Ethernet-over-xDSL
Complete Proposal

Ethernet in the First Mile

Raleigh NC, January 14-16 2002

Supporters

- Michael Beck, Alcatel (author)
- Behrooz Rezvani, Ikanos Communications
- Jacky Chow, Jubilant Communications
- John M. Cioffi, Stanford University
- Christophe Del-Toso, STMicroelectronics
- Marc Kimpe, Adtran
- …

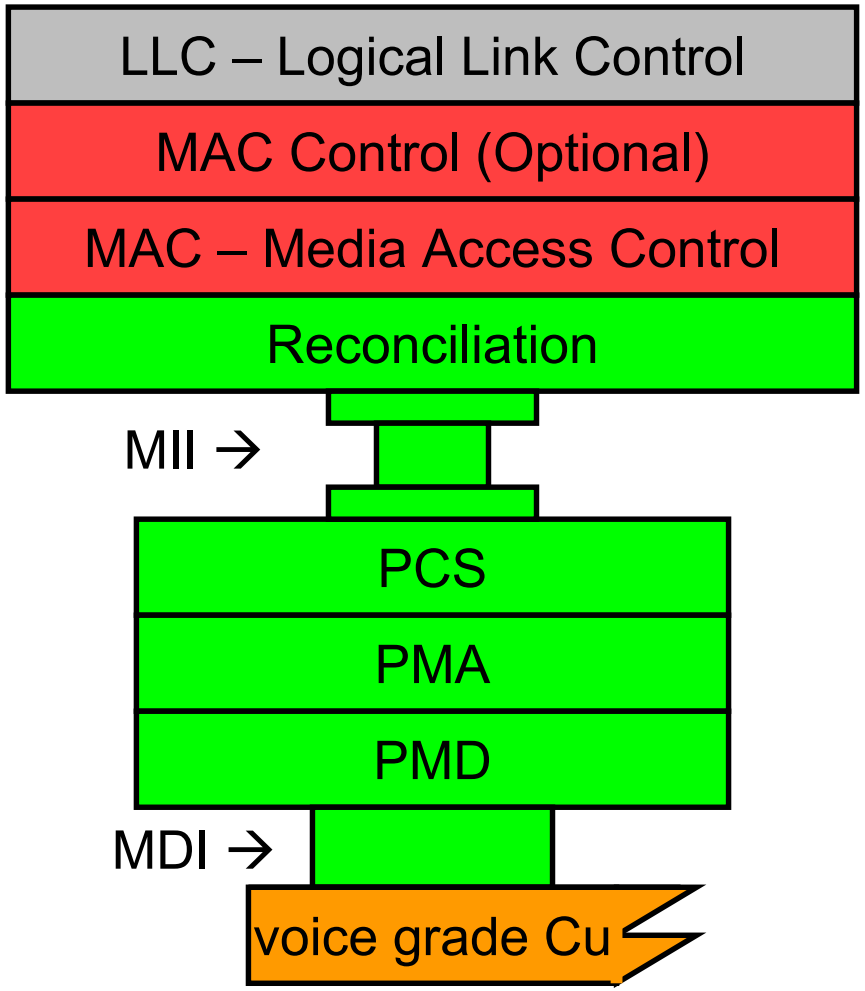
Goals

- Specify a PHY which is compliant with
  - IEEE 802.3 Architecture
  - ITU-T G.995.1 Reference Layered Protocol Architecture
- and which covers all the objectives of the EFM Task Force (Cu track):
  - 10Mbps @ 2500ft
  - 4 Mbps @ 3700m (0.5mm)
  - 256 kbps @ 4600m (0.4mm)
  - Spectrally Compatible
  - Optional Multi-pair Mode

Principles

- Within the domain of other standards bodies, take text from existing standards “as is”.
  - If you think it would help to **add** things → go to the standardization body that wrote the standard.
  - If you think it would help to **remove** things → go to the standardization body that wrote the standard.
- Add specifications only for parts that are not yet standardized elsewhere.
- We’re not violating the “unique identity” criterion by selecting multiple solutions for multiple problems. A long copper loop and a short copper loop are essentially different media.

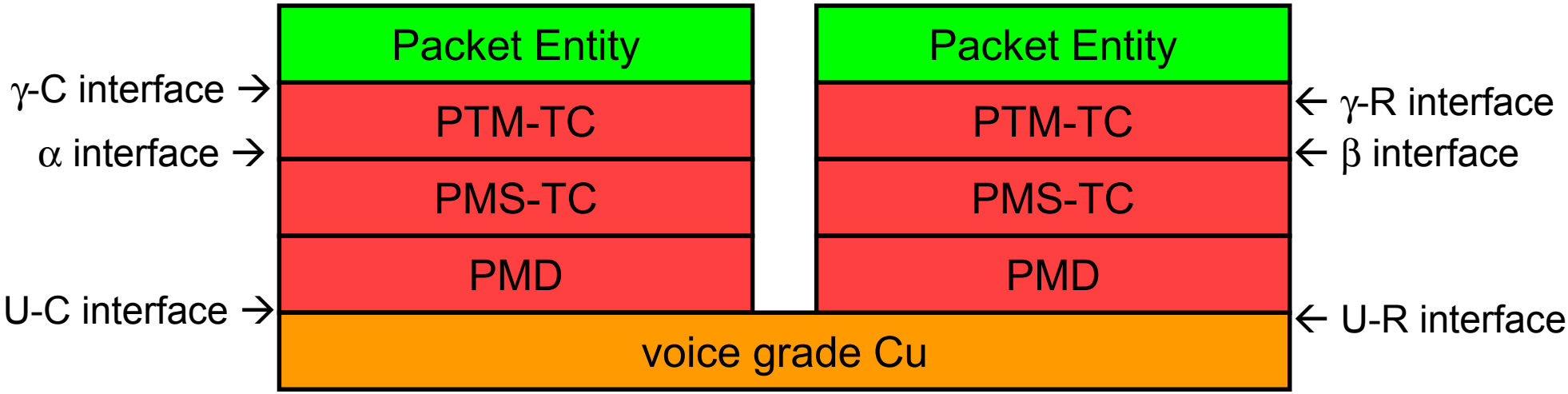
Architectural Requirements
IEEE 802.3 (100 Mbps)



