O A EFM For

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Topology Considerations

Point to point

```
[Service Provider] ————————— [Media Converter] ——— [Subscriber]
```

Fiber to the building

```
[Service Provider] ————————— [Switch] ——— [Subscriber]
                                     \
                                      [Subscriber]
                                       .
                                       .
                                       .
                                      [Subscriber]
```

• Due to the delicate nature of fiber, it is likely that copper connections will be exposed on the customer end

• The demarc point occurs at the subscriber service box

• OAM needs to be able to maintain intermediate links

• Copper links may be either xDSL or regular Ethernet over CAT5
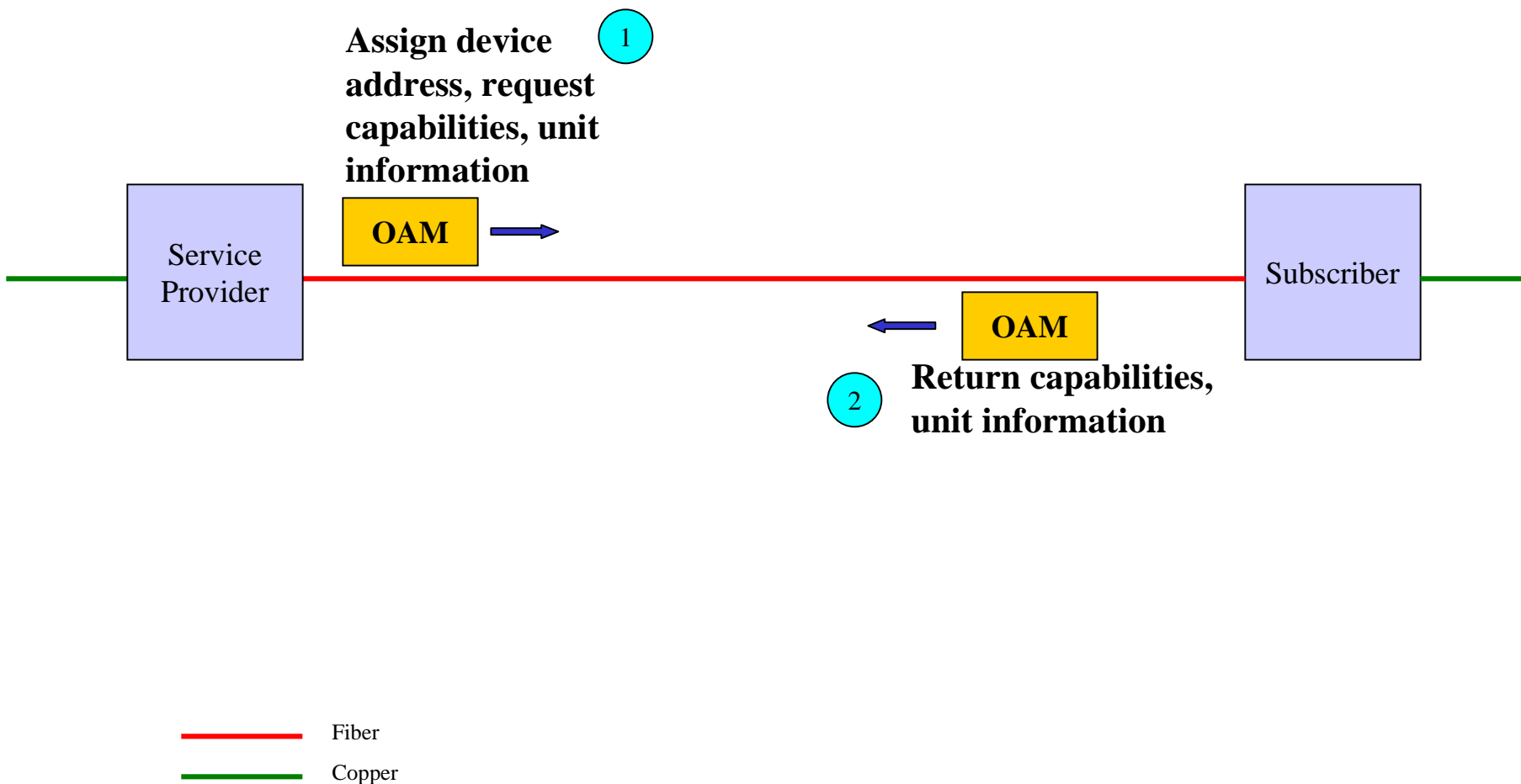
——— Copper

——— Fiber

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Service Provider Requirements

- Multi-link connections

- Remote control of active units

- Ability to view specific parameters in remote units

- Ability to observe link integrity without viewing user data

- Fast alerts for failure conditions

- Ability to start and stop data service while still being able to converse with OAM

