Network Working Group
Request for Comments: 3255
Category: Standards Track

N. Jones
Agere Systems
C. Murton
Nortel Networks

April 2002

Extending Point-to-Point Protocol (PPP) over Synchronous Optical NETwork/Synchronous Digital Hierarchy (SONET/SDH) with virtual concatenation, high order and low order payloads

Status of this Memo

Copyright Notice

Abstract

This document describes an extension to the mapping of Point-to-Point Protocol (PPP) into Synchronous Optical NETwork/Synchronous Digital Hierarchy (SONET/SDH) to include the use of SONET/SDH SPE/VC virtual concatenation and the use of both high order and low order payloads.

Table of Contents

1. Introduction

Current implementations of PPP over SONET/SDH are required to select transport structures from the relatively limited number of contiguously concatenated signals that are available.

The only currently supported SONET/SDH SPE/VCs in RFC 2615 [3] are the following:

SONET	SDH
STS-3c-SPE	VC-4
STS-12c-SPE	VC-4-4c
STS-48c-SPE	VC-4-16c
STS-192c-SPE	VC-4-64c

Note that VC-4-4c and above are not widely supported in SDH networks at present.

The use of virtual concatenation means that the right size SONET/SDH bandwidth can be selected for PPP links.

For the convenience of the reader, the equivalent terms are listed below:

SONET	SDH
SPE	VC
VT (1.5/2/6)	Low order VC (VC-11/12/2)
STS SPE	Higher Order VC (VC-3/4/4-Nc)
STS-1 frame	STM-0 frame (rarely used)
STS-1 SPE	VC-3
STS-1-nv	VC-3-nv (virtual concatenation)
STS-1 payload	C-3
STS-3c frame	STM-1 frame, AU-4
STS-3c SPE	VC-4
STS-3c-nv	VC-4-nv (virtual concatenation)
STS-3c payload	C-4
STS-12c/48c/192c frame	STM-4/16/64 frame, AU-4-4c/16c/64c
STS-12c/48c/192c-SPE	VC-4-4c/16c/64c
STS-12c/48c/192c payload	C-4-4c/16c/64c

This table is an extended version of the equivalent table in RFC 2615 [3]. Additional information on the above terms can be found in Bellcore GR-253-CORE [4], ANSI T1.105 [5], ANSI T1.105.02 [6] and ITU-T G.707 [7].

2. Rate Comparisons

Currently supported WAN bandwidth links for PPP over SONET/SDH:

ANSI	ETSI
STS-3c (150Mbit/s)	STM-1 (150Mbit/s)
STS-12c (620Mbit/s)	STM-4 AU-4-4c (620Mbit/s)
STS-48c (2.4Gbit/s)	STM-16 AU-4-16c (2.4Gbit/s)
STS-192c (9.6Gbit/s)	STM-64 AU-4-64c (9.6Gbit/s)

Note that AU-4-4c and AU-4-16c are not generally available in SDH networks at present.

With virtual concatenation the following additional WAN bandwidth links would be available for PPP over SONET/SDH:

SONET

VT-1.5-nv (n=1-64)	1.6Mbit/s-102Mbit/s
STS-1-nv (n=1-64)	49Mbit/s-3.1Gbit/s
STS-3c-nv (n=1-64)	150Mbit/s-10Gbit/s

SDH

VC-12-nv (n=1-64)	2.2Mbit/s-139Mbit/s
VC-3-nv (n=1-64)	49Mbit/s-3.1Gbit/s
VC-4-nv (n=1-64)	150Mbit/s-10Gbit/s

Higher levels of virtual concatenation are possible, but not necessarily useful. Lower levels of virtual concatenation are defined in the telecommunications standards for use if needed.

Table 1 and Table 2, respectively depict the SONET/SDH transport structures that are currently available to carry various popular bit rates. Each table contains three columns. The first column shows the bit rates of the service to be transported.

The next column contains two values:

a) the logical signals that are currently available to provide such transport and, b) in parenthesis, the percent efficiency of the given transport signal without the use of virtual concatenation.

Likewise, the final column also contains two values:

a) the logical signals that are currently available to provide such transport and, b) in parenthesis, the percent efficiency of the given transport signal with the use of virtual concatenation.

Note, that Table 1, contains SONET transport signals with the following effective payload capacity: VT-1.5 SPE = 1.600 Mbit/s, STS-1 SPE = 49.536 Mbit/s, STS-3c SPE = 149.760 Mbit/s, STS-12c SPE = 599.040 Mbit/s, STS-48c SPE = 2,396.160 Mbit/s, and STS-192c SPE = 9,584.640 Mbit/s.

Table 1. SONET Virtual Concatenation

Bit rate	Without	With
10Mbit/s	STS-1 (20%)	VT-1.5-7v (89%)
100Mbit/s	STS-3c (67%)	STS-1-2v (100%)
200Mbit/s	STS-12c(33%)	STS-1-4v (100%)
1Gbit/s	STS-48c(42%)	STS-3c-7v (95%)

Similarly, Table 2, contains SDH transport signals with the following effective payload capacity: VC-12 = 2.176 Mbit/s, VC-3 = 48.960 Mbit/s, VC-4 = 149.760 Mbit/s, VC-4-4c = 599.040 Mbit/s, VC-4-16c = 2,396.160 Mbit/s, and VC-4-64c = 9,584.640 Mbit/s.

