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SERIES X: DATA NETWORKS AND OPEN SYSTEM  
COMMUNICATIONS

Public data networks – Transmission, signalling and  
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Internet protocol aspects – Transport

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**Ethernet over LAPS**

ITU-T Recommendation X.86/Y.1323

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**Ethernet over LAPS**

**Summary**

This Recommendation specifies how to operate Ethernet (defined by IEEE WG 802.3) over LAPS (Link Access Procedure – SDH) and provides a simple technique to connect LANs and provides Ethernet LAN extension over Wide Area Network (WAN) within a private and/or public network. The characteristics of this technique include low latency variance, remote performance monitoring capability, remote fault indication capability, active flow control in burst traffic condition and ease of use and maintenance, especially in the area of SDH transmission.

**Source**

ITU-T Recommendation X.86/Y.1323 was prepared by ITU-T Study Group 7 (2001-2004) and approved under the WTSA Resolution 1 procedure on 2 February 2001.

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## **Introduction**

The Internet market has been growing at a great rate. Growth is an important issue and creates the need to expand 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 X.85/Y.1321 to 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.

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 X.200, and applies to Synchronous Digital Hierarchy (ITU-T G.707/Y.1322). LAPS protocol and specification introduced in ITU-T 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 bidirectional operation. Connecting Ethernet Switches to a 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 the Rate Adaptation are presented in the following diagram (see Figure 1).

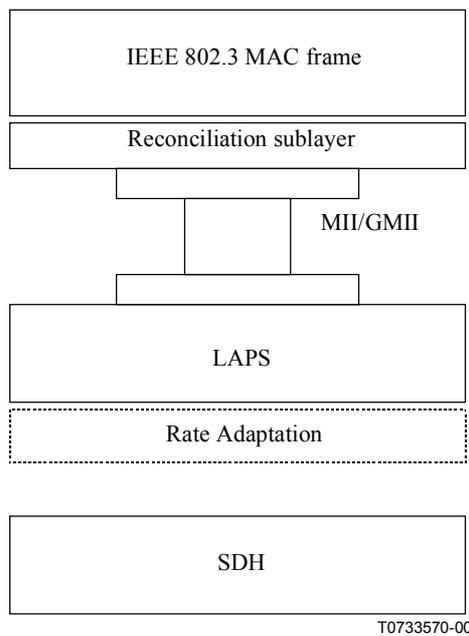


Figure 1/X.86/Y.1323 – The relationship between Ethernet frame and LAPS and SDH

This Recommendation does not specify the method of mapping LAPS to SDH. No change is made for all Ethernet-based protocols (including IEEE 802.3 Ethernet) and all SDH standards.

NOTE 1 – It is intended that Ethernet over LAPS can be extended, in future amendments, to support additional new types of data service.

NOTE 2 – LAPS used in this Recommendation is not used to coexist with HDLC (ISO/IEC 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; 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 the currently valid ITU-T Recommendations is regularly published.

### 2.1 Normative references

#### 2.1.1 ITU-T Recommendations

- [1] ITU-T X.85/Y.1321 (2001), *IP over SDH using LAPS*.
- [2] ITU-T G.703 (1998), *Physical/electrical characteristics of hierarchical digital interfaces*.
- [3] ITU-T G.707/Y.1322 (2000), *Network node interface for the synchronous digital hierarchy (SDH)*.
- [4] ITU-T G.708 (1999), *Sub STM-0 network node interface for the synchronous digital hierarchy (SDH)*.
- [5] ITU-T G.957 (1999), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy*.
- [6] ITU-T X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open System Interconnection – Basic Reference Model: The Basic Model*.

#### 2.1.2 ISO/IEC Standards

- [7] ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*. (Equivalent to IEEE 802.3.)

