Extended Reach Baseline Proposal

*G991.2 **S**ymmetric **H**igh Bit Rate **D**igital **S**ubscriber **L**oop as a Physical Medium definition within 802.3ah*

Contributors:

Steve Jackson
Matt Squire
Paul Tuong
Walter Juras
Dong Wei
Hugh Barrass
Marc Kimpe
Amir Leshem

HATTERAS NETWORKS

Supporters

- Dong Wei
- Kishan Shenoi
- Paul Tuong
- Matt Squire
- Craig Easley
- Hugh Barrass
- Barry O'Mahony
- John Egan
- Marc Kimpe
- Amir Leshem
- Walter Juras
- Bruce Tolley
- Massimo Sorbara
- Jim Apfel

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Goals
(just two)

1. List and rationalize the 5 requirements for extended reach
   - What meets the new objective
   - Mapping to the PAR requirements
   - Engineering data points
2. Get consensus

5 Requirements

- First Three:
  1. Symmetry
  2. Reach
  3. Rate

- Needed to meet new objective as stated:
  - **PHY for single-pair non-loaded voice-grade copper with distance >= 2700 m and speed >= 2 Mbps full duplex**

5 Requirements

- Two 'Final Factors' for Ethernet-icity
  4. Spectral Compatibility
  5. Simplicity

- ***Ethernet deployment must be straightforward***
  - Not hampered by spectrum management concerns
  - Able to deploy without extensive engineering
  - Ethernet should be "plug 'n' play"

Why Two PHYs?

- One PHY for short reach
  - Building riser, bandwidth optimized
- One PHY for long reach
  - Business apps, symmetrical, T1 “replacement”
- Magic 1-PHY-fits-all has long been sought
  - Appears to be in Atlantis
- Irresponsible to believe it will be found
  - Physics behind the problem have not changed
  - Mostly same people working on the PMD aspects

Why Two PHYs?

- Several DSLs are available to select from
- Well-thought-out, pragmatic approach
  - Optimized various DSLs for different objectives of reach and symmetry
- Technologies based on needs and abilities
  - ADSL, VDSL, SHDSL, …
- Selecting a PHY that isn't encumbered by a line coding selection contention is a good idea

Why Two PHYs?

- Multiple PHYs are OK!
  - Look at optics track – how many PMDs there?
  - Look at 10GE, 1GE, etc. – how many PMDs?
  - 100BASE-TX, 100BASE-T4, 100VG, etc.
- Different PMDs target different applications
  - One PMD for short-reach objective
    - rezvani_1_0302.pdf
  - One PMD for long-reach objective
    - wei_(n)_0702.pdf
- Simple!

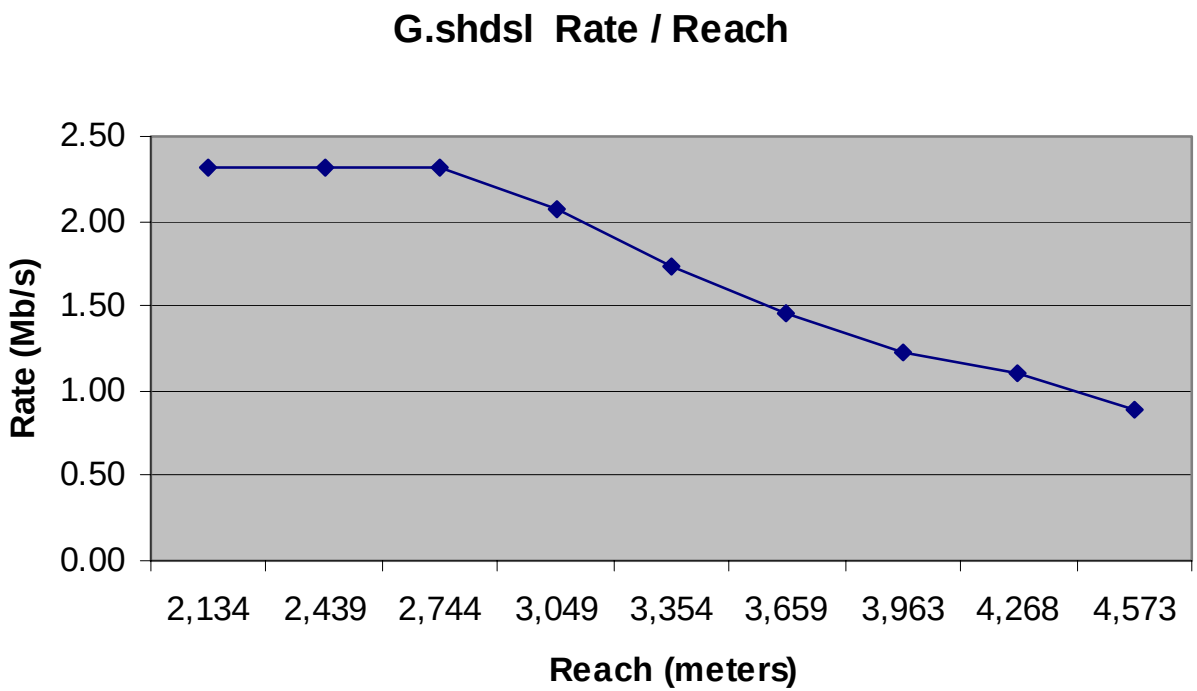
Which Two PHYs?

