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TITLE: DRAFT NEW RECOMMENDATION X.86 (X.eos) ON ETHERNET OVER LAPS

Summary

Transferring Ethernet over LAPS is a simple and cheap technique to connect LANs within a private and public network. This Recommendation specifies a protocol suite structure of Ethernet (defined by IEEE WG 802.3) over LAPS for the purpose of providing the future protocol compatibility among peer systems, and applies to Synchronous Digital Hierarchy (ITU-T Recommendation G.707). The capabilities of supporting the LAPS protocol procedure at high speed, and IEEE802.3 frame directly mapping to LAPS are mainly included. This Recommendation will be used to data network and open system communications related to private and public networks.

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Introduction

Internet market has been growing at a greater rate. Growth is a basic issue which caused there to be a need for expanding the scope of Ethernet area. Transferring Ethernet (defined by IEEE WG 802.3) over LAPS is a simple and cheap technique to connect LANs within a private and public network. This Recommendation expands the scope of LAPS which was introduced in ITU-T Recommendation X.85/Y.1321to adapt Ethernet frame to LAPS. The full transparency is guaranteed for mapping Ethernet frame to LAPS, and mapping LAPS to SDH. The model of Ethernet over LAPS shall be particularly well suited for the network resource of the existing network infrastructure.

DRAFT NEW RECOMMENDATION X.86
Ethernet over LAPS

1. Scope

This Recommendation specifies a protocol suite structure of Ethernet Frame (defined by IEEE WG 802.3) over LAPS for the purpose of providing the future protocol compatibility among peer systems in the light of ITU-T Recommendation X.200, and applies to Synchronous Digital Hierarchy (ITU-T Recommendation G.707). LAPS protocol and specification introduced in ITU-T Recommendation X.85/Y.1321, continue to be used to address its capabilities of providing the adaptation from Ethernet to LAPS. LAPS describes an HDLC-like framing structure to encapsulate IEEE 802.3 Ethernet MAC frame as shown in Figure 7, provide a point-to-point full-duplex simultaneous bi-directional operation. Connecting Ethernet Switches to a ~~LAPS~~ SDH network is a very attractive way to provide Ethernet over a Wide Area Network. It is transparent to the Ethernet switch that one or more Ethernet switch ports are connected. The relationship between LAPS and Ethernet and SDH physical layer, together with ~~relative primitives~~the Rate Adaptation are presented as following diagram (see Figure 1).

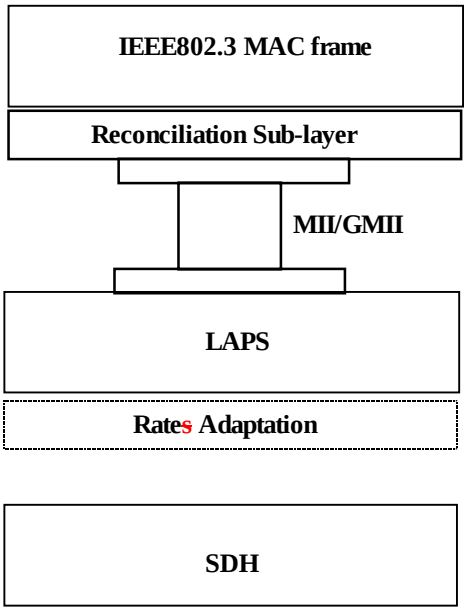


Figure 1/X.86
The relationship between Ethernet frame and LAPS and SDH

This Recommendation does not specify the method of mapping LAPS to SDH. No change is made for all Ethernet-based protocols (including IEEE802.3 Ethernet) and all SDH standards.

NOTE 1 - It is intended that Ethernet over LAPS can be extended, in future amendments, to support additional new type of data service.
NOTE 2 - LAPS used in Draft new Recommendation X.86 is not used to coexist with HDLC (ISO 3309 or RFC 1662), LAPB/ITU-T X.25, LAPD/ITU-T Q.921 and LAPF/ITU-T Q.922 within the same physical layer in future.
NOTE 3 - This Recommendation shall be applied to SDH sub-rates for IEEE 802.3 Ethernet.

2. References

The following ITU-T Recommendations, and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of currently valid ITU-T Recommendations is regularly published.

