Attaching an Ethernet MAC to a DSL PHY:
The Rate Adaptation Problem

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Ethernet in the First Mile
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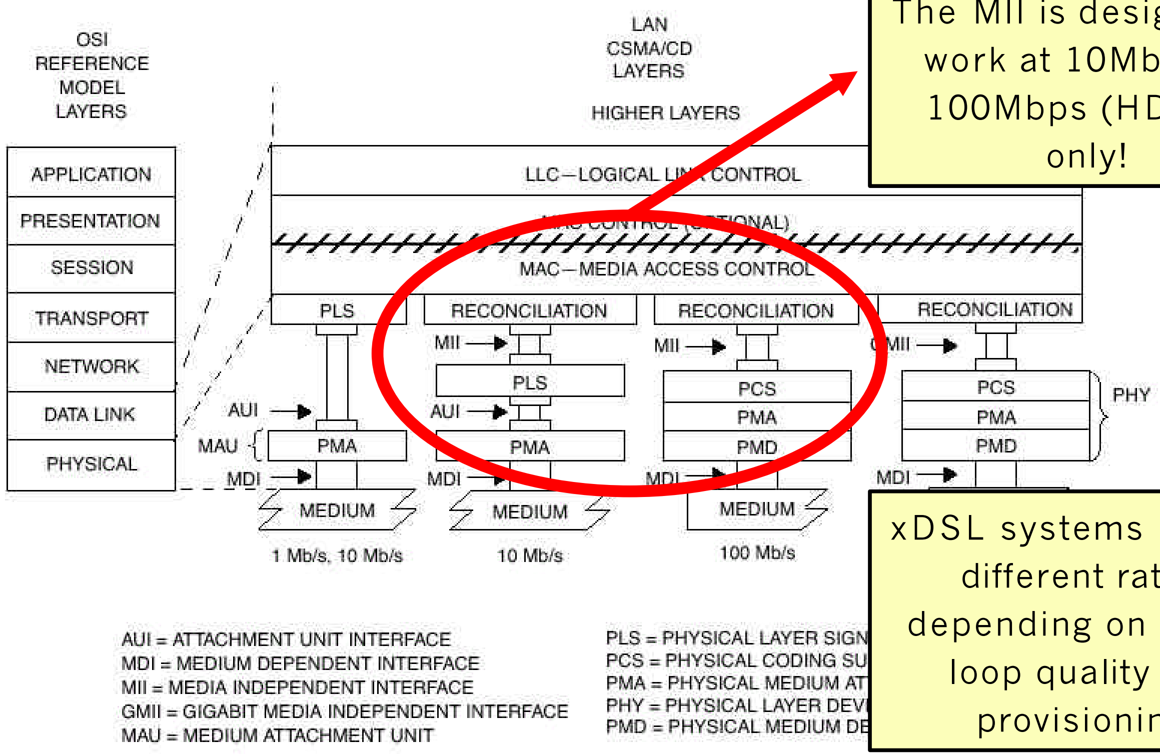
Is the MII really "media independent"?



The MII is designed to work at 10Mbps or 100Mbps (HD/FD) only!

xDSL systems work at different rates, depending on flavor, loop quality and provisioning.