## 3 Definitions

This Recommendation defines the following terms:

**3.1 Ethernet over LAPS:** The data communication architecture of combination Ethernet (IEEE 802.3) 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 rate 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 ISO/IEC 2382-25

This Recommendation makes use of the following abbreviations specified in IEEE 802.3:

LAN	Local area network
LLC	Logical link control
MAC	Media access control

### 4.2 Abbreviations specified in ITU-T G.707/Y.1322

This Recommendation makes use of the following abbreviations specified in ITU-T G.707/Y.1322:

SDH	Synchronous Digital Hierarchy
STM	Synchronous Transfer Module
sSTM	Sub-STM
VC	Virtual Container

### 4.3 Abbreviations specified in ITU-T Q.921

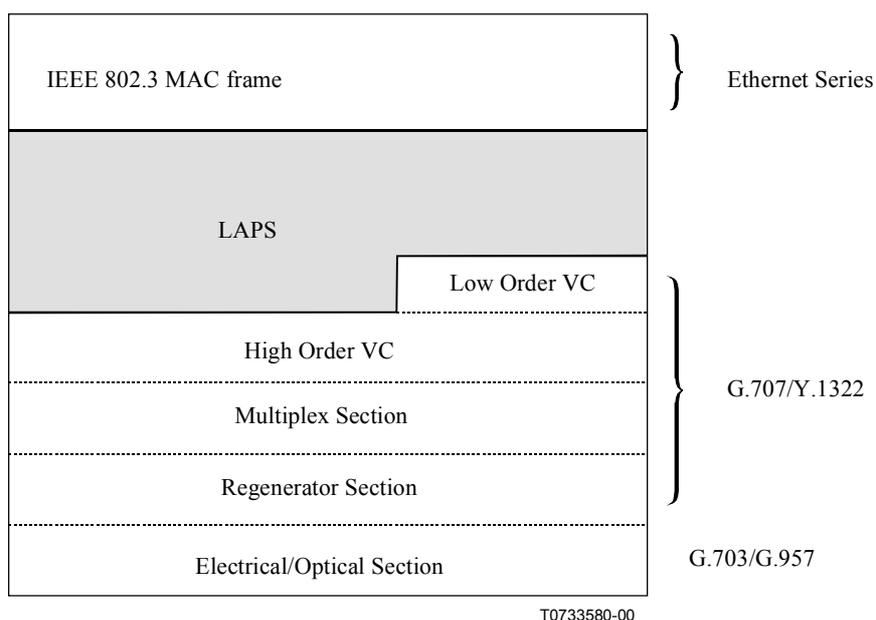
SAPI	Service Access Point Identifier
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### 4.4 Abbreviations specified in this Recommendation

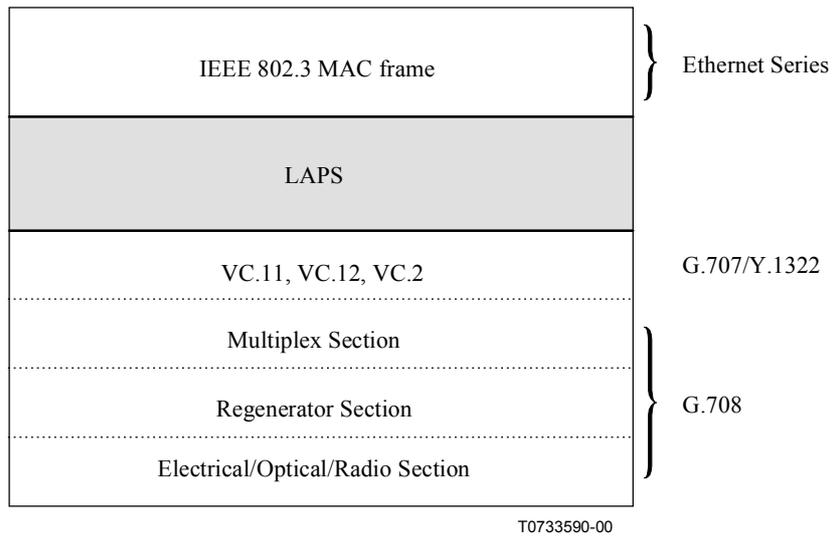
LAPS	Link Access Procedure – SDH
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## 5 The protocol framework of Ethernet over LAPS

