VDSL PHY for EFM copper

Presented by:

Steven Haas, Infineon

John Egan, Infineon

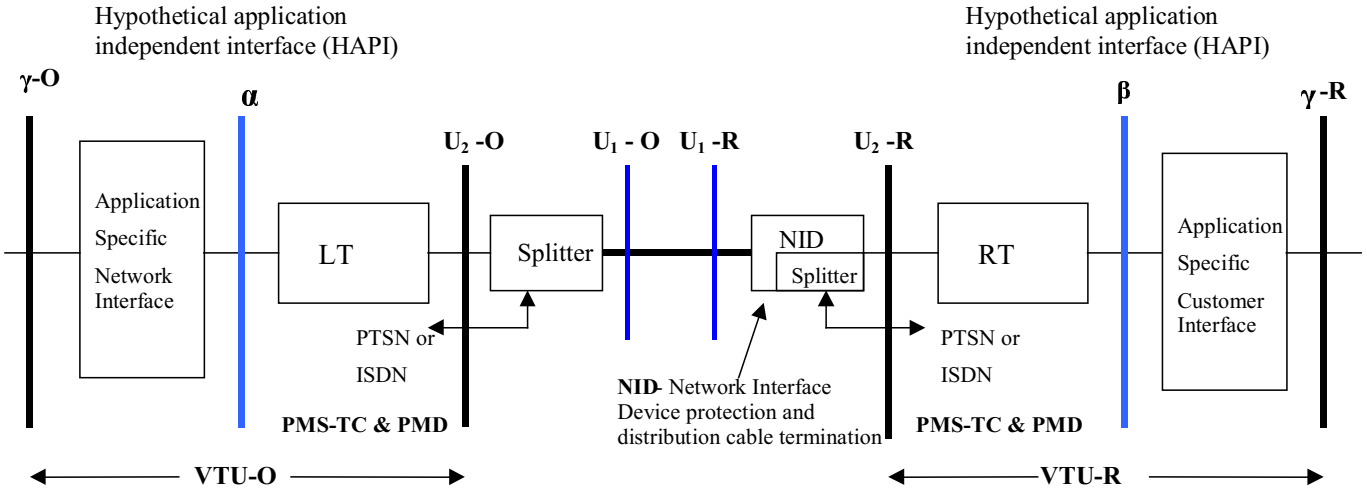
Standardized VDSL as EFM-Copper PHY

This presentation provides the details and open issues:

- How standards-based VDSL can be the 802.3ah PHY
- What layers can be taken, as is, from ANSI/ETSI/ITU standards for VDSL
- What changes/additions need to be defined by the EFM in order to create a definition that meets public network standards and IEEE PAR objectives