"Minimal changes" are allowed here if necessary.

The approved PAR authorizes the EFM Task Force to specify these layers.

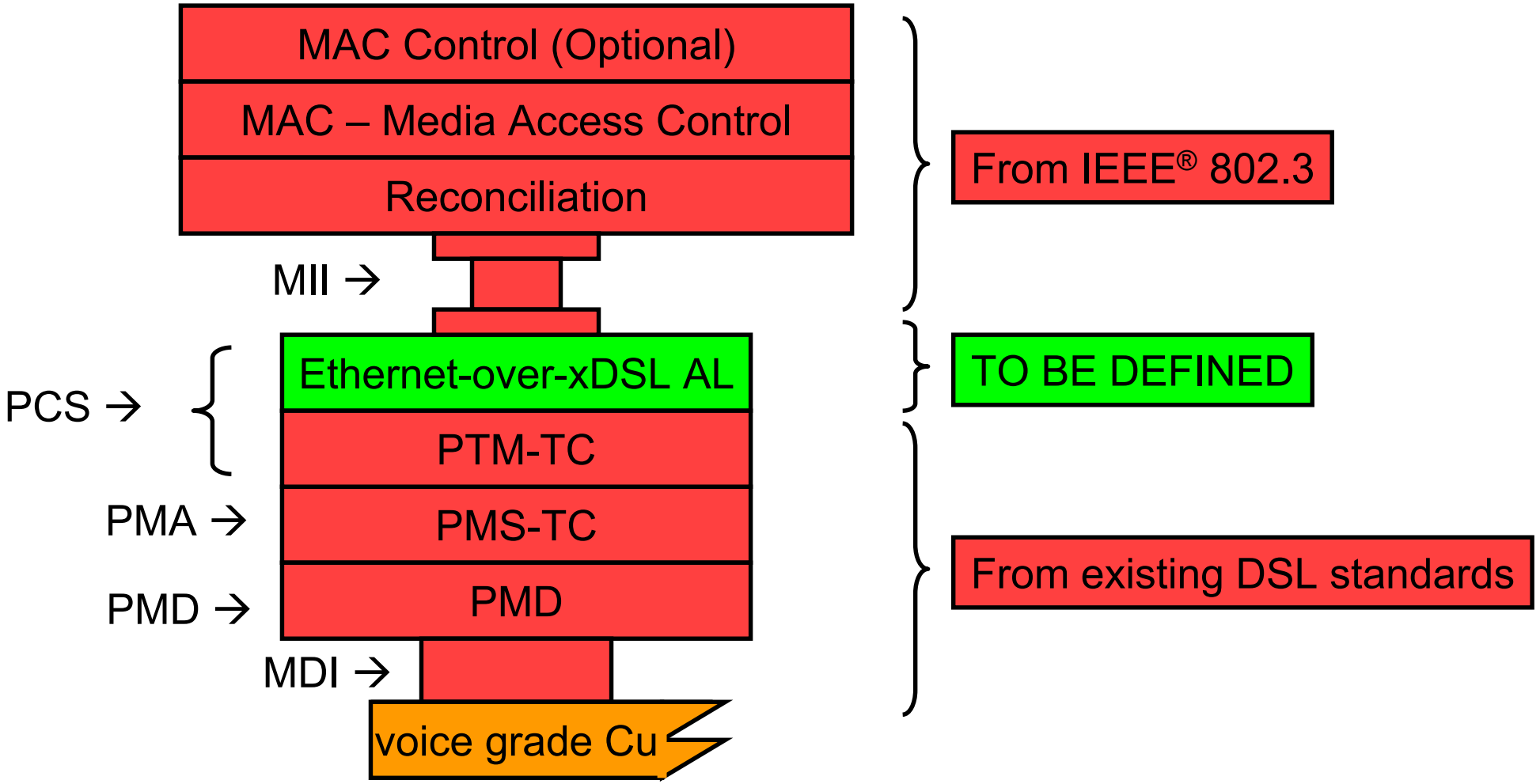
Architectural Requirements
ITU-T G.ref



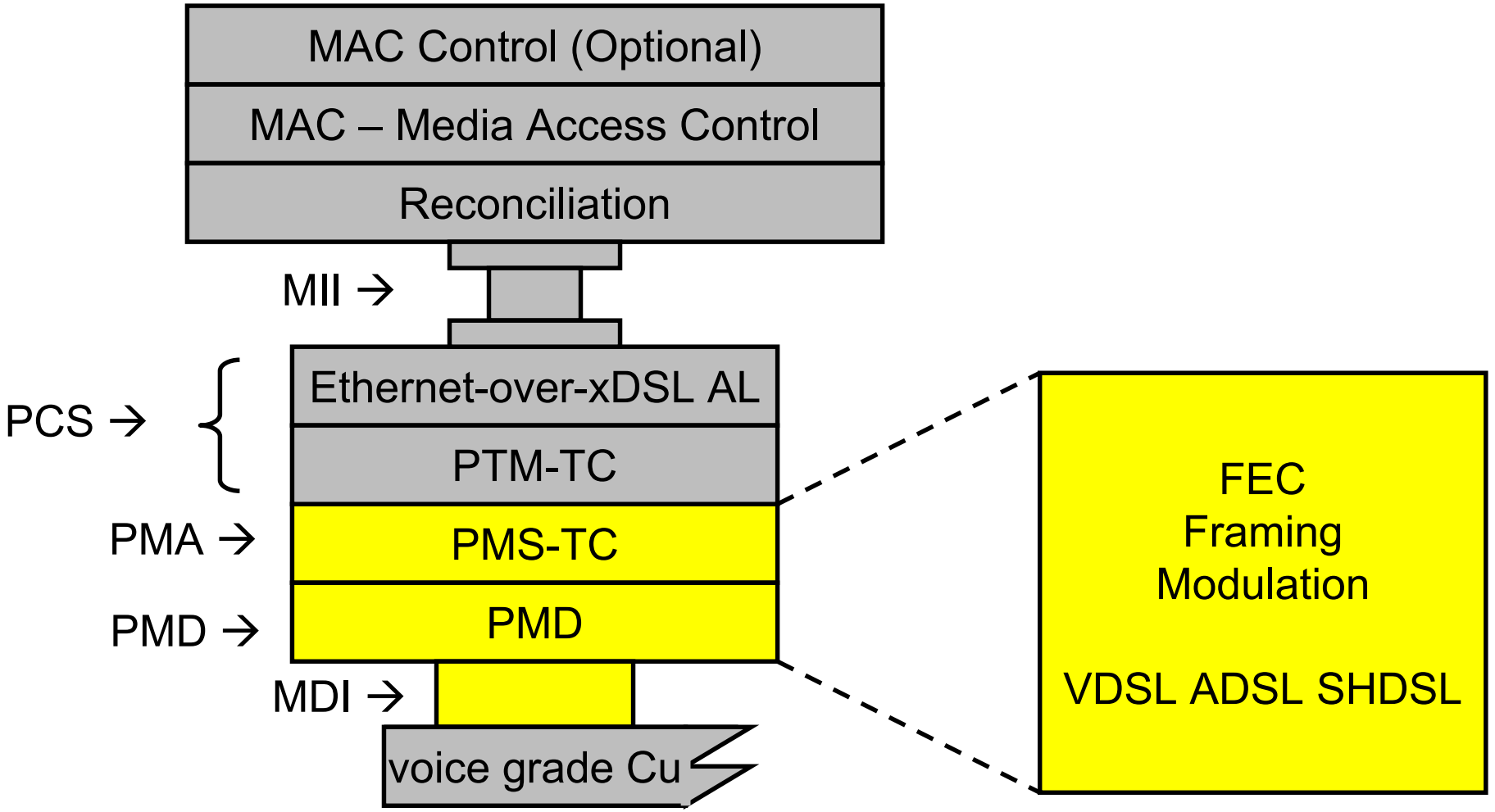
The red blocks have been specified for different media/service requirements.

The green blocks have been declared “out of scope” by ITU-T, and can be used for EFM.

Architectural Requirements
Merged Model



PMS-TC/PMD


MAC Control (Optional)
MAC – Media Access Control
Reconciliation
MII →
PCS →
Ethernet-over-xDSL AL
PTM-TC
PMA →
PMS-TC
PMD →
PMD
MDI →
voice grade Cu
FEC
Framing
Modulation
VDSL ADSL SHDSL

PMS-TC/PMD
ITU-T G.99x Transceiver Specifications

- G.991.1 HDSL / G.991.2 SHDSL
  - Long reach, symmetric services.
- G.992.1 ADSL / G.992.2 ADSL Lite
  - Long reach, typically asymmetric services.
- G.993.1 VDSL
  - Short reach / high bandwidth
  - Different regional band plans approved by ITU-T. New ones may be needed for private networks.
  - At this time, the Recommendation does not yet specify the transceiver. A pointer to the physical layers of the T1E1.4 Trial Use standard is appropriate.
- G.pnt