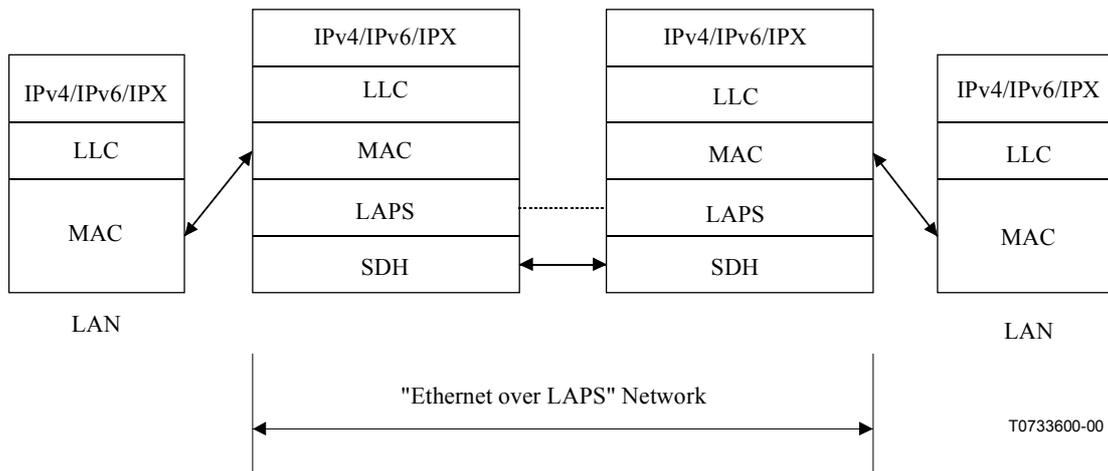
The layer/protocol stacks for Ethernet over LAPS in the STM-N sSTM-n are shown in Figures 2 and 3 respectively. Figures 4 and 5 illustrate protocol configuration and possible network examples of Ethernet over LAPS respectively.



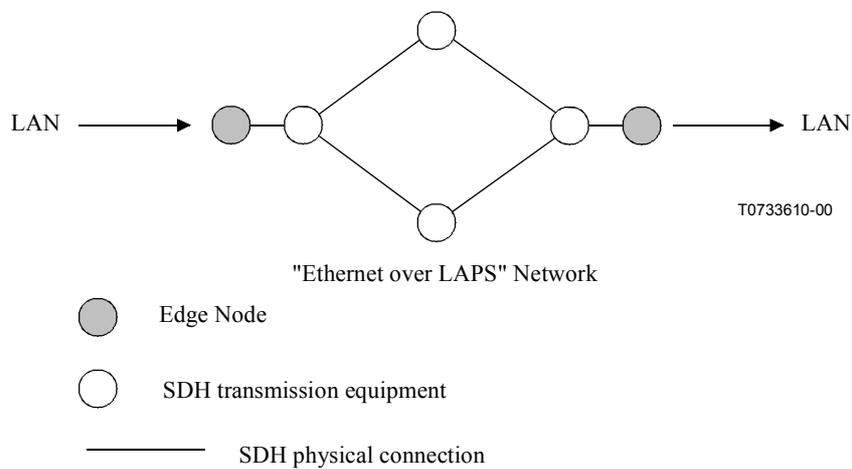
**Figure 2/X.86/Y.1323 – Layer/protocol stack for Ethernet over LAPS in STM-N**



**Figure 3/X.86/Y.1323 – Layer/protocol stack for Ethernet over LAPS in sSTM**



**Figure 4/X.86/Y.1323 – The protocol configuration of Ethernet over LAPS**



**Figure 5/X.86/Y.1323 – "Ethernet over LAPS" network example**

## 6 The SDH physical layers

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 methods. 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 X.85/Y.1321). This Recommendation uses the future concatenation of virtual containers as defined in the next version of ITU-T G.707/Y.1322.

