         MAPOS - Multiple Access Protocol over SONET/SDH Version 1

Status of this Memo

Authors' Note

   This memo documents a multiple access protocol for transmission of
   network-protocol datagrams, encapsulated in High-Level Data Link
   Control (HDLC) frames, over SONET/SDH. This document is NOT the
   product of an IETF working group nor is it a standards track
   document. It has not necessarily benefited from the widespread and
   in depth community review that standards track documents receive.

Abstract

   This document describes the protocol MAPOS, Multiple Access Protocol
   over SONET/SDH, for transmitting network-protocol datagrams over
   SONET/SDH. It focuses on the core protocol -- other documents listed
   in the bibliography may be referenced in conjunction with this
   document to provide support and services for protocols at higher
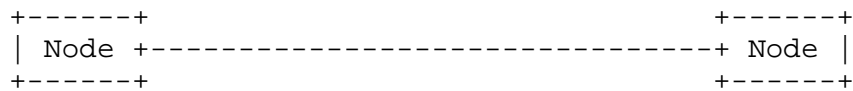   layers.

1. Introduction

1.1 SONET/SDH

   The Synchronous Optical Network/Synchronous Digital Hierarchy
   (SONET/SDH) [1][2][3][4] family of ITU-T standard protocols are
   designed to provide common, simple, and flexible interface for
   broadband optical fiber transmission systems. It enables direct
   octet-synchronous multiplexing of lower rate tributaries.
   SONET/SDH-compliant transmission systems are widely deployed by
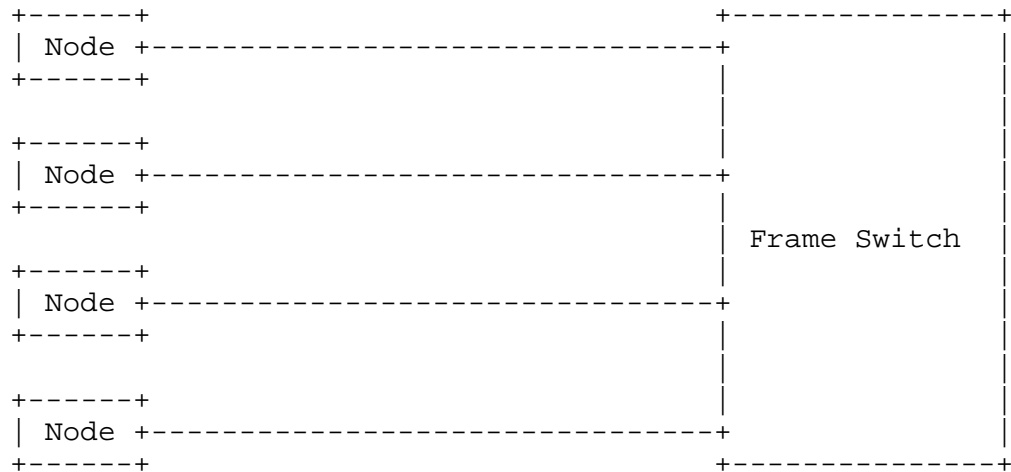   telephone carriers world wide.

   This document defines the MAPOS protocol -- a method for transmitting
   HDLC frames over SONET/SDH. The protocol provides multiple access
   capability to SONET/SDH, an inherently point-to-point link. This
   enables construction of seamless networking environment using
   SONET/SDH as transmission media for both LAN and WAN.

1.2 Possible Configurations

   The MAPOS protocol provides multiple access, broadcast / multicast-
   capable switched LAN environment using SONET/SDH lines as
   transmission media. Possible configurations of MAPOS system are
   shown in the following diagrams. In (a), two end nodes are connected
   to each other. Figure (b) shows a star-topology "SONET-LAN" where
   multiple end nodes are connected to an HDLC frame switch. The frame
   switch forwards packets between nodes and provides multiple access
   capability. In (c), multiple frame switches are linked together,
   creating a switching cluster.

```
            +------+                             +------+
            | Node +-----------------------------+ Node |
            +------+                             +------+

                  (a) Point-to-Point configuration
```

```
        +------+                              +--------------+
        | Node +------------------------------+              |
        +------+                            |  |              |
                                            |  |              |
        +------+                            |  |              |
        | Node +-----------------------------+ |              |
        +------+                            |  |              |
                                            |  |  Frame Switch |
        +------+                            |  |              |
        | Node +-----------------------------+ |              |
        +------+                            |  |              |
                                            |  |              |
        +------+                            |  |              |
        | Node +-----------------------------+ |              |
        +------+                              +--------------+
```