2.1 Normative references

2.1.1 ITU-T Recommendations

[1] ITU-T Recommendation X.85/Y.1321, *IP over SDH using LAPS*

[2]ITU-T Recommendation G.703 (1998), *Physical/electrical characteristics of hierarchical digital interfaces.*

[32] ITU-T Recommendation G.707 (1996), *Network node interface for the synchronous digital hierarchy (SDH).*

[43] ITU-T Recommendation G.708 (1999), *Sub STM-0 network node interface for the synchronous digital hierarchy (SDH).*

[54] ITU-T Recommendation G.957 (1995), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.*

[65] ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1 (1994), Information technology - *Open System Interconnection - Basic reference model: The basic model.*

2.1.2 IEEE Specifications

[76] IEEE802.3 *CSMA/CD Access Method and Physical Layer Specifications,1998 Edition.*

3. Definitions

For the purposes of this Recommendation, the following definitions apply:

3.1 Ethernet over LAPS: The data communication architecture of combination Ethernet (IEEE802.3) with LAPS network. The physical layer is defined as SDH, the second layer is the combination of three elements: LLC/MAC/LAPS.

3.2 LAPS: A type of HDLC, including data link service and protocol specification which have been used to IP over SDH using LAPS.

3.3 Information Field of LAPS: Destination address, source address, length/type, MAC client data, PAD field (if any) and FCS field of the intact MAC frame.

3.4 Rates Adaptation: A mechanism that adjusts the rate of Ethernet MAC MII to SDH VC rate since SDH and MAC are operated in the way of period and burst respectively.

4. Abbreviations

4.1 Abbreviations specified in IEEE 802.3

This Recommendation makes use of the following abbreviations specified IEEE 802.3

- **a) LAN** — **Local area network**
- **b) LLC** — **Logical link control**
- **c) MAC** — **Media access control**

4.2 Abbreviations specified in ITU-T G.707

This Recommendation makes use of the following abbreviations specified in ITU-T G.707.

a) SDH Synchronous Digital Hierarchy

b) STM Synchronous Transfer Module

c) sSTM Sub-STM

d) VC Virtual Container

4.3 Abbreviations specified by this Recommendation

a) LAPS Link Access Procedure - SDH

b) SAPI Service Access Point Identifier

5. The protocol framework of Ethernet over LAPS

The layer/protocol stacks for Ethernet over LAPS in the STM-N sSTM-n are shown in Figure 2 and Figure 3 respectively. The Figure 4 and Figure 5 illustrate protocol configuration and possible network example of Ethernet over LAPS respectively.