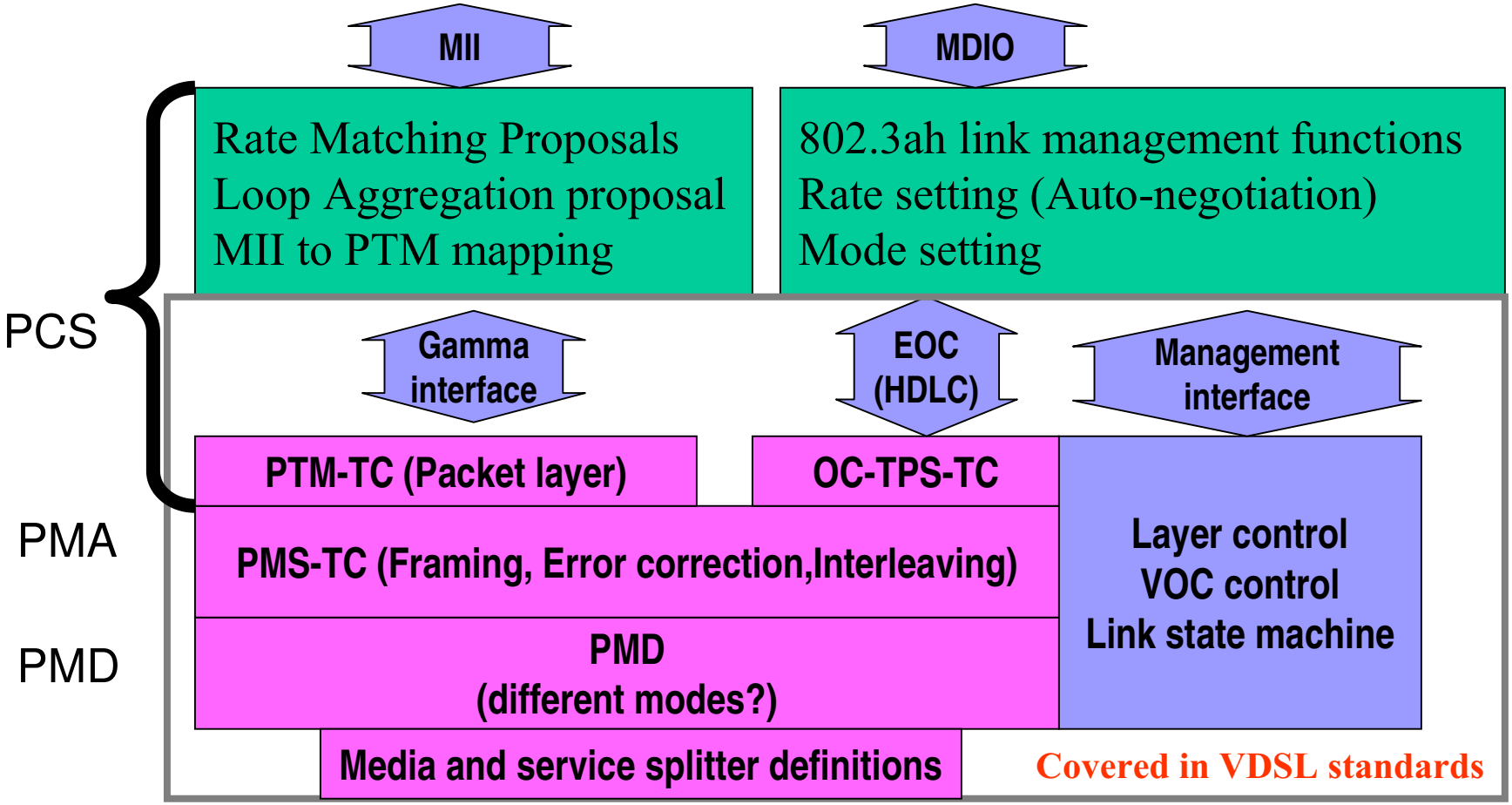
- VDSL is standardized in:
  - ETSI TS10127001 (requirements) and TS10127002 (specification)
  - T1E1's trial use standard
  - ITU's G.vdsl.f standard (G.993.1)

VDSL reference model



- **The VDSL reference model is common for MCM and SCM transmission technology (chapter 5.1 VDSL-Part 1/T1E1.4)**
- **There are 2 types of devices:**
  - **VTU-O: The master device, located in the switch/line card**
  - **VTU-R: The slave device, located in customer's premises (such as a NIC or CPE)**
- **Service splitter allows the loop to be shared with POTS or BR-ISDN**

VDSL as a superset of EFM needs



The PMD layer (VDSL Part 1, section 8)

- PMD performs physical layer functions
- Two line codes are referenced by section 8 of ANSI's pt 1:
  - SCM PMD is defined in part 2 of VDSL spec (T1E1.4)
  - MCM PMD is defined in part 3 of VDSL spec (T1E1.4)
- A T1E1 trial use standard is valid for two years with both line codes supported during this period
- Power control and line interfacing performed by PMD layer

PMD details – Parts 2 & 3 of T1E1.4

- **Separate proposals corresponding to parts 2 & 3**
  - **VDSL PMD – single carrier**
  - **VDSL PMD – multiple carrier**
  - **First draft of EFM should include both sections**
- **PMD proposals to include:**
  - **All items covered in parts 2 and 3 of T1E1.4 trial use spec**
  - **PMD MIB parameters**
  - **Profiles (as appropriate)**
  - **Control functions (via Code words, EOC/VOC, link state?)**
  - **Simplifications where applicable**
- **Common elements between line codes will be included**
  - **States, PSD masks …**

