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MAPOS/PPP Tunneling mode

Status of this Memo

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IESG Note

This memo documents a way of tunneling PPP over Sonet over MAPOS networks. 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 specifies tunneling configuration over MAPOS (Multiple Access Protocol over SONET/SDH) networks. Using this mode, a MAPOS network can provide transparent point-to-point link for PPP over SONET/SDH (Packet over SONET/SDH, POS) without any additional overhead.

1. Introduction

MAPOS [1][2] frame is designed to be similar to PPP over SONET/SDH (Packet over SONET/SDH, POS)[3][4] frame (Figure 1).

a) MAPOS frame header (version 1)

b) MAPOS frame header (MAPOS 16)

c) PPP frame header

Figure 1. Header similarity of MAPOS frame and POS frame

This means that a MAPOS network can easily carry POS frames with no additional header overhead by rewriting only 1 or 2 octets. PPP tunneling configuration over MAPOS networks (MAPOS/PPP tunneling mode) provides for efficient L2 multiplexing by which users can share the cost of high speed long-haul links.

This document specifies MAPOS/PPP tunneling mode. In this mode, a MAPOS network provides a point-to-point link for those who intend to connect POS equipment. Such link is established within a MAPOS switch, or between a pair of MAPOS switches that converts between POS header and MAPOS header for each L2 frame.

Chapter 2 describes the specification in two parts. First part is user network interface (UNI) specification and the second part is operation, administration, management and provisioning (OAM&P) description. Other issues such as congestion avoidance, end-to-end fairness control are out of scope of this document.

Implementation issues are discussed in Chapter 3. Security considerations are noted in Chapter 4.

2. MAPOS/PPP tunneling mode

2.1 Overview

MAPOS/PPP tunneling mode is based on header rewriting. Figure 2. shows an example of MAPOS/PPP tunneling mode. The MAPOS network uses MAPOS 16 [2] in this example. Consider a tunneling path between customer premise equipment (CPE) A and CPE B which are industry standard POS equipment. The ingress/egress MAPOS switches A/B assigns unique MAPOS addresses (0x0203 and 0x0403) to the CPEs. These MAPOS addresses are used in the MAPOS network, for frame forwarding between CPE A and CPE B. NSP [5] will not be running between the CPEs and the switches in this case.

MAPOS switch A rewrites the first 2 octets of every frame from CPE A, which are fixed as 0xFF and 0x03, to the MAPOS address of its peer, which is 0x0403. Frames are forwarded by the MAPOS network and arrives at the egress MAPOS switch B which rewrites the first 2 octets to their original values. If MAPOS v1 [1] is used in the MAPOS network, only the first octet is rewritten.

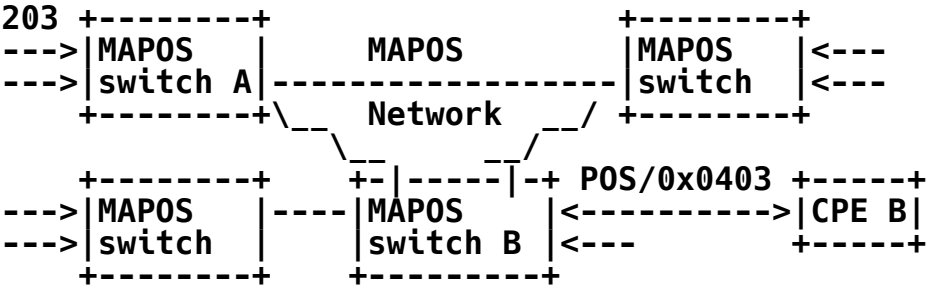


Figure 2. MAPOS/PPP tunneling mode

The tunneling path between the two CPEs is managed by the ingress/egress MAPOS switches.

2.2 User-Network Interface(UNI)

2.2.1 Physical Layer

For transport media between border MAPOS switch and CPE, SONET/SDH signal is utilized. Signal speed, path signal label, light power budget and all physical requirements are the same as those of PPP over SONET/SDH [3].