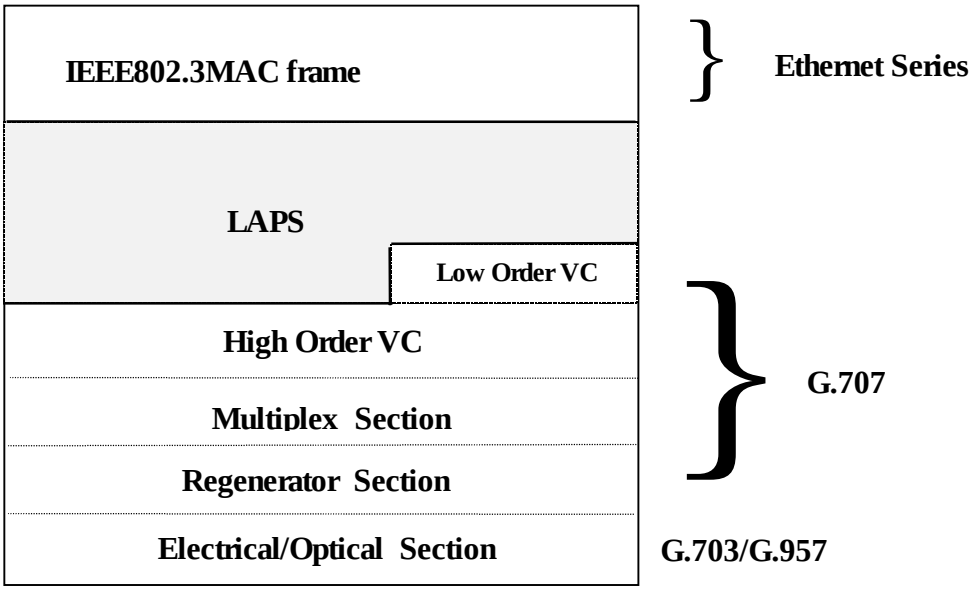


Figure 2/X.86
Layer/Protocol Stack for Ethernet over LAPS in STM-N

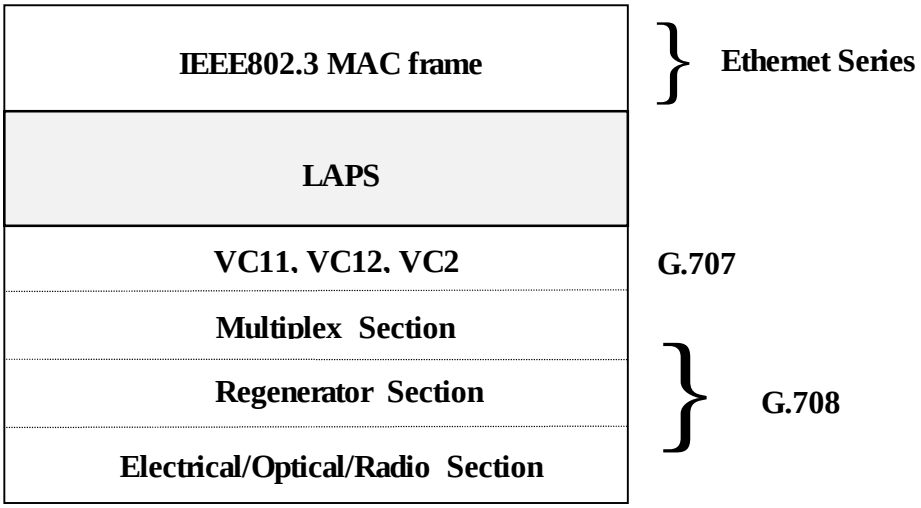


Figure 3/X.86
Layer/Protocol Stack for Ethernet over LAPS in sSTM

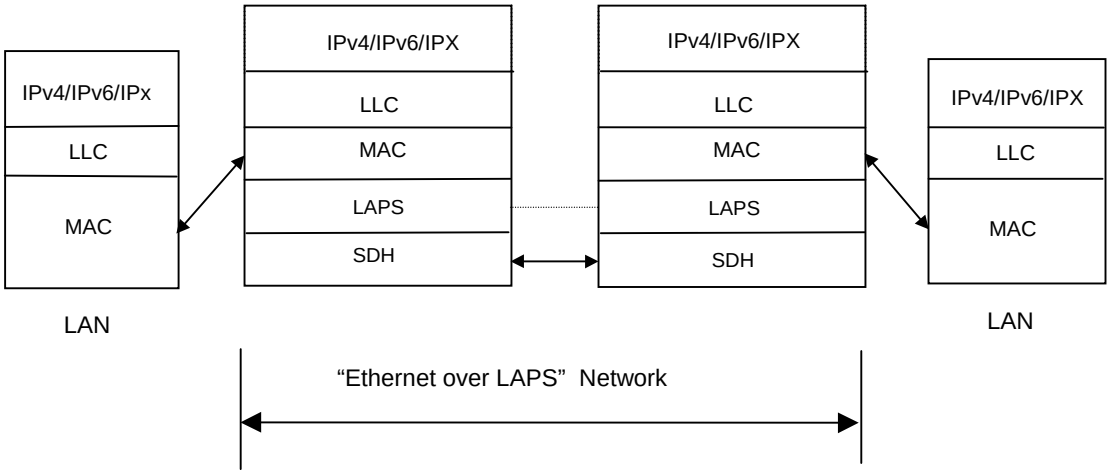


Figure 4/X.86
The Protocol Configuration of Ethernet over LAPS

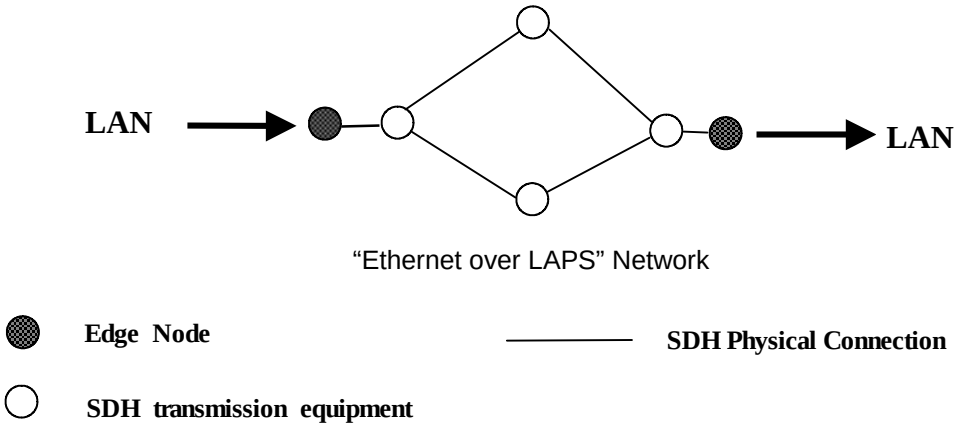


Figure 5/X.86
"Ethernet over LAPS" network example

6. The SDH Physical layer

This Recommendation treats SDH transport as an octet-oriented synchronous point-to-point full-duplex link. The SDH frame is an octet-oriented synchronous multiplex mapping structure which specifies a series of standard rates, formats and mapping method. Table 1 shows the bandwidth value of the VCs and Table 2 of the STMs which is currently specified. The use of control signals is not required. The self-synchronous scrambling/descrambling ($x^{43} + 1$) function is applied during insertion/extraction into/from the synchronous payload envelope (see Annex C of ITU-T Recommendation X.85/Y.1321~~/Y.1321~~). This Recommendation uses the future concatenation of virtual containers as defined in the next version of ITU-T Recommendation G.707.

TABLE 1 - The bandwidth of the VCs

VC type	VC bandwidth (kbit/s)	VC payload (kbit/s)
VC-11	1 664	1 600
VC-12	2 240	2 176
VC-2	6 848	6 784
VC-3	48 960	48 384
VC-4	150 336	149 760
VC-4-4c	601 304	599 040
VC-4-16c	2 405 376	2 396 160
VC-4-64c(*)	9 621 504	9 584 640

(*) For further study

TABLE 2 - STM interface rates

STM type	STM bit rate (kbit/s)
sSTM-11	2 880
sSTM-12	5 184
sSTM-14	9 792
sSTM-18	19 792
sSTM-116	37 444
sSTM-21	7 488
sSTM-22	14 400
sSTM-24	28 224
STM-0	51 840
STM-1	155 052
STM-4	622 080
STM-16	2 488 320
STM-64	9 953 280