- Works with PHY-only devices

- Get box / device model number, serial number, etc.
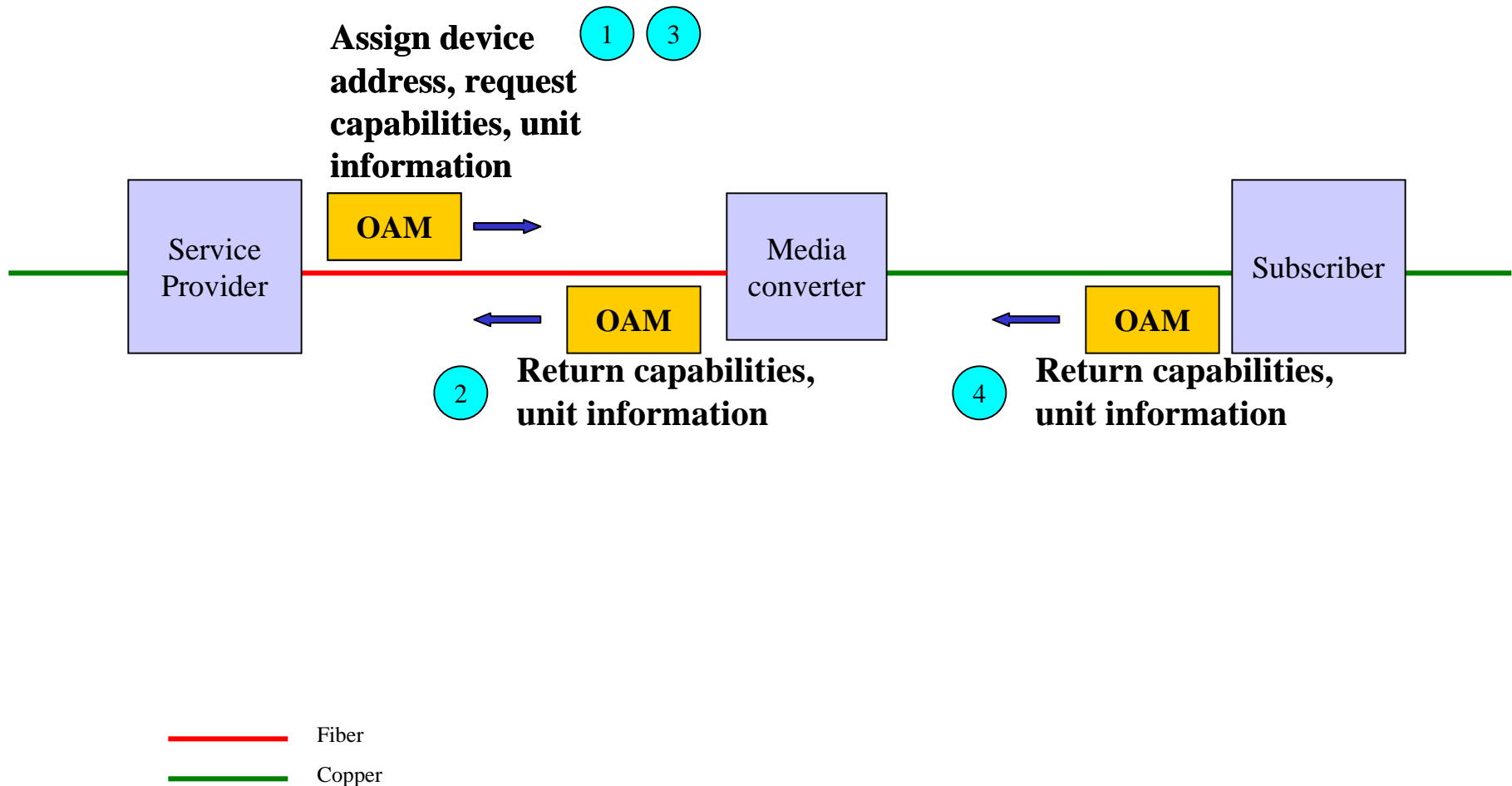
- Provide redundancy for premium services

E t h e r n e t F i r s t M i l e

Basic Elements Needed

• Physical addressing system to communicate with individual links in multi-link spans

• Command / response codes to execute all OAM functions with future expansion capability

• Sufficient data space for remote data reads and writes as well as supplying enough individual code points for system alarms

• Addressing system for reading and writing remote registers (MDIO / OAM)