- VDSL #1 for high-rate, short-reach PMD
  - Line-code TBD (QAM or DMT)
- SHDSL designed for
  - Long reach
  - Graceful degradation of rate as reach increases
  - Symmetry, maintained at all rate/reach ratios
  - No need for upstream power back-off
  - Can be repeated (in some areas)
  - Can be accelerated, with reverse compatibility
    - work is ongoing to increase SHDSL rate
  - Spectral compatibility with other technologies

Relevant Existing Standards

- VDSL
  - ITU G.993.1
  - ANSI T1.424/Trial-Use
  - ETSI TS10127001 (requirements) and TS10127002 (specification)
- SHDSL
  - ITU G.991.2
  - ANSI T1.PP.422-2001; T1.TRQ.6-2001
  - ETSI TS101-524(V1.1.3-2001-11)
- General
  - G.994.1 Handshake
  - G.995.1 Architecture/Overview of DSL standards
  - G.996.1 Test procedures

G 991.2 Rate – Reach Curve



Meter distances listed convert to 7,000 to 15,000 Feet, in 1,000 foot increments

For Broad Market Acceptance: T1.417

- North American requirement
  - Since G.shdsl has been selected as a basis system by draft T1.417 issue 2, deployment of G.shdsl on unbundled loops will be protected
- Good SM helps in Other Places, too
  - G.shdsl is an international standard, and is already taken into account in many SM plans. Example: Europe (UK, Belgium, France, Switzerland, etc.), Hong Kong. (& China?)

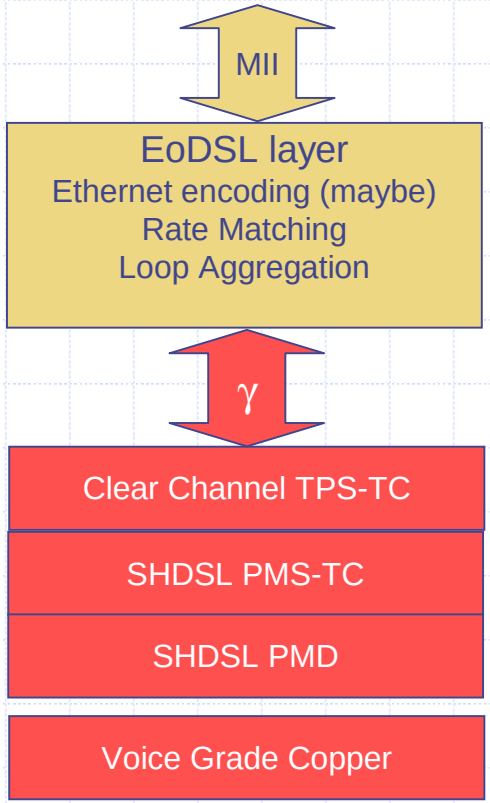
Principles and Strategy

- Require little or no changes to existing standards
  - IEEE
  - ITU
  - ANSI
- Try to keep changes below MAC and above gamma interface
- Specify interfaces and new functionality only (reference rather than duplicate)