The LAPS is a physical coding sub-layer, which provides point-to-point transferring over SDH virtual containers and interface rates. The supported UITS is connectionless-mode service. The rates adaptation between LAPS and SDH is applied. It provides a mechanism that adjusts the rate of Ethernet MAC MII to SDH VC rate, and also prevents MAC frame going to SDH VC is written to the SDH overhead since SDH and MAC are operated in the way of period and burst respectively.

7. Service facilities and protocol specifications of LAPS

The default maximum frame size of LAPS shall be capable of supporting an information field of 1600 octets (at least) for Ethernet over LAPS. The SAPI of MAC is assigned to 0x0c (hexadecimal). The associated service facilities and protocol specifications of LAPS ~~is~~ are included in Annex A of ITU-T Recommendation X.85/Y.1321.

NOTE - It is needed to replace "Layer 3 or network layer or IP based network", "IP packet" and "Layer 2 or data link layer" with "MAC layer", "MAC frame" and "LAPS " respectively in Annex A of ITU-T Recommendation X.85/Y.1321.

8. Encapsulation

LAPS link entity accepts frames from the MAC layer through the Reconciliation sub-layer and an equivalent MII (Media Independent Interface). No address filtering function is used here. The format of LAPS information field as defined in the shaded region of Figure 6. Figure 7 presents the format of LAPS frame after encapsulating MAC field. The order of those octets and bits shaded area as show in Figure 7, is kept intact. The FCS computations of LAPS and MAC refer to ITU-T Recommendation X.85/Y.1321 and IEEE 802.3 standard respectively. The function unit of Ethernet over LAPS forwards all incoming LAPS information field to its peer connected link except the originating link port, and is permitted to buffer one or more incoming frames before forwarding them. Figure 8 shows the relationship between the Reconciliation sub-layer/ MII and LAPS/SDH.

