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Generalized Multiprotocol Label Switching Extensions to Control Non-Standard SONET and SDH Features

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Abstract

This document is a companion to the Generalized Multiprotocol Label Switching (GMPLS) signaling extensions to control SONET and SDH that define the SONET/SDH technology specific information needed when using GMPLS signaling.

This informational document defines GMPLS signaling extensions to control four optional non-standard (i.e. proprietary) SONET and SDH features: group signals, arbitrary concatenation, virtual concatenation of contiguously concatenated signals and per byte transparency.

1. Introduction

Generalized MPLS (GMPLS) [GMPLS-ARCH] extends MPLS from supporting packet (Packet Switching Capable - PSC) interfaces and switching to include support of four new classes of interfaces and switching: Layer-2 Switch Capable (L2SC), Time-Division Multiplex (TDM), Lambda Switch Capable (LSC) and Fiber-Switch Capable (FSC).

A functional description of the extensions to MPLS signaling needed to support the new classes of interfaces and switching is provided in [GMPLS-SIG]. [GMPLS-RSVP] describes RSVP-TE specific formats and mechanisms needed to support all five classes of interfaces, and CR-LDP extensions can be found in [GMPLS-LDP].

[GMPLS-SONET-SDH] presents details that are specific to SONET/SDH. Per [GMPLS-SIG], SONET/SDH specific parameters are carried in the signaling protocol in traffic parameter specific objects.

This informational document defines GMPLS signaling extensions to control four optional non-standard (i.e. proprietary) SONET/SDH features: group signals (section 2), arbitrary concatenation (section 3), virtual concatenation of contiguously concatenated signals (section 4), and per byte transparency (section 5). Section 6 gives examples of SONET/SDH traffic parameters (also referred to as signal coding) when requesting a SONET/SDH LSP.

Such features are already implemented or under development by a significant number of manufacturers. For instance, arbitrary concatenation is already implemented in many legacy SONET and SDH equipment that don't support any byte-oriented protocol based control plane.

This document doesn't specify how to implement these features in the transmission plane but how to control their usage with a GMPLS control plane.

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. Signal Type Values Extension For Group Signals

This section defines the following optional additional Signal Type values for the Signal Type field of section 2.1 of [GMPLS-SONET-SDH]:

```
    Value         Type
    -----  ---------------------
     13     VTG      / TUG-2
     14                TUG-3
     15     STSG-3   / AUG-1
     16     STSG-12  / AUG-4
     17     STSG-48  / AUG-16
     18     STSG-192 / AUG-64
     19     STSG-768 / AUG-256
```

Administrative Unit Group-Ns (AUG-Ns) and STS Groups-3*Ns (STSG-Ms), are logical objects defined as a collection of AU-3s/STS-1 SPEs, AU-4s/STS-3c SPEs and/or AU-4-Xcs/STS-3*Xc SPEs (X = 4,16,64,256).

When used as a signal type this means that all the VC-3s/STS-1_SPEs, VC-4s/STS-3c_SPEs or VC-4-Xcs/STS-3*Xc SPEs in the AU-3s/STS-1 SPEs, AU-4s/STS-3c SPEs or AU-4-Xcs/STS-3*Xc SPEs that comprise the AUG-N/STSG-3*N are switched together as one unique signal.

In addition the structure of the VC-3s/STS-1_SPEs, VC-4s/STS-3c_SPEs and VC-4-Xcs/STS-3*Xc_SPEs in the AUG-N/STSG-3*N are preserved and are allowed to change over the life of an AUG-N/STSG-3*N.

It is this flexibility in the relationships between the component VCs or SPEs that differentiates this signal from a set of VC-3s/STS-1_SPEs, VC-4s/STS-3c_SPEs or VC-4-Xcs/STS-3*Xc_SPEs. Whether the AUG-N/STSG-3*N is structured with AU-3s/STS-1 SPEs, AU-4s/STS-3c SPEs and/or AU-4-Xcs/STS-3*Xc SPEs does not need to be specified and is allowed to change over time. The same reasoning applies to TUG-2/VTG and TUG-3 signal types.

For example an STSG-48 could at one time consist of four STS-12c signals and at another point in time of three STS-12c signals and four STS-3c signals.

Note that the use of VTG, TUG-X, AUG-N and STSG-M as circuit types is not described in ANSI and ITU-T standards. These signal types are conceptual objects that intend to designate a group of physical objects in the data plane.

A label for AUG-X and STSG-3*X is assigned following the same rule as for the Standard Contiguous Concatenation (see [GMPLS-SONET-SDH]).

A label for TUG-3 has K>0, L=0 and M=0. A label for VTG and TUG-2 within a VC-3 has K=0, L>0, M=0. A label for TUG-2 within a VC-4 has K>0, L>0, M=0. See [GMPLS-SONET-SDH] for KLM definition.

