EFM Copper

Technical Overview

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Technical Overview

- ## The Components of the Standard

  ### Introduction - Hugh

  ### EFM developed features - Hugh
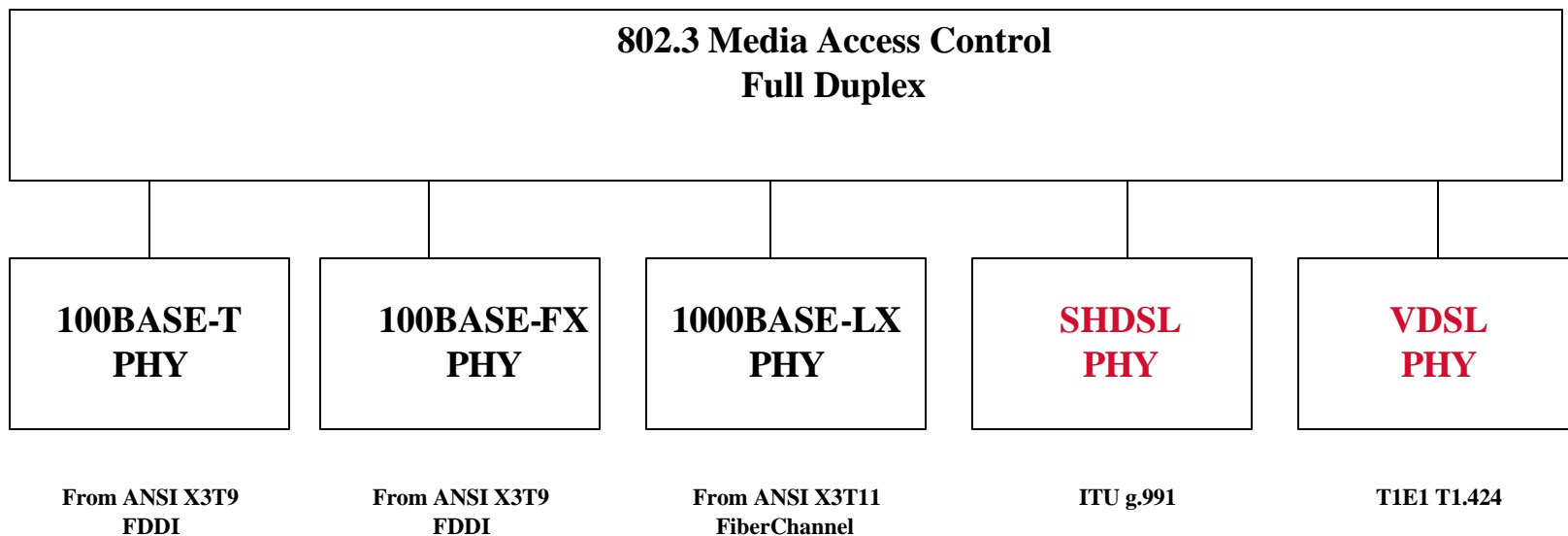
  ### SCM technical recap - Steven

  ### MCM technical recap - Behrooz
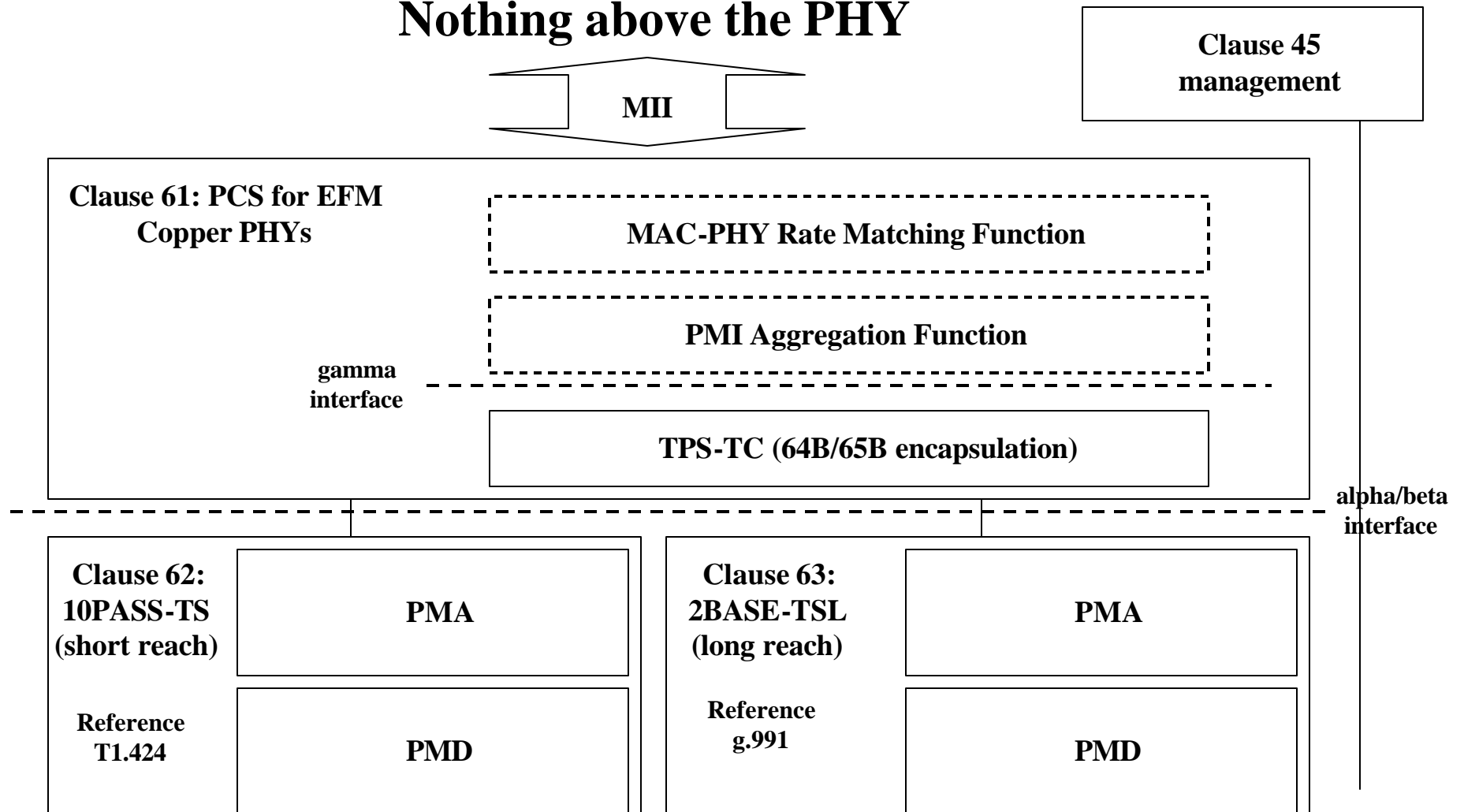
  ### Summary - Barry

An Ethernet Tradition

Historical precedent – use existing PHY

802.3 Media Access Control Full Duplex

100BASE-T PHY	100BASE-FX PHY	1000BASE-LX PHY	SHDSL PHY	VDSL PHY
From ANSI X3T9 FDDI	From ANSI X3T9 FDDI	From ANSI X3T11 FiberChannel	ITU g.991	T1E1 T1.424

- **Builds on known working Physical Layer (historical precedent)**
- **Ethernet "value add" – simple & low cost**
- **Two DSL PHYs imported for EFM Copper**

The EFM Cu Clauses

Nothing above the PHY

MII

Clause 45 management

Clause 61: PCS for EFM Copper PHYs

MAC-PHY Rate Matching Function

PMI Aggregation Function

gamma interface

TPS-TC (64B/65B encapsulation)

alpha/beta interface

Clause 62: 10PASS-TS (short reach)