• CRC to protect the transfer across the link
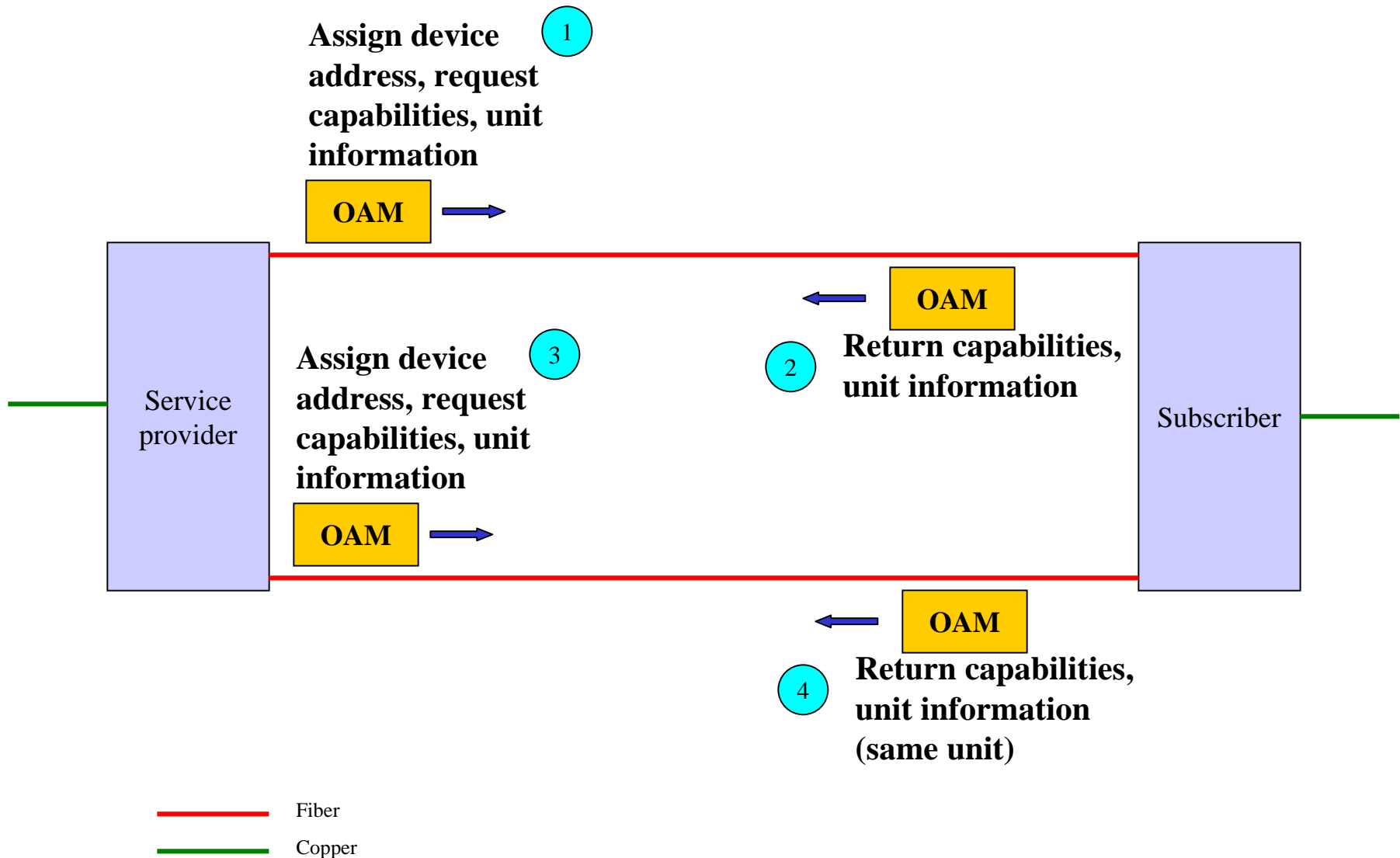
• Overall data integrity checking on the link

Assign device address, request capabilities, unit information (1)

Service Provider	OAM →

← OAM

(2) **Return capabilities, unit information**

Subscriber

─── Fiber

─── Copper

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Addressing Methods & Assignment (with intermediate)

Assign device address, request capabilities, unit information (1) (3)

Service Provider — **OAM** → Media converter — Subscriber

← **OAM** **Return capabilities, unit information** (2)

← **OAM** **Return capabilities, unit information** (4)

— Fiber (red)

— Copper (green)

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Assign device address, request capabilities, unit information

① 1

OAM →

Return capabilities, unit information

② 2

OAM ←

Assign device address, request capabilities, unit information

③ 3

OAM →

Return capabilities, unit information (same unit)

④ 4

OAM ←

Service provider

Subscriber

——— Fiber

——— Copper

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Remote Register Programming

- Register access is defined by capabilities exchanged initially

- Remote programming is available for both MDIO and OAM registers

- Layer 2 and above registers are not accessible as these are available through SNMP

- Semaphores are used to arbitrate access between remote device and local agent

- The OAM frame contains all the information needed to address, read and/or write the PHY registers

OAM Operations in an Active Network

- Monitor all active and inactive links for error thresholds

    - Check to see if error threshold has been exceeded

    - Take corrective action (redundant link) if programmed to do so

- Report alarm conditions

    - Last gasp, service door ajar, fan failure, overtemp, adjacent port failure, etc.

