
VDSL as the PMD for EFM copper

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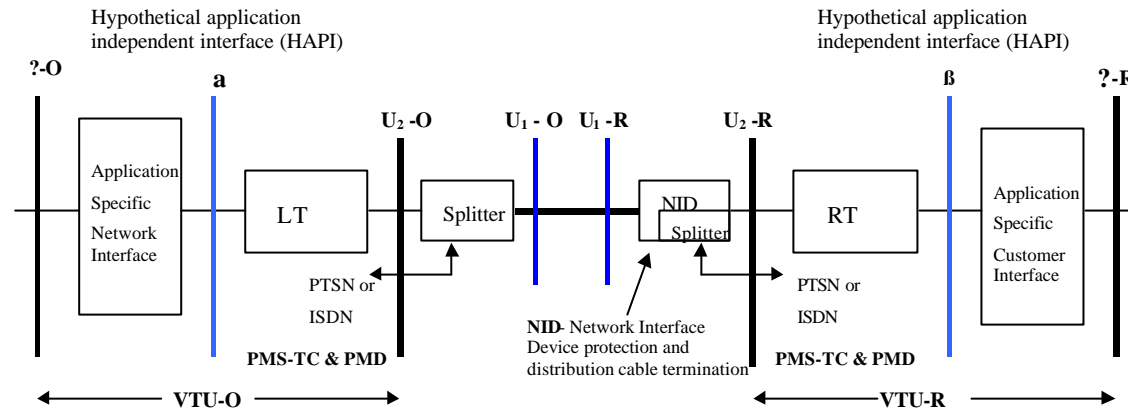
- You can here as well.

Standardized VDSL can be EFM-Copper PHY

This presentation will explain:

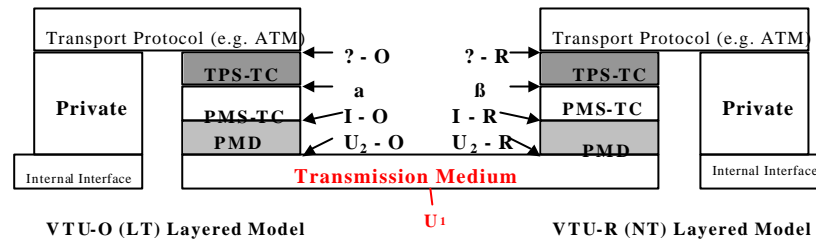
- What functions are covered by the VDSL standards
- What layers can be taken, as is, from ANSI/ETSI/ITU standards for VDSL
- What additional functions need to be defined by the EFM in order to create a definition that meets public network standards and IEEE PAR objectives
- VDSL is standardized in:
 - ETSI TS10127001 (requirements) and TS10127002 (specification)
 - T1E1's trial based standard
 - ITU's G.vdsl.f standard (G.993.1)

VDSL reference model



- The VDSL reference model is common for MCM and SCM line codes (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).