PMA

Reference T1.424

PMD

Clause 63: 2BASE-TSL (long reach)
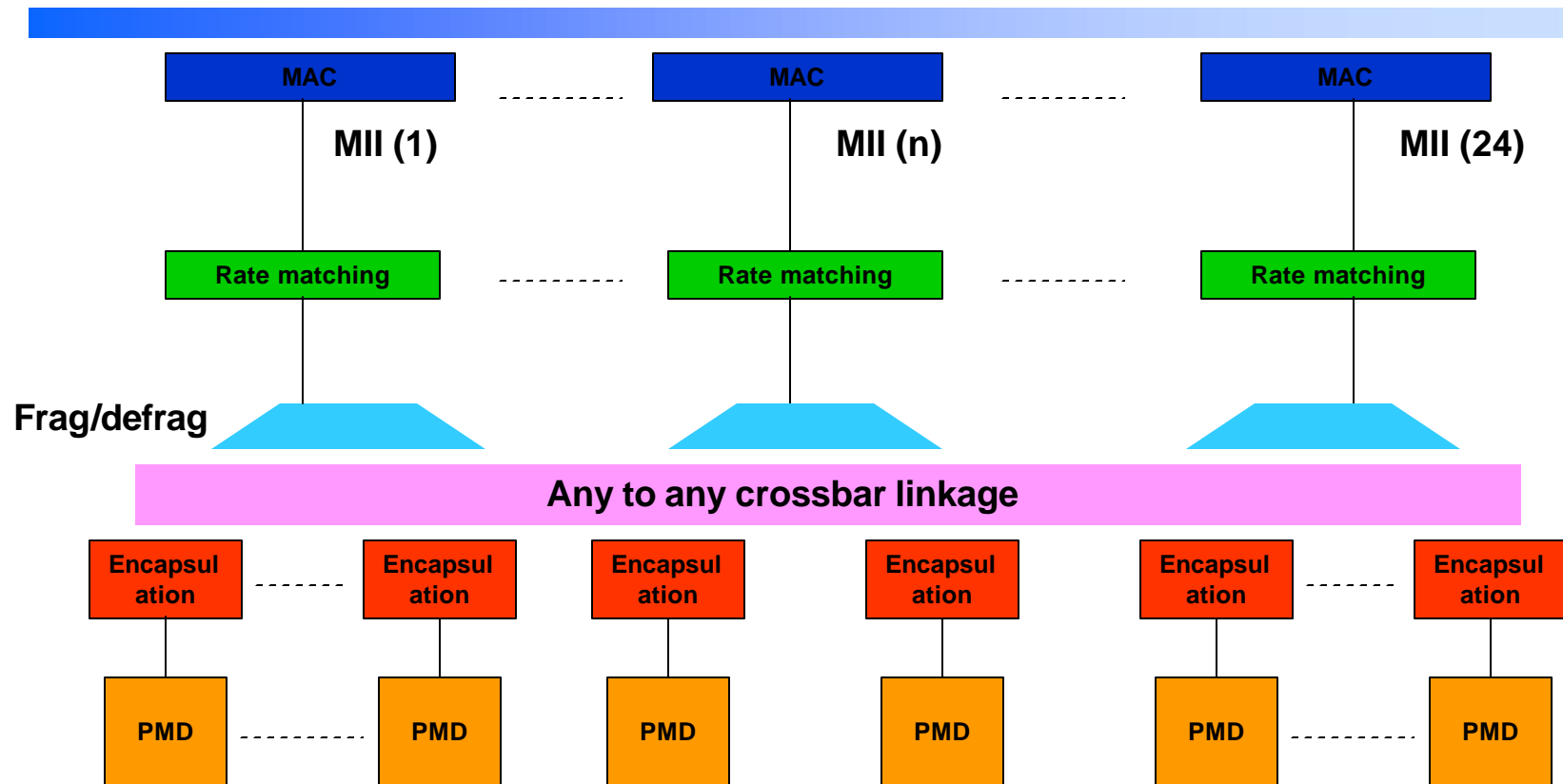
PMA

Reference g.991

PMD

The "EFM Additions"

- ## All of Clause 61

  MAC-PHY Rate Matching

  PMI Aggregation

