        Generalized MPLS (GMPLS) Data Channel Switching Capable (DCSC)
                     and Channel Set Label Extensions

Abstract

   This document describes two technology-independent extensions to
   Generalized Multi-Protocol Label Switching (GMPLS). The first
   extension defines the new switching type Data Channel Switching
   Capable. Data Channel Switching Capable interfaces are able to
   support switching of the whole digital channel presented on single
   channel interfaces. The second extension defines a new type of
   generalized label and updates related objects. The new label is
   called the Generalized Channel_Set Label and allows more than one
   data plane label to be controlled as part of a Label Switched Path
   (LSP).

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1. Introduction

   This document describes two technology-independent extensions to
   Generalized Multi-Protocol Label Switching (GMPLS). Both of these
   extensions were initially defined in the context of Ethernet
   services, see [RFC6004] and [RFC6005], but are generic in nature and
   may be useful to any switching technology controlled via GMPLS.

   The first extension defines a new switching type, which is called
   Data Channel Switching Capable (DCSC). DCSC interfaces are able to
   support switching of the whole digital channel presented on single
   channel interfaces. The second extension defines a new type of

generalized label and updates related objects. The new label is
called the Generalized Channel_Set Label and allows more than one
data plane label to be controlled as part of a GMPLS Label Switched
Path (LSP).

1.1. 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. Data Channel Switching

Current GMPLS switching types are defined in [RFC3945] and [RFC3471]
and support switching at the packet (PSC), frame (L2SC), time-slot
(TDM), frequency (LSC), and fiber (FSC) granularities. Parallel
definitions for these switching types are also made in [RFC4202],
[RFC4203], and [RFC5307].

One type of switching that is not well represented in this current
set is switching that occurs when all data received on an ingress
port is switched through a network to an egress port. While there
are similarities between this level of switching and the "opaque
single wavelength" case, described in Section 3.5 of [RFC4202], such
port-to-port switching is not limited to the optical switching
technology implied by the LSC type. FSC is also similar, but it is
restricted to fiber ports and also supports multiple data channels
within a fiber port.

This document defines a new switching type called Data Channel
Switching Capable (DCSC). Port switching seems a more intuitive
name, but this naming collides with PSC so is not used. DCSC
interfaces are able to support switching of the whole digital channel
presented on single channel interfaces. Interfaces that inherently
support multiple channels, e.g., Wavelength Division Multiplexing
(WDM) and channelized TDM interfaces, are specifically excluded from
this type. Any interface that can be represented as a single digital
channel are included. Examples include concatenated TDM and line-
encoded interfaces. Framed interfaces may also be included when they
support switching on an interface granularity, for example Ethernet
terminated at the physical (port) level and all traffic received on a
port is switched to a physical port at the LSP egress.

DCSC is represented in GMPLS, see [RFC3471] and [RFC4202], using the
value 125. The DCSC value is carried in routing protocols in the
Interface Switching Capability Descriptor defined in [RFC4202], and
used in OSPF [RFC4203] and IS-IS [RFC5307]. These documents are not
otherwise modified by this document.

The DCSC Switching Type may be used with the Generalized Label
Request object, [RFC3473], or the Generalized Channel_Set
LABEL_REQUEST object defined below. Port labels, as defined in
[RFC3471], SHOULD be used for LSPs signaled using the DCSC Switching
Type.

2.1. Compatibility

Transit and egress nodes that do not support the DCSC Switching Type
when receiving a Path message with a Label Request containing the
DCSC Switching Type will behave in the same way nodes generally
handle the case of an unsupported Switching Type. Specifically, per
[RFC3473], such nodes are required to generate a PathErr message,
with a "Routing problem/Unsupported Encoding" indication.

Ingress nodes initiating a Path message containing a Label Request
containing the DCSC Switching Type, receiving such a PathErr
messages, then notify the requesting application user as appropriate.

3. Generalized Channel_Set Label Related Formats

This section defines a new type of generalized label and updates
related objects. This section updates the label-related definitions
of [RFC3473]. The ability to communicate more than one label as part
of the same LSP was motivated by the support for the communication of
one or more VLAN IDs. Simple concatenation of labels as is done in
[RFC4606] was deemed impractical given the large number of VLAN IDs
(up to 4096) that may need to be communicated. The formats defined
in this section are not technology specific and may be useful for
other switching technologies. The LABEL_SET object defined in
[RFC3473] serves as the foundation for the defined formats.

3.1. Generalized Channel_Set LABEL_REQUEST Object

The Generalized Channel_Set LABEL_REQUEST object is used to indicate
that the Generalized Channel_Set LABEL object is to be used with the
associated LSP. The format of the Generalized Channel_Set
LABEL_REQUEST object is the same as the Generalized LABEL_REQUEST
object and uses a C-Type of 5.