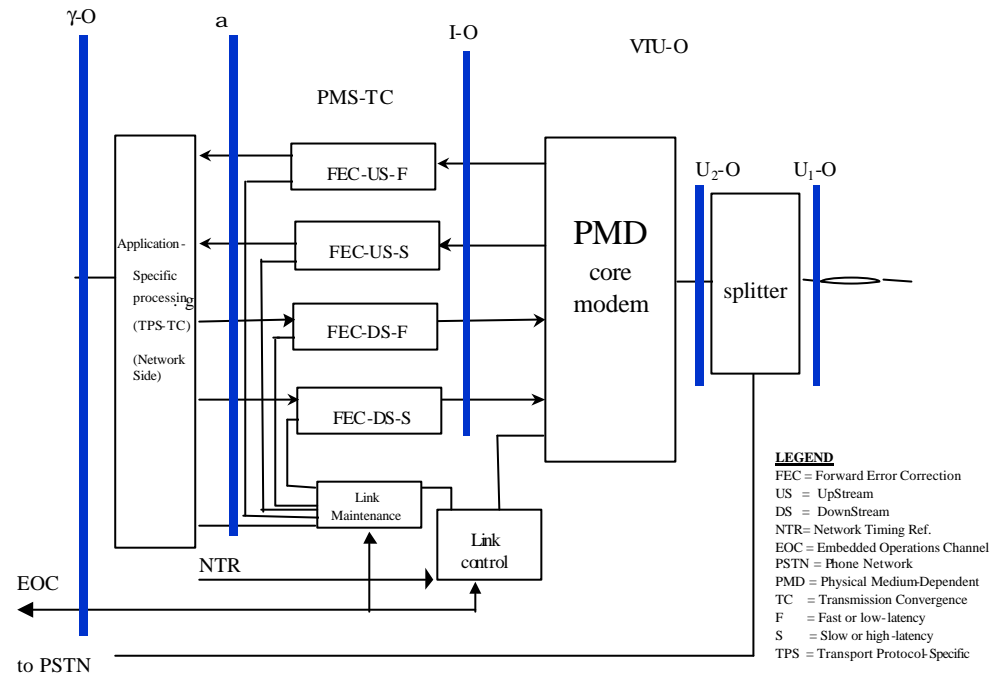
Layers in the VDSL standard



- The PMD performs physical layer functions
- The PMS-TC performs VDSL specific framing functions
- The TPS-TC performs transport protocol specific functions
- The U, I and alpha/beta interfaces are common to all transport protocols and modulations

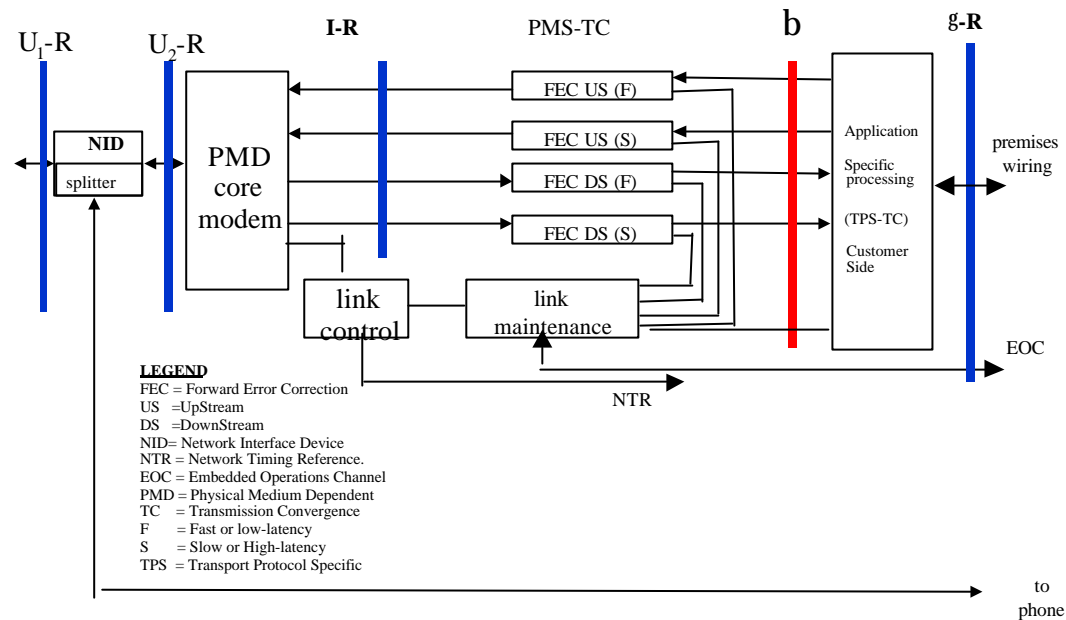
(VDSL Part 1/T1E1.4, section 5.2)

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



- Both MCM and SCM have the same reference model.
- The VTU-O (LT) is a self contained device with a 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)