Table 2. SDH Virtual Concatenation

Bit rate	Without	With
10Mbit/s	VC-3 (20%)	VC-12-5v (92%)
100Mbit/s	VC-4 (67%)	VC-3-2v (100%)
200Mbit/s	VC-4-4c(33%)	VC-3-4v (100%)
1Gbit/s	VC-4-16c(42%)	VC-4-7v (95%)

3. Physical Layer Requirements

There are two minor modifications to the physical layer requirements as defined in RFC 2615 when virtually concatenated SPEs/VCs are used to provide transport for PPP over SONET/SDH.

First, the path signal label (C2 byte) value for SONET/SDH STS-1/VC-3 and above SPE/VCs is required to be the same for all constituent channels. This is in contrast to the use of a single C2 byte for PPP transport over contiguously concatenated SONET/SDH SPE/VCs. The values used for the C2 bytes should be in accordance with RFC 2615. For SONET VT-1.5/2/6 and SDH VC-11/12/2 the path signal label (V5 byte bits 5-7) is required to be the same for all constituent channels per ITU-T G.707 [7] and ANSI T1.105.02 [6].

Second, for SONET/SDH STS-1/VC-3 and above SPE/VCs the multi-frame indicator (H4) byte will be unused for transport links utilizing contiguously concatenated SONET/SDH SPE/VCs. When the concatenation scheme is virtual as opposed to contiguous, the H4 byte must be populated as per ITU-T G.707 or T1.105.02. Similarly, for virtual concatenation based on SONET VT-1.5/2/6 and SDH VC-11/12/2 channels bit 2 of the path overhead K4 byte will be set to the value indicated per ITU-T G.707 [7] and ANSI T1.105.02 [6].

4. Standards Status

ITU-T (SG13/SG15), ANSI T1X1 and ETSI TM1/WP3 have developed a global standard for SONET/SDH High Order and Low Order payload Virtual Concatenation. This standard is defined in the following documents:

ITU-T G.803 Architecture of transport networks based on the synchronous digital hierarchy (SDH)

ITU-T G.707 Network Node Interface for the Synchronous Digital Hierarchy (SDH)

ITU-T G.783 Characteristics of Synchronous Digital Hierarchy (SDH) Equipment Functional Blocks

ANSI T1.105 Synchronous Optical Network (SONET) - Basic Description including Multiplex Structure, Rates and Formats

ANSI T1.105.02 Synchronous Optical Network (SONET) - Payload Mappings

ETSI EN 300 417-9-1 Transmission and Multiplexing (TM) Generic requirements of transport functionality of equipment Part 9: Synchronous Digital Hierarchy (SDH) concatenated path layer functions. Subpart 1: Requirements

Work in ITU-T, ANSI T1X1 and ETSI TM1/WP3 has ensured global standards alignment.

With the completion of a standard for SONET/SDH SPE/VC virtual concatenation it is appropriate to document the use of this standard for PPP transport over SONET/SDH, which is the intent of this document.

5. Security Considerations

The security discussion in RFC 2615 also applies to this document. No new security features have been explicitly introduced or removed compared to RFC 2615.

6. References

[1] Simpson, W., "The Point-to-Point Protocol (PPP)", STD 51, RFC 1661, July 1994.

[2] Simpson, W., "PPP in HDLC-like Framing", STD 51, RFC 1662, July 1994.

[3] Malis, A. and W. Simpson, "PPP over SONET/SDH RFC 2615, June 1999.

[4] Bellcore Publication GR-253-Core "Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria" January 1999

[5] American National Standards Institute, "Synchronous Optical Network (SONET) - Basic Description including Multiplex Structure, Rates and Formats" ANSI T1.105-1995

[6] American National Standards Institute, "Synchronous Optical Network (SONET) - Payload Mappings" ANSI T1.105.02-1998

[7] ITU-T Recommendation G.707 "Network Node Interface for the Synchronous Digital Hierarchy" 1996

7. Acknowledgements

We would like to acknowledge Huub van Helvoort, Maarten Vissers (Lucent Technologies), Paul Langner (Lucent Microelectronics), Trevor Wilson (Nortel Networks), Mark Carson (Nortel Networks) and James McKee (Nortel Networks) for their contribution to the development of virtual concatenation of SONET/SDH payloads.

8. Authors' Addresses

Nevin Jones
Agere Systems
Broadband IC Systems Architecture
Rm. 7E-321
600 Mountain Avenue
Murray Hill, NJ 07974

EMail: nrjones@agere.com

Chris Murton
Nortel Networks Harlow Laboratories
London Road, Harlow,
Essex, CM17 9NA UK

EMail: murton@nortelnetworks.com

9. Full Copyright Statement

Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.