EFM OAM on Preamble

Hiroshi Suzuki, Sanjeev Mahalawat, Cisco Systems
Rich Taborek, Intel
Ben Brown, AMCC
Martin Nuss, Internet Photonics
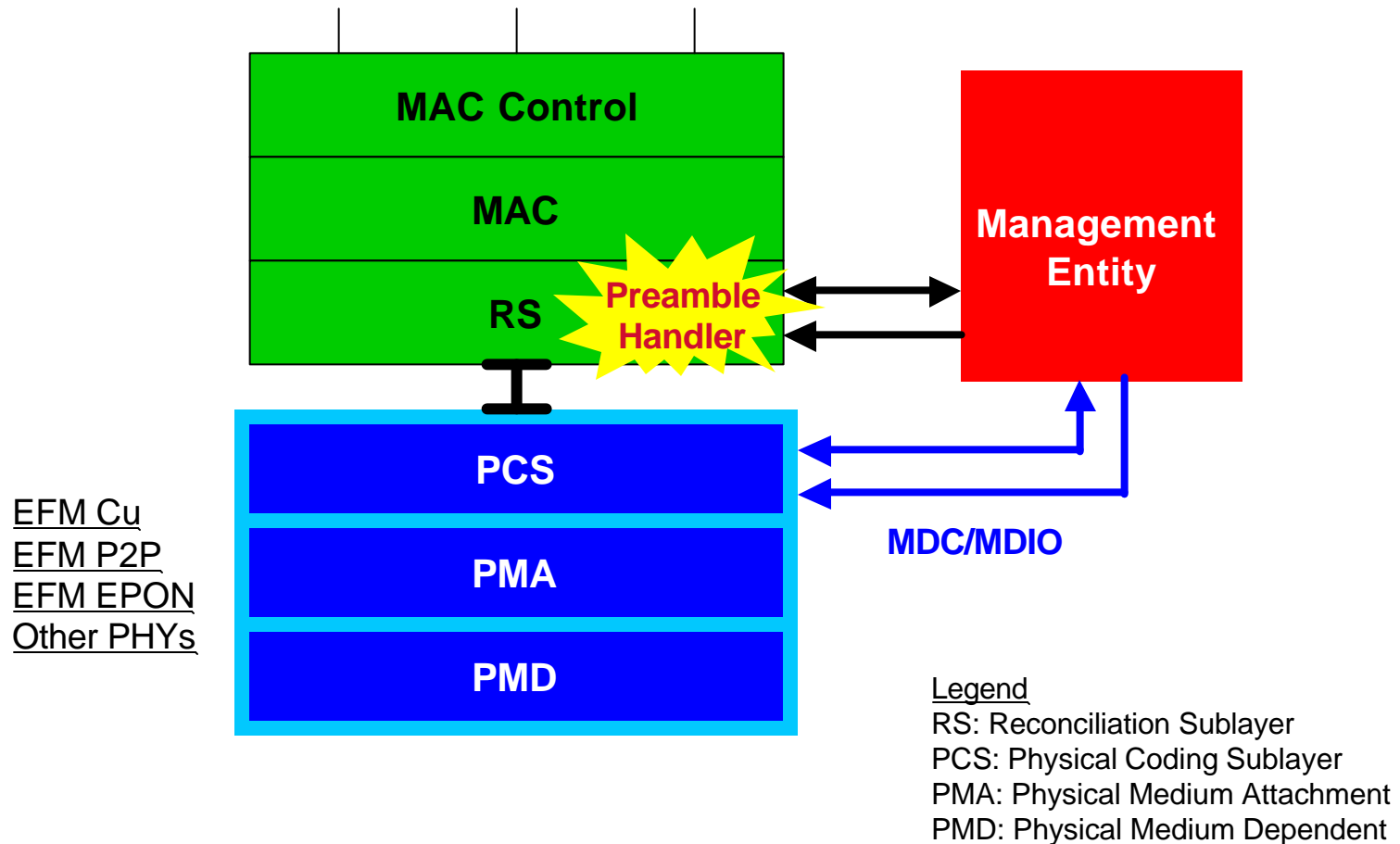**Jian Song, Sarila Systems**
Bob Barrett, Fiberintheloop

OAM Functions

- **Loopback (Ping)**

- **Dying Gasp**

- **Remote Fault Indication**

- **Remote Read/Write Link Monitor Registers**

- **Possible Future Extensions**

Where is Preamble Handler?

MAC Control

MAC

RS

Preamble Handler

Management Entity

PCS

PMA

PMD

EFM Cu
EFM P2P
EFM EPON
Other PHYs

MDC/MDIO

Legend
RS: Reconciliation Sublayer
PCS: Physical Coding Sublayer
PMA: Physical Medium Attachment
PMD: Physical Medium Dependent