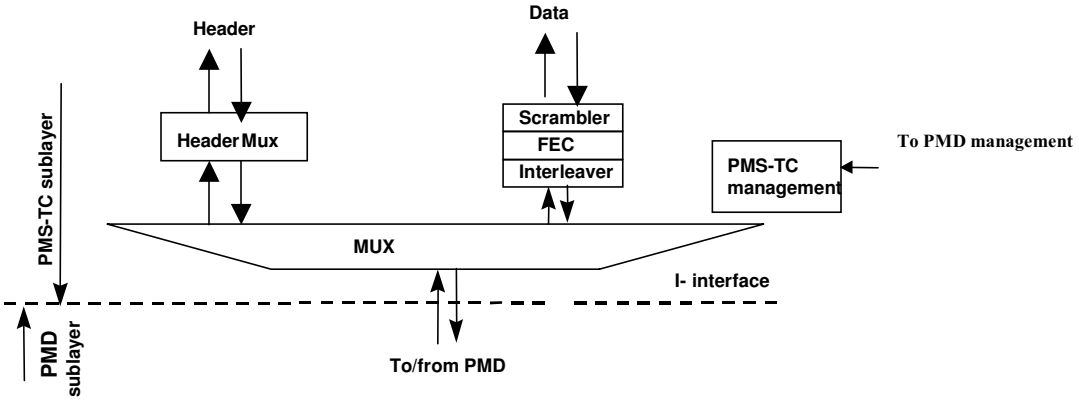
PMD – items defined in VDSL pt 1 (i)

- Section 5.5 coexistence with POTS & ISDN (also section 12)
  - **Do we need ISDN co-existence? Regional Annex (A,B,C)?**
- Sections 5.6, 5.7 – remote power and repeater – not needed
- Section 6 transport capacity & performance
  - **Payload rates better defined in parts 2 & 3 than part 1**
  - **Define profiles / parameters for the MIB?**
- Performance requirements
  - **Probability of error 10^{-7} (with 6dB margin)**
  - **This is effective BER with RS FEC**

PMD – items defined in VDSL pt 1 (ii)

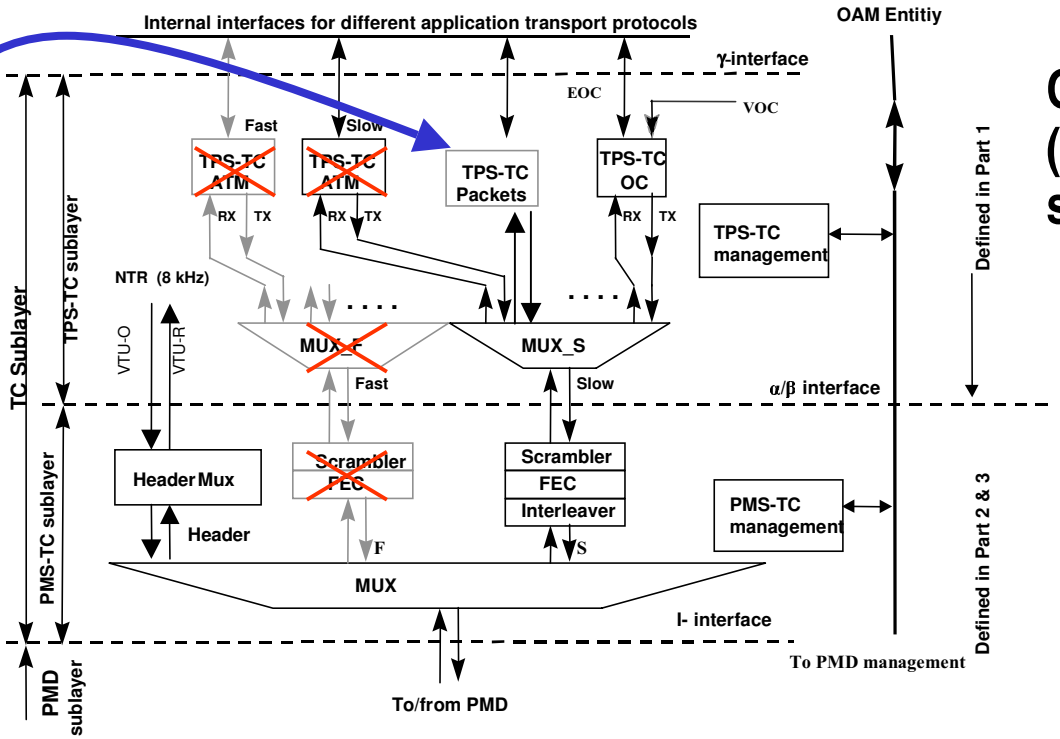
- Section 7 – U interface
  - **PSD templates/power – use as is?**
  - **Spectral Plan – 998, 997, Fx, proprietary?**
  - **Allow variances (via MIB parameters) or fix?**
  - **PnP compatibility with multiple spectra?**
- Section 7.1.3 Power control (includes UPBO)
  - **PBO mask or "better" technique?**
- Termination impedance, return loss, signal balance
  - **All – as is**
- Connector definition?
  - **Demarcation point for standard…**