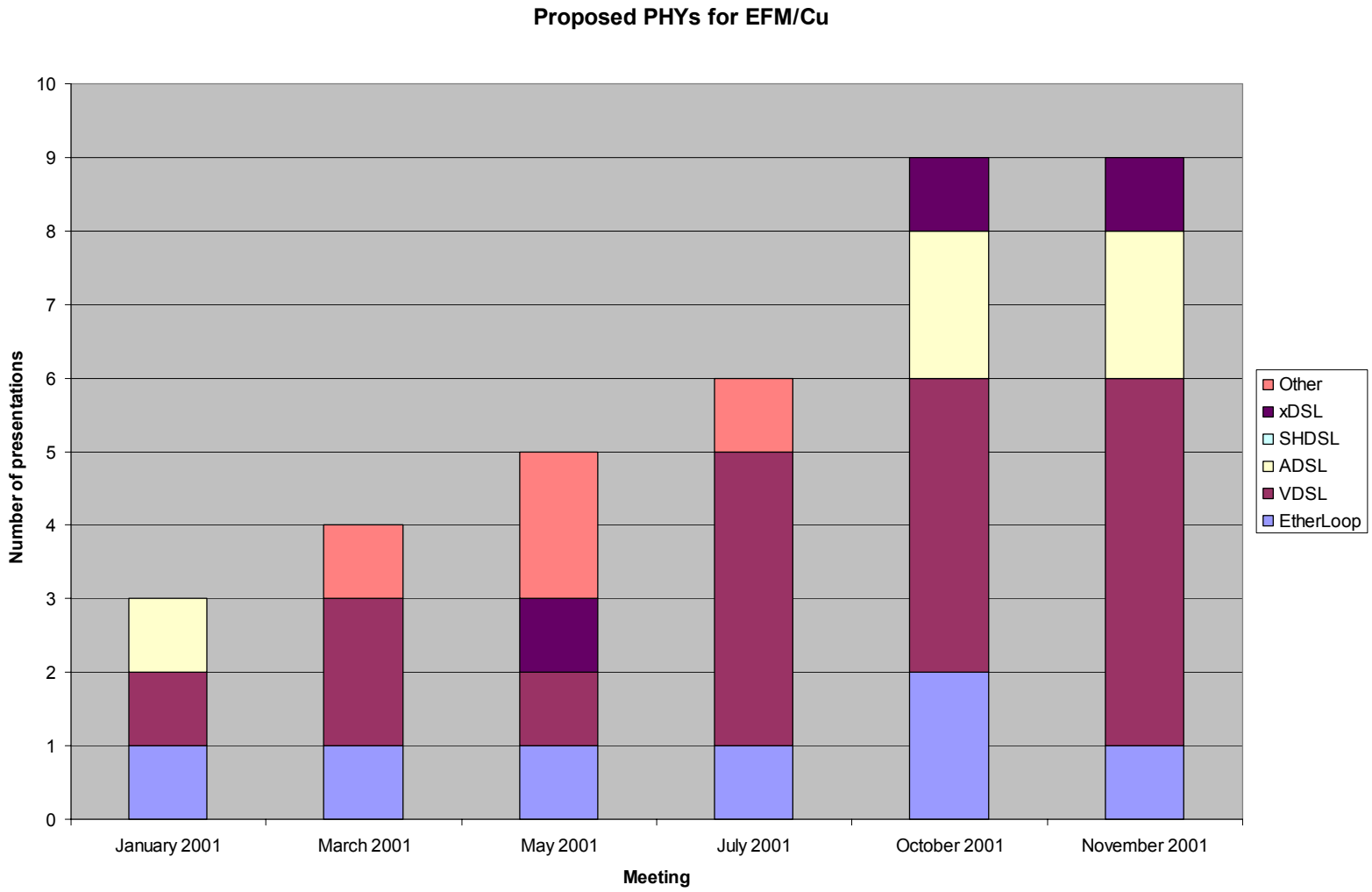
PMS-TC/PMD
ITU-T G.99x Current and Future Projects

- ITU-T Q4/15 is currently finalizing a number of “bis” standards:
  - G.dmt.bis
  - G.lite.bis
- Future projects may lead to new transceiver specifications. Such systems will automatically fit into the EFM/Copper architecture, as long as they have a PTM-TC γ-interface!

PMS-TC/PMD
ITU-T G.99x Common Documents

- G.994.1 “Handshaking Procedures for DSL Transceivers”
- G.995.1 “Overview of DSL Recommendations”
- G.996.1 “Test Procedures for DSL Transceivers”
- G.997.1 “Physical Layer Management for DSL Transceivers”
- G.voice (addresses channelized voice over DSL)
- G.bond (addresses multi-pair operation)