Overview

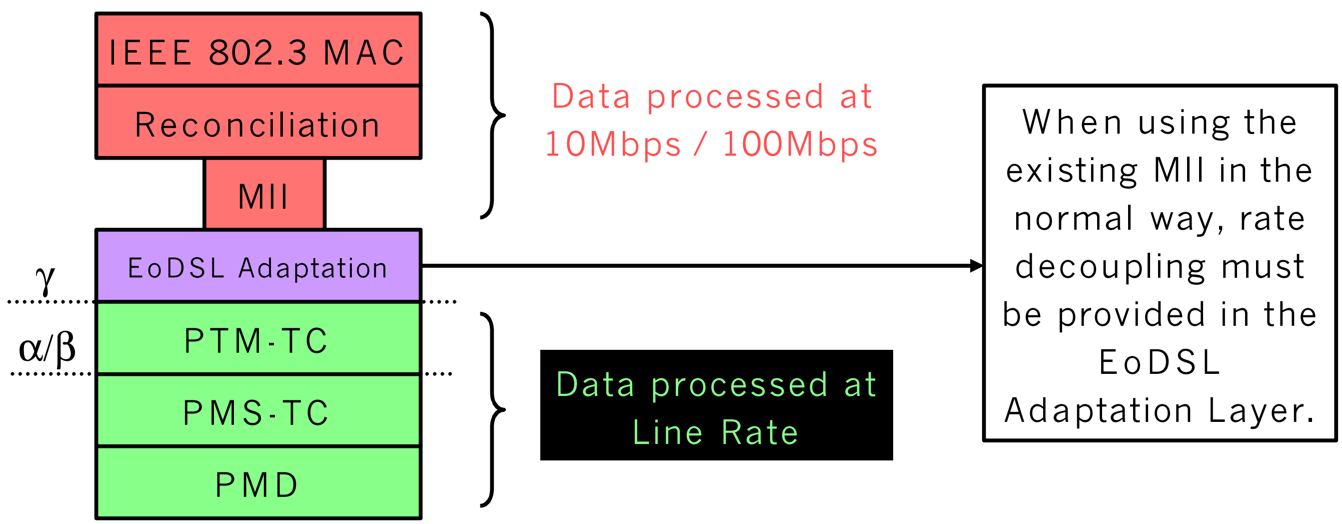
- Rate Adaptation in the Ethernet-over-DSL Adaptation Layer

- Rate Adaptation by doing New Tricks with Old Tools

- Rate Adaptation by changing the MII into a “VMII”