PMA layer (**PMS-TC**)



- **PMA – mostly common between line codes**
  - **Scrambler, FEC, Interleaver all common**
- **I-interface (to PMD)**
  - **Only one data stream (Tx + Rx)**
  - **Is I-interface common for 2 line codes?**
  - **EOC, VOC defined as part of frame across I-interface**
- **Latency**
  - **Single latency only with programmable delay?**
  - **Do we need a low latency channel in addition, with a second MII?**

Transmission Convergence reference model
(VDSL Part 1, section 9)

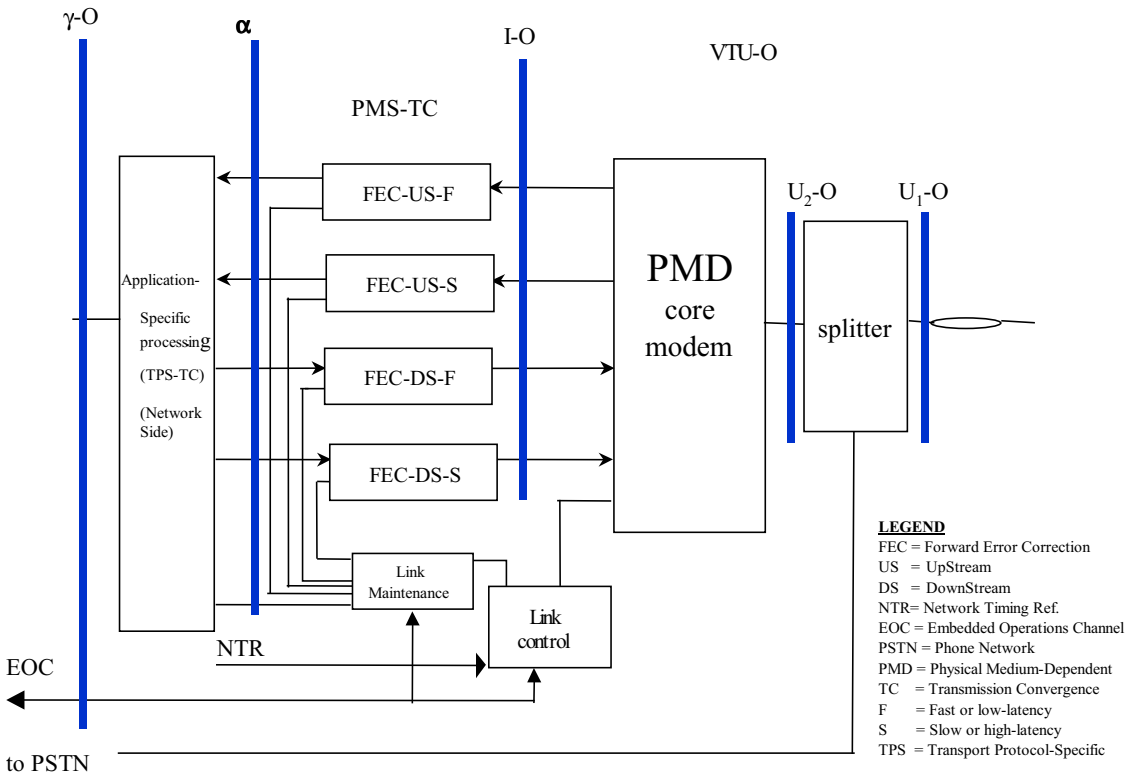


The Packet TPS-TC is specified in ITU-T G.993.1 (not yet in T1E1)

Only the interleaved (slow) path may be supported

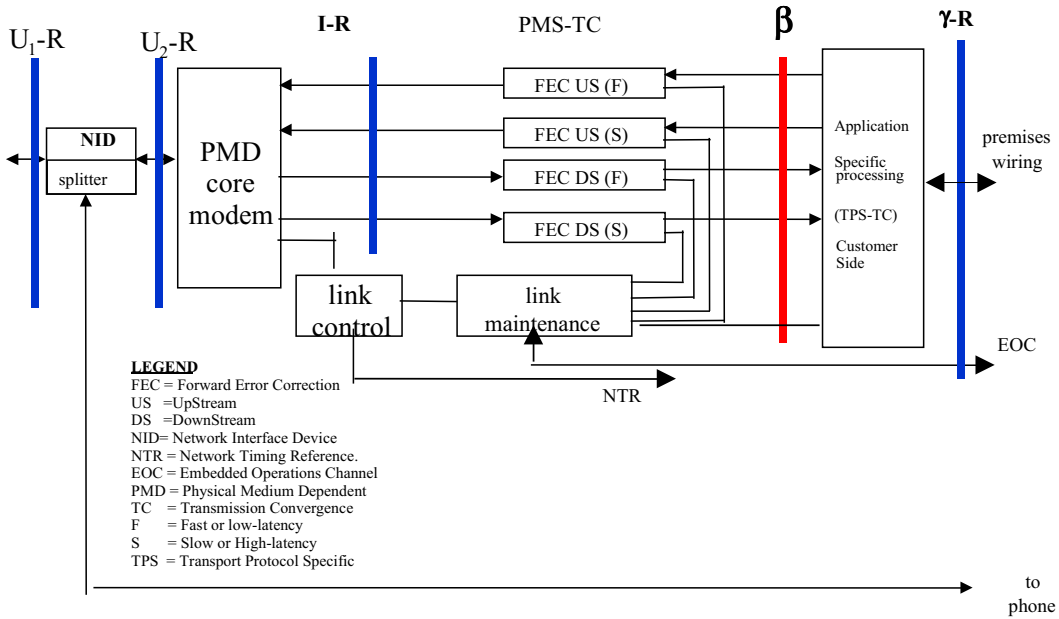
- Only two TPS-TC functions should be supported:
  - Packet Transfer Mode as defined in Annex H of G.993.1 (G.vdsl.f)
  - VDSL embedded operations channel (EOC)
  - PCS (TPS-TC) is common for both line codes

Detailed VTU-O (LT) reference model
(VDSL part 1/T1E1.4, section 5.3)