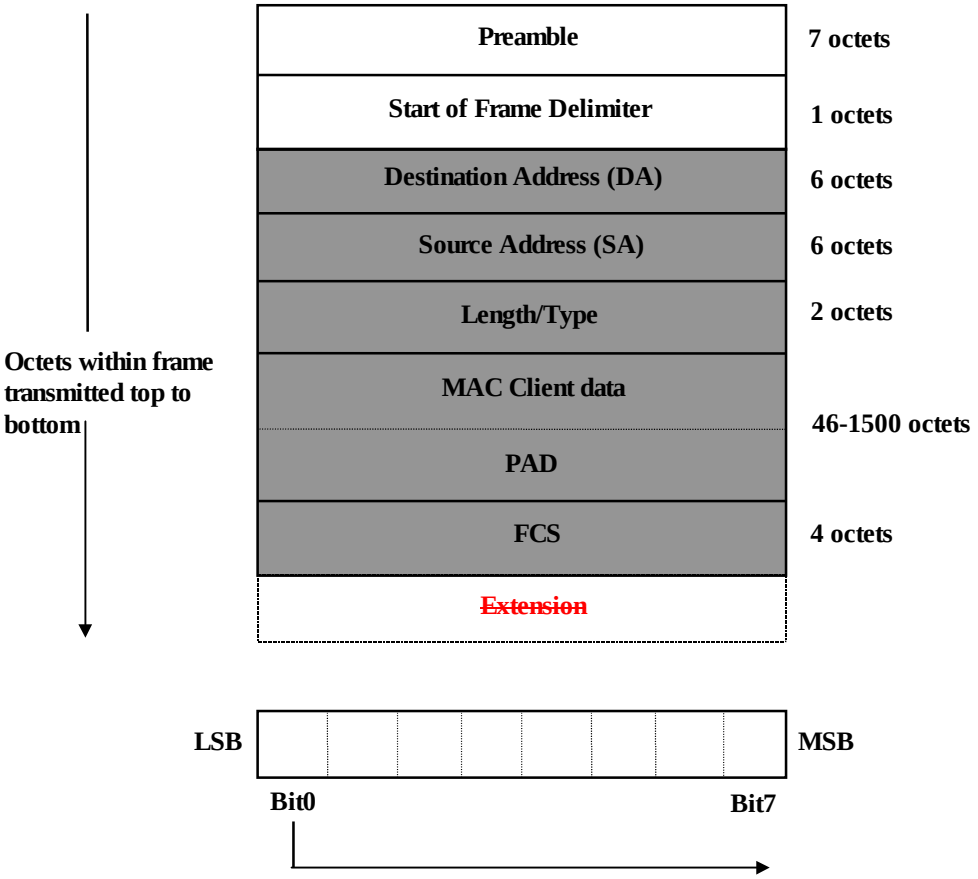


Figure 6/X.86
The format of IEEE 802.3 Ethernet MAC frame, LAPS information field as defined in the shaded region