Ethernet-over-DSL Functional Model
Rate Adaptation in the EoDSL AL

IEEE P802.3ah

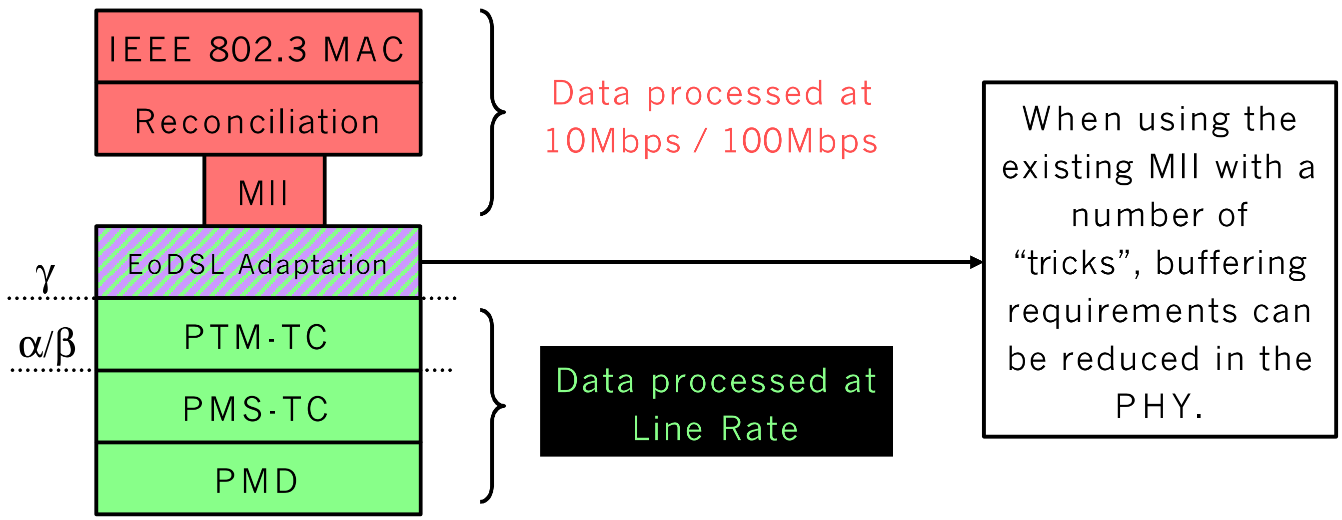


Implementing
Rate Adaptation in the EoDSL AL

- Several options come to mind to accomplish MAC-to-PHY Rate Adaptation in the EoDSL Adaptation Layer:
  - Implement an additional transmit buffer in the PHY and discard all frames that are received when the buffer is full;
    - ➔ Potentially high percentage of frames gets discarded
  - Implement a transmit buffer and generate PAUSE frames when the buffer is (nearly) full
    - ➔ Can we accept the fact that a MAC frame is generated in a PHY layer? Will this conflict with PAUSE frames from the far end?
- PHY-to-MAC Rate Adaptation is a lesser issue, provided there is enough memory in the EoDSL AL to buffer one MAC frame.

Ethernet-over-DSL Functional Model
New Tricks with Old Tools

IEEE P802.3ah

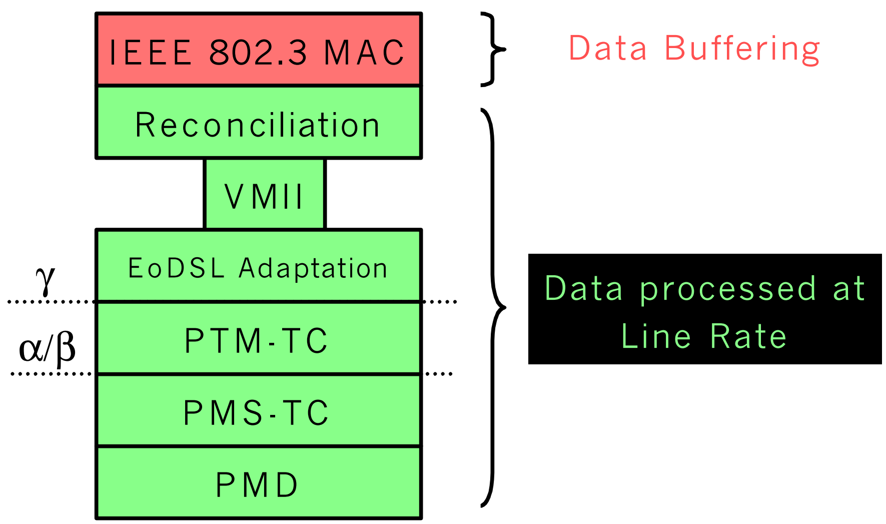


Implementing
New Tricks with Old Tools

- These tricks essentially provide frame-based flow control over the existing MII.
- How can the PHY use the MII interface to temporarily suspend the transmission of MAC frames?
  - Clock stretching (can this deal with a bursty PHY rate?)
  - IPG stretching
  - Extend the use of the Collision signal to Full Duplex mode, and use it to suspend MII transmission when PHY buffer is full
- All these methods still require the presence of a frame buffer in the PHY.

Ethernet-over-DSL Functional Model
Rate Adaptation with the VMII

IEEE P802.3ah



When using the VMII, buffering in the MAC entity provides rate decoupling.

Implementing Rate Adaptation with the VMII

- The real problem is the fact that the MII works at **10/100Mbps only**
- By adding a small set of signals (e.g. transmit_suspend and receive_suspend) to the MII, the PHY gets the means to effectively control the flow, on a byte/nibble/bit basis.
- This variable-rate MII (VMII) would then mimic the γ-interface (between PMS-TC and PTM-TC), which is also byte-oriented and controlled by the lower layers.
- **The VMII removes the need for buffering in the PHY!**

Where did the buffers go?

- Buffering is removed from the PHY, which implies that packets will have to be buffered longer in the MAC entity.
  - MAC entities are usually implemented in a MAC bridge or a NIC, where larger amounts of RAM are available
  - Space and memory are at a premium in PHY implementations, so removing buffering requirements there is an improvement.

Conclusions

- The VMII can effectively operate at any bitrate $\leq$ 100Mpbs
- The VMII is therefore really “media independent”
- The VMII requires only minimal changes for a PTM-enabled xDSL system to become “Ethernet-over-DSL”-enabled.
- The VMII is a clean solution that places buffering requirements there where they can be most easily met: in the MAC entity.