Preamble Format

- **8 byte Preamble includes:**

    1 byte: **SOP (Start of Packet)**

    2-4 bytes: **OAM, Message, Reserved**

    2 bytes: **Logical PHY ID (Reserved)**

    1 byte: **CRC**

- **When no data frame exists, generate a "dummy frame".**

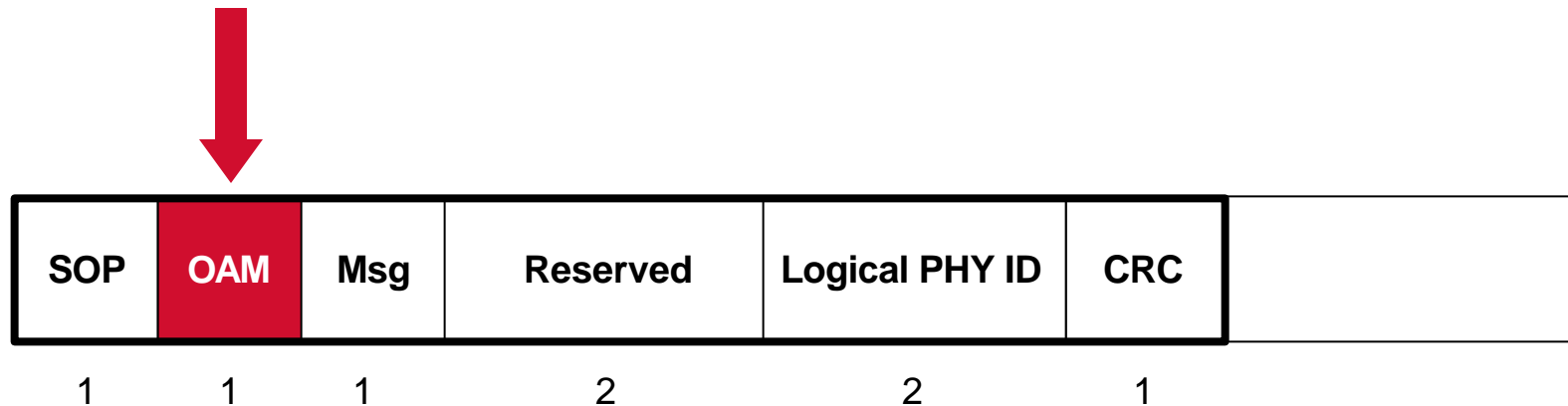- **When passing a frame to MAC, convert to standard Preamble.**

8 bytes

SOP	OAM	Msg	Reserved	Logical PHY ID	CRC	
1	1	1	2	2	1	
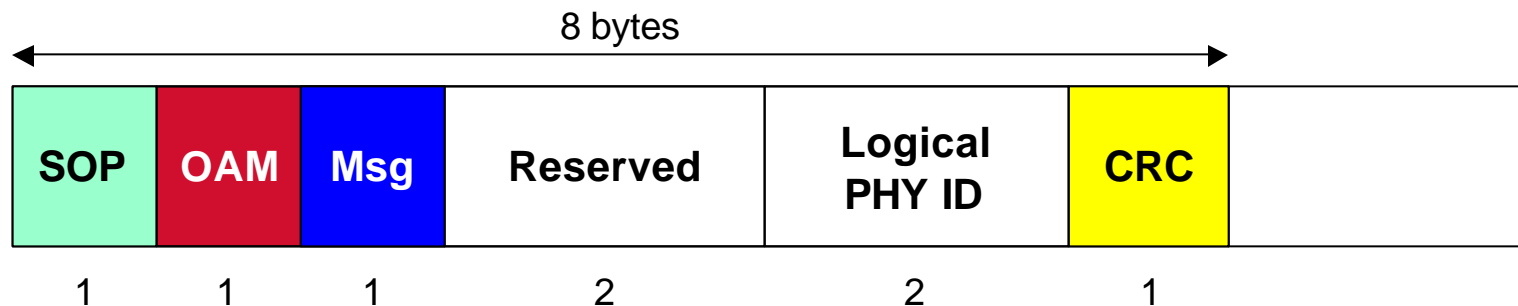
OAM Type Field
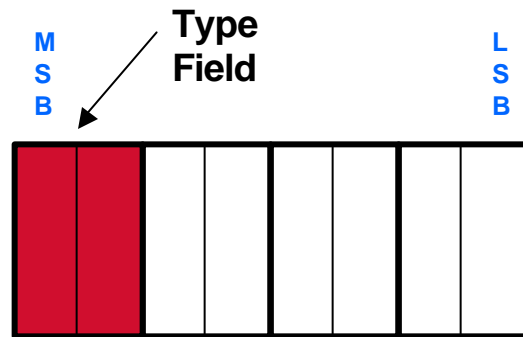
M L
S S
B B

0 0: OAM Preamble with Data

0 1: Standard Preamble

1 0: Dummy Frame

1 1: Reserved

Type
Field

MSB

LSB

SOP	OAM	Msg	Reserved	Logical PHY ID	CRC
1	1	1	2	2	1

OAM Code Points

```
          M                        L
          S                        S
          B                        B
```

Type ———→ [Type | Loopback | Dying Gasp | Remote/Local Fault Indication]

Loopback
(Ping based)

Dying Gasp

Remote/Local
Fault Indication

SOP	OAM	Msg	Reserved	Logical PHY ID	CRC
1	1	1	2	2	1

Loopback (Ping)