  64byte/65byte encapsulation

  Handshaking (our own tree based on g.hs)

- ## Other Stuff

  PMA Enhancements: PAM-32, QAM-4096

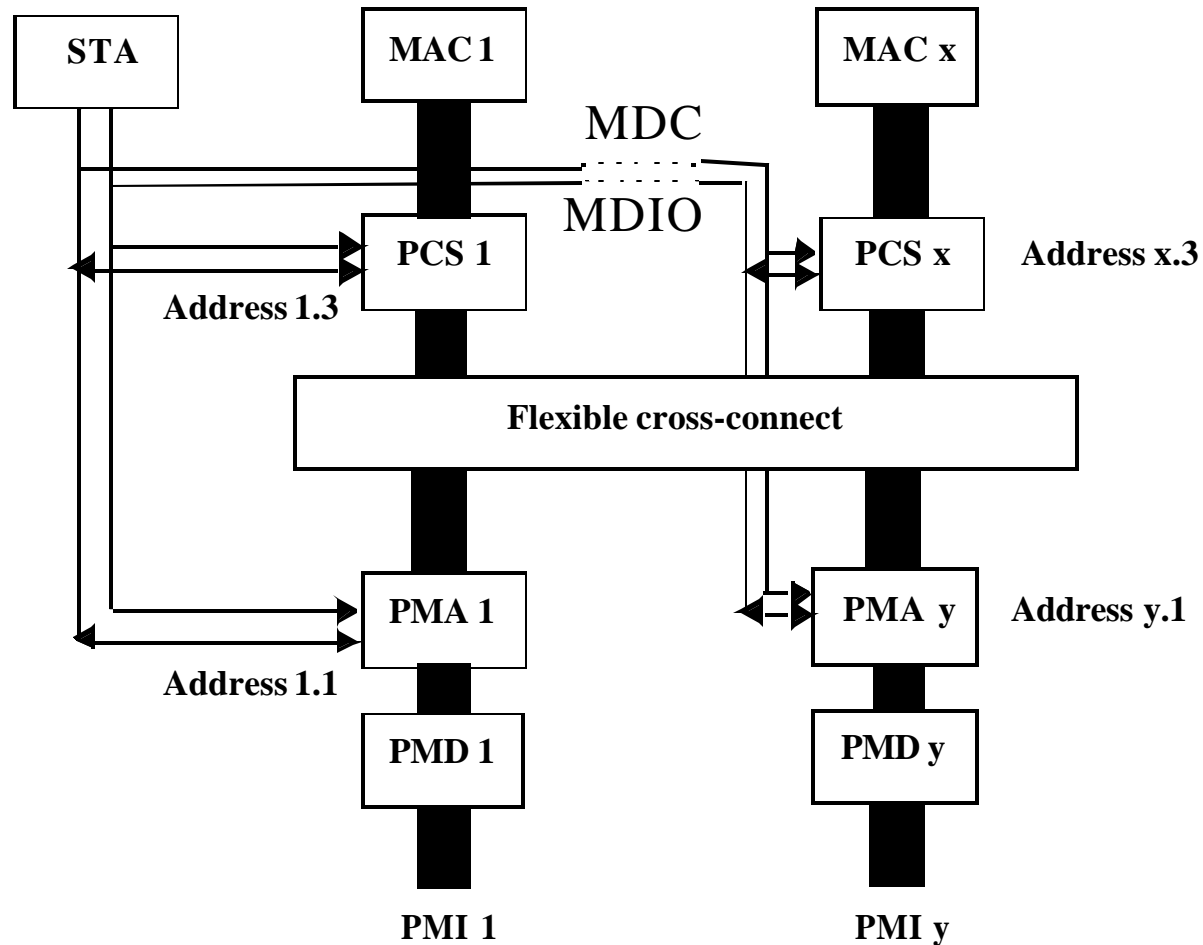 **Management: Tone Group Control Register**