SONET/SDH overheads are terminated at the ingress/egress switches. SONET/SDH performance monitors and alarms are used for the link management between a CPE and the switch. Inter-switch links are similarly managed by SONET/SDH monitors and alarms.

A CPE should synchronize to the clock of the border MAPOS switch. The corresponding port of the MAPOS switch uses its internal clock. When the CPE is connected to the MAPOS switch through SONET/SDH transmission equipment, both should synchronize to the clock of the SONET/SDH transmission equipment.

2.2.2 Link layer

Link layer framing between CPE and MAPOS switch also follows the specification of PPP over SONET/SDH [3].

HDLC operation including byte stuffing, scrambling, FCS generation is terminated at the ingress/egress switch. In a MAPOS switch, HDLC frame [4] is picked up from a SONET/SDH payload and the first octet (HDLC address) for MAPOS v1 [1], or the first two octets (HDLC address and control field) for MAPOS 16 [2] are rewritten. The operation inside the border switch is as follows:

From CPE (Ingress Switch receiving):

```
SONET/SDH framing
   -> X^43+1 De-scrambling -> HDLC Byte de-stuffing
   -> HDLC FCS detection (if error, silently discard)
   -> L2 HDLC address/control rewriting
       (0xFF   -> MAPOS v1 destination address, or
        0xFF03 -> MAPOS 16 destination address)
   -> MAPOS-FCS generation
   -> HDLC Byte stuffing -> X^43+1 Scrambling -> SONET/SDH framing
```

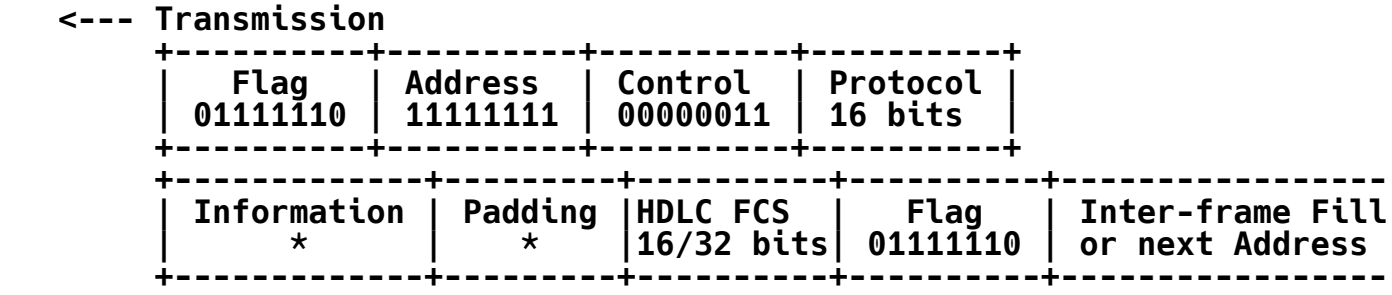
To CPE (Egress Switch transmitting):

```
SONET/SDH framing
   -> X^43+1 De-scrambling -> HDLC Byte de-stuffing
   -> MAPOS-FCS detection (if error, silently discard)
   -> L2 HDLC address/control rewriting
       (MAPOS v1 address -> 0xFF, or
        MAPOS 16 address -> 0xFF03)
   -> HDLC FCS generation
   -> HDLC Byte stuffing -> X^43+1 Scrambling -> SONET/SDH framing
```