M S B

L S B

Local   **Remote**
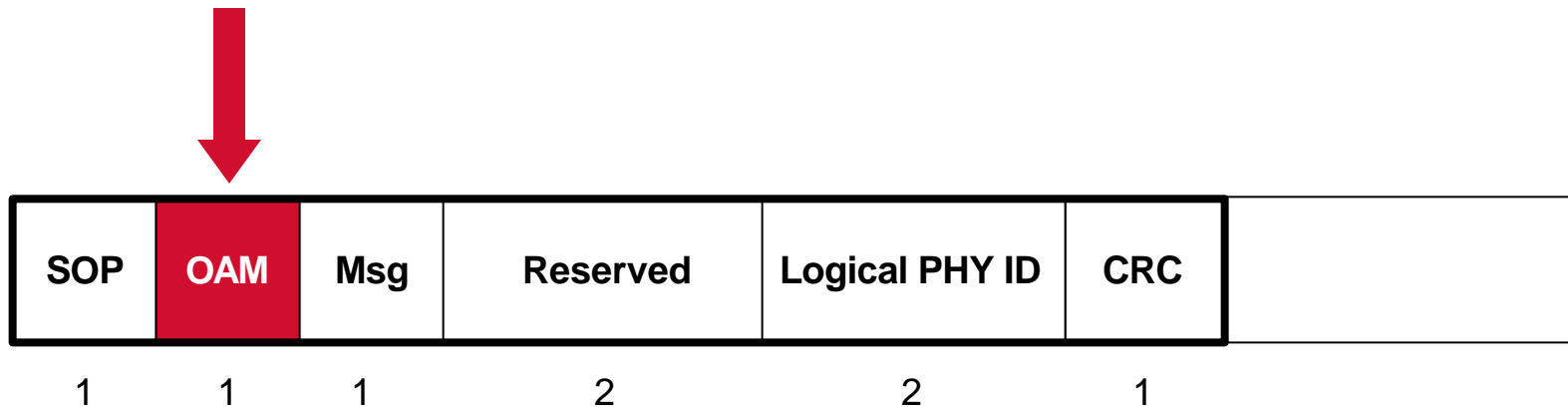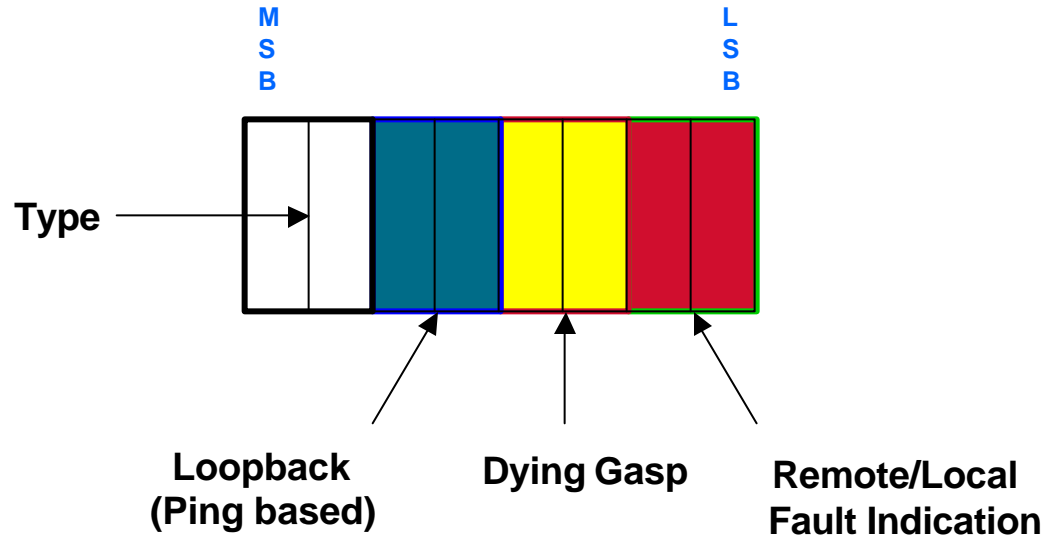
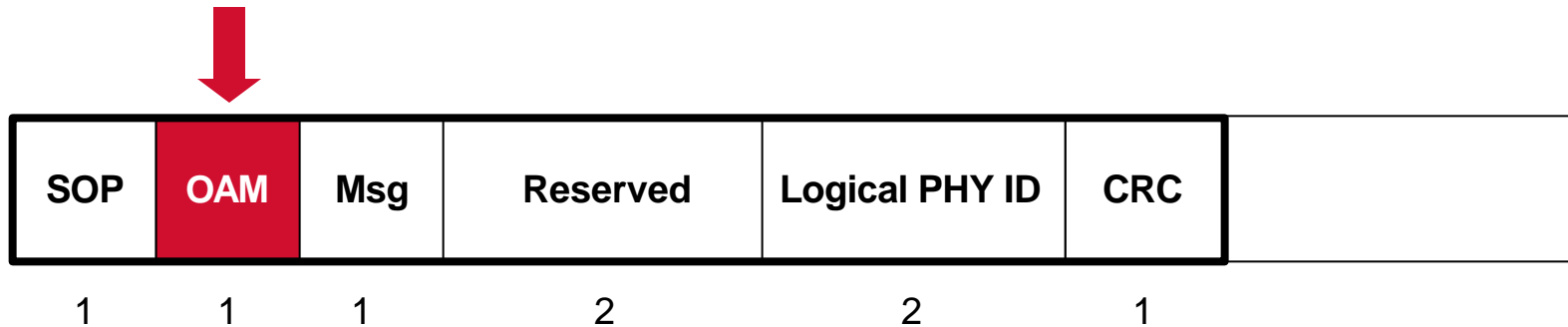Ping Request (01)
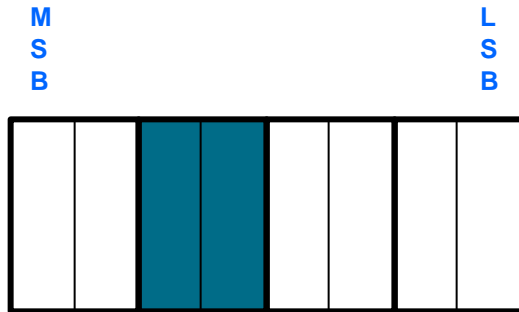
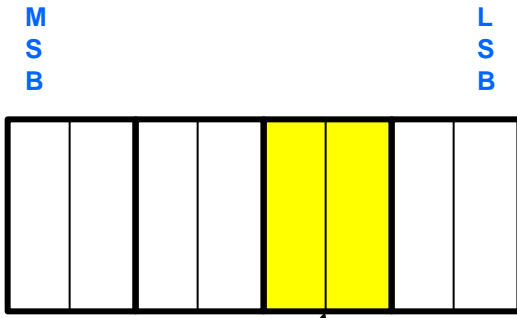Ping Response (10)