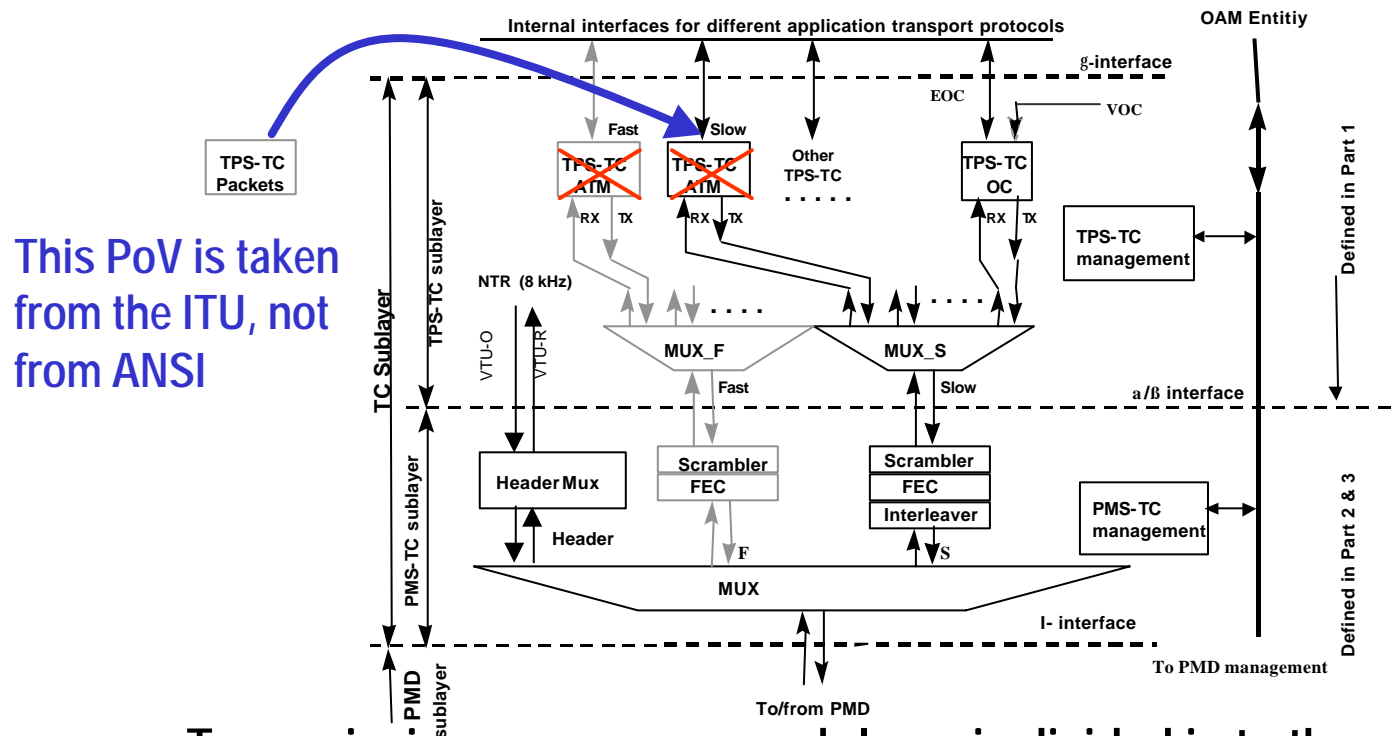


- The VTU-R (NT) resembles the VTU-O except:
 - Network timing reference (NTR) is an output
 - The device acts as a slave link state machine and is controlled by the VTU-O

The PMD layer (VDSL Part 1, section 8)