3. Contiguous Concatenation Extension

This section defines the following optional extension flag for the Requested Contiguous Concatenation (RCC) field defined in section 2.1 of [GMPLS-SONET-SDH]:

Flag 2 (bit 2): Arbitrary contiguous concatenation.

This flag allows an upstream node to signal to a downstream node that it supports arbitrary contiguous concatenation. This type of concatenation is not defined by ANSI or ITU-T.

Arbitrary contiguous concatenation of VC-4/STS-1 SPE/STS-3c SPE allows the contiguous concatenation of respectively any number X of VC-4/STS-1 SPE/STS-3c SPE with X less or equal N, resulting in a VC-4-Xa/STS-1-Xa SPE/STS-3c-Xa SPE signal. In addition, it allows the arbitrary contiguous concatenated signal to start at any location (AU-4/STS-1/STS-3 timeslot) in the STM-N/STS-N signal.

This flag can be setup together with Flag 1 (Standard Contiguous Concatenation) to give a choice to the downstream node. The resulting type of contiguous concatenation can be different at each hop according to the result of the negotiation.

A label is assigned following the same rule as for the Standard Contiguous Concatenation (see [GMPLS-SONET-SDH]).

4. Virtual Concatenation Extension

This section defines the following optional extension for the signals that can be virtually concatenated.

In addition to the elementary signal types, which can be virtual concatenated as described in section 2.1 of [GMPLS-SONET-SDH], identical contiguously concatenated signals may be virtually concatenated. In this last case, it allows for instance to request the virtual concatenation of several VC-4-4c/STS-12c SPEs (i.e. per [GMPLS-SONET-SDH] (STS-3c)-4c SPE), or more generally any VC-4-Xc/STS-3c-Xc SPEs to obtain a VC-4-Xc-Yv/STS-3c-Xc-Yv.

The virtual concatenation can also be applied to arbitrary contiguously concatenated signals to form VC-4-Xa-Yv/STS-1-Xa-Yv

SPE/STS-3c-Xa-Yv SPE. Note that STS-3c-Xa-Yv SPE signal is described only for completeness of the mechanism defined in this document.

The standard definition for virtual concatenation allows each virtual concatenation components to travel over diverse paths. Within GMPLS, virtual concatenation components must travel over the same (component) link if they are part of the same LSP. This is due to the way that labels are bound to a (component) link. Note however, that the routing of components on different paths is indeed equivalent to establishing different LSPs, each one having its own route. Several LSPs can be initiated and terminated between the same nodes and their corresponding components can then be associated together (i.e. virtually concatenated).

In case of virtual concatenation of a contiguously concatenated signal, the same rule as described in section 3 of [GMPLS-SONET-SDH] for virtual concatenation applies, except that a component of the virtually concatenated signal is now a contiguously concatenated signal. The first label indicates the first contiguously concatenated signal; the second label indicates the second contiguously concatenated signal, and so on.

5. Transparency Extension

This section defines the following optional extension for the Transparency field defined in section 2.1 of [GMPLS-SONET-SDH].

This "extended" transparency (simply referred here as transparency) can be requested for a particular SOH/RSOH or MSOH/LOH field in the STM-N/STS-N signal.

Transparency is not applied at the interfaces of the initiating and terminating LSRs, but is only applied between intermediate LSRs. Moreover, the transparency extensions can be implemented effectively in very different ways, e.g. by forwarding the corresponding overhead bytes unmodified, or by tunneling the bytes.

This document specifies neither how transparency is achieved; nor the behavior of the signal at the egress of the transparent network during fault conditions at the ingress of the transparent network or within the transparent network; nor network deployment scenarios. The signaling is independent of these considerations.

When the signaling is used between intermediate nodes it is up to a data plane profile or specification to indicate how transparency is effectively achieved in the data plane. When the signaling is used at the interfaces with the initiating and terminating LSRs it is up to the data plane specification to guarantee compliant behavior to G.707/T1.105 under fault free and fault conditions.

Note that B1 in the SOH/RSOH is computed over the complete previous frame, if one bit changes, B1 must be re-computed. Note that B2 in the LOH/MSOH is also computed over the complete previous frame, except the SOH/RSOH.

When an "extended" transparent STM-N/STS-M (M=1, 3, 12, 48, 192, 768) is requested, the label is coded as for the case of contiguous concatenation, i.e. it is in this case: S>0, U=0, K=0, L=0, M=0.

The different transparency extension flags are the following:

```
Flag 3  (bit 3) : J0.
Flag 4  (bit 4) : SOH/RSOH DCC (D1-D3).
Flag 5  (bit 5) : LOH/MSOH DCC (D4-D12).
Flag 6  (bit 6) : LOH/MSOH Extended DCC (D13-D156).
```

Flag 7 (bit 7) : K1/K2.
Flag 8 (bit 8) : E1.
Flag 9 (bit 9) : F1.
Flag 10 (bit 10): E2.
Flag 11 (bit 11): B1.
Flag 12 (bit 12): B2.
Flag 13 (bit 13): M0.
Flag 14 (bit 14): M1.