Loopback (Ping)
00: No operation
01: Ping Request
10: Ping Response
11: Reserved
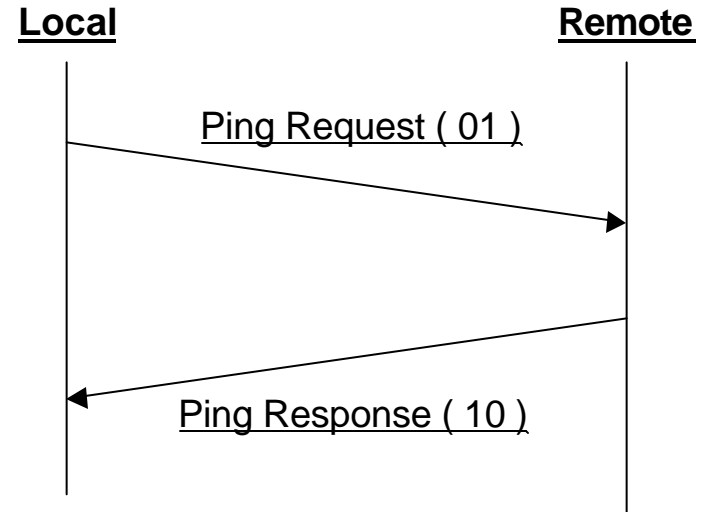
Local) Sends Ping Request, awaits Response/timeout
Remote) Sends Ping Response to Request

SOP	OAM	Msg	Reserved	Logical PHY ID	CRC
1	1	1	2	2	1

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Dying Gasp

M S B   L S B

Dying Gasp
00: Normal Operation
01: Dying due to power off
10: Dying due to reset
11: Dying due to other reasons

Local   **Remote**

Dying Gasp { 01 / 10 / 11 }
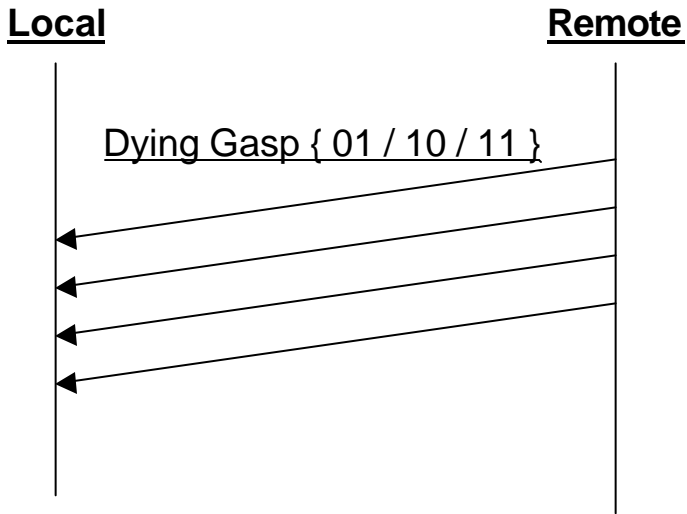
Remote) Before dying, send the pattern based on particular reason for all frames.