**Table 1/X.86/Y.1323 – 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	601 344	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/X.86/Y.1323 – 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 sublayer, which provides point-to-point transferring over SDH virtual containers and interface rates. The supported UITS is a connectionless-mode service. The rate 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 from being written to the SDH overhead since SDH and MAC are operated in the way of period and burst respectively.

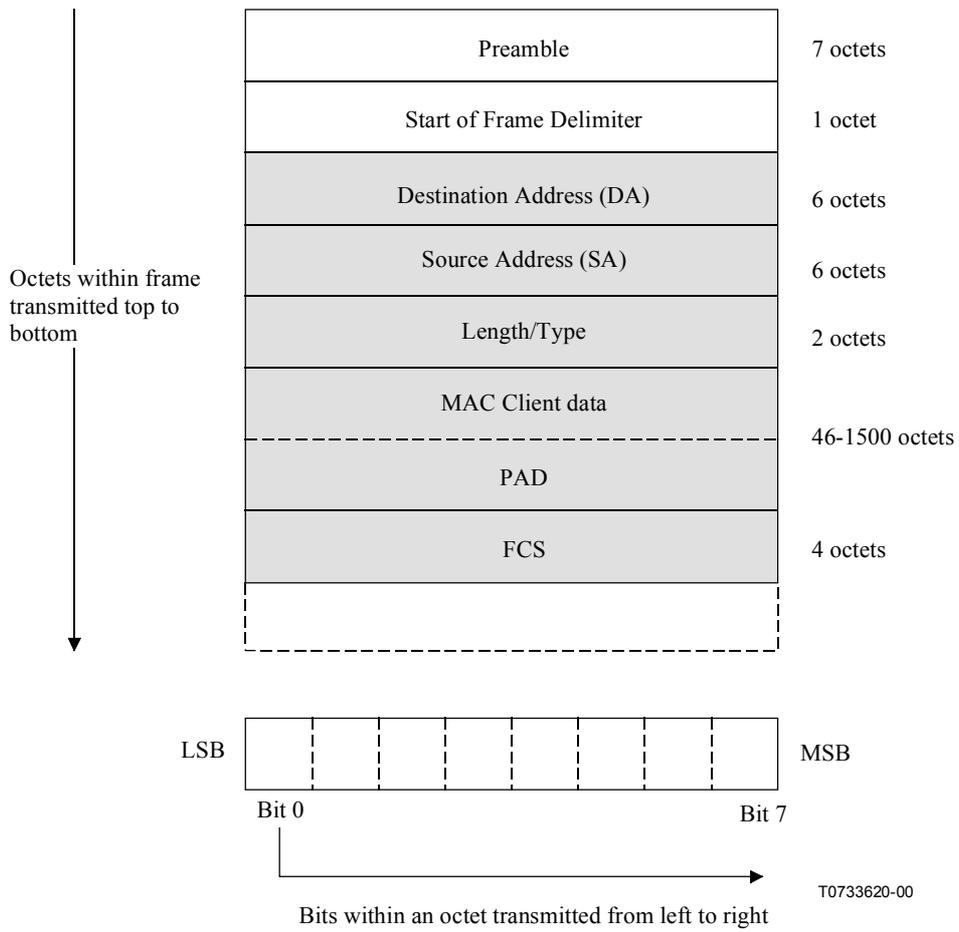
## **7 Service facilities and protocol specifications of LAPS**

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 0xfe01 (hexadecimal). The associated service facilities and protocol specifications of LAPS are included in Annex A of ITU-T X.85/Y.1321.