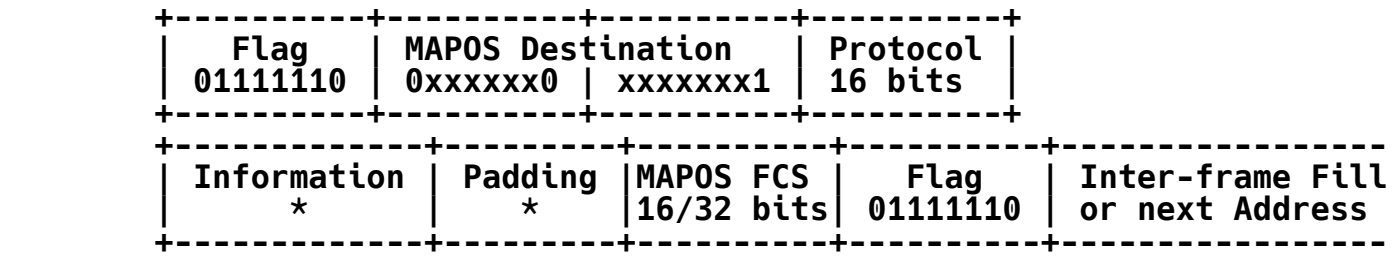
For STS-3c-SPE/VC-4, non-scrambled frame can be used for compatibility with RFC 1619. However, the use of 32bit-CRC and X^43+1 scrambling is recommended in RFC2615 [3] and for MAPOS networks.

Maximum transmission unit (MTU) of the link must not be negotiated larger than MAPOS-MTU which is 65280 octets.

Figure 3 shows a CPE-side L2 frame and the converted frame in the ingress/egress MAPOS switches. Note that the MAPOS/PPP tunneling mode is not a piggy-back encapsulation, but it is a transparent link with no additional header overhead.



(a) HDLC frame from/to CPE



(b) Converted MAPOS 16 frame, forwarded in MAPOS networks

Figure 3. HDLC frame from/to CPE and its conversion

2.3 Operation, Administration, Management and Provisioning (OAM&P)

2.3.1 MAPOS/PPP mode transition

When a port of MAPOS switch is configured to PPP tunneling mode, at least the following operations are performed in the switch.

a) Disable NSP [5] and SSP [6] (for the port, same below)
b) Disable MAPOS broadcast and multicast forwarding

c) Reset the Path Signal Label (C2) to 0x16 if X^43+1 scrambling is used. The value 0xCF is used for non-scrambled OC3c signal.
d) Enable header rewriting function to specified destination address

When the port is configured back to MAPOS mode, reverse order of the operations above are performed. That means;

a) Disable header rewriting function (for the port, same below)
b) Reset the Path Signal Label (C2) to MAPOS default (0x8d)
c) Enable MAPOS broadcast and multicast forwarding
d) Enable NSP and SSP

SONET/SDH alarms (B1/B2/B3 error exceeding, SLOF, SLOS, etc.) should not affect this transition. Figure 4 shows mode transition described above.

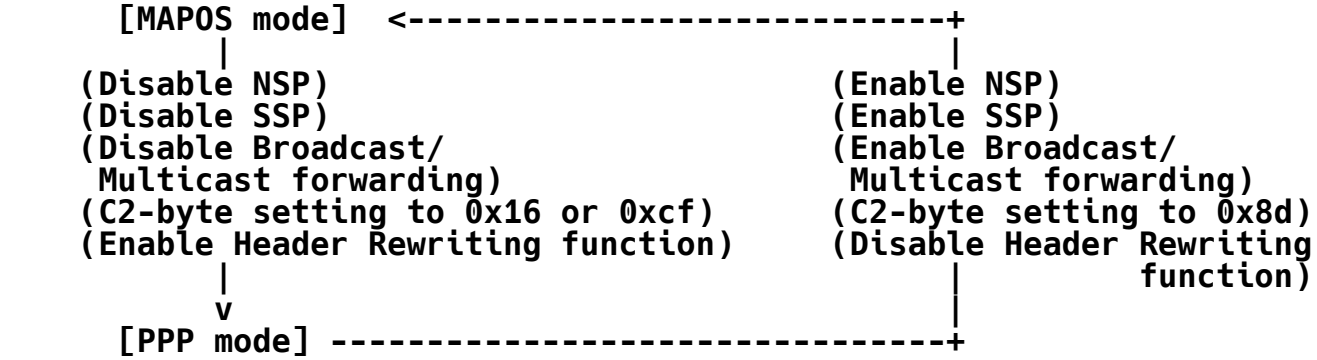


Figure 4. MAPOS/PPP tunneling mode state transition diagram

2.3.2 Path Establishment

A MAPOS/PPP tunneling path is established by following steps.