PMS-TC/PMD
Trend of the Proposals



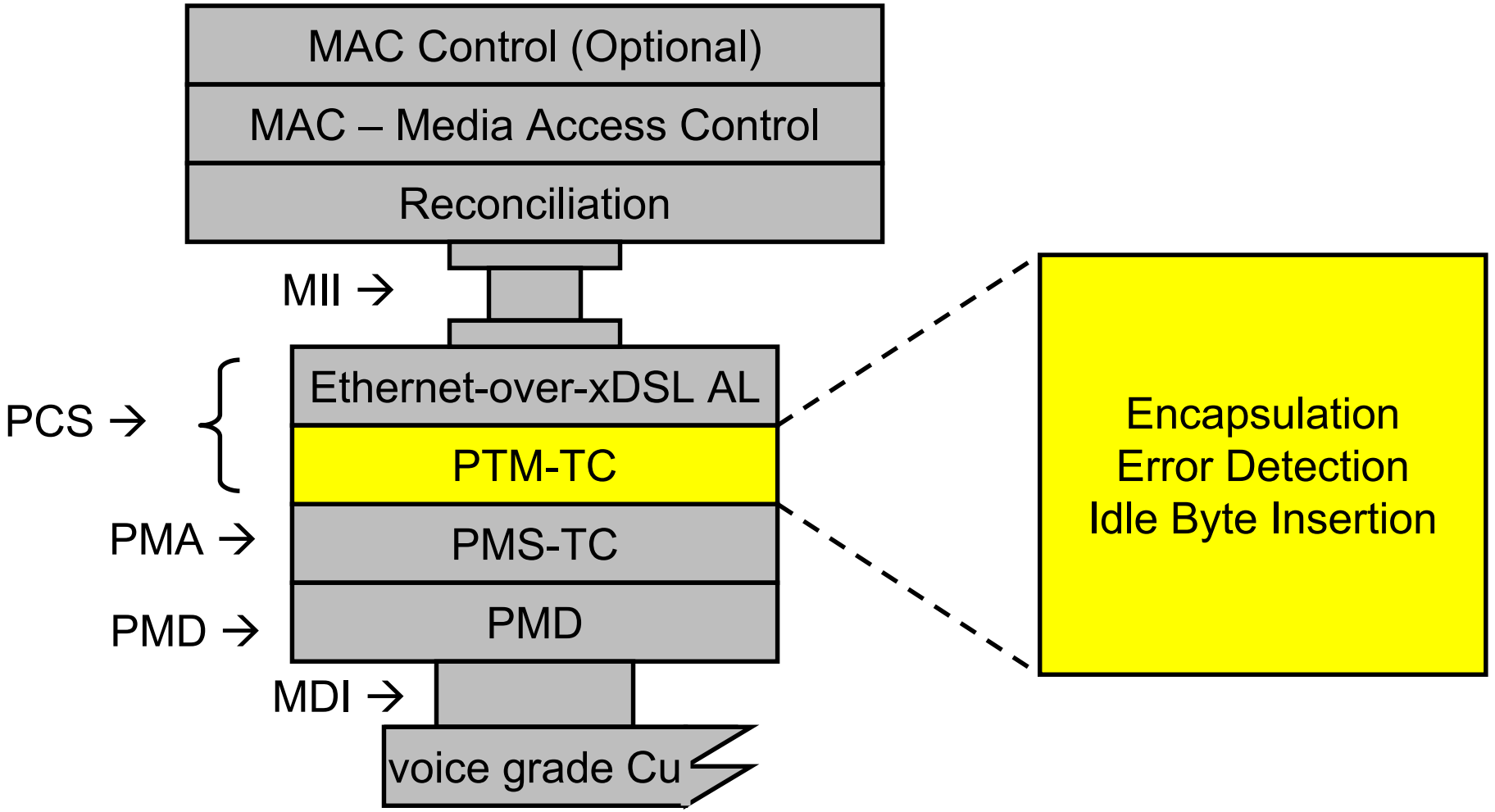
PMS-TC/PMD References (1/2)

- Proposals to use any xDSL or a combination of xDSLs
  - staszak_1_01_2001.pdf
  - easley_1_0501.pdf
  - kimpe_1_0901.pdf
  - langston_1_0901.pdf
  - bar-or_1_1101.pdf
  - langston_1_1101.pdf
- Proposals to use ADSL
  - frazier_1_0901.pdf
  - rezvani_4_1101.pdf

PMS-TC/PMD References (2/2)

- Proposals to use VDSL
  - barrass_1_0301.pdf
  - beck_1_0301.pdf
  - mizrahi_1_0501.pdf
  - oksman_1_0701.pdf
  - rezvani_1_0701.pdf
  - mizrahi_1_0701.pdf
  - penazzi_1_0701.pdf
  - rezvani_2_0901.pdf
  - oksman_1_0901.pdf
  - jacobsen_1_0901.pdf
  - rezvani_3_1101.pdf
  - haas_1_1101.pdf
  - del-toso_1_1101.pdf

PTM-TC


MAC Control (Optional)
MAC – Media Access Control
Reconciliation
MII →
PCS →
Ethernet-over-xDSL AL
PTM-TC
PMA →
PMS-TC
PMD →
PMD
MDI →
voice grade Cu
Encapsulation
Error Detection
Idle Byte Insertion

PTM-TC Overview

- Transmit PTM-TC Layer performs HDLC encapsulation
  - Byte stuffing mode
  - 0x7E Bytes are inserted between packets
  - CRC-16 is calculated “on the fly” (no buffers required)
- Receive PTM-TC Layer performs decapsulation
  - Every received packet is sent to the Packet Entity, an error signal is provided at the end of the packet (OK/CRC/abort)
- Interfaces
  - With the physical layer: α/β-interface
  - With the Packet Entity: γ-interface (PTM-TC controls the flow)