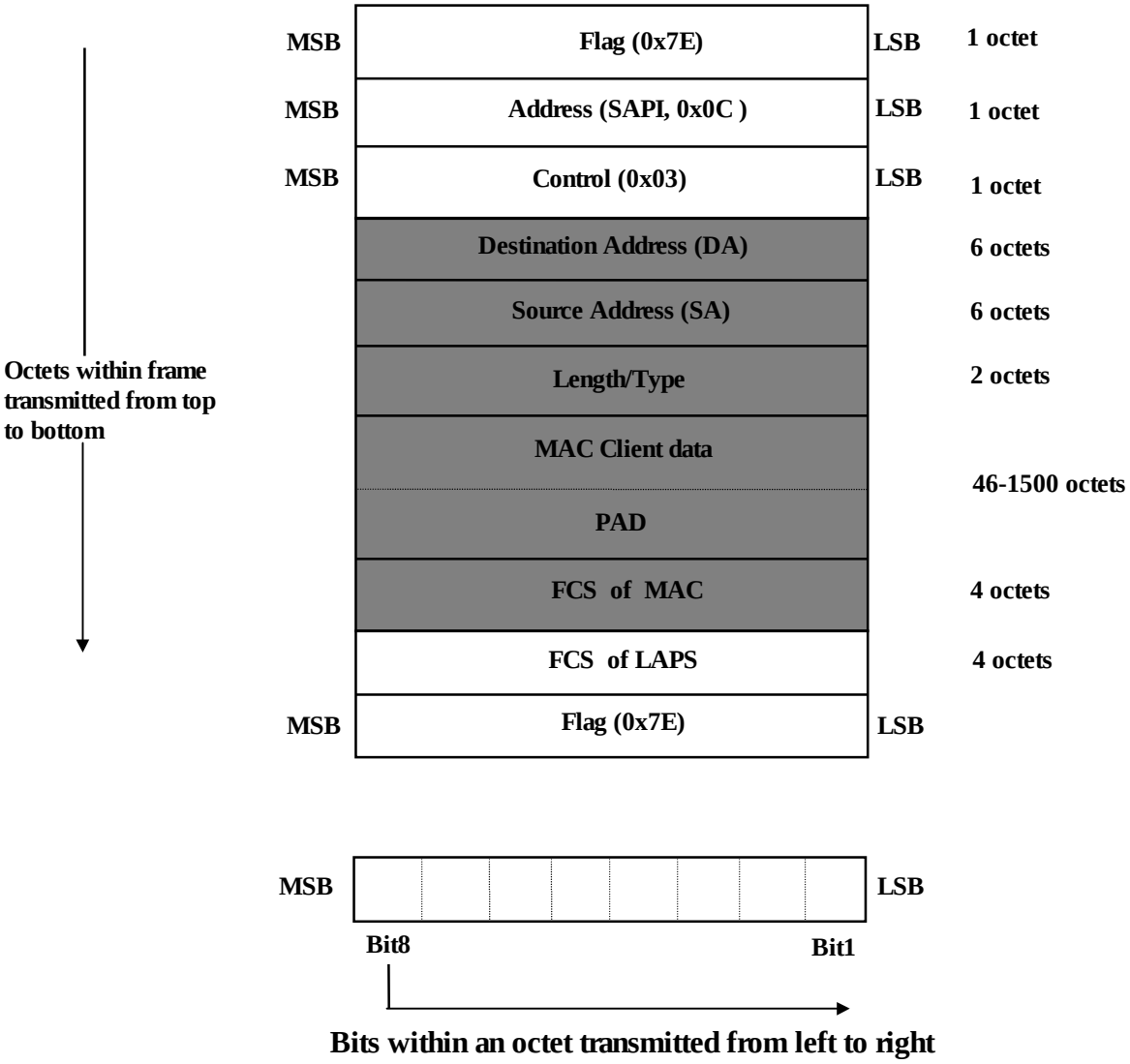


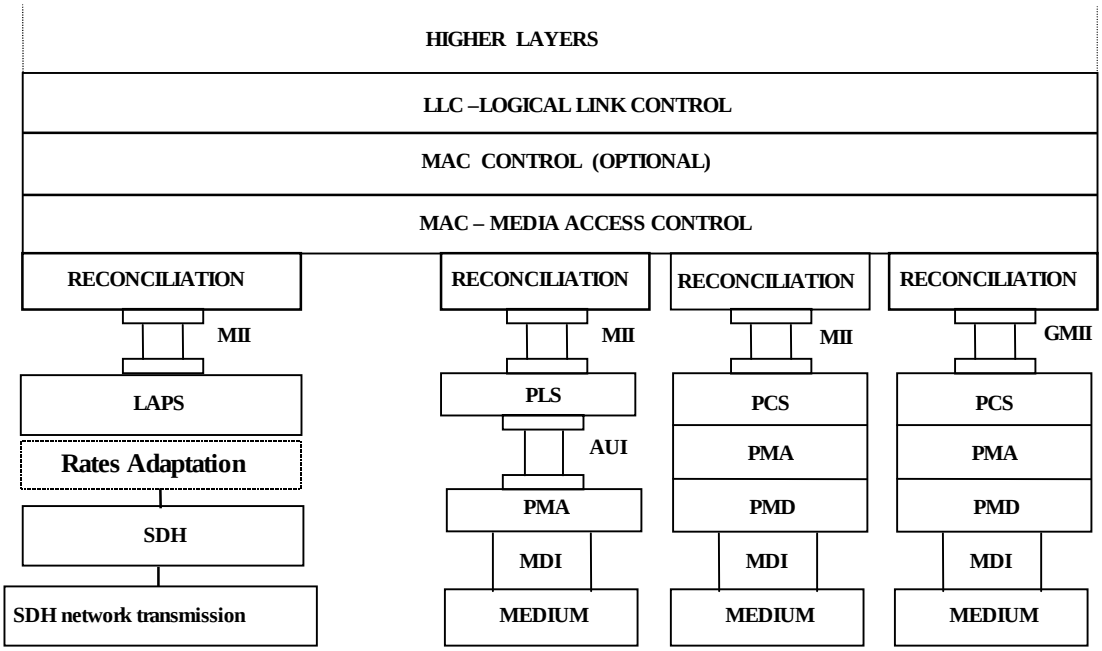
Figure 7/X.86
The format of LAPS frame after encapsulating MAC field

9. Functional elements of Gigabit Ethernet over LAPS

The full-duplex is used only. The functional elements of IEEE 802.3 Ethernet, along with LAPS/SDH are illustrated in Figure 8.