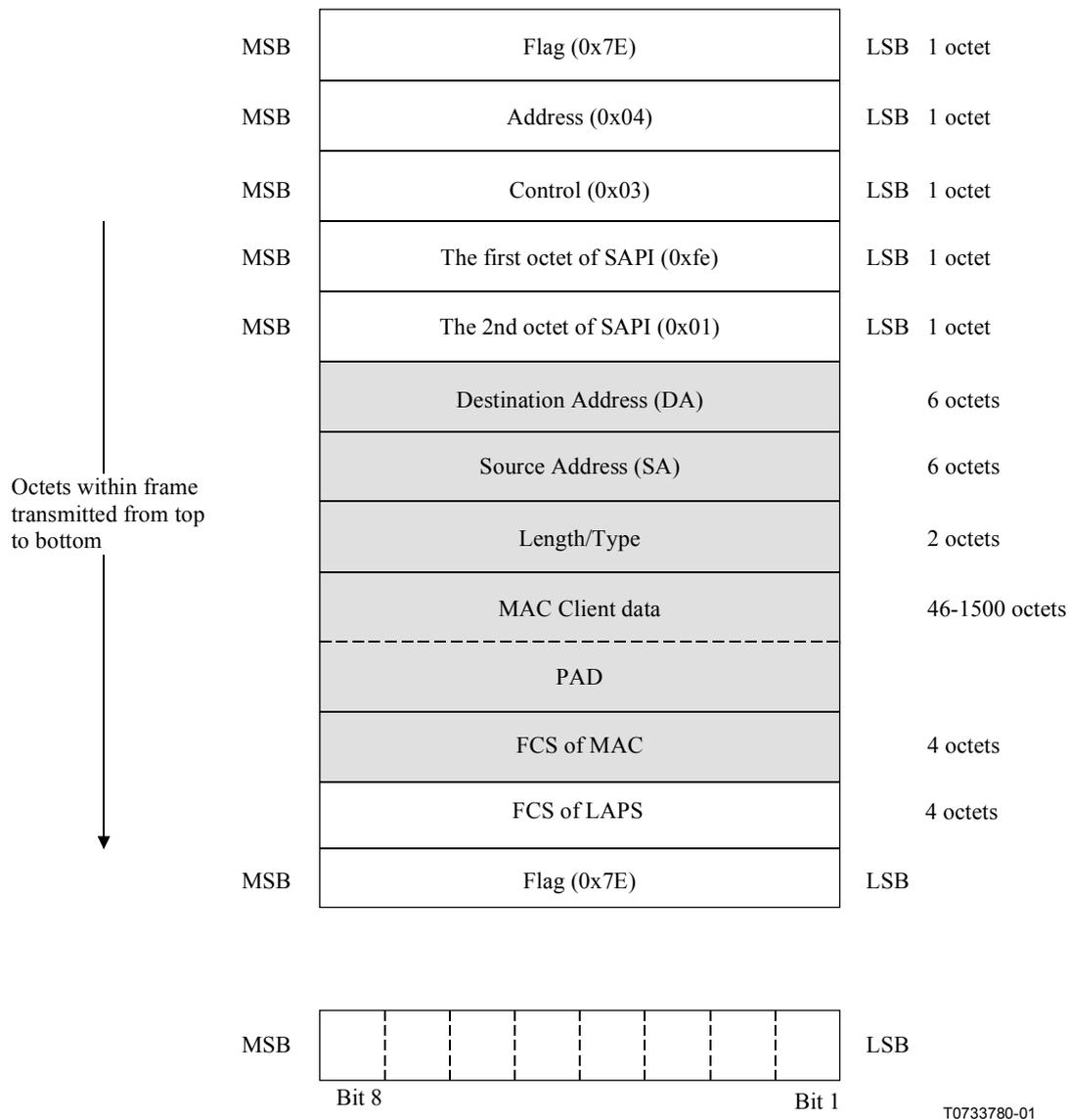
NOTE – It is needed to replace "Layer 3 or network layer or IP based network", "IP packet" and "Layer 2 or data link layer" with "MAC layer", "MAC frame" and "LAPS" respectively in Annex A of ITU-T X.85/Y.1321.

## **8 Encapsulation**

LAPS link entity accepts frames from the MAC layer through the reconciliation sublayer and an equivalent MII (Media Independent Interface). No address filtering function is used here. The format of LAPS information field is 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 shown in Figure 7) is kept intact. The FCS computations of LAPS and MAC refer to ITU-T 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 sublayer/MII and LAPS/SDH.