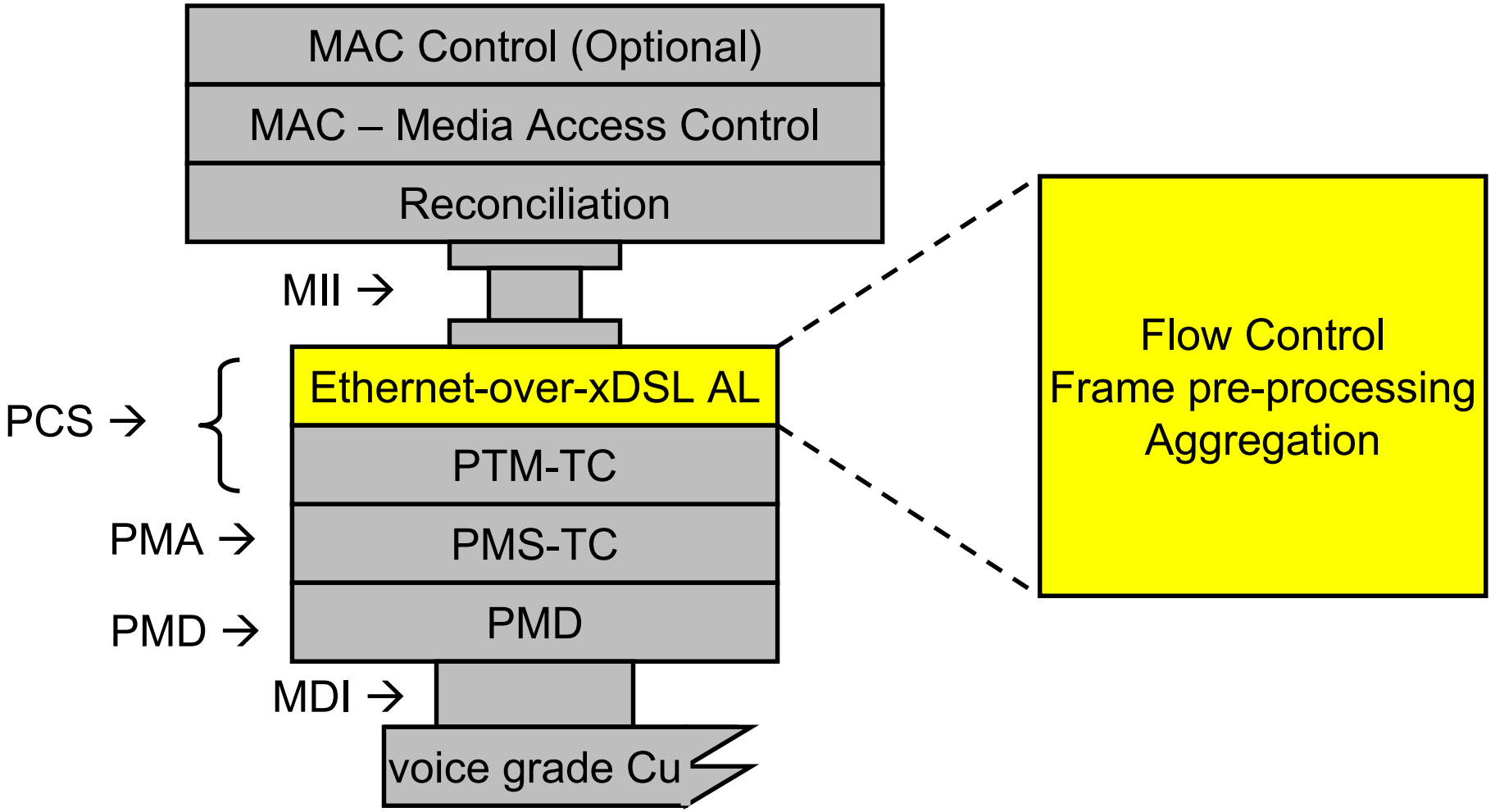
PTM-TC
Further Information

- Although the PTM-TC layer was originally defined for the G.vdsl project, it's being referenced by the other G.99x recommendations.
- HDLC encapsulation may not be "optimal" for Ethernet frames, but it allows a generic architecture that accommodates any kind of packets.
- Pre-processing of the MAC-frames in higher layers may be used to improve the throughput, if we wish.
- ITU-T is considering aggregation in the PTM-TC in its G.bond project.

PTM-TC References

- Architecture and γ-interface
  - ITU-T Draft Recommendation G.993.1 Annex H
  - ITU-T Liaison Letter SC-097R2.pdf