10. Rate Adaptation

If the Rate Adaptation is needed in the LAPS transmit processing, transmit entity adds the rate-adaptation octet(s) "0xdd" within the frame by sending sequence(s) of {0x7d, 0xdd}. This function is performed just after transparency processing and before the end flag is added. In receive direction, receive entity will remove the Rate Adaptation octet(s) "0xdd" within the LAPS frame when detecting sequence(s) of {0x7d, 0xdd}, This function will be done just before transparency processing and after the end flag is detected.



LAPS = LINK ACCESS PROCEDURE - SDH
SDH = Synchronous Digital Hierarchy
AUI = Attachment Unit Interface
MDI = Medium Independent Interface
MII = Media Independent Interface
GMII = Gigabit Media Independent Interface

MAU = Medium Attachment Unit
PLS = Physical Layer Signalling
PCS = Physical Coding Sub-layer
PMA = Physical Medium Attachment
PHY = Physical Layer Device
PMD = Physical Medium Dependent

Figure 8/X.86
The relationship between the Reconciliation sublayer /MII and LAPS/SDH on Ethernet over LAPS

APPENDIX I
An Example of Data Processing

The LAPS processing is divided into transmit and receive processing as follows.

A.1 The LAPS Transmit Processing

(1) Receive MAC frame through MII or GMII from MAC and detect the SFD (Start Frame Delimiter);
(2) Synchronize it to the SDH clock;
(3) Add start flag (0x7e) of LAPS frame;
(4) Add SAPI and Control field to the LAPS frame;
(5) FCS generation over SAPI, Control, and LAPS information field (shaded area as show in Figure 7), it does not include the Flag, Inter-frame gap, Rate Adaptation sequence, and Abort sequence (0x7d7e, option) octets;
(6) Transparency processing or octet stuffing within the LAPS frame:

- 0x7e -> 0x7d, 0x5e;
- 0x7d -> 0x7d, 0x5d;

Octet stuffing does not occur during the transfer of Rate Adaptation sequence, Abort sequence, Flag;
(7) If needed, add the rate-adaptation octet(s) "0xdd" within the LAPS frame by sending sequence(s) of {0x7d, 0xdd};
(8) Add end flag (0x7e) of LAPS frame;
(9) Add IFG (Inter-Frame-Gap) fill octet(s) (0x7e), if needed;
(10) Scramble all octets before send to SDH payload.

A.2 The LAPS Receive Processing

(1) De-scramble all octets before processing;
(2) Remove IFG (Inter-Frame-Gap) fill octet(s) (0x7e) if needed;
(3) Detect start flag (0x7e)of LAPS frame;
(4) Remove the rate-adaptation octet(s) "0xdd" within the LAPS frame when detecting sequence(s) of {0x7d, 0xdd};
(5) Perform octet removal (transparency processing), within the LAPS frame:

- 0x7d, 0x5e -> 0x7e
- 0x7d, 0x5d -> 0x7d;

(6) Check for valid the SAPI/Control field;
(7) Perform the FCS generation and checking;
(8) Detect closing flag (0x7e);
(9) Synchronize the MAC frame to MII RX_CLK;
(10) Add preamble and SFD (Start Frame Delimiter) and send it to MAC through MII.or GMII.

A.3 Erroneous Frame Handling

The MII or GMII Interface provides a method by which the MAC device could indicate to the LAPS entity by TX_ERR when a particular packet contains errors and should be aborted or discarded.

The Ethernet over LAPS supports two options for aborting an erroneous frame.
The first option is to abort a packet by inserting the abort sequence, 0x7d7e. Reception of this code at the far end will cause the receiver to discard this frame (The Abort sequence octets are also scrambled).

For the second option, the LAPS entity can also abort an erroneous packet by simply inverting the FCS bytes to generate a FCS error. The selection of abort mode is controlled via the management

interface.

An invalid frame is a frame which:

a) is not properly bounded by two flags; or

b) has fewer than six octets between flags of frames; or

c) contains a frame check sequence error; or

d) contains a service access point identifier which is mismatched to 0x0c or not supported by the receiver; or

e) contains an unrecognized Control field value; or

f) is invalid control sequence, i.e., {0x7d, ZZ} where ZZ octet is not 5d, 5e, 7e, dd (Rate Adaptation).

Invalid frames shall be discarded without notification to the sender. No action is taken as the result of that frame.