              (b) Point-to-Multipoint configuration


```
        +--------+                      +--------+
        | Frame  +----------------------+ Frame  |
        | Switch +--------+    +--------+ Switch |
        +--+-----+        +-+----+-+    +--------+
           |             | Frame  |                    +--------+
        +--+-----+       | Switch |                    | Frame  |
        | Frame  |       +-----+--+    +--------+       | Switch |
        | Switch |             +--------+ Frame +------+ Switch |
        | Switch |             +--------+ Switch |     ++-------+
        +-------++                      +--------+      |
                |_____|
```

              (c) Switching cluster configuration

              Figure 1. Possible configurations

   Each port on a switch has an unique identifier within the switch. A
   node connected to a switch port must inherit the address of the port.
   That is, the node address is equal to the port identifier and is
   unique within the switch.

   In a switch cluster, a node address is subnetted. The high-order
   bits, the part where the corresponding bits in the "subnet mask" are
   1, indicate the switch address. The remaining low-order bits
   indicate the unique node address within the switch. The two fields
   form an unique address for a given node.

   In either case, the address may be configured manually into a node
   interface, or automatically by the address assignment mechanism
   described in [5].

   Note that any two components may be connected either directly, or via
   a long-haul SONET/SDH leased line.

1.3 Packet Transmission

   The protocol is connection-less -- when a node wish to communicate
   with some other node, it simply fills-in the destination address of
   an HDLC frame, places it in one or more SONET/SDH payloads, and sends
   it over a SONET/SDH link.

   The switch forwards the frame to its destination based on the
   destination address. In a switch cluster, the frame may be forwarded
   by multiple switches and is eventually delivered to the specified
   node. Broadcast and multicast are also supported. Frames with an
   invalid destination address are silently discarded.

   Like ethernet, the multiple access capability is provided by a switch
   or a switch cluster. Since MAPOS is a link layer protocol, it is
   independent of the upper layer protocols. That is, it can support any
   network layer protocols such as IP. MAPOS IPv4 support is described
   in [6].

2. Physical Layer

   This protocol treats the underlying end-to-end SONET/SDH transmission
   link as if it was a plain, transparent channel. It sends HDLC frames
   in SONET/SDH payloads, and expects them to arrive at the other end
   unaltered.

   Each node and switch should terminate SONET/SDH overhead such as
   section overhead, line overhead, and path overhead according to the
   specification of SONET/SDH. Unfortunately, SONET and SDH overhead
   interpretations are not identical. In addition, some SONET/SDH
   implementations utilize some overhead bytes in proprietary manner.

   The detail of the interpretation is beyond the scope of this
   document. Appendix A describes some of the most significant
   differences among SONET, SDH, and their implementations that often
   causes interoperability problems. Implementors of SONET/SDH
   interfaces are strongly encouraged to be aware of such differences,
   and provide workaround options in their products.