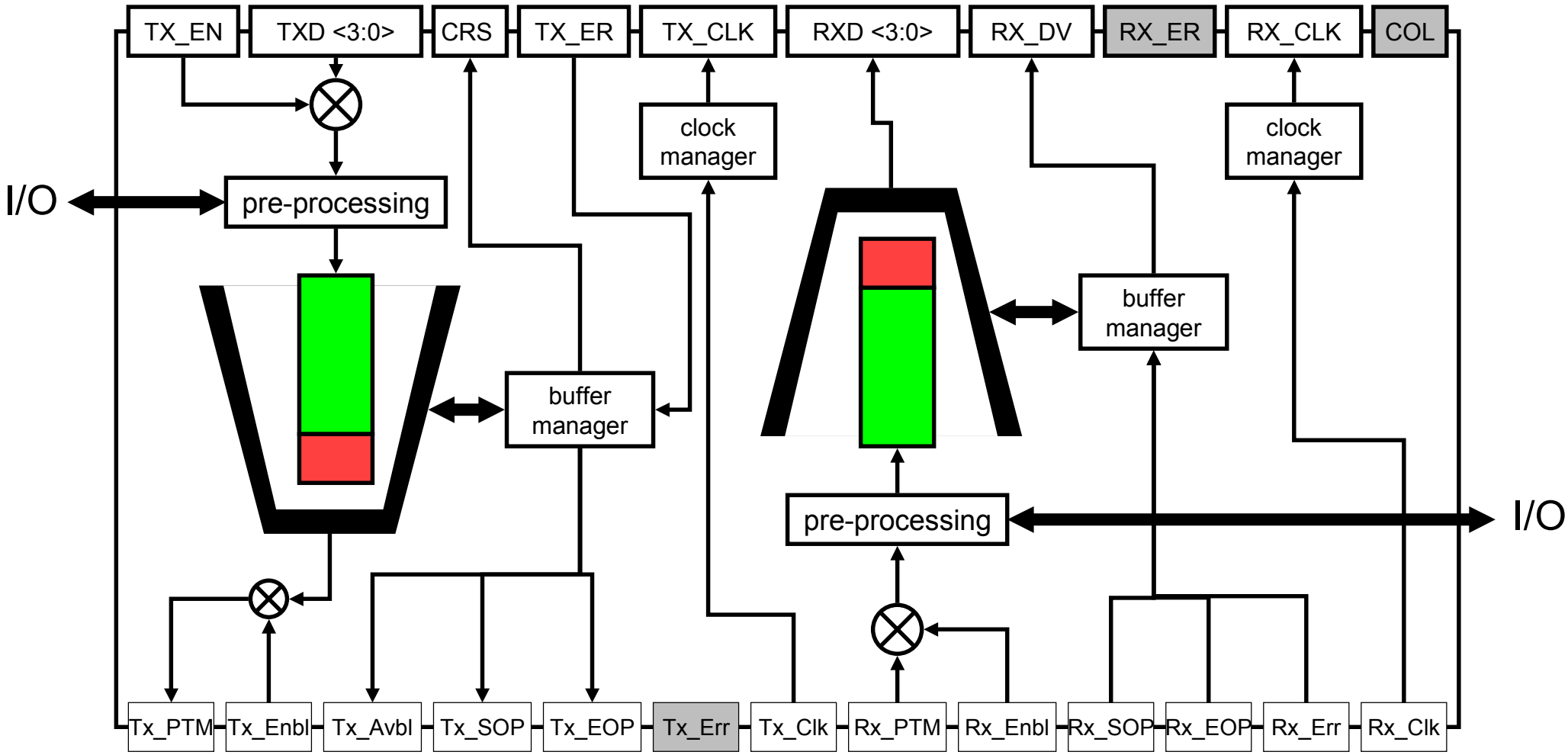
Ethernet-over-xDSL Adaptation Layer



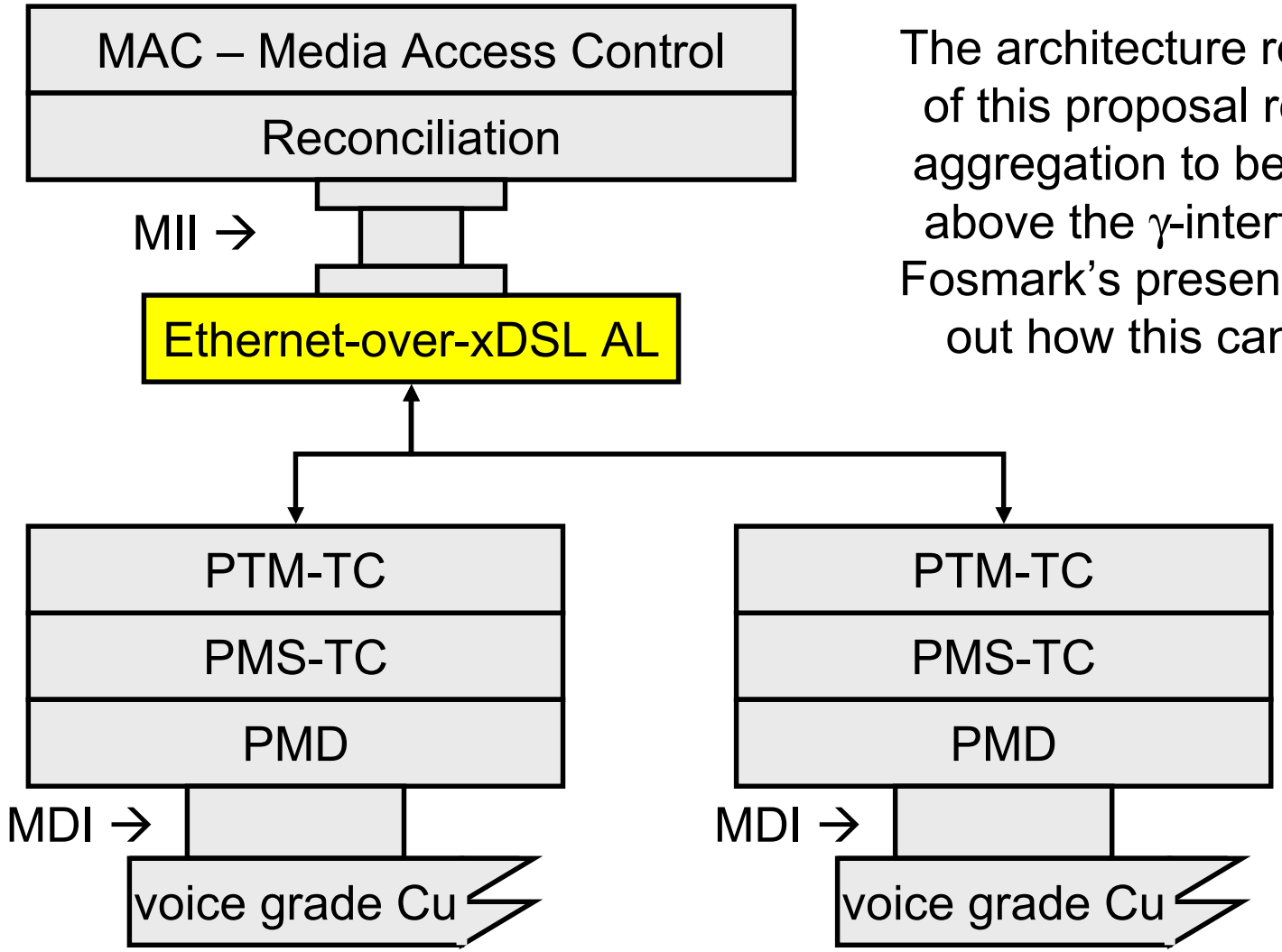
Ethernet-over-xDSL Adaptation Layer Requirements

- Flow Control:
  - It is an architectural and economic requirement that the EOXAL can interface with the standard MII. The CRS mechanism fulfills this requirement.
  - It would be more than nice if a similar solution could be found on interfaces like the RMII/SMII.
  - A completely bufferless solution, such as the VMII, may be defined as an optional alternative.
- Optional Multi-pair Operation
  - It should be defined above the γ-interface. ITU-T may still provide multi-pair optimizations on lower layers (G.bond).
- Frame Pre-processing
  - We can safely remove the preamble. Let's leave the rest alone.