a) Choose MAPOS address pair on both ingress/egress switches and configure their ports to PPP tunneling mode (see 2.3.1).

b) When the routes for both directions become stable, the tunneling path is established. The link between the CPEs may be set up at that moment; PPP LCP controls are transparently exchanged by the CPEs.

To add a new path, operators should pick unused MAPOS address-pair. They may be determined simply by choosing switches and ports for each CPE, because there is one-to-one correspondence between MAPOS addresses and switch ports.

Then, those ports should be configured to MAPOS/PPP tunneling mode on both of the switches. Frame reachability is provided by SSP [6] in the MAPOS network. When the frame forwarding for each direction are stable, the path is established and frame forwarding is started. Until then, the link between border switches and CPE should be down.

A MAPOS/PPP tunneling path should be managed by the pair of MAPOS addresses. It should be carefully handled to avoid misconfiguration such as path duplication. For convenient management, path database can be used to keep information about pairs of MAPOS addresses. Note that the path database is not used for frame forwarding. It is for OAM&P use only.

2.3.3 Failure detection and indication

When any link or node failure is detected, it should be indicated to each peer of the path. This is done by PPP [7] keep-alive (LCP Echo request/reply) for end-to-end detection.

Consideration is required to handle SONET/SDH alarms. When a link between CPE and the MAPOS switch fails, it is detected by both the MAPOS switch and the CPE seeing SONET/SDH alarms. However, far-side link remains up and no SONET/SDH error is found; SONET/SDH alarms are not transferred to the far end because each optical path is terminated in MAPOS network. In this case, the far end will see 'link up, line protocol down' status due to keep-alive expiration.

For example, Figure 5 shows a tunneling path. When link 1 goes down, MAPOS sw A and CPE A detects SONET/SDH alarms but MAPOS sw B and CPE A' do not see this failure. When PPP keep-alive expires, CPE A' detects the failure and stops the packet transmission. The same mechanism is used for failure within the MAPOS cloud (link 2). When a MAPOS switch is down, SSP handles it as a topology change.

Figure 5. Link failure

2.3.4 Path removal

A MAPOS/PPP tunneling path is removed by following steps.

a) Choose the path to remove, configure MAPOS switches on both ends of the path to disable the ports connected to the CPEs.

b) Path database may be updated that the path is removed.

c) When CPE is detached, port may be reset to MAPOS default configurations.

Frames arriving after the destination port was disabled should be silently discarded and should not be forwarded to the port.

2.3.5 Provisioning and Design Consideration

Because MAPOS does not have any QoS control at its protocol level, and POS does not have flow-control feature, it is difficult to guarantee end-end throughput. Sufficient bandwidth for inter-switch link should be prepared to support all paths on the link.

Switches are recommended to ensure per-port fairness using any appropriate queuing algorithm. This is especially important for over-subscribed configuration, for example to have more than 16 OC12c paths on one OC192c inter-switch link.

Although MAPOS v1 can be applied to the MAPOS/PPP tunneling mode, MAPOS 16 is recommended for ease of address management.

Automatic switch address negotiation mechanism is not suitable for the MAPOS/PPP tunneling mode, because the path management mechanism becomes much more complex.

