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Ethernet Traffic Parameters with Availability Information
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Abstract

   A packet switching network may contain links with variable
   bandwidth, e.g., copper, radio, etc. The bandwidth of such links is
   sensitive to external environment (e.g., climate). Availability is
   typically used for describing these links when doing network
   planning. This document introduces an optional Bandwidth
   Availability TLV in Resource ReSerVation Protocol - Traffic Engineer
   (RSVP-TE) signaling. This extension can be used to set up a
   Generalized Multi-Protocol Label Switching (GMPLS) Label Switched
   Path (LSP) in conjunction with the Ethernet SENDER_TSPEC object.

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Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
"OPTIONAL" in this document are to be interpreted as described in
BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all
capitals, as shown here.

The following acronyms are used in this draft:

RSVP-TE Resource Reservation Protocol-Traffic Engineering

LSP   Label Switched Path

SNR   Signal-to-noise Ratio

TLV   Type Length Value

LSA   Link State Advertisement

1. Introduction

The RSVP-TE specification [RFC3209] and GMPLS extensions [RFC3473]
specify the signaling message including the bandwidth request for
setting up a Label Switched Path in a packet switching network.

Some data communication technologies allow seamless change of
maximum physical bandwidth through a set of known discrete values.
The parameter availability [G.827], [F.1703], [P.530] is often used
to describe the link capacity during network planning. The
availability is based on a time scale, which is a proportion of the
operating time that the requested bandwidth is ensured. A more
detailed example on the bandwidth availability can be found in
Appendix A. Assigning different bandwidth availability classes to
different types of services over such kind of links provides for a
more efficient planning of link capacity. To set up an LSP across
these links, bandwidth availability information is required for the
nodes to verify bandwidth satisfaction and make bandwidth
reservation. The bandwidth availability information should be
inherited from the bandwidth availability requirements of the
services expected to be carried on the LSP. For example, voice
service usually needs "five nines" bandwidth availability, while
non-real time services may adequately perform at four or three nines
bandwidth availability. Since different service types may need
different availabilities guarantees, multiple <availability,
bandwidth> pairs may be required when signaling.

If the bandwidth availability requirement is not specified in the
signaling message, the bandwidth will likely be reserved as the
highest bandwidth availability. Suppose, for example, the bandwidth
with 99.999% availability of a link is 100 Mbps; the bandwidth with
99.99% availability is 200 Mbps. When a video application makes a
request for 120 Mbps without bandwidth availability requirement, the
system will consider the request as 120 Mbps with 99.999% bandwidth
availability, while the available bandwidth with 99.999% bandwidth
availability is only 100 Mbps, therefore the LSP path cannot be set
up. But, in fact, the video application doesn't need 99.999%
bandwidth availability; 99.99% bandwidth availability is enough. In
this case, the LSP could be set up if bandwidth availability is also
specified in the signaling message.

To fulfill LSP setup by signaling in these scenarios, this document
specifies a Bandwidth Availability TLV. The Bandwidth Availability
TLV can be applicable to any kind of physical links with variable
discrete bandwidth, such as microwave or DSL. Multiple Bandwidth
Availability TLVs together with multiple Ethernet Bandwidth Profiles
can be carried by the Ethernet SENDER_TSPEC object [RFC6003]. Since
the Ethernet FLOWSPEC object has the same format as the Ethernet
SENDER_TSPEC object [RFC6003], the Bandwidth Availability TLV can
also be carried by the Ethernet FLOWSPEC object.

2. Overview

A tunnel in a packet switching network may span one or more links in
a network. To setup a Label Switched Path (LSP), a node may collect
link information which is advertised in a routing message, e.g.,
OSPF TE LSA message, by network nodes to obtain network topology
information, and then calculate an LSP route based on the network
topology. The calculated LSP route is signaled using a PATH/RESV
message for setting up the LSP.

In case that there is (are) link(s) with variable discrete bandwidth
in a network, a <bandwidth, availability> requirement list should be
specified for an LSP at setup. Each <bandwidth, availability> pair
in the list means the listed bandwidth with specified availability
is required. The list could be derived from the results of service
planning for the LSP.

A node which has link(s) with variable discrete bandwidth attached
should contain a <bandwidth, availability> information list in its
OSPF TE LSA messages. The list provides the mapping between the link
nominal bandwidth and its availability level. This information can
then be used for path calculation by the node(s). The routing
extension for availability can be found in [RFC8330].

When a node initiates a PATH/RESV signaling to set up an LSP, the
PATH message should carry the <bandwidth, availability> requirement
list as a bandwidth request. Intermediate node(s) will allocate the
bandwidth resource for each availability requirement from the
remaining bandwidth with corresponding availability. An error
message may be returned if any <bandwidth, availability> request
cannot be satisfied.