MAC-PHY Rate Matching

- **Use Deference (false CRS)**

  MII @ 100Mbps, MAC in half duplex mode

  Transmit paused when CRS held asserted

  Needs full frame Tx + Rx buffering

  Most MACs can receive while transmitting

- **Advantages**

  100Mbps full duplex

  No Pause frames – PHY doesn't generate frames

  Closed loop – copes with any (aggregated) data rate

  Runs with std clocks – good for multi-MAC devices

  No changes to current MAC silicon

PMI Aggregation Function

- **Any connection between MII's and PMI's**
- **Implementation could use arbitrary number of MII's vs PMI's**
- **System vendor could choose optimal ratio**

Addressing the PCSs & PMAs

- **Use Clause 45 ability to address PCS & PMA/PMD separately**

Needs fragmentation

SequenceNumber (14 bits)	StartOfPacket (1 bit)	EndOfPacket (1 bit)	Fragment Data

- **Details of algorithm unconstrained – allows innovative implementation**

- **Constraints placed on min / max fragment size and …**

- **… maximum differential latency**

- **Robust definition allows frames to continue after single link loss without intervention**

   Lets OAM find cause of failure

TPS-TC & Encapsulation

- **Transport Protocol Specific – Transmission Convergence**

- **Identify packet delineation over byte stream**

- **Use 64byte/65byte**

- **Constant overhead – no data dependence (good for QOS/SLA)**

- **Minimal buffering – not frame oriented**

- **Fast lock after link interruption**

64byte/65byte encapsulation

- **Similar in principle to 64/66 – but byte oriented**

- **<2% overhead**

- **Don't transport IPG & preamble – frame-to-frame with no Z allowed**

Type	Frame Data	Sync byte	Byte fields 1-64									
All data	DDDD---DDDD	OF_{16}	D_0	D_1	D_2	D_3	D_4	D_5	…	D_{61}	D_{62}	D_{63}
End of frame	Contain k D's where k=0 to 63	FO_{16}	C_k	D_0	D_1	D_2	D_3	…	D_{k-1}	Z	…	Z
All idle	ZZZZ---ZZZZ	FO_{16}	Z	Z	Z	Z	Z	Z	…	Z	Z	Z
Start of frame while idle	Contain k D's, where k=0 to 63, and contains j Z's where j=63 - k	FO_{16}	Z	Z	S	D_0	D_1	…	…	D_{k-3}	D_{k-2}	D_{k-1}
Start of frame while trans-mitting	Contains last k D's of 1st frame, where k=0 to 62; & first j D's of 2nd frame, where j= 0 to 62	FO_{16}	C_k	D_0	…	D_{k-1}	Z	…	S	D_0	…	D_{j-1}

Summary

- **Clause 61 hooks Ethernet MAC to DSL PHYs**

  Designed as "best solution" for Ethernet

  Uses standard DSL interfaces (alpha/beta, gamma)

  Defined for VDSL & SHDSL

  Liaise into ITU for use by any DSL PHY

- **Other innovations**

  Increased data rates with larger constellations

  Straightforward and logical progression

  Tone group control register (for DMT)

  Allows ultimate flexibility for tone control

  Simple and compact interface

  Write your name in tones