Line/Multiplex Section layer transparency (refer to section 2.1 of [GMPLS-SONET-SDH]) can be combined only with any of the following transparency types: J0, SOH/RSOH DCC (D1-D3), E1, F1; and all other transparency flags must be ignored.

Note that the extended LOH/MSOH DCC (D13-D156) is only applicable to (defined for) STS-768/STM-256.

If B1 transparency is requested, this means transparency for the bit error supervision functionality provided by the B1. The B1 contains the BIP8 calculated over the previous RS/Section frame of the STM-N/STS-N signal at the RS/Section termination source. At the RS/Section termination sink the B1 BIP is compared with the local BIP also calculated over the previous RS/Section frame of the STM-N/STS-N. Any difference between the two BIP values is an indication for a bit error that occurred between the termination source and sink. In case of B1 transparency this functionality shall be preserved. This means that a B1 bit error detection as described above performed after the transparent transport (at a RS/Section termination sink) indicates exactly the bit errors that occur between the B1 insertion point (RS/Section termination source) and this point. Any intended changes to the previous RS/Section frame content due to the implementation of the transparency feature (e.g. modifications of the RS/Section overhead, modifications of the payload due to pointer justifications) have to be reflected in the B1 BIP value, it has to be adjusted accordingly.

If B2 transparency is requested, this means transparency for the bit error supervision functionality provided by the B2. The B2 contains the BIP24*N/BIP8*N calculated over the previous MS/Line frame of the STM-N/STS-N signal at the MS/Line termination source. At the MS/Line termination sink the B2 BIP is compared with the local BIP also calculated over the previous MS/Line frame of the STM-N/STS-N. Any difference between the two BIP values is an indication for a bit error that occurred between the termination source and sink. In case of B2 transparency this functionality shall be preserved. This means that a B2 bit error detection as described above performed after the transparent transport (at a MS/Line termination sink) indicates exactly the bit errors that occur between the B2 insertion point (MS/Line termination source) and this point. Any intended changes to the previous MS/Line frame content due to the implementation of the transparency feature (e.g. modifications of the MS/Line overhead, modifications of the payload due to pointer justifications) have to be reflected in the B2 BIP value, it has to be adjusted accordingly.

M1 and M1/M0 transparency are only meaningful when the B2 transparency is requested.

6. Examples

This section defines examples of SONET and SDH signal coding. Their objective is to help the reader to understand how works the traffic parameter coding and not to give examples of typical SONET or SDH signals.

As stated in [GMPLS_SONET_SDH], signal types are Elementary Signals to which successive concatenation, multiplication and transparency transforms can be applied.

1. An STM-64 signal with RSOH and MSOH DCCs transparency is formed by the application of RCC with value 0, NCC with value 0, NVC with value 0, MT with value 1 and T with flag 4 and 5 to an STM-64 Elementary Signal.

2. An STS-192 signal with K1/K2 and LOH DCC transparency is formed by the application of RCC with value 0, NVC with value 0, MT with value 1 and T with flags 5 and 7 to an STS-192 Elementary Signal.

3. An STS-48 signal with LOH DCC and E2 transparency is formed by the application of RCC with flag 0, NCC with value 0, NVC with value 0, MT with value 1 and T with flag 5 and 10 to an STS-48 Elementary Signal.

4. An STS-768 signal with K1/K2 and LOH DCC transparency is formed by the application of RCC with flag 0, NCC with value 0, NVC with value 0, MT with value 1 and T with flag 5 and 7 to an STS-768 Elementary Signal.

5. 4 x STS-12 signals with K1/K2 and LOH DCC transparency is formed by the application of RCC with value 0, NVC with value 0,

MT with value 4 and T with flags 5 and 7 to an STS-12 Elementary

Signal.

6. A VC-4-3a signal is formed by the application of RCC with flag 2 (arbitrary contiguous concatenation), NCC with value 3, NVC with value 0, MT with value 1 and T with value 0 to a VC-4 Elementary Signal.

7. An STS-1-34a SPE signal is formed by the application of RCC with flag 2 (arbitrary contiguous concatenation), NCC with value 34, NVC with value 0, MT with value 1 and T with value 0 to an STS-1 SPE Elementary Signal.

8. 2 x STS-1-4a-5v SPE signal is formed by the application of RCC with flag 2 (for arbitrary contiguous concatenation), NCC with value 4, NVC with value 5, MT with value 2 and T with value 0 to an STS-1 SPE Elementary Signal.

7. Acknowledgments

Valuable comments and input were received from the CCAMP mailing list where outstanding discussions took place.

8. Security Considerations

This draft introduces no new security considerations to [GMPLS-SONET-SDH].

9. Intellectual Property Notice

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10. Normative References

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