**Figure 6/X.86/Y.1323 – The format of IEEE 802.3 Ethernet MAC frame, LAPS information field as defined in the shaded region**



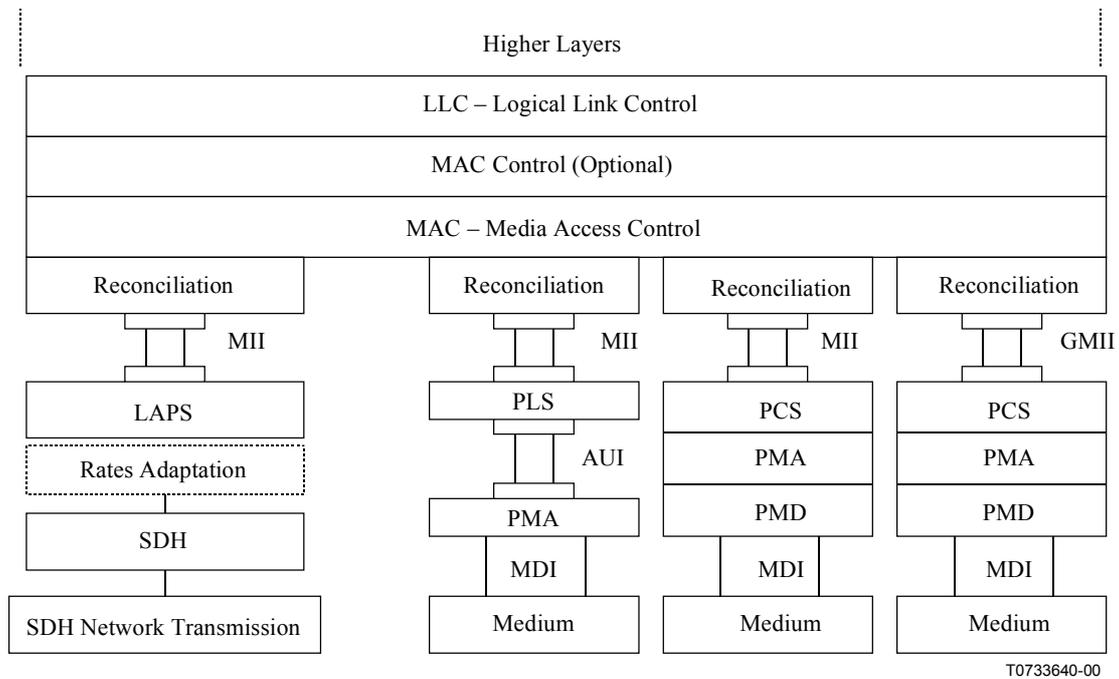
**Figure 7/X.86/Y.1323 – The format of LAPS frame after encapsulating MAC field**

## 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.



AUI	Attachment Unit Interface	PCS	Physical Coding Sublayer
GMII	Gigabit Media Independent Interface	PHY	Physical Layer Device
LAPS	Link Access Procedure – SDH	PLS	Physical Layer Signalling
MAU	Medium Attachment Unit	PMA	Physical Medium Attachment
MDI	Medium Independent Interface	PMD	Physical Medium Dependent
MII	Media Independent Interface	SDH	Synchronous Digital Hierarchy

**Figure 8/X.86/Y.1323 – 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:

#### I.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, Control and Address field to the LAPS frame.
- 5) FCS generation over Address, Control, SAPI, and LAPS information field (shaded area as shown 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:
  - $0x7e \geq 0x7d, 0x5e;$
  - $0x7d \geq 0x7d, 0x5d.$

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.

## **I.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 of the Address, Control and the SAPI 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.

## **I.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 an FCS error. The selection of abort mode is controlled via the management interface.