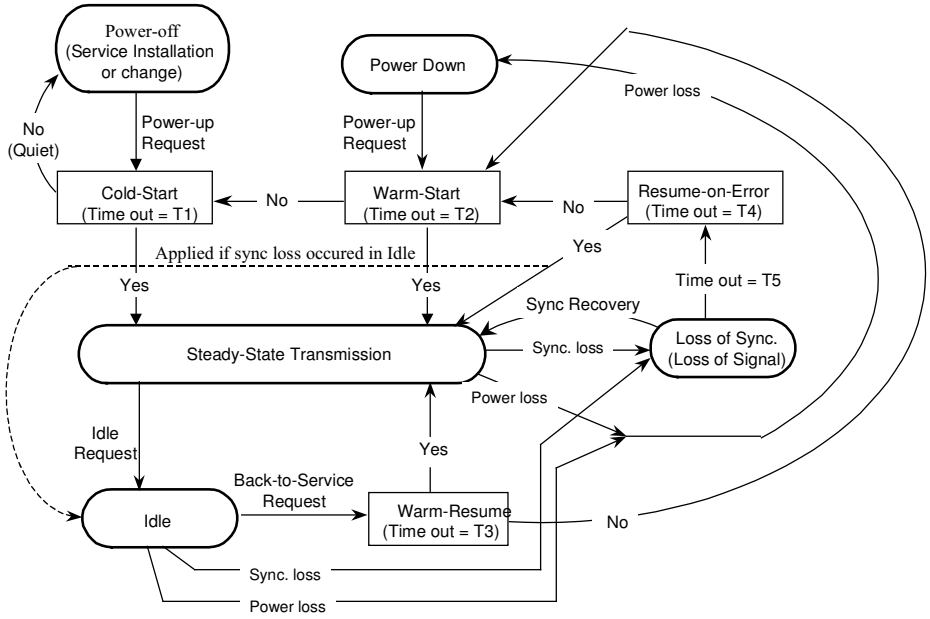
- Both MCM & SCM have same reference model
- The VTU-O (LT) is self contained device with link management state machine
- EFM can use this “black box” with well defined Gamma interfaces

Detailed VTU-R (NT) reference model
(VDSL part 1, section 5.4)



- The VTU-R (NT) resembles the VTU-O except:
  - Network timing reference (NTR) is an output
  - Device acts has a slave link state machine and is controlled by the VTU-O
  - Same reference model for SCM and MCM

The VDSL link state machine



- Management must define the link configuration for each state.
  - ➢This can be a result of EFM objectives

Link state machine

- **Simplification**
  - **Unnecessary states?**
    - **Warm start, Resume on error, Power down, Loss of sync, Warm resume, Idle…**
  - **To be examined…**
- **Timing & stability**
  - **Define hysteresis**