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

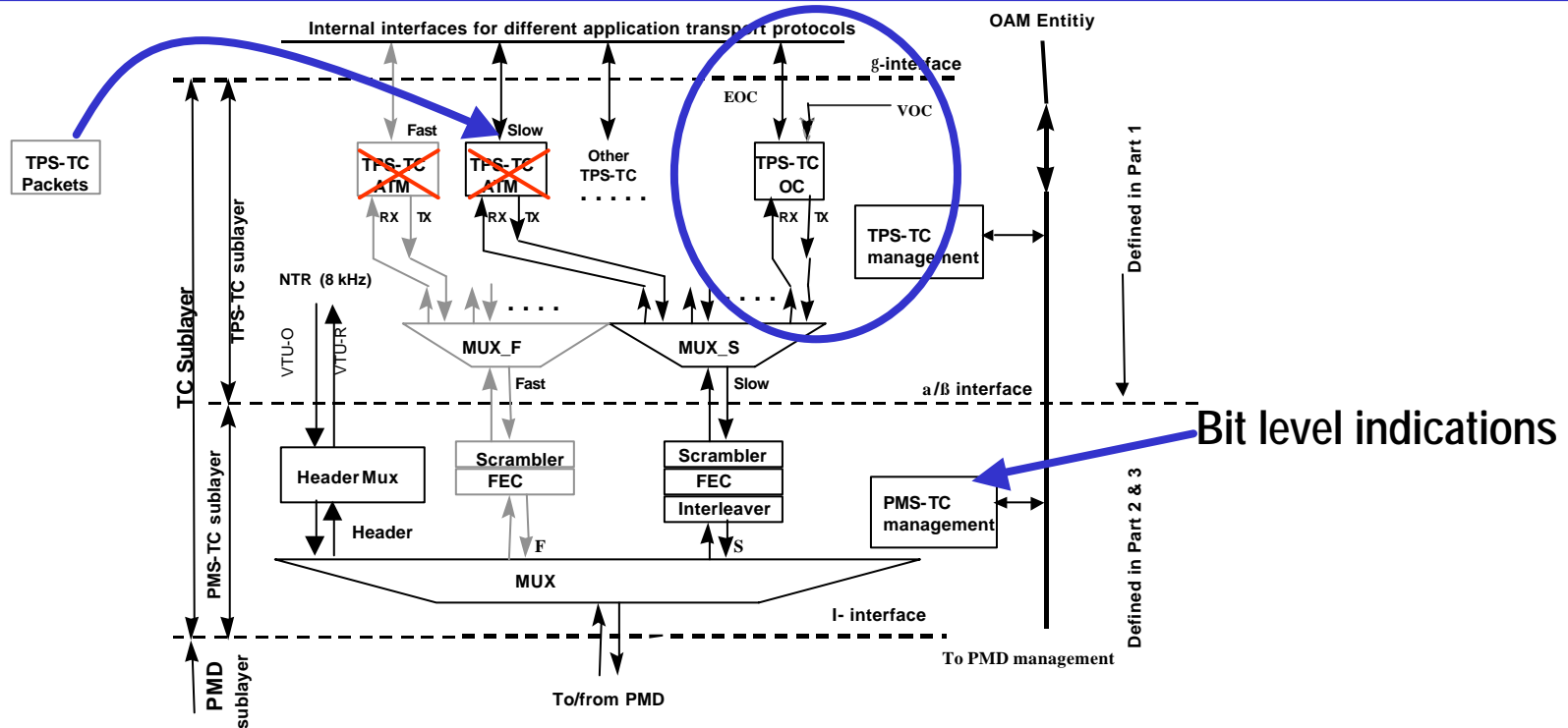
Transmission Convergence reference model (VDSL Part 1, section 9)



This PoV is taken from the ITU, not from ANSI

- Transmission convergence sub-layer is divided into the:
 - PMS-TC which performs framing, error correction and interleaving
 - TPS-TC which performs protocol specific functions:
 - ANSI defined an ATM, STM and Operation Channel TPS-TC
 - The ITU also defined a Packet over VDSL TPS-TC (G.vdsl.f)

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

The Fast channel is optional

Table 9.1 - a(b)-interface signal summary

Signal(s)	Description	Direction	Notes
<i>Data Signals</i>			
Tx_s	Transmit data, Slow	TPS-TC ----> PMS-TC	Mandatory
Tx_f	Transmit data, Fast		Optional
Rx_s	Receive data, Slow	TPS-TC <---- PMS-TC	Mandatory
Rx_f	Receive data, Fast		Optional
<i>Synchronization Signals</i>			
Clk_t	Transmit bit timing	TPS-TC <---- PMS-TC	Optional
Osync_t	Transmit octet timing		Mandatory
Fsync_t	Transmit frame timing		Optional
Clk_r	Receive bit timing		Optional
Osync_r	Receive octet timing		Mandatory
Fsync_r	Receive frame timing		Optional
NTR_t	Transmit NTR		TPS-TC ----> PMS-TC
NTR_r	Receive NTR	TPS-TC <---- PMS-TC	Optional, VTU-R only

- Slow is interleaved
- Interleaving depth is programmable
- Fast has no interleaver
- Fast is optional
- NTR is optional
- Does EFM need Fast or NTR?

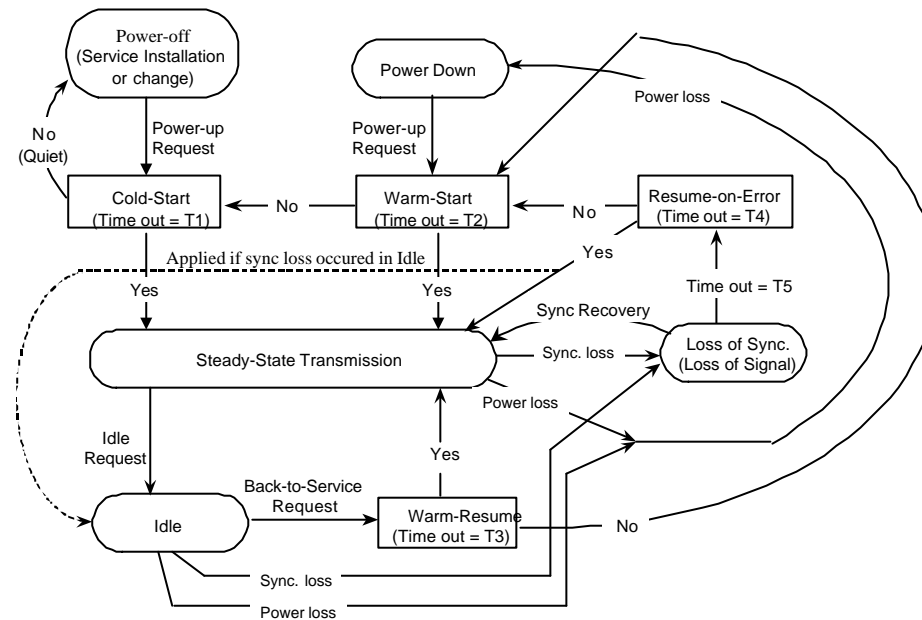
The Packet TPS-TC (HDLC) is defined in ITU G.vdsl.f (section 20)