SOP	OAM	Msg	Reserved	Logical PHY ID	CRC
1	1	1	2	2	1

Fault Indication

M S B   **L S B**
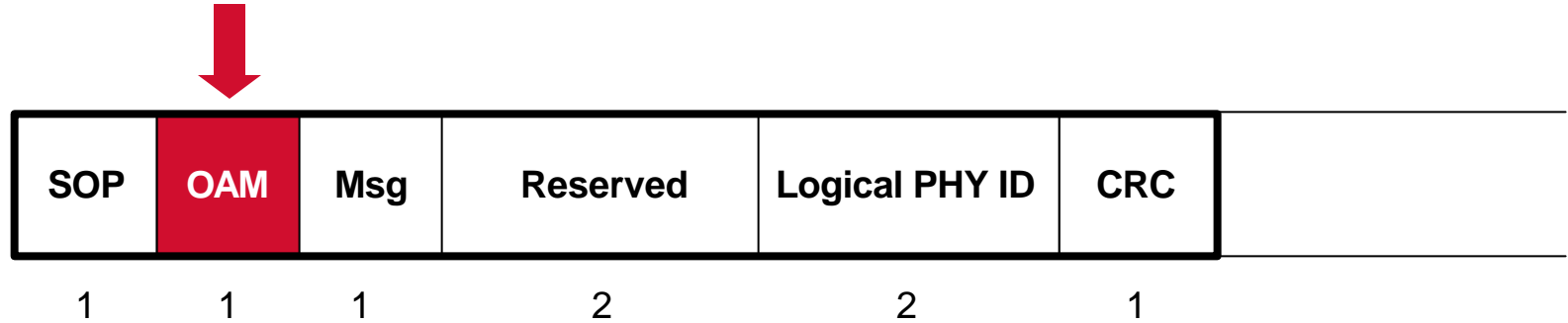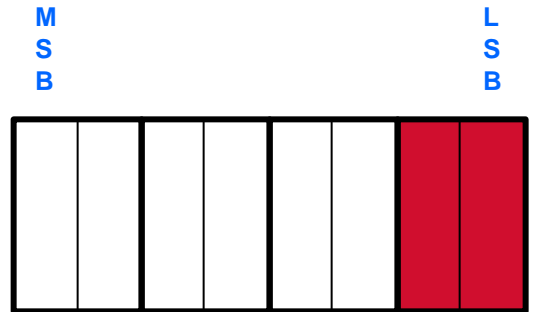
Remote Fault Indication bit
0: Normal Operation
1: Remote Fault

Local Fault Indication bit
0: Normal Operation
1: Local Fault

SOP	OAM	Msg	Reserved	Logical PHY ID	CRC
1	1	1	2	2	1

PHY Rx Fault Detect

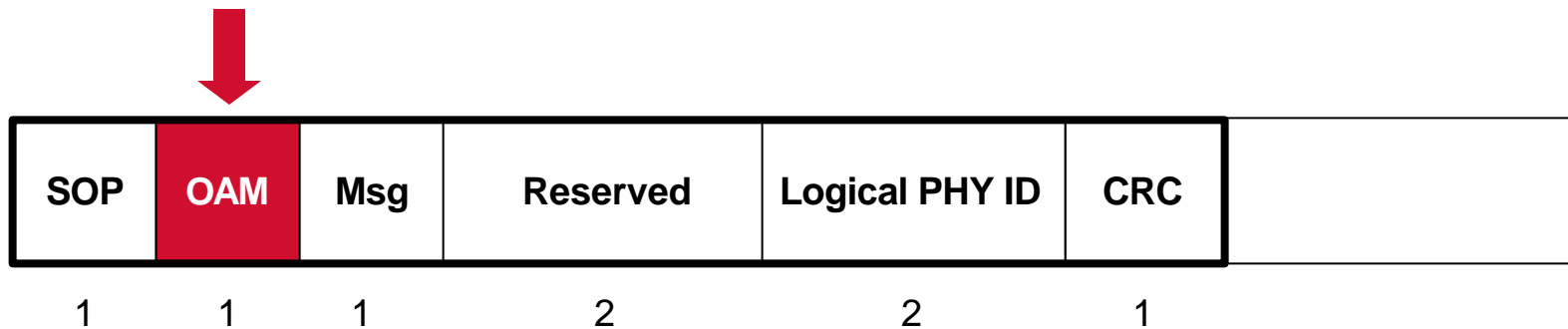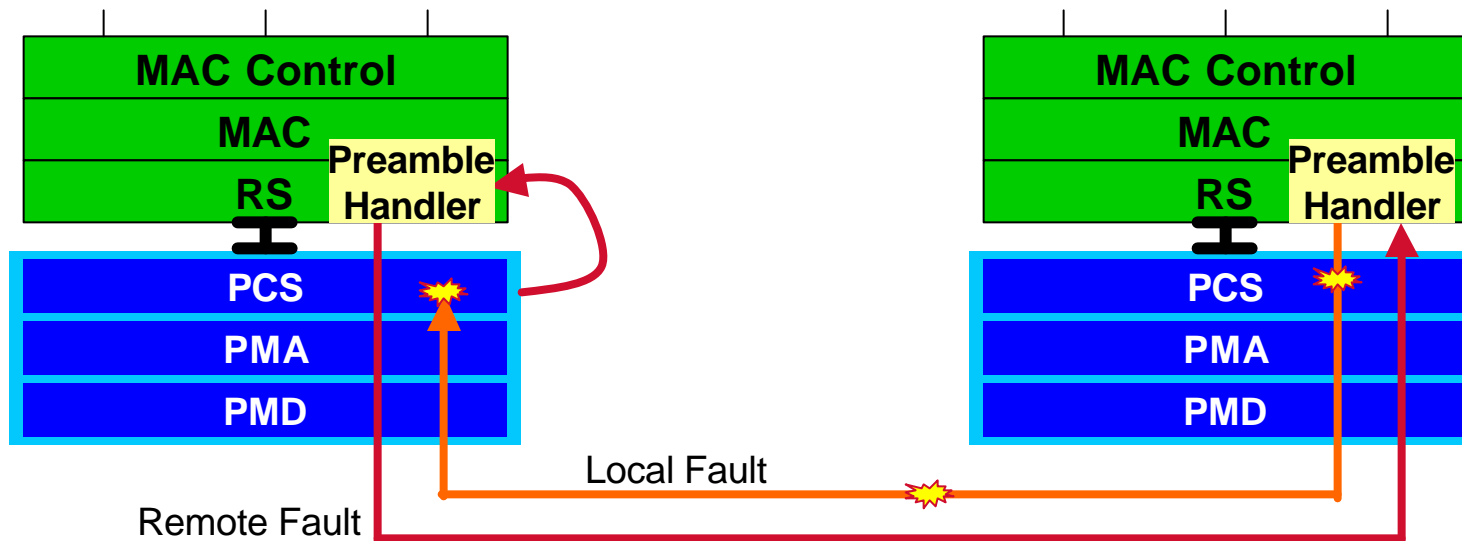- **1) When PHY Rx detects a Fault:**
  - Set PHY Local Fault register and indicate Local Fault to RS
  - RS indicates Remote Fault in Tx direction