3. Extension to RSVP-TE Signaling

3.1. Bandwidth Availability TLV

A Bandwidth Availability TLV is defined as a TLV of the Ethernet
SENDER_TSPEC object [RFC6003] in this document. The Ethernet
SENDER_TSPEC object MAY include more than one Bandwidth Availability
TLV. The Bandwidth Availability TLV 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Type             |              Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Index     |                 Reserved                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Availability                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
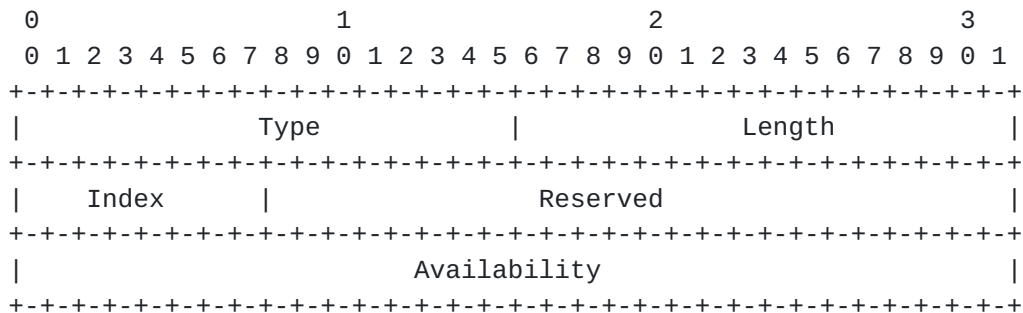
Figure 1: Bandwidth Availability TLV

Type (2 octets): 0x04(suggested; TBD by IANA)

Length (2 octets): 0x0C. Indicates the length in bytes of the
whole TLV including the Type and Length fields, in this case 12
bytes.

Index (1 octet):

When the Bandwidth Availability TLV is included, the Ethernet
Bandwidth Profile TLV MUST also be included. If there are multiple
bandwidth requirements present (in multiple Ethernet Bandwidth
Profile TLVs) and they have different availability requirements,
multiple Bandwidth Availability TLVs MUST be carried. In such a
case, the Bandwidth Availability TLV has a one to one
correspondence with the Ethernet Bandwidth Profile TLV by having
the same value of Index field. If all the bandwidth requirements
in the Ethernet Bandwidth Profile have the same Availability
requirement, one Bandwidth Availability TLV SHOULD be carried. In
this case, the Index field is set to 0.

Reserved (3 octets): These bits SHOULD be set to zero when sent
and MUST be ignored when received.

Availability (4 octets): a 32-bit floating-point number in binary
interchange format [IEEE754] describes the decimal value of the
availability requirement for this bandwidth request. The value

MUST be less than 1 and is usually expressed in the value of
0.99/0.999/0.9999/0.99999. The IEEE floating-point number is used
here to align with [RFC8330]. However when representing values
higher than 0.999999, the floating-point number starts to
introduce errors in relation to intended precision. However in
reality, 0.99999 is normally considered as the highest
availability value (5 minutes outage in a year) in telecom
network, therefore the use of floating-point number in
availability is acceptable.

3.2. Signaling Process

The source node initiates a PATH message which may carry a number of
bandwidth requests, including one or more Ethernet Bandwidth Profile
TLVs and one or more Bandwidth Availability TLVs. Each Ethernet
Bandwidth Profile TLV corresponds to an availability parameter in
the associated Bandwidth Availability TLV.

The intermediate and destination nodes check whether they can
satisfy the bandwidth requirements by comparing each bandwidth
request inside the SENDER_TSPEC objects with the remaining link sub-
bandwidth resource with respective availability guarantee on the
local link when the PATH message is received.

   o   When all <bandwidth, availability> requirement requests can
       be satisfied (the requested bandwidth under each availability
       parameter is smaller than or equal to the remaining bandwidth
       under the corresponding availability parameter on its local
       link), the node SHOULD reserve the bandwidth resource from each
       remaining sub-bandwidth portion on its local link to set up
       this LSP. Optionally, a higher availability bandwidth can be
       allocated to a lower availability request when the lower
       availability bandwidth cannot satisfy the request.

   o   When at least one <bandwidth, availability> requirement
       request cannot be satisfied, the node SHOULD generate PathErr
       message with the error code "Admission Control Error" and the
       error value "Requested Bandwidth Unavailable" (see [RFC2205]).

When two LSPs request bandwidth with the same availability
requirement, contention MUST be resolved by comparing the node IDs,
with the LSP with the higher node ID being assigned the reservation.
This is consistent with general contention resolution mechanism
provided in section 4.2 of [RFC3471].