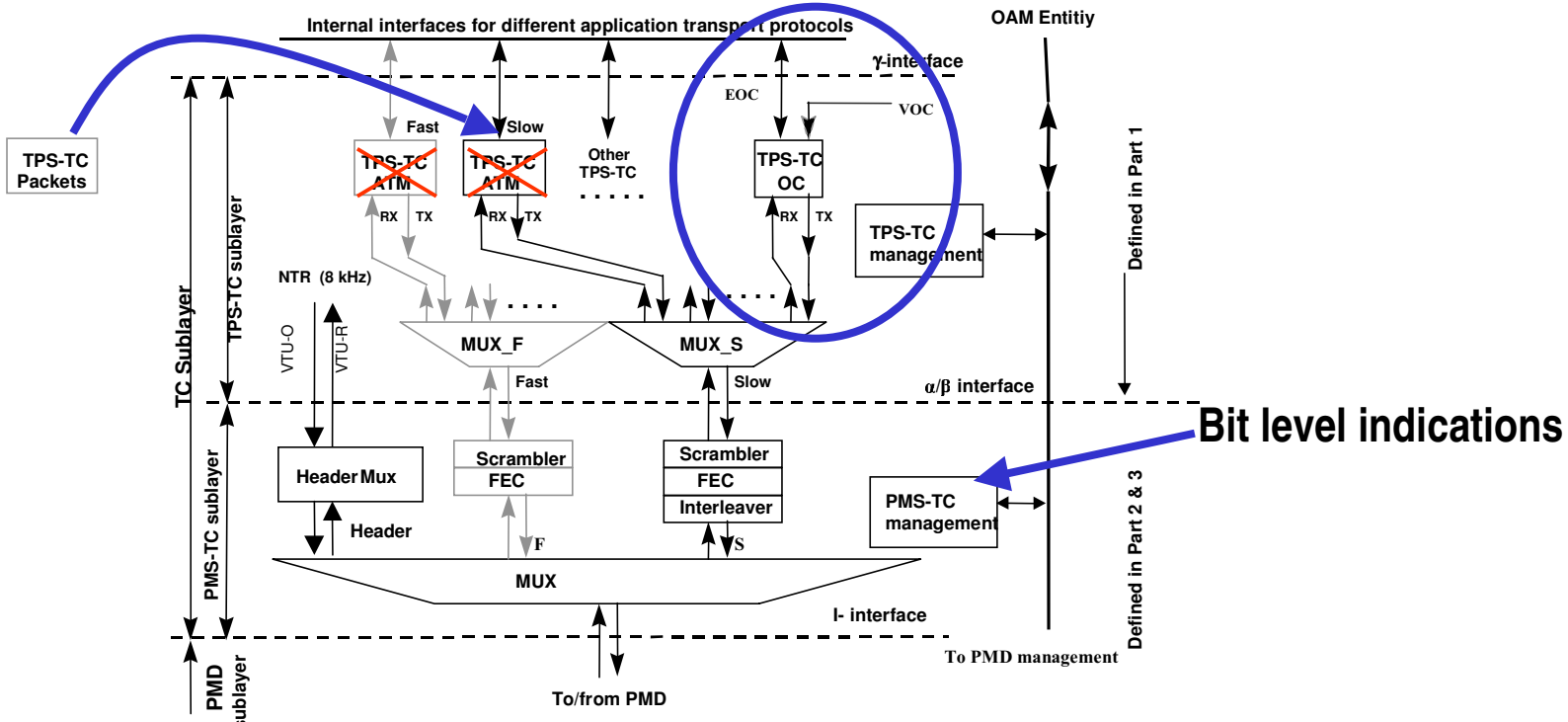
PCS – Encapsulation

- Between MII interface and alpha/beta interface
  - HDLC as defined in G993.1 annex H
  - More functions needed?
  - Between HDLC I/O and MII
- Error handling
  - Errored frames are handled as defined by ITU
  - Decision is above HDLC for errored frames
  - Frame abort from HDLC decoder -> MII?
  - MII TxErr to HDLC encoder?
- OAM
  - OAM as defined or changed for EFM?

PCS – MII interface

- PHY/MAC rate matching covered in separate proposal
  - Defines control of MII signals
  - Buffering requirement?
  - Between HDLC I/O and MII
  - Note “buried interfaces” are always optional
    - E.g. PHY/MAC rate buffer may be hidden in interleaver
- IPG & header
  - Transfer across VDSL or strip?
  - Utilize rate matching buffer
- MDIO - MIB
  - Definition of MDIO view of internal MIB + EOC/VOC codes

An operational channel is defined for VDSL
(VDSL Part 1/T1E1.4, section 9.2.3.1)



- **The operational channel TPS-TC is part of the VDSL standard**
  - **An external Embedded operational channel (EOC) is multiplexed with an internal VDSL operational channel (VOC)**
  - **Management controls the usage of the VOC messages**
  - **All VDSL management functions can be controlled with the EOC/VOC**

MDIO – operation channel

- Remote OAM
  - Read of remote parameters
    - SNR, Rx pwr, RS error counts
  - Control of remote
  - Other OAM
    - Dying gasp
- Link state
  - State messages defined
- GP EOC/VOC operation
  - Addressable r/w registers
  - PHY identification (mfr, device id, version)

Summary

- Existing VDSL standards provide a complete definition of lower PHY layers
- Upper layers must be added by EFM
- Simplification improves uniformity, Ethernet compatibility & interoperability
- EoVDSL will meet the EFM copper objectives:

  >= 2500 feet with >= 10Mbps aggregate bit rate
  - Longer reach can be attained with use of optional band below 138khz

  Compliant with spectral management standard and frequency plans approved by ITU-T,NRIC, and ETSI/TM6

Conclusion

- EoVDSL is what should be the EFM standard PHY
  - Proven use in MxU and local loops in several markets already
- Upper layers (above gamma interface) should be defined
- Open issues in red need work assignments to complete
- Other open issues related to Loop Aggregation and extended reach need to be addressed