3.2. Generalized Channel_Set LABEL Object
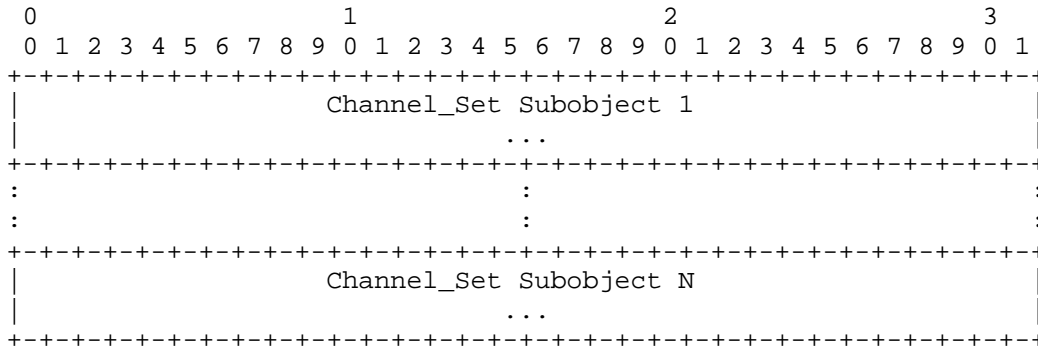
The Generalized Channel_Set LABEL Object communicates one or more
labels, all of which can be used equivalently in the data path
associated with a single LSP. The format of the Generalized
Channel_Set LABEL Object is based on the LABEL_SET object defined in
[RFC3473]. It differs from the LABEL_SET object in that the full set
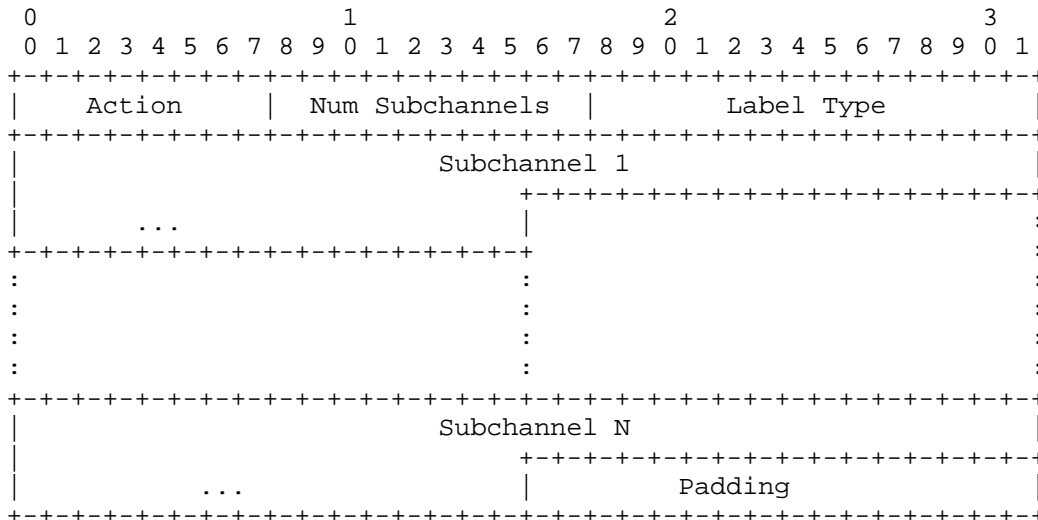may be represented in a single object rather than the multiple

objects required by the [RFC3473] LABEL_SET object. The object MUST
be used on LSPs that use the Generalized Channel_Set LABEL_REQUEST
object. The object MUST be processed per [RFC3473]. Make-before-
break procedures, see [RFC3209], SHOULD be used when modifying the
Channel_Set LABEL object.

The format of the Generalized Channel_Set LABEL object is:

o Generalized Channel_Set LABEL object: Class = 16, C-Type = 4

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                  Channel_Set Subobject 1                      |
   |                          ...                                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   :                              :                                :
   :                              :                                :
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                  Channel_Set Subobject N                      |
   |                          ...                                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The Channel_Set Subobject size is measured in bytes and MUST always
be a multiple of 4, and at least 4, and has the following format:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Action     |  Num Subchannels  |         Label Type        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        Subchannel 1                           |
   |                          +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      ...                 |                                    :
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+                                    :
   :                              :                                :
   :                              :                                :
   :                              :                                :
   :                              :                                :
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        Subchannel N                           |
   |                          +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      ...                 |              Padding               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Action: 8 bits

   See [RFC3471] for definition of actions. Range actions SHOULD be
   used when possible to minimize the size of the Channel_Set LABEL
   Object.

Number of Subchannels: 10 bits

   Indicates the number of subchannels carried in the subobject.
   When the number of subchannels required exceeds the limit of the
   field, i.e., 1024, multiple Channel_Set Subobjects MUST be used.
   Note that the size of the subobject may result in a Path message
   being larger than a single unfragmented IP packet. See Section
   4.4 of [RFC6004] for an example of how this case may be handled.