APPENDIX II

The possible application area of this technology
(This appendix I does not form an integral port of this Recommendation)

I.1 The SDH private network connection for the Layer 2 switch of 10BASE-T and 100BASE-T, 1000Base-x which is showed in Figure I.1.

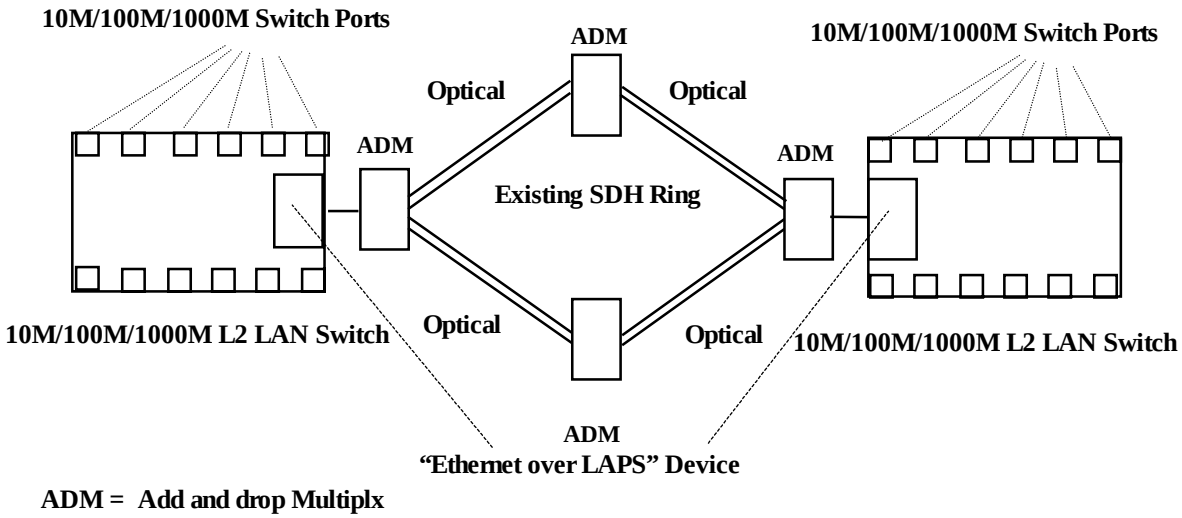


Figure I.1/X.86
An example of private network of Ethernet over LAPS

I.2 The SDH public network connection with Layer 3 switches with IEEE 802.3 Ethernet (see Figure I.2)

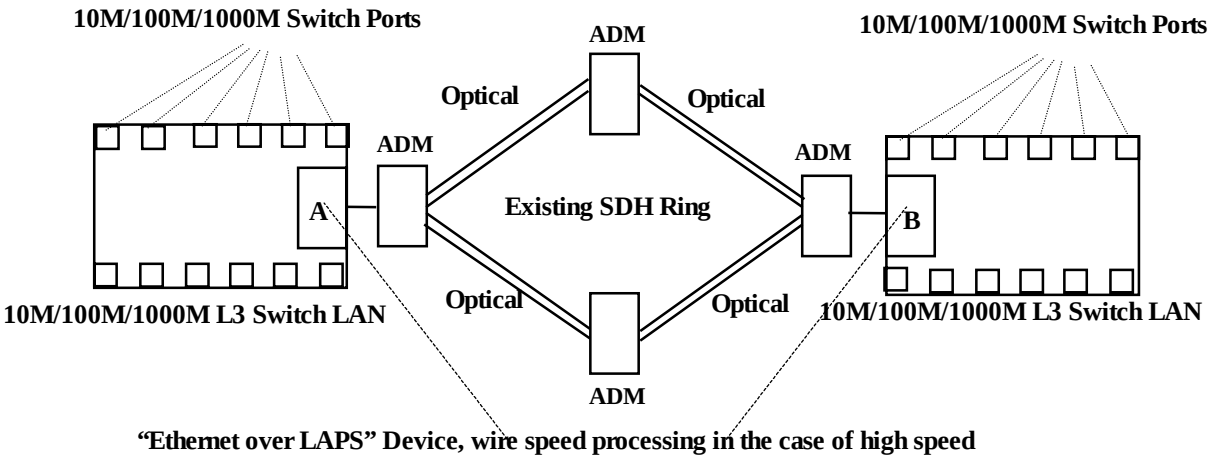


Figure I.2/X.86
An example of public network of Ethernet over LAPS

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