- The packet transported over the γ -interface may be of variable length. If either of data streams (upstream or downstream direction) is transmitted serially, the first octet of the packet shall be transmitted first and the LSB of each octet shall be transmitted first.
- The interface shall include the following error messages:
 - Transmit error message (Tx_Err/Stop_Tx): optionally asserted by the PTM entity and intended to indicate that either an errored packet or any other packet undesirable for transmission is transported from PTM-TC to PTM entity.
 - Receive error message (Rx_Err): Shall be asserted by the PTM-TC and is intended to indicate that an errored packet is transported from PTM-TC to PTM entity.

VDSL specifications define more

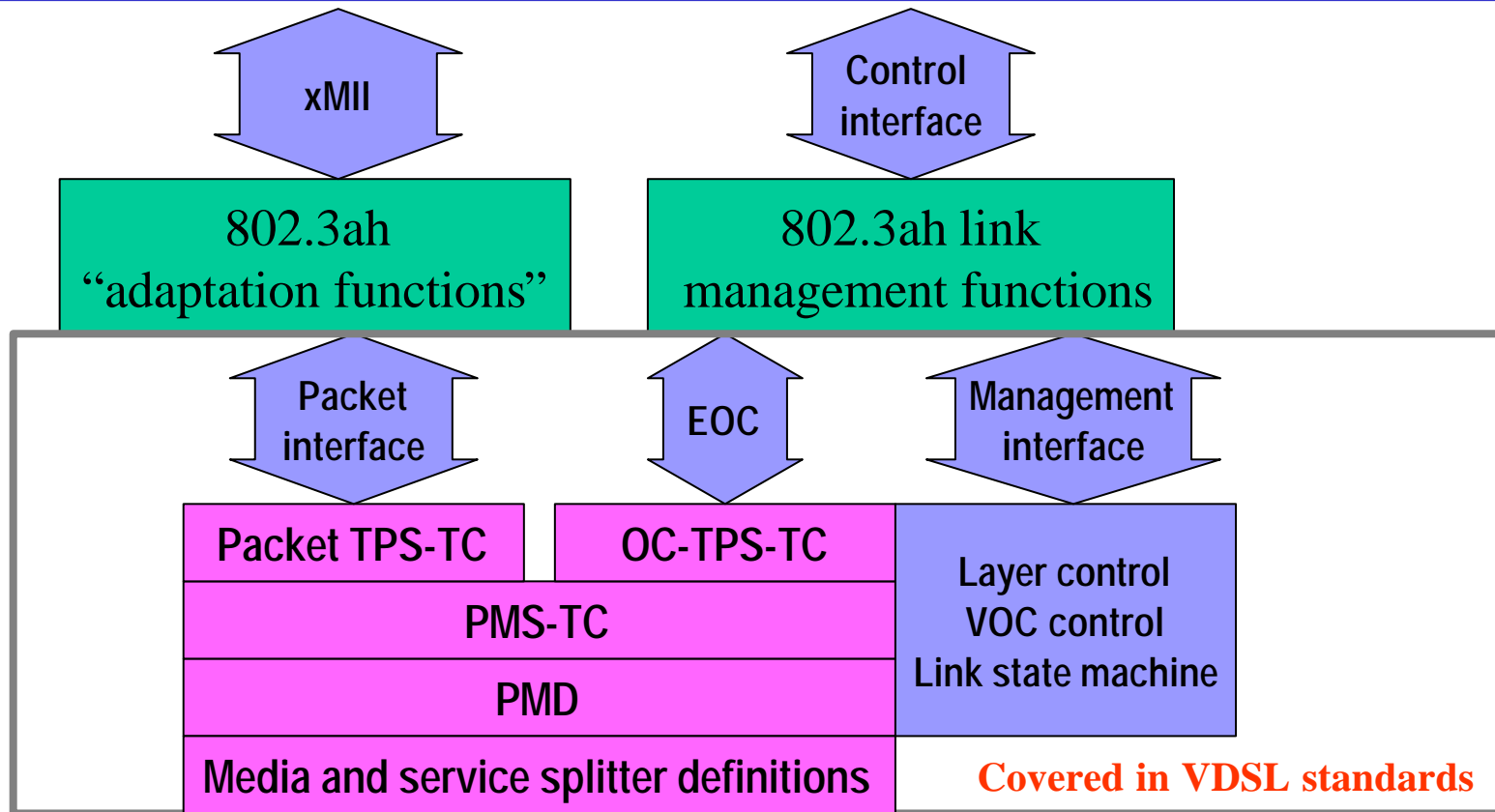
- VDSL Part 1 from E1T1.4 defines:
 - The link state machines
 - The OAM functions needed to support the link
 - The band plan allowed in a public network
 - The electrical characteristics required by VDSL
 - The test loops and impairment tests
 - The environmental conditions of the equipment
- VDSL part 2 and 3 define the specific line code functions and management message channels