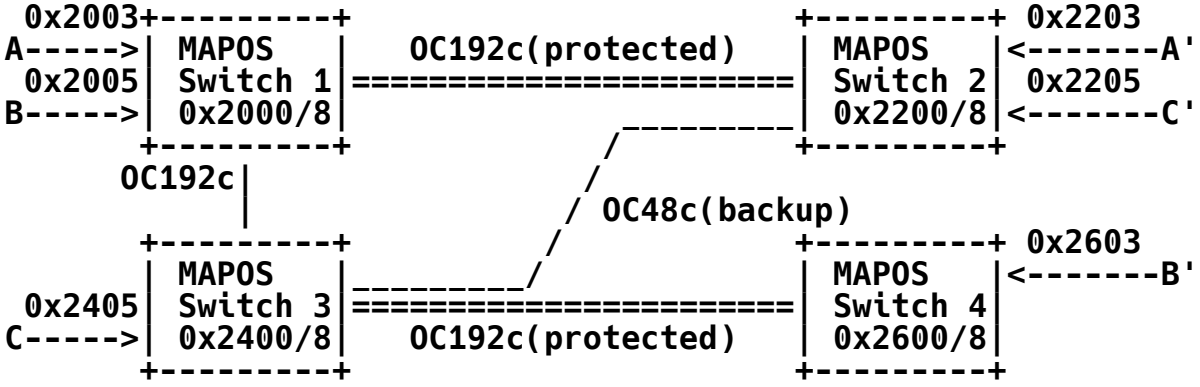
3. Implementation

3.1 Service example

Figure 6 shows an example of MAPOS network with four switches. Inter-switch links are provided at OC192c and OC48c rate, customer links are either OC3c or OC12c rate. Some links are optically protected. Path database is used for path management.

Using MAPOS-netmask with 8 bits, this topology can be extended up to 64 MAPOS switches, each equipped with up to 127 CPE ports. Switch addresses are fixed to pre-assigned values.

The cost of optical protection (< 50ms) can be shared among paths. Unprotected link can also be coupled for more redundancy in case of link failure. SSP provides restoration path within few seconds.



Path database entries:

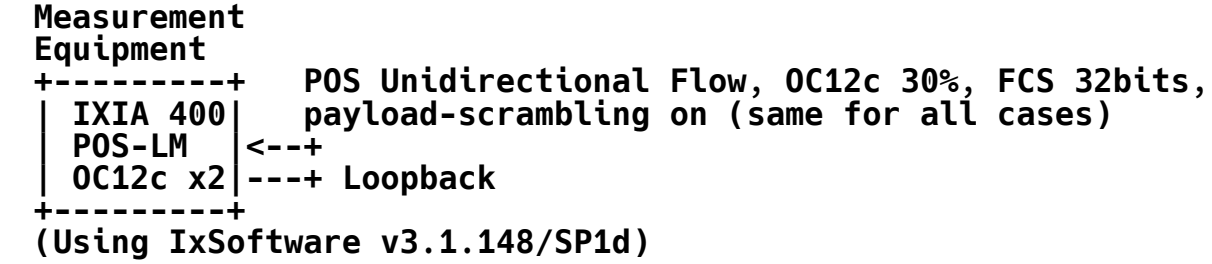
User	Speed	Mode	Address pair	Status
A-A'	OC3c	CRC32, scramble	0x2003-0x2203	Up and running
B-B'	OC12c	CRC32, scramble	0x2005-0x2603	B Down
C-C'	OC3c	CRC16, no-scram	0x2405-0x2205	C' Down

Figure 6. Example Topology and its Path Management

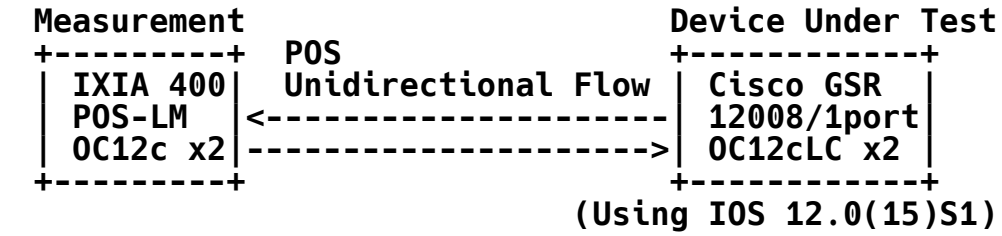
3.2 Evaluation of latency of reference implementation

Figure 7 shows evaluation platforms in terms of latency measurement of MAPOS/PPP tunneling mode.