- Uniquely identify where error is coming from

    - Should be able to send specific physical address and specific failure code or codes

    - All error codes can be reported in one OAM frame (individual bits)

    - Select immediate or deferred reporting on a per error basis

    - P2MP can only be immediate if error occurs during its grant window

- Be able to run loopbacks to diagnose a link or groups of links

   - Ability to turn frames around at various loop points

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OAM in 802.3 Protocol Stack

L2	MAC	• Uses standard RS to connect

To data service

	MAC
L2	RS
	OAM
L1	PCS
	PMA
	PMD
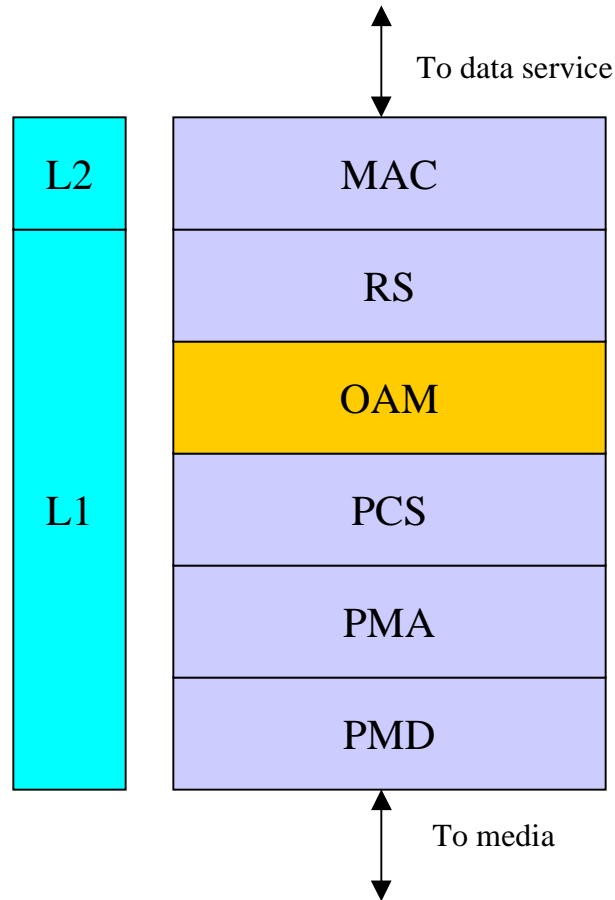
• Uses standard RS to connect
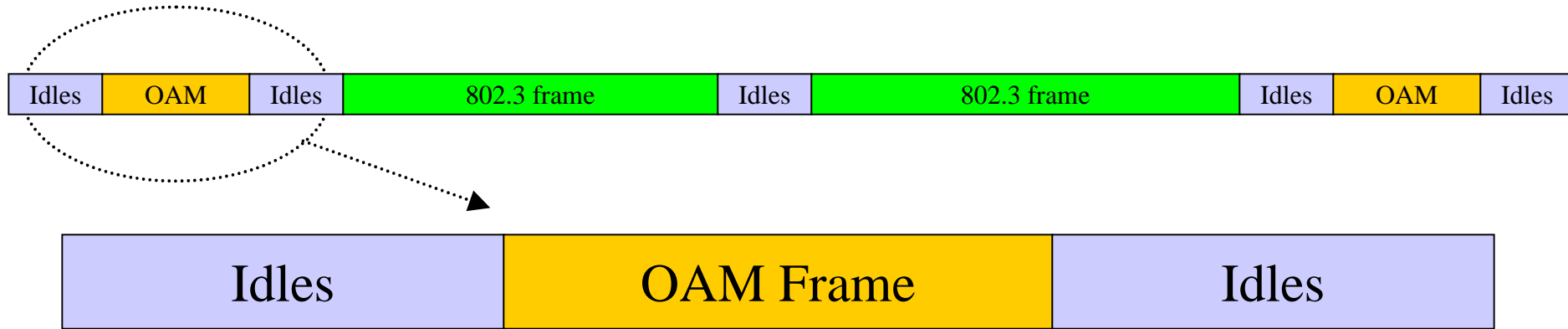
• Connects to existing PCS interfaces