Slaying the Jargon Dragon

- **TPS-TC**
  - Transport Protocol Specific Transmission Convergence
- **PMS-TC**
  - Physical Medium Specific Transmission Convergence
- **PMT-TC**
  - Physical Medium Transport Transmission Convergence

Interfaces and Architecture



ITU View

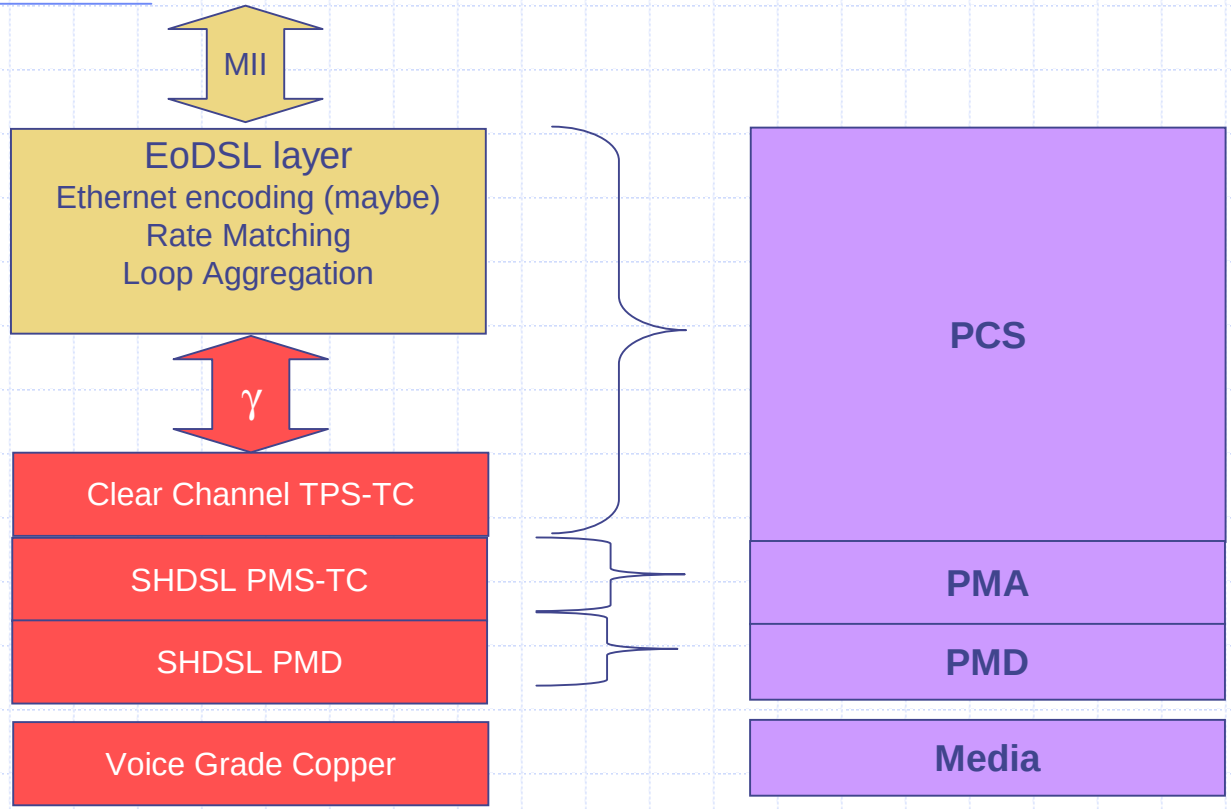
Functional View

Ethernet Framing
Encoder/Decoder
Rate Adaptation
Loop Aggregation

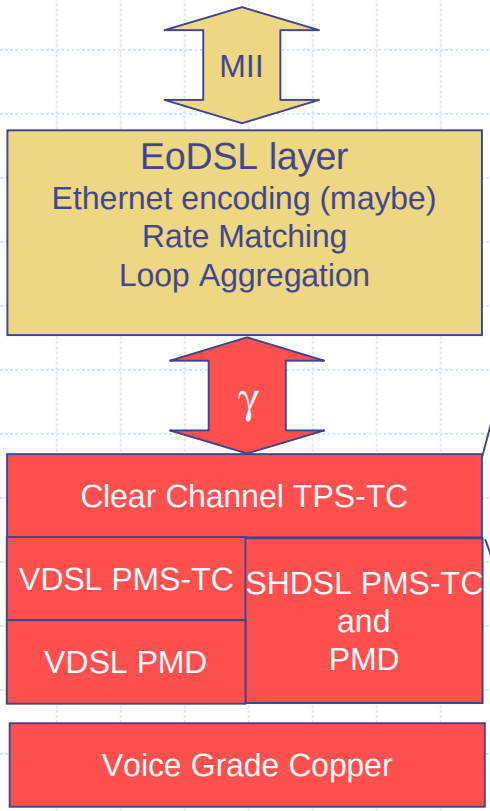
SHDSL Framing
Synchronization
Scrambler/Descrambler

Symbol generation/recovery
Symbol timing
Modulation/demodulation
Echo cancellation
Line equalization
Link startup

Interfaces and Architecture



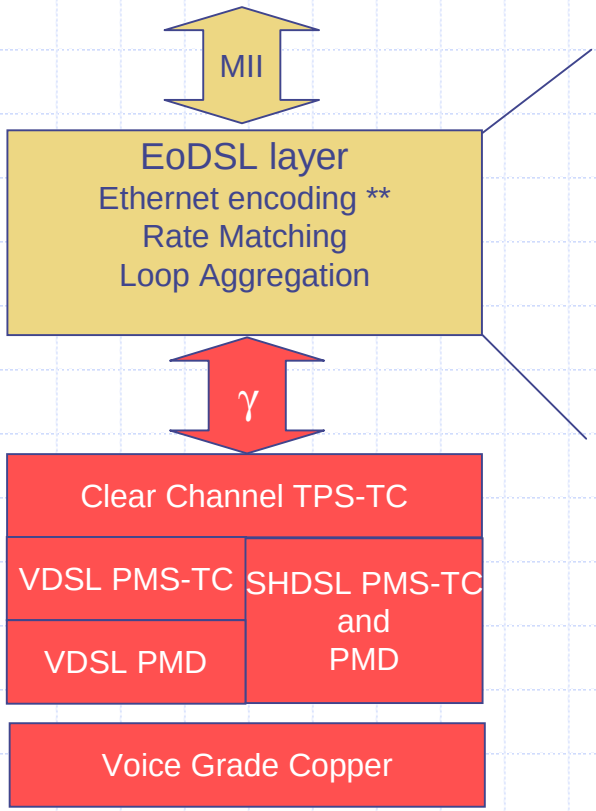
Interfaces and Architecture



Items in RED defined in ITU/ANSI standards
- VDSL (G.993.1) has defined PMS-TC and PMD
- SHDSL (G.991.2) has defined PMS-TC and PMD
- VDSL defines PTM-TC for packet transfer mode
  - Packet interface
  - HDLC byte stuffing
  - HDLC framing
  - HDLC CRC
- Clear channel TPS-TC defined in G.991.2
  - Very simple bit-transfer interface
  - **Not** defined in G.993.1 (VDSL)
  - Provides maximal flexibility to EoDSL layer (bit-pump)
- **Decision on HDLC vs 66/64 is independent of TPS-TC**
- **Decision on loop aggregation is independent of TPS-TC**
- Issues:
  - -Where does framing and encoding happen?
  - -How is it done?

Need a consistent interface (clear channel vs PTM-TC) for all PHYs.

Interfaces and Architecture