Case 1: Base latency measurement



Case 2: Router latency measurement



Case 3: MAPOS/PPP tunneling switch latency measurement

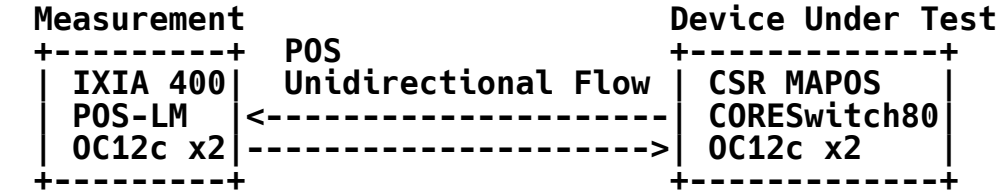


Figure 7. Latency measurement of reference platform for MAPOS/PPP tunneling mode

There is a PPP connection between port 1 and 2 of the measurement equipment. Traffic comes from measurement equipment (IXIA 400) and forwarded by a device under test back to the equipment. Timestamping and latency calculation are performed by IXIA 400 automatically. Traffic Load is set to 30% of OC12c for offloading router.

Results are shown in Table 1. Measurements were taken according to the RFC2544 requirements [8]. We measured 25 trials of 150 seconds duration for each frame size. Results are averaged and rounded to the 20 ns resolution of IXIA. 95% confidence interval (C.I.) value are also rounded.

Frame size (bytes)	64	128	256	512	1024	1280	1518
Latency(ns)							
Case 1: Baseline	4060	5640	6940	9840	16420	20700	23340
95% C.I.(+/-)	20	80	60	180	80	100	120
Case 2: Router	26560	28760	33860	44600	68280	80500	91160
95% C.I.(+/-)	200	100	160	220	100	100	200
Case 3: Switch	11100	13480	16620	22920	36380	43900	49920
95% C.I.(+/-)	120	120	120	200	100	160	120

Table 1. Results of Latency (ns) - Frame size (bytes)

This results shows that MAPOS/PPP tunneling mode does not cause any performance degradation in terms of latency view. A POS L2 switch was reasonably faster than a L3 router.

4. Security Considerations

There is no way to control or attack a MAPOS network from CPE side under PPP tunneling mode. It is quite difficult to inject other stream because it is completely transparent from the viewpoint of the CPE. However, operators must carefully avoid misconfiguration such as path duplication. Per-path isolation is extremely important; switches are recommended to implement this feature (like VLAN mechanism).

In addition, potential vulnerability still exists in a mixed environment where PPP tunneling mode and MAPOS native mode coexists in the same network. Use of such environment is not recommended, until an isolation feature is implemented in all MAPOS switches in the network. Note that there is no source address field in the MAPOS framing, which may make path isolation difficult in a mixed MAPOS/PPP environment.

5. References

[1] Murakami, K. and M. Maruyama, "MAPOS - Multiple Access Protocol over SONET/SDH Version 1", RFC 2171, June 1997.

[2] Murakami, K. and M. Maruyama, "MAPOS 16 - Multiple Access Protocol over SONET/SDH with 16 Bit Addressing", RFC 2175, June 1997.

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

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

[5] Murakami, K. and M. Maruyama, "A MAPOS version 1 Extension - Node Switch Protocol," RFC 2173, June 1997.

[6] Murakami, K. and M. Maruyama, "A MAPOS version 1 Extension - Switch-Switch Protocol", RFC 2174, June 1997.

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

[8] Bradner, S. and J. McQuaid, "Benchmarking Methodology for Network Interconnect Devices", RFC 2544, March 1999.

6. Acknowledgments

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