- **2) When the Fault is no longer detected by the PHY Rx:**
  - Clear Local Fault indication in PHY and RS
  - RS stops indicating Remote Fault

| MAC Control |
| MAC |
| RS | Preamble Handler |
| PCS |
| PMA |
| PMD |

| MAC Control |
| MAC |
| RS | Preamble Handler |
| PCS |
| PMA |
| PMD |

Local Fault

Remote Fault

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RS Fault Detect

- **1) When RS detects a Fault:**
  - **Set Local Fault indication RS**
  - **RS indicates Remote Fault in Tx direction**

- **2) When the Fault is no longer detected by the RS**
  - **Clear Local Fault indication in RS**
  - **RS stops indicating Remote Fault**
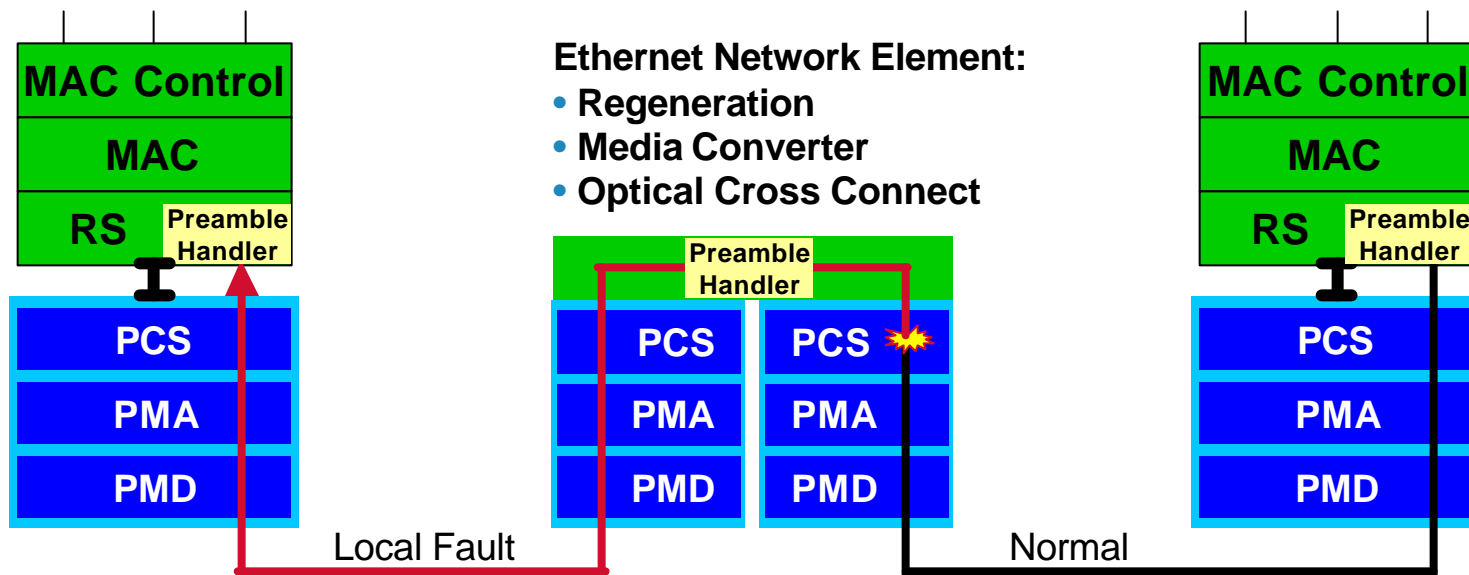
**Local Fault occurs at
reset phase/RS Fault**