The VDSL link state machine



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

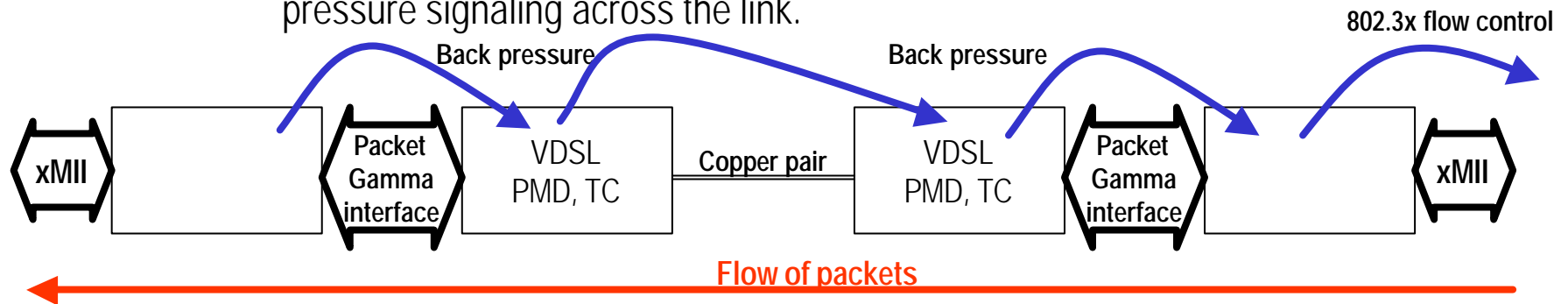
T1E1's VDSL can be used as a "black box"



- xMII to Packet TPS-TC adaptation must be defined
- The control of the internal management functions needs definition

xMII to Gamma interface adaptation

- How is the Ethernet frame taken from the MII to the Gamma interface of the Packet TPS-TC ?
 - The preamble and SFD can be stripped.
 - Should we touch the CRC?
- The rates can be different:
 - The MII rates on both sides of the link may differ. Duplexing configuration may differ at the MII interfaces..
 - The link rate is not always equal to the MII rate.
 - Standard 802.3x flow control can be used on the MII side.
 - Dedicated TPS TC indicator bits in the VDSL header can be used for back pressure signaling across the link.



OAM functions need to be defined

- What rates will EFM support
 - A link state machine exists
 - Methods to configure the link exist
 - Now an “auto-negotiation” state machine that uses these must be created, based on EFM rate objectives.
- What information will be held in the 802.3ah MIB?
- What special EFM (if any) functions should be added to the indications and OAM primitives defined for VDSL?

Summary

- The VDSL standards provide a complete definition of a PHY for the public network
- Minimal layers must be added by the EFM
- This new standard will meet the EFM copper objectives:
 - > = 2500 feet with \geq 10Mbps aggregate bit rate
 - Compliant to spectral management decisions and frequency plans approved by ITU-T SG15/Q4, T1E1.4 and ETSI/TM6