3. Data Link Layer

3.1 HDLC Frame Format

   MAPOS uses the same HDLC-like framing as used in PPP-over-SONET,
   described in RFC-1662[7]. Figure 2 shows the frame format. Logical
   Link Control (LLC), and Sublayer/Sub-Network Access Protocol (SNAP)
   are not used. It does not include the bytes for transparency. The
   fields are transmitted from left to right.

```
            +----------+----------+----------+----------+
            |          |          |          |          |
            |   Flag   | Address  | Control  | Protocol |
            | 01111110 |  8bits   | 00000011 | 16 bits  |
            +----------+----------+----------+----------+

               +------------+-----------+----------+-----------
               |            |           |          |Inter-frame
               | Information|    FCS    |   Flag   |fill or next
               |            | 16/32 bits| 01111110 |address
               +------------+-----------+----------+-----------
```
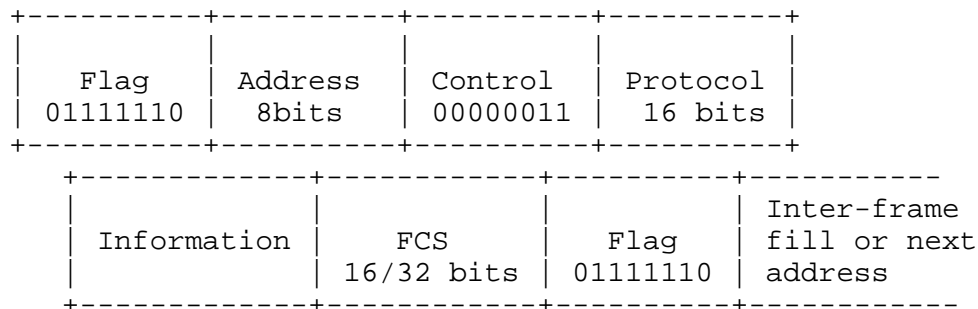
                      Figure 2. Frame format

   Flag Sequence

   Flag sequence is used for frame synchronization. Each frame begins
   and ends with a flag sequence 01111110 (0x7E). If a frame
   immediately follows another, one flag sequence may be treated as
   the end of the preceding frame and the beginning of the immediately
   following frame. When the line is idle, the flag sequence is to be
   transmitted continuously on the line.

   Address

   The address field contains the destination HDLC address. A frame
   is forwarded by a switch based on this field. It is 8 bits wide.
   The LSB indicates the end of this field, and must always be 1. The
   MSB is used to indicate if the frame is a unicast or a multicast
   frame. The MSB of 0 means unicast, with the remaining six bits
   indicating the destination node address. MSB of 1 means multicast,
   with the remaining six bits indicating the group address. The
   address 11111111 (0xFF) means that the frame is a broadcast frame.
   The address 00000001 (0x01) is reserved to identify the control
   processor inside a switch. Frames with an invalid address should
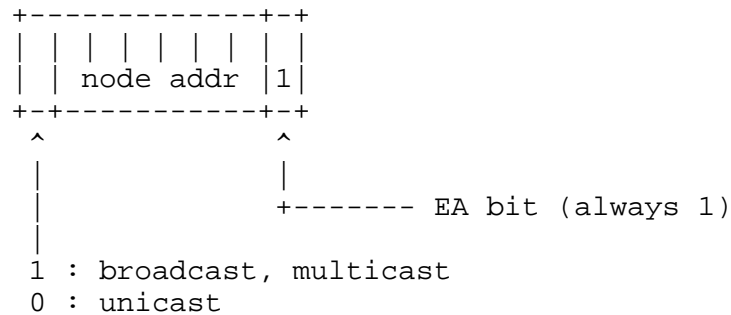   be silently discarded.

```
            +------------+-+
            | | | | | | | | |
            | | node addr |1|
            +-+----------+-+
             ^            ^
             |            |
             |            +------- EA bit (always 1)
             |
            1 : broadcast, multicast
            0 : unicast
```

                      Figure 3 Address format

    Control

    The control field contains single octet 00000011 (0x03) which, in
    HDLC nomenclature, means that the frame is an Unnumbered
    Information (UI) with the Poll/Final (P/F) bit set to zero. Frames
    with any other control field values should be silently discarded.

    Protocol

    The protocol field indicates the protocol to which the datagram
    encapsulated in the information field belongs. It conforms to the
    ISO 3309 extension mechanism, and the value for this field may be
    obtained from the most recent "Assigned Numbers" [8] and "MAPOS
    Version 1 Assigned Numbers" [9].

    Information

    The information field contains the datagram for the protocol
    specified in the protocol field. The length of this field may
    vary, but shall not exceed 65,280 (64K - 256) octets.

    Frame Check Sequence (FCS)

    By default, the frame check sequence (FCS) field is 16-bits long.
    Optionally, 32 bit FCS may be used instead. The FCS is calculated
    over all bits of the address, control, protocol, and information
    fields prior to escape conversions. The least significant octet of
    the result is transmitted first as it contains the coefficient of
    the highest term.