   A value of zero (0) has special meaning and MAY be used in either
   the LABEL or UPSTREAM_LABEL object. A value of zero (0) is used
   in a LABEL or UPSTREAM_LABEL object to indicate that the
   subchannel(s) used in the corresponding (downstream or upstream)
   direction MUST match the subchannel(s) carried in the reverse
   directions label object. When value of zero (0) is used, no
   subchannels are included in the Channel_Set Subobject and only one
   Channel_Set Subobject may be present. The zero (0) value MUST NOT
   be used in both the LABEL and UPSTREAM_LABEL objects of the same
   LSP. Note that unacceptable label values continue to be handled
   according to [RFC3209] and [RFC3473], i.e., they result in PathErr
   or ResvErr messages with a "Routing problem/Unacceptable label
   value" indication. For example, in the case where a Resv message
   containing a zero (0) in both the LABEL and UPSTREAM_LABEL objects
   is received, the node would generate a ResvErr message.

Label Type: 14 bits

   See [RFC3473] for a description of this field.

Subchannel: Variable

   See [RFC3471] for a description of this field. Note that this
   field might not be 32-bit aligned.

Padding: Variable

   Padding is used to ensure that the length of a Channel_Set
   Subobject meets the multiple of 4 byte size requirement stated
   above. The field is only required when the Subchannel field is
   not 32-bit aligned and the number of included Subchannel fields
   result in the Subobject not being 32-bit aligned.

The Padding field MUST be included when the number of bits
represented in all the Subchannel fields included in a Generalized
Channel_Set Subobject result in the Subobject not being 32-bit
aligned. When present, the Padding field MUST have a length that
results in the Subobject being 32-bit aligned. When present, the
Padding field MUST be set to a zero (0) value on transmission and
MUST be ignored on receipt. These bits SHOULD be passed through
unmodified by transit nodes.

Note that the overall length of a Channel_Set Subobject is
determined based on the value of the Num Subchannels field
together with the size of each Subchannel field as well as any
required padding. The size of the Subchannel field is uniquely
identified by the Label Type field.

3.3. Other Label-Related Objects

The previous section introduced a new LABEL object. As such the
formats of the other label-related objects and subobjects are also
impacted. Processing of these objects and subobjects is not modified
and remains per their respective specifications. The other label
related objects and subobjects are defined in [RFC3473] and include:

    - SUGGESTED_LABEL object
    - LABEL_SET object
    - ACCEPTABLE_LABEL_SET object
    - UPSTREAM_LABEL object
    - RECOVERY_LABEL object
    - Label ERO subobject
    - Label RRO subobject

The label-related objects and subobjects each contain a Label field,
all of which may carry any label type. As any label type may be
carried, the introduction of a new label type means that the new
label type may be carried in the Label field of each of the label-
related objects and subobjects. No new definition needs to specified
as their original specification is label-type agnostic.

3.4. Compatibility

Transit and egress nodes that do not support the Generalized
Channel_Set Label related formats will first receive a Path message
containing Generalized Channel_Set LABEL_REQUEST object. When such a
node receives the Path message, per [RFC3209], it will send a PathErr
with the error code "Unknown object C_Type".

Ingress nodes initiating a Path message containing a Generalized
Channel_Set LABEL_REQUEST object on receiving such a PathErr
messages, then notify the requesting application user as appropriate.

4. IANA Considerations

IANA has assigned new values for namespaces defined in this document
and summarized in this section. The registries are available from
http://www.iana.org.

4.1. Data Channel Switching Type

IANA has made the following assignment in the "Switching Types"
section of the "GMPLS Signaling Parameters" registry.

Value	Type	Reference
125	Data Channel Switching Capable (DCSC)	[RFC6002]

The assigned value is reflected in IANAGmplsSwitchingTypeTC of the
IANA-GMPLS-TC-MIB available from http://www.iana.org.

4.2. Generalized Channel_Set LABEL_REQUEST Object

IANA has made the following assignment in the "Class Names, Class
Numbers, and Class Types" section of the "RSVP PARAMETERS" registry.

A new class type for the existing LABEL_REQUEST Object class number
(19) with the following definition:

    Class Types or C-Types:

      5 Generalized Channel_Set   [RFC6002]

4.3. Generalized Channel_Set LABEL Object

IANA has made the following assignment in the "Class Names, Class
Numbers, and Class Types" section of the "RSVP PARAMETERS" registry.

A new class type for the existing RSVP_LABEL Object class number (16)
with the following definition:

    Class Types or C-Types:

      4 Generalized Channel_Set   [RFC6002]

5. Security Considerations

   This document introduces new message object formats for use in GMPLS
   signaling [RFC3473]. It does not introduce any new signaling
   messages, nor change the relationship between LSRs that are adjacent
   in the control plane. As such, this document introduces no
   additional security considerations. See [RFC3473] for relevant
   security considerations. Additionally, the existing framework for
   MPLS and GMPLS security is documented in [RFC5920].

6. References

6.1. Normative References

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6.2. Informative References

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              for Metro Ethernet Forum and G.8011 User Network Interface
              (UNI)", RFC 6005, October 2010.

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