MAC Control
MAC
RS   Preamble Handler

| PCS |
| PMA |
| PMD |

MAC Control
MAC
RS   Preamble Handler

| PCS |
| PMA |
| PMD |

Local Fault
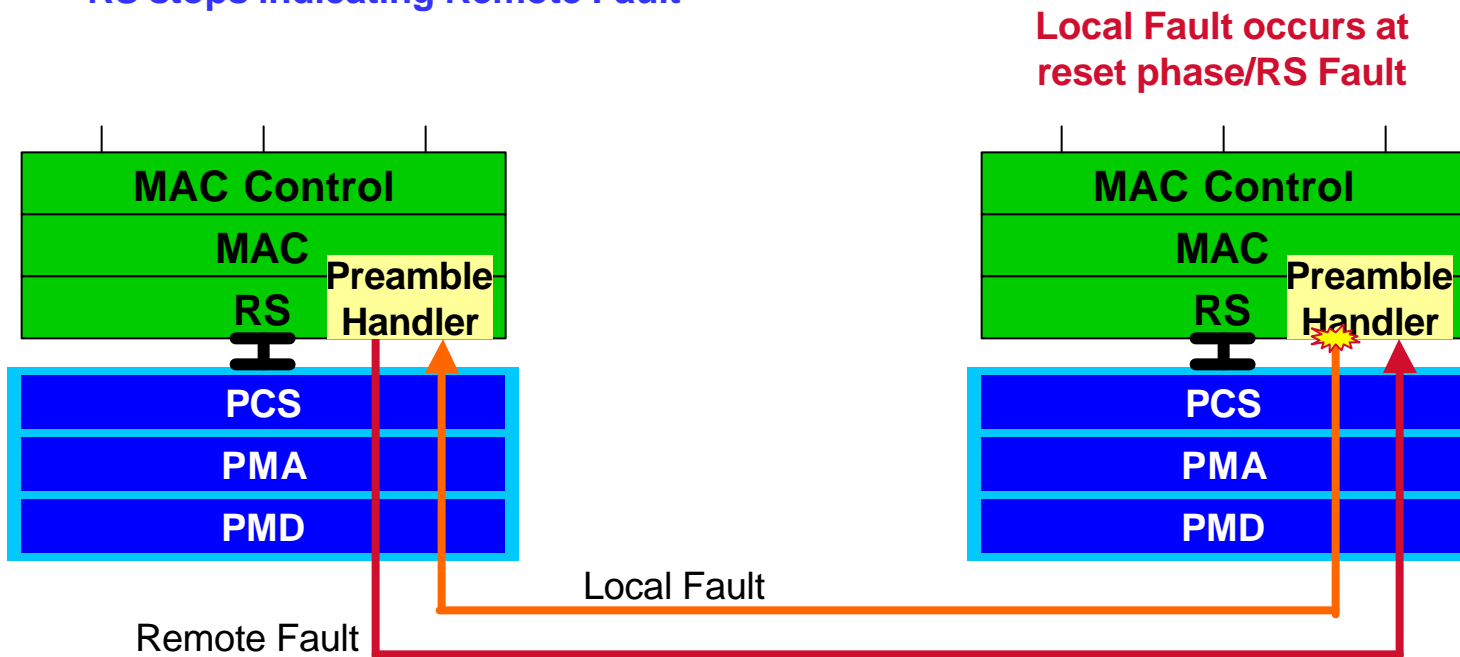
Remote Fault

Optional Features of OAM Fault Indication

- **Ethernet Network Element (ENE) includes OAM Preamble Handler**

- **RS generates and terminates Local and Remote Fault**

- **ENE OAM Preamble Handler reflects link-based Fault to RS across multiple link segments**

Ethernet Network Element:
- **Regeneration**
- **Media Converter**
- **Optical Cross Connect**

MAC Control
MAC
RS | Preamble Handler
PCS
PMA
PMD

Preamble Handler
PCS | PCS
PMA | PMA
PMD | PMD

MAC Control
MAC
RS | Preamble Handler
PCS
PMA
PMD

Local Fault

Normal

Remote R/W Link Monitor

- **Remote Read/Write Link Monitor Register Command**

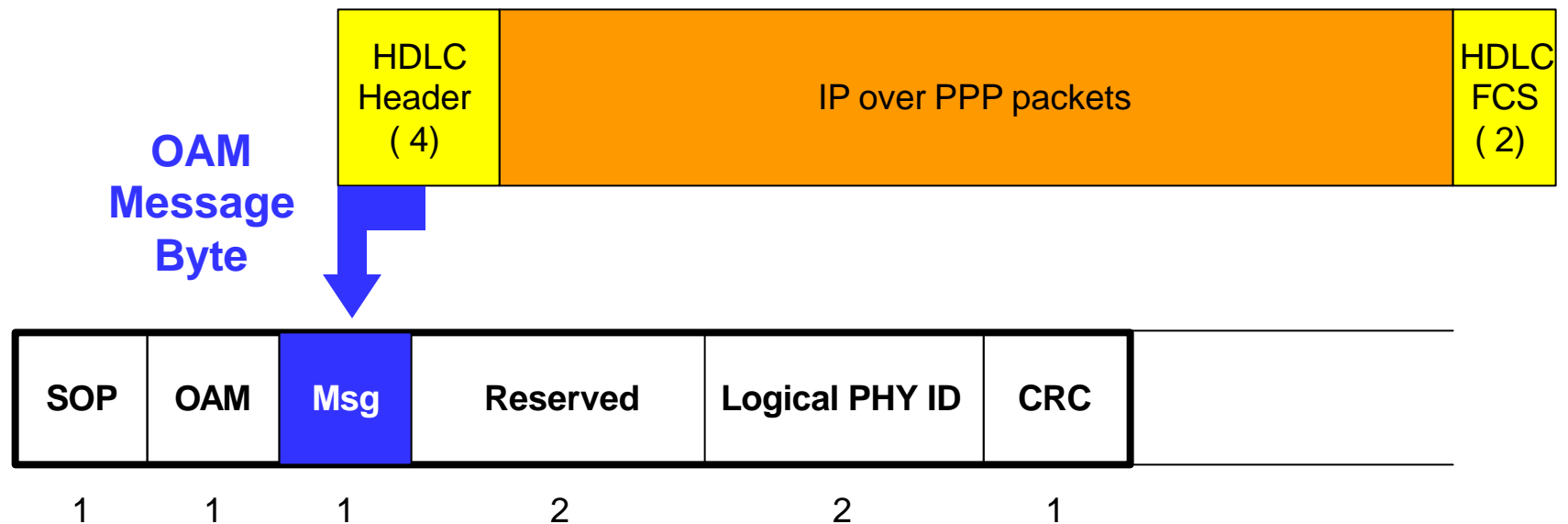 **Link Status / BER / SN / CRC Error / MAC Tx&Rx Stats / Control Registers**