    Inter-frame fill

    A sending station must continuously transmit the flag sequence as
    inter-frame fill after the FCS field. The inter-frame flag
    sequences must be silently discarded by the receiving station.

When an under-run occurs during DMA in the sending station, it must
abort the frame transfer and continuously send the flag sequence to
indicate the error.

3.2 Octet-Synchronous Framing

MAPOS uses an octet stuffing procedure because it treats SONET/SDH as
a byte-oriented synchronous link. Since SONET/SDH provides
transparency, Async-Control-Character-Map (ACCM) is not used. HDLC
frames are mapped into the SONET/SDH payload as follows.

Each HDLC frame is separated from another frame by one or more flag
sequence, 01111110 (0x7E). An escape sequence is defined to escape
the flag sequence and itself. Prior to sending the frame, but after
the FCS computation, every occurrence of 01111110 (0x7E) other than
the flags is to be converted to the sequence 01111101 01011110 (0x7D
0x5E), and the sequence 01111101 (0x7D) is to be converted to the
sequence 01111101 01011101 (0x7D 0x5D). Upon receiving a frame, this
conversion must be reversed prior to FCS computation.

4. Further Reading

To fully utilize MAPOS protocol, it is useful to reference other
documents[5][6][9][10] in conjunction with this document.

5. Security Considerations

Security issues are not discussed in this memo.

References

[1]   CCITT Recommendation G.707: Synchronous Digital Hierarchy Bit
      Rates (1990).

[2]   CCITT Recommendation G.708: Network Node Interface for
      Synchronous Digital Hierarchy (1990).

[3]   CCITT Recommendation G.709: Synchronous Multiplexing Structure
      (1990).

[4]   American National Standard for Telecommunications - Digital
      Hierarchy - Optical Interface Rates and Formats Specification,
      ANSI T1.105-1991.

[5]   Murakami, K. and M. Maruyama, "A MAPOS version 1 Extension -
      Node Switch Protocol," RFC2173, June, 1997.

   [6] Murakami, K. and M. Maruyama, "IPv4 over MAPOS Version 1,"
        RFC2176, June, 1997.

   [7] Simpson, W., editor, "PPP in HDLC-like Framing," RFC1662, July
        1994.

   [8] IANA, "IANA-Assignments,"
        http://www.iana.org/iana/assignments.html

   [9] Maruyama, M. and K. Murakami, "MAPOS Version 1 Assigned
        Numbers," RFC2172, June 1997.

   [10] Murakami, K. and M. Maruyama, "A MAPOS version 1 Extension -
        Switch Switch Protocol," RFC2174, June, 1997.

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APPENDIX A. Differences among SONET, SDH, and their Implementations

   This section briefly describes the major differences among SONET
   which is an ANSI standard, SDH, an ITU-T standard, and their
   implementations.

      AU pointer (H1, H2, H3)

      The AU pointer consists of bytes H1, H2, and H3. The bits 5 and 6
      of the H1 byte are called "SS bits," and are used to indicate the
      offset into the payload where the beginning of a SPE is located.
      (Note that "SPE" is a SONET term -- SDH calls it "VC.") In the
      case of OC-3c, SONET sets the SS bits of the second and the third
      H1 bytes to 0, whereas SDH sets them to 10 for AU-4, and 01 for
      AU-31. Although the SS bits may be ignored at the receiving
      station, some transmission systems discards SONET/SDH frames with
      SS bits that it doesn't expect -- the sending station should be
      aware of this, and include a configuration option to handle it.

      Z1 and Z2

      The Z bytes are reserved in SONET/SDH. Some transmission systems,
      however, use them in a proprietary manner. SONET uses Z1 for Line
      Error Monitoring. NTT, a carrier in Japan, utilized Z1 for
      Automatic Protection Switching (APS.)

      DCC Bytes

      The D bytes are called the Data Communication channel (DCC), and
      are defined for maintenance and operations. However, some carriers
      and vendors use them in a proprietary manner. For example, NTT's
      STM-1 UNI uses the D4, D5, and D6 bytes to transfer section and
      path maintenance information.