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Ethernet Traffic Parameters with Availability Information

Abstract

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

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1. Introduction

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

Some data communication technologies allow a seamless change of the 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 of bandwidth availability can be found in Appendix A. Assigning different bandwidth availability classes to different types of services over links with variable discrete bandwidth 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 a 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 99.999% bandwidth availability, while non-real-time services may adequately perform at 99.99% or 99.9% bandwidth availability. Since different service types may need different availability 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, and the bandwidth with 99.99% availability is 200 Mbps. When a video application makes a request for 120 Mbps without a 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. However, 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 the bandwidth availability is also specified in the signaling message.

To fulfill an 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 link with variable discrete bandwidth, such as microwave or DSL. Multiple Bandwidth Availability TLVs, together with multiple Ethernet

Bandwidth Profile TLVs, 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.

1.1. 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 document:

RSVP-TE Resource Reservation Protocol - Traffic Engineering

LSP Label Switched Path

SNR Signal-to-Noise Ratio

TLV Type-Length-Value

LSA Link State Advertisement

QAM Quadrature Amplitude Modulation

QPSK Quadrature Phase Shift Keying

2. Overview

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

If a network contains one or more links with variable discrete bandwidths, 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 can be derived from the results of service planning for the LSP.

A node that 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 resources for each availability requirement from the remaining bandwidth with the 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): 4

Length (2 octets): 0x0C. Indicates the length in bytes of the whole TLV, including the Type and Length fields. In this case, the length is 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 as both have the same value in the Index field. If all the bandwidth requirements in the Ethernet Bandwidth Profile TLV 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 as one of the following values: 0.99, 0.999, 0.9999, or 0.99999. The IEEE floating-point number is used here to align with [RFC8330]. When representing values higher than 0.999999, the floating-point number starts to introduce errors to intended precision. However, in reality, 0.99999 is normally considered the highest availability value (which results in 5 minutes of outage in a year) in a telecom network. Therefore, the use of a floating-point number for 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.

When the intermediate and destination nodes receive the PATH message, the nodes compare the requested bandwidth under each availability level in the SENDER_TSPEC objects, with the remaining link bandwidth resources under a corresponding availability level on a local link, to check if they can meet the bandwidth requirements.

- o When all <bandwidth, availability> requirement requests can be satisfied (that is, 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 resources 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 a 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, the contention MUST be resolved by comparing the node IDs, where the LSP with the higher node ID is assigned the reservation. This is consistent with the 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 (note that the availability level of the reserved bandwidth is unknown). When a node receives Bandwidth Availability TLVs with a mix of zero and non-zero indexes, 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 Ethernet Bandwidth Profile TLVs, the message MUST be ignored and MUST NOT be propagated. When a node receives several <bandwidth, availability> pairs, but there are extra Ethernet Bandwidth Profile TLVs that do not match the index of any Bandwidth Availability TLV, the extra Ethernet Bandwidth Profile 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. In particular, 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 using 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 a registry of GMPLS parameters called the "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Parameters" registry. This registry includes the "Ethernet Sender TSpec TLVs/ Ethernet Flowspec TLVs" subregistry that contains the TLV type values for TLVs carried in the Ethernet SENDER_TSPEC object. This subregistry has been updated to include the Bandwidth Availability TLV:

Type	Description	Reference
4	Bandwidth Availability	RFC 8625

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Appendix A. Bandwidth Availability Example

In mobile backhaul networks, microwave links are very popular for providing connections of last hops. To maintain link connectivity in heavy rain conditions, the microwave link may lower the modulation level since moving to a lower modulation level provides for a lower SNR requirement. This is called "adaptive modulation" technology [EN-302-217]. However, a lower modulation level also means a lower link bandwidth. When a link bandwidth is reduced because of modulation downshifting, high-priority traffic can be maintained, while lower-priority traffic is dropped. Similarly, copper links may change their link bandwidth due to external interference.

Presume that a link has three discrete bandwidth levels:

- o The link bandwidth under modulation level 1 (e.g., QPSK) is 100 Mbps.
- o The link bandwidth under modulation level 2 (e.g., 16QAM) is 200 Mbps.
- o The link bandwidth under modulation level 3 (e.g., 256QAM) is 400 Mbps.

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

Light rain with a X mm/h rate triggers the system to change the modulation level from level 3 to level 2, with the 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.

Heavy rain with a Y(Y>X) mm/h rate triggers the system to change the modulation level from level 2 to level 1, with the 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 100 Mbps bandwidth of modulation level 1, only extreme weather conditions 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, which is 99.999% available. It's treated effectively as "always available" since better availability is not possible. If the weather is bad but not the worst possible conditions, modulation level 2 can be used, which gets an additional 100 Mbps bandwidth (i.e., 200 Mbps total). Therefore, 100 Mbps is in the 99.999% bucket, and 100 Mbps is in the 99.995% bucket. In clear weather, modulation level 3 can be used to get 400 Mbps total, but that's only 200 Mbps more than at modulation level 2, so the 99.99% bucket has that "extra" 200 Mbps, and the other two buckets still have 100 Mbps each.

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

Sub-bandwidth (Mbps)	Availability
200	99.99%
100	99.995%
100	99.999%

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