- **Carried by HDLC Encapsulated Message on OAM Message Byte Stream**

- **Min BW = 1 byte / Longest Frame**

  about 600 kb/s for 1GE; 60 kb/s for FE; 6 kb/s for 10M Ethernet

HDLC Header (4)	Read/ Write	Link Monitor Register Address	Values	HDLC FCS (2)

OAM Message Byte

SOP	OAM	Msg	Reserved	Logical PHY ID	CRC
1	1	1	2	2	1

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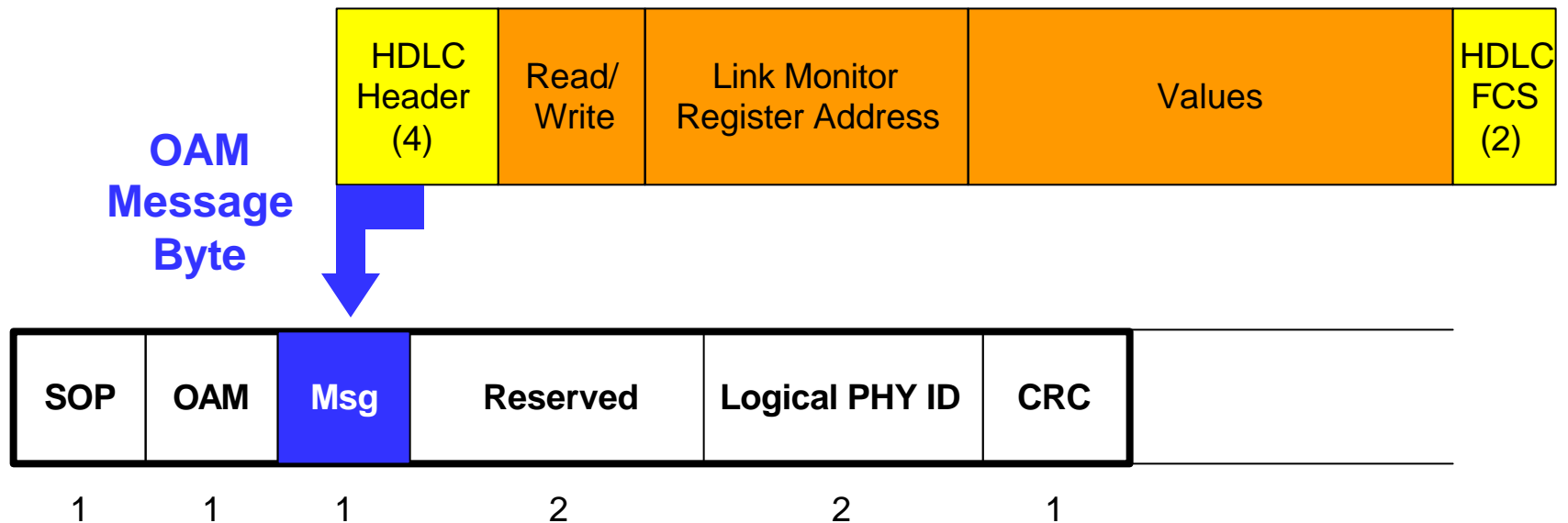
Example Optional OAM Msg Byte Use

- **IP over PPP Carried by HDLC Encapsulated Message on OAM Message Byte Stream**

HDLC Header (4)	IP over PPP packets	HDLC FCS (2)

OAM Message Byte

SOP	OAM	Msg	Reserved	Logical PHY ID	CRC
1	1	1	2	2	1

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OAM Security

- **Security is of concern if a malicious CPE box is directly connected to the link as SP demarcation point (DEMARC).**

    Higher layer authentication resolves this issue

- **Security is of greater concern when OAM is at a higher layer:**

    If it allows access from MAC/MAC Control client (e.g. PC firmware, etc.)

    -and- the frame can be forwarded beyond DEMARC

    Example: What if DEMARC is a simple media converter and

    if my PC behind it can generate MAC control frame?

    ➡ **Would need Authentication & Security for MAC/MAC control frame**

- **Preamble OAM is strictly terminated at DEMARC**

    It is strictly terminated at the Reconciliation Sublayer

    It is never visible beyond DEMARC

    It is never forwarded to the MAC

Conclusion

- **Preamble OAM enables Ethernet Carrier Class Link Management**

  - **Secure at Layer 1**

  - **Fast, multi-segment Link Fault Indication**

  - **Bandwidth transparency**

  - **Higher Layer protocol transparency**

  - **Flexibility for future features**