An invalid frame is a frame which:

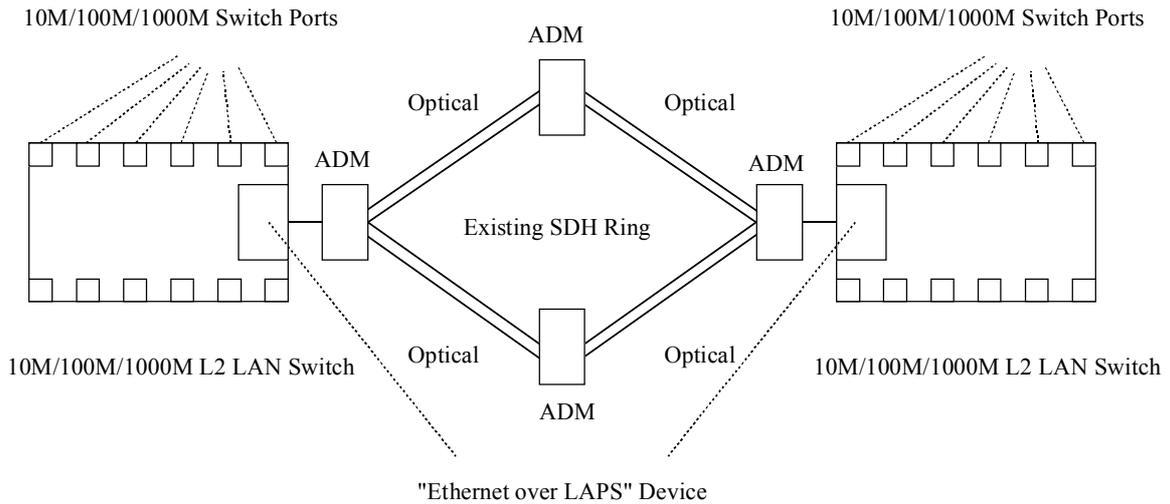
- a) is not properly bounded by two flags; or
- b) has fewer than six octets between flags of frames; or
- c) contains a frame check sequence error; or
- d) contains a service access point identifier which is mismatched to 0x0c or not supported by the receiver; or
- e) contains an unrecognized Control field value; or
- f) has an 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

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

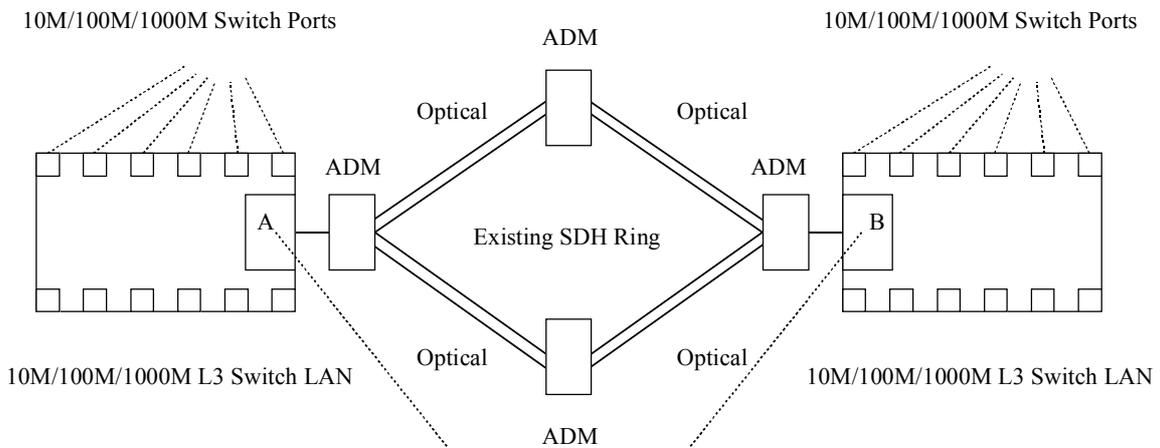


ADM Add and drop multiplex

T0733650-00

**Figure II.1/X.86/Y.1323 – An example of a private network of Ethernet over LAPS**

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



"Ethernet over LAPS" Device, wire speed processing in the case of high speed

T0733660-00

ADM Add and drop multiplex

**Figure II.2/X.86/Y.1323 – An example of a public network of Ethernet over LAPS**



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