Ethernet-over-xDSL Adaptation Layer Flow Control Schematic



Ethernet-over-xDSL Adaptation Layer Reference Model for Aggregation

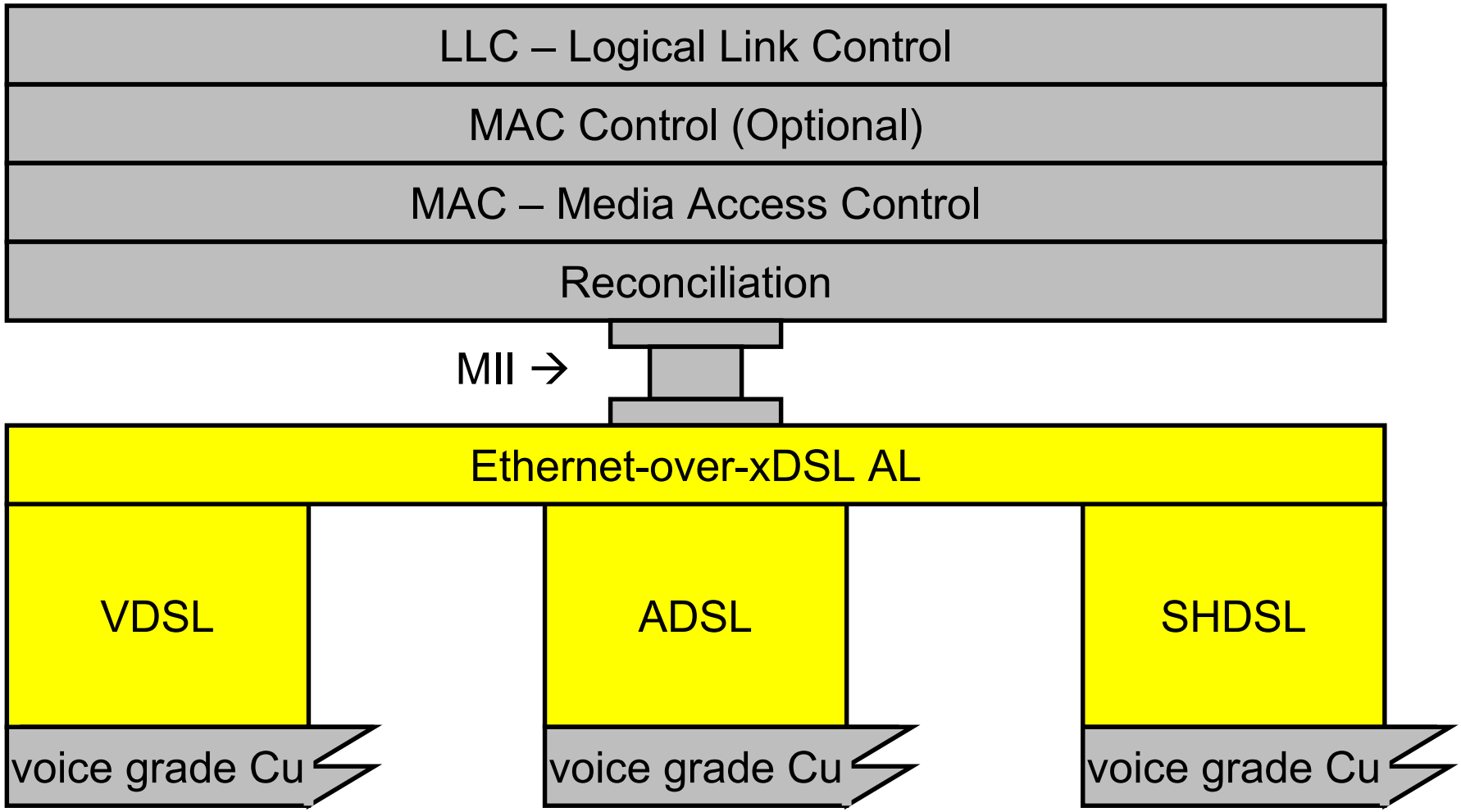


The architecture requirements of this proposal require loop aggregation to be carried out above the γ-interface. Klaus Fosmark's presentation points out how this can be done.

Ethernet-over-xDSL Adaptation Layer References

- Flow Control
  - MII: Arthur Marris' proposal (email exploder)
  - VMII: beck_2_1101.pdf
- Aggregation
  - fosmark_1_1101.pdf (updated in email exploder)

Conclusions



Conclusions

- The authors and supporters of this presentation propose to specify a generic “Ethernet-over-xDSL Adaptation Layer” that fits on the γ-interface.
- Existing G.99x Recommendations can be used as physical layers for EFM, covering all the rate/reach objectives and spectrum compatibility constraints.
- Ethernet will be a data link protocol with the same wide applicability as ATM has today.
- Nothing beats reusing existing things when it comes to “time to market”.