When a node does not support the Bandwidth Availability TLV, the
node should send a PathErr message with error code "Unknown

Attributes TLV", as specified in [RFC5420]. An LSP could also be set up in this case if there's enough bandwidth (the availability level of the reserved bandwidth is unknown). When a node receives Bandwidth Availability TLVs with a mix of zero index and non-zero index, the message MUST be ignored and MUST NOT be propagated. When a node receives Bandwidth Availability TLVs (non-zero index) with no matching index value among the bandwidth-TLVs, the message MUST be ignored and MUST NOT be propagated. When a node receives several <bandwidth, availability> pairs, but there are extra bandwidth-TLVs without matching the index of any Availability-TLV, the extra bandwidth-TLVs MUST be ignored and MUST NOT be propagated.

4. Security Considerations

This document defines a Bandwidth Availability TLV in RSVP-TE signaling used in GMPLS networks. [RFC3945] notes that authentication in GMPLS systems may use the authentication mechanisms of the component protocols. [RFC5920] provides an overview of security vulnerabilities and protection mechanisms for the GMPLS control plane. Especially section 7.1.2 of [RFC5920] discusses the control-plane protection with RSVP-TE by using general RSVP security tools, limiting the impact of an attack on control-plane resources, and authentication for RSVP messages. Moreover, the GMPLS network is often considered to be a closed network such that insertion, modification, or inspection of packets by an outside party is not possible.

5. IANA Considerations

IANA maintains registries and sub-registries for RSVP-TE used by GMPLS. IANA is requested to make allocations from these registries as set out in the following sections.

5.1 Ethernet Sender TSpec TLVs

IANA maintains a registry of GMPLS parameters called "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Parameters".

IANA has created a sub-registry called "Ethernet Sender TSpec TLVs / Ethernet Flowspec TLVs" to contain the TLV type values for TLVs carried in the Ethernet SENDER_TSPEC object. The sub-registry needs to be updated to include the Bandwidth Availability TLV which is defined as follow. This document proposes a suggested value for the Availability sub-TLV; it is requested that the suggested value be granted by IANA.

   Type   Description   Reference

   -----   --------------------   ---------

   0x04   Bandwidth Availability   [This ID]

   (Suggested; TBD by IANA)

   The registration procedure for this registry is Standards Action as
   defined in [RFC8126].

6. References

6.1. Normative References

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7. Appendix: Bandwidth Availability Example

In a mobile backhaul network, microwave links are very popular for
providing connections of last hops. In case of heavy rain
conditions, to maintain the link connectivity, the microwave link
may lower the modulation level since moving to a lower modulation
level provides for a lower Signal-to-Noise Ratio (SNR) requirement.
This is called adaptive modulation technology [EN 302 217]. However,
a lower modulation level also means lower link bandwidth. When link
bandwidth is reduced because of modulation down-shifting, high-

priority traffic can be maintained, while lower-priority traffic is dropped. Similarly, copper links may change their link bandwidth due to external interference.

Presuming that a link has three discrete bandwidth levels:

The link bandwidth under modulation level 1, e.g., QPSK, is 100 Mbps;

The link bandwidth under modulation level 2, e.g., 16QAM, is 200 Mbps;

The link bandwidth under modulation level 3, e.g., 256QAM, is 400 Mbps.

On a sunny day, the modulation level 3 can be used to achieve 400 Mbps link bandwidth.

A light rain with X mm/h rate triggers the system to change the modulation level from level 3 to level 2, with bandwidth changing from 400 Mbps to 200 Mbps. The probability of X mm/h rain in the local area is 52 minutes in a year. Then the dropped 200 Mbps bandwidth has 99.99% availability.

A heavy rain with Y(Y>X) mm/h rate triggers the system to change the modulation level from level 2 to level 1, with bandwidth changing from 200 Mbps to 100 Mbps. The probability of Y mm/h rain in the local area is 26 minutes in a year. Then the dropped 100 Mbps bandwidth has 99.995% availability.

For the 100M bandwidth of the modulation level 1, only the extreme weather condition can cause the whole system to be unavailable, which only happens for 5 minutes in a year. So the 100 Mbps bandwidth of the modulation level 1 owns the availability of 99.999%.

There are discrete buckets per availability level. Under the worst weather conditions, there's only 100 Mbps capacity and that's 99.999% available. It's treated as effectively "always available" since there's no way to do any better. If the weather is bad but not the worst weather, modulation level 2 can be used, which gets an additional 100 Mbps bandwidth (i.e., 200 Mbps total), so there are 100 Mbps in the 99.999% bucket and 100 Mbps in the 99.995% bucket. In clear weather, modulate level 3 can be used to get 400 Mbps total, but that's only 200 Mbps more than at modulation level 2, so 99.99% bucket has that "extra" 200 Mbps, and the other two buckets still have their 100 Mbps each.

Therefore, the maximum bandwidth is 400 Mbps. According to the
weather condition, the sub-bandwidth and its availability are shown
as follows:

Sub-bandwidth (Mbps)   Availability

------------------   ------------

200   99.99%

100   99.995%

100   99.999%

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