• Requires digital modification to PHY

• Doesn't need MAC to be operating or even exist

To media

L1

| RS |
| OAM |
| PCS |
| PMA |
| PMD |

To media

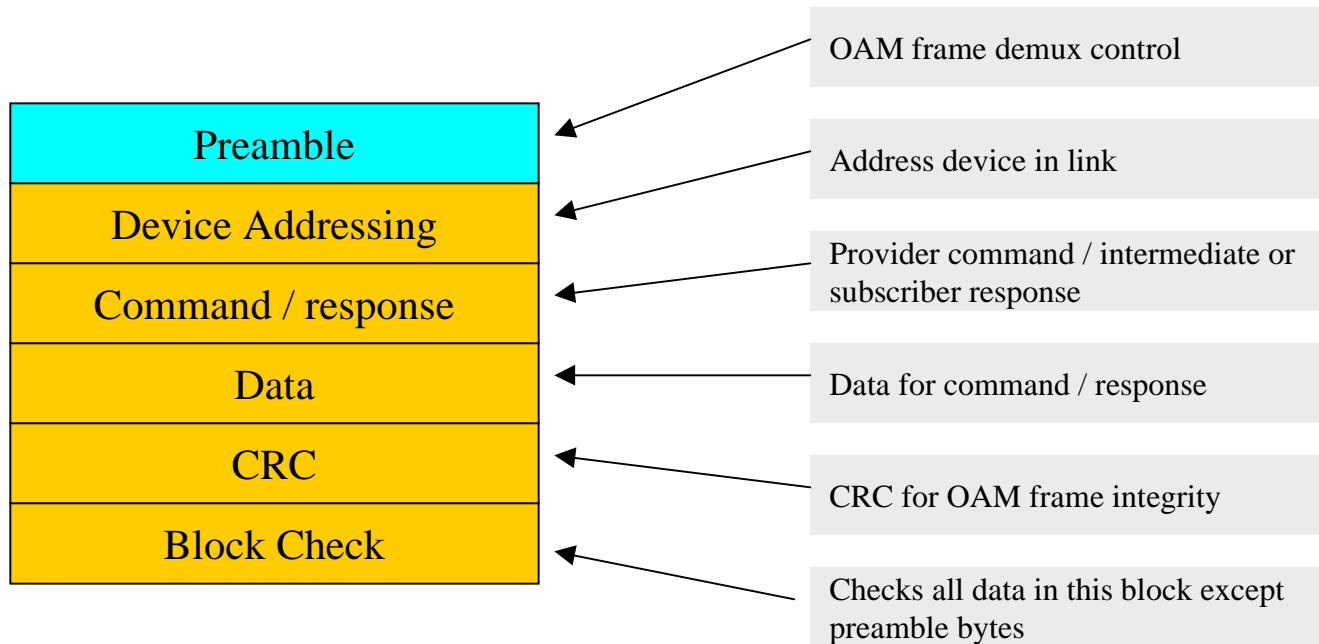| RS |
| OAM |
| PCS |
| PMA |
| PMD |

To media
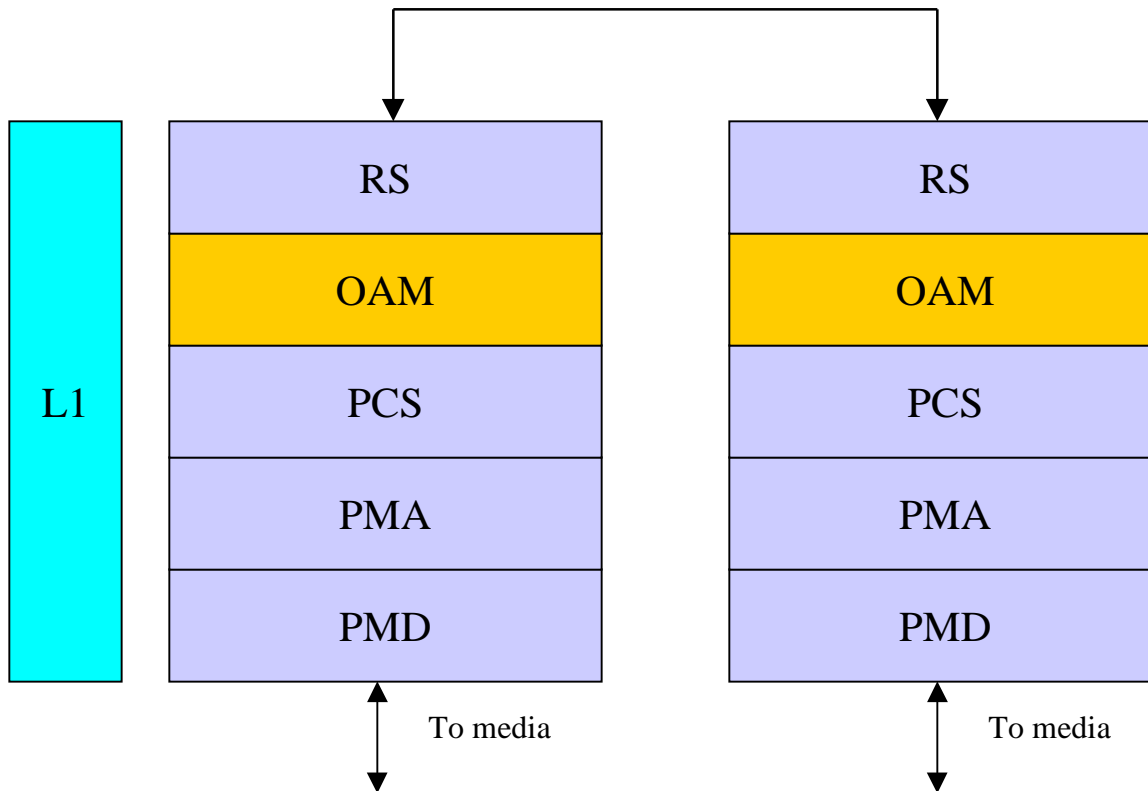
- Performs basic OAM functions
- Minimizes hardware requirements
- Minimizes material costs
- This function will be needed to expose copper to subscribers
- Potentially one of these will exist for each subscriber

