes optional TLVs that encode objective function parameters. Each TLV includes a 16-bit type identifier.

The IANA is requested to create a new registry, the "PCEP OF TLV" registry, and manage TLV type identifiers as follows:

- TLV Type value
- TLV Name
- Defining RFC

Type values in the range 1-32767 are to be assigned as follows:

- Values 1 through 1023 are to be assigned by IANA using the "IETF Consensus" policy.
- Values 1024 through 32767 are to be assigned by IANA, using the "First Come First Served" policy.

Type values in the range 32768-65535 are for "Private Use".

### **[6.2.3.](#) PCEP Error values**

A new PCEP Error-Type is defined in this document, with two error values (Error-Type and Error-value to be assigned by IANA):

Error-type	Meaning and error values	Reference
14	Objective Function Error Error-value=1: unknown objective function (request rejected) Error-value=2: unsupported objective function	(this doc)

(request rejected)

Two new error values are defined for the error type "policy violation" (type 5):

Error-type	Meaning and error values	Reference
5	Policy violation	
	Error-value=3: objective function not allowed (this doc) (request rejected)	
	Error-value=4: OF bit of the RP object set (request rejected)	(this doc)

#### **6.2.4. RP Object flag**

A new flag of the RP object (specified in [[PCEP](#)]) is defined in this document. The IANA is requested to make the following allocation (suggested value):

Bit Number	Hex	Name	Reference
08	0x200	OF	(this document)

When set, this indicates that the PCC requests the inclusion, in the PCRep message, of the objective function actually used to compute the path.

#### **6.3. IS-IS OF-List sub-TLV**

Once a registry for the IS-IS PCED sub-TLV defined in [[ISIS-PCED](#)] will have been assigned, IANA will assign a new sub-TLV code-point for the OF-List sub-TLV carried in the PCED sub-TLV. Here is the suggested value:

Value	TLV name	References
-----	-----	-----
6	OF-List	(This document)

#### **6.4. OSPF OF-List sub-TLV**

Once a registry for the OSPF PCED TLV defined in [[OSPF-PCED](#)] will have been assigned, IANA will assign a new sub-TLV code-point for the OF-List sub-TLV carried in the PCED TLV. Here is the suggested value:

Value	TLV name	References
-----	-----	-----
6	OF-List	(This document)



## **7. Security Considerations**

Mechanisms discussed in [[ISIS-PCED](#)] and [[OSPF-PCED](#)] to secure the PCED TLV can be used to secure the PCED sub-TLV as well.

Mechanisms discussed in [[PCEP](#)] to secure a PCEP session can be used to secure the PCEP OF object as well.

## **8. Manageability Considerations**

### **8.1. Control of Function and Policy**

It MUST be possible to configure the activation/deactivation of Objective Function Discovery in the PCED protocol.

In addition to the parameters already listed in section 8.1 of [[PCEP](#)], a PCEP implementation SHOULD allow configuring on a PCE a list of authorized objective functions. This may apply to any session the PCEP speaker participates in, to a specific session with a given PCEP peer or to a specific group of sessions with a specific group of PCEP peers.

Note that an implementation may support the specification of the OF to be used in PCEP without supporting the discovery of the set of OF via the IGP.

Also note that it is not mandatory for an implementation to support all objective functions defined in [section 5](#).

### **8.2. Information and Data Models**

The PCED MIB Module defined in [PCED-MIB] MUST be extended to include Objective Functions.

The PCEP MIB Module defined in [PCEP-MIB] MUST be extended to include Objective Functions.

### **8.3. Liveness Detection and Monitoring**

Mechanisms defined in this document do not imply any new liveness detection and monitoring requirements in addition to those already listed in [[PCEP](#)], [[ISIS-PCED](#)] and [[OSPF-PCED](#)].

### **8.4. Verify Correct Operations**

Mechanisms defined in this document do not imply any new operation verification requirements in addition to those already listed in [[PCEP](#)], [[ISIS-PCED](#)] and [[OSPF-PCED](#)].



## **8.5. Requirements on other protocols**

Mechanisms defined in this draft do not imply any requirements on other protocols in addition to those already listed in [[PCEP](#)], [[ISIS-PCED](#)] and [[OSPF-PCED](#)].

## **8.6. Impact on network operations**

Mechanisms defined in this document do not imply any impact on network operations in addition to those already listed in [[PCEP](#)], [[ISIS-PCED](#)] and [[OSPF-PCED](#)].

## **9. Acknowledgments**

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## **10. References**

### **10.1. Normative references**

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## **10.2. Informative references**

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