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OAM Transport

Idles	OAM	Idles	802.3 frame	Idles	802.3 frame	Idles	OAM	Idles

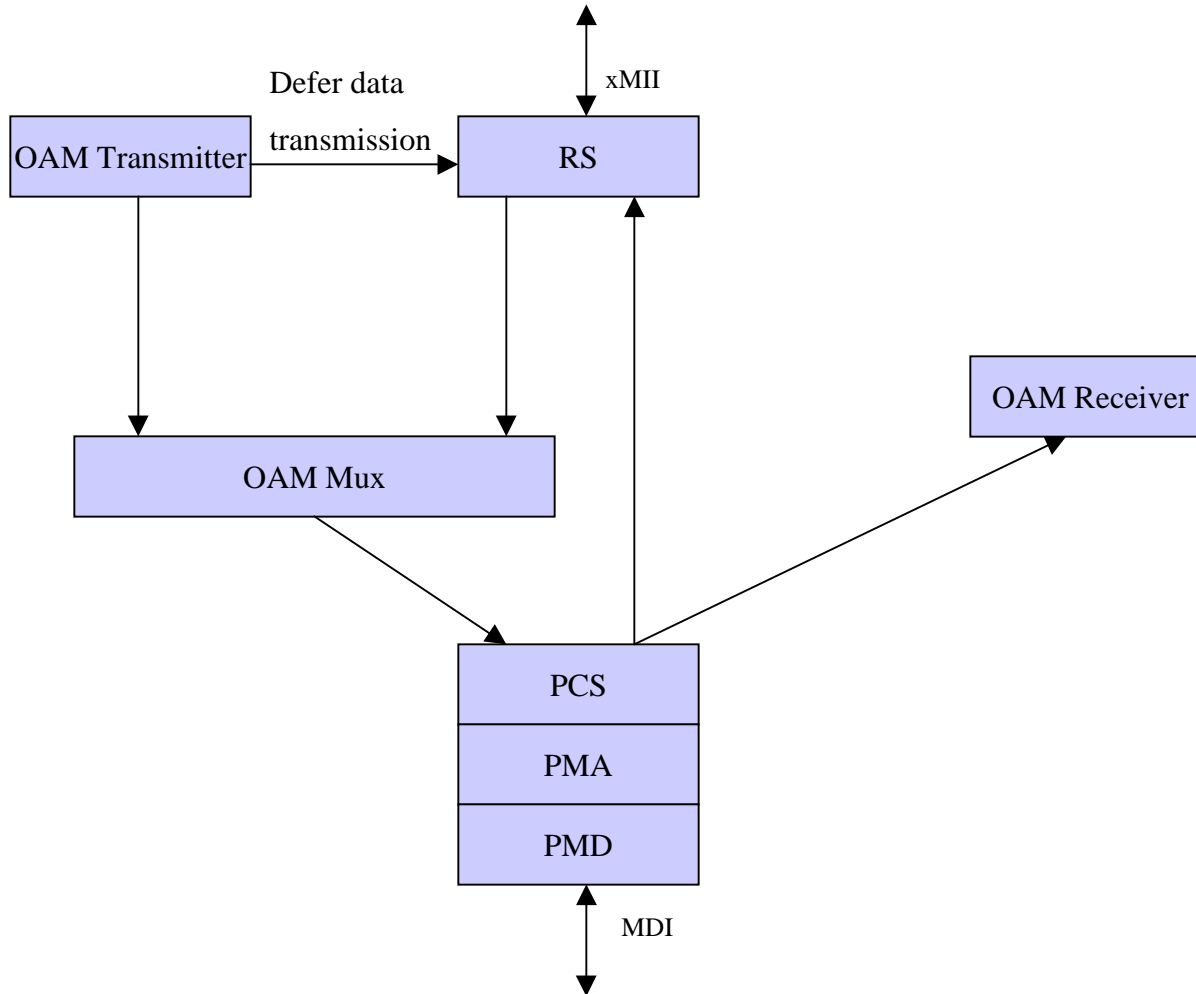| Idles	OAM Frame	Idles

- Runs in between frames

- Not understood by layer 2 - doesn't rely on MAC operating or even existing

- Uses special preamble for demux function

- Maintains IPG

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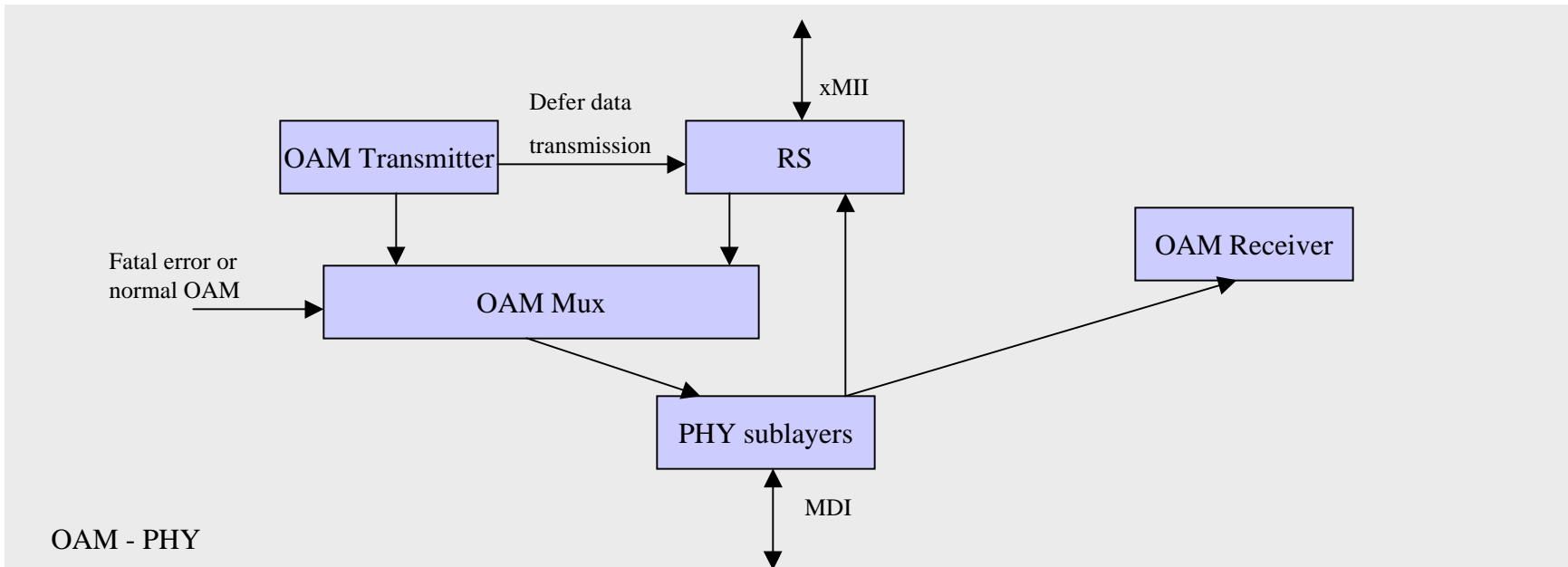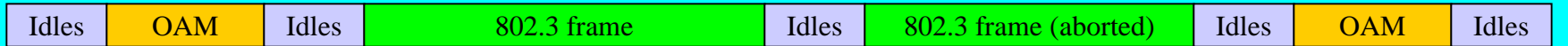| Frame Field	Description
Preamble	OAM frame demux control
Device Addressing	Address device in link
Command / response	Provider command / intermediate or subscriber response
Data	Data for command / response
CRC	CRC for OAM frame integrity
Block Check	Checks all data in this block except preamble bytes

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Defer data

transmission

xMII

OAM Transmitter

RS

OAM Mux

OAM Receiver

PCS

PMA

PMD

MDI

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OAM Override for Fatal Conditions

Transmission from MAC or repeated link

Idles	802.3 frame	Idles	802.3 frame	Idles

Transmission from PHY

Fatal error occurs - abort data frame

Idles	OAM	Idles	802.3 frame	Idles	802.3 frame (aborted)	Idles	OAM	Idles

OAM - PHY

- OAM frames can interrupt data frames to report fatal errors
- Switching occurs below the MAC (if existant)

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OAM in Copper PHY using HDLC Framing

Flags	OAM	Flags	802.3 frame	Flags	802.3 frame	Flags	OAM	Flags

Flags	Inverted preamble	OAM Frame	Flags

| Flags	Normal preamble	802.3 frame
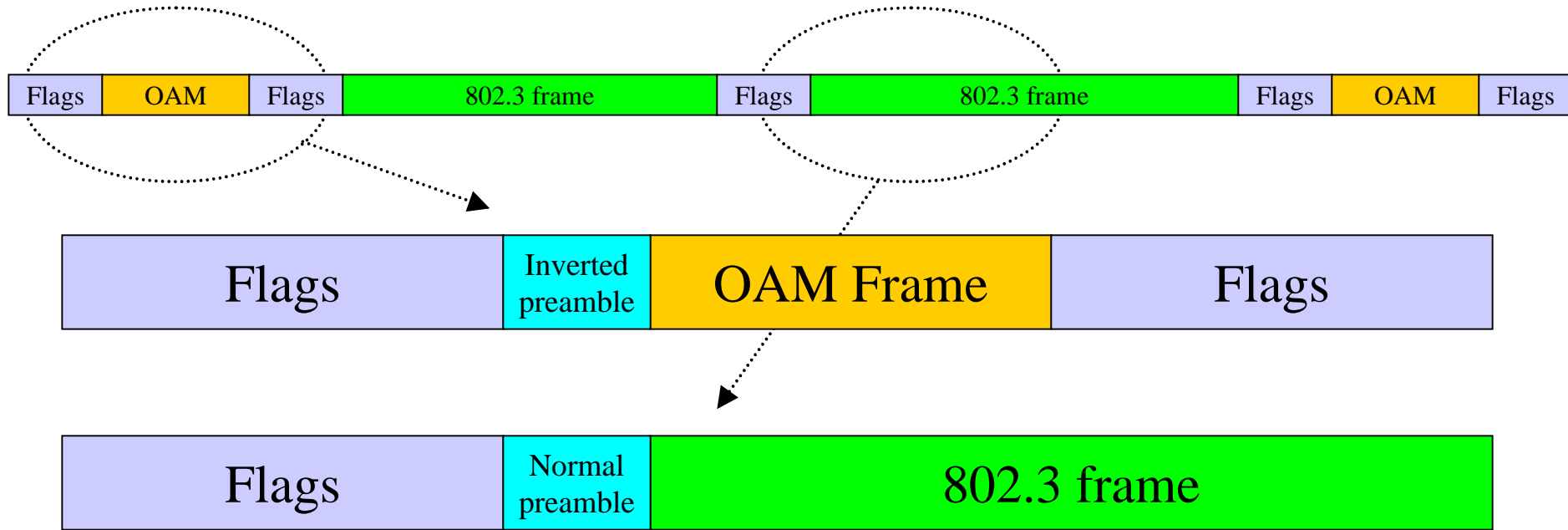
- xDSL copper physical devices easily multiplex on the preamble byte

- Data frames include at least one regular preamble byte

- HDLC framing rules apply for both types of frames

- Standard OAM frames are maintained across a mixture of Ethernet and telephony links

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Use of Block Checks
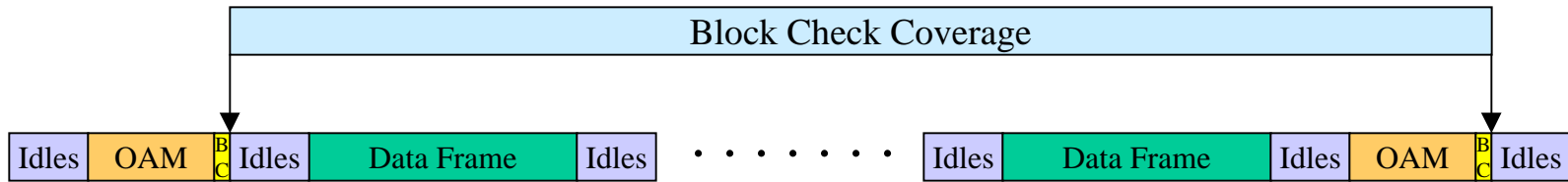
- Block check includes all data symbols (non-control) except preamble bytes

- Block check is generated on the transmission side of the link and checked on the receive side of the link
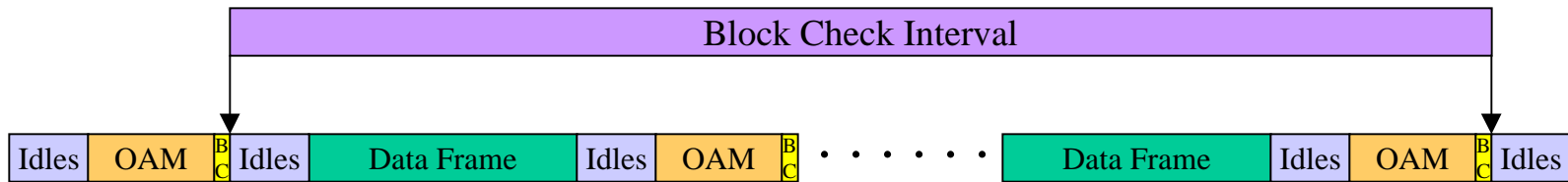
- The Block Check Interval includes a variable amount of Block Checks

- Error counts are accumulated during the Block Check Interval and cleared at the interval boundary

- If Error counts exceed the specified threshold, a link error is reported

- Additional warning thresholds can be established if desired

- On Error counts over the threshold, there is an option to switch to a redundant path

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- OAM deferral can be achieved by running half duplex and using CS

    - But, it would be better to allow specific deferral in full duplex using CS

    - This may become a requirement for the copper group as well

    - It also allows for loopbacks to run concurrently with data services in a deferred manner

    - Impacts clause 4

- Provide means to forward OAM frames inside of a device to another physical port

    - All OAM methods have to avoid bridges for multi-link forwarding

    - New 802.3ah clause

- Provide means of locally programming OAM registers

    - Can be implemented as a new ST frame type via MDIO

    - New 802.3ah clause

Conclusions

• This OAM solution provides an open framework for multi-link and shared topologies over fiber and copper

• Addresses important issues that are requirements from service providers

• Fits in with existing 802.3 philosophy

• Brings a complete solution for OAM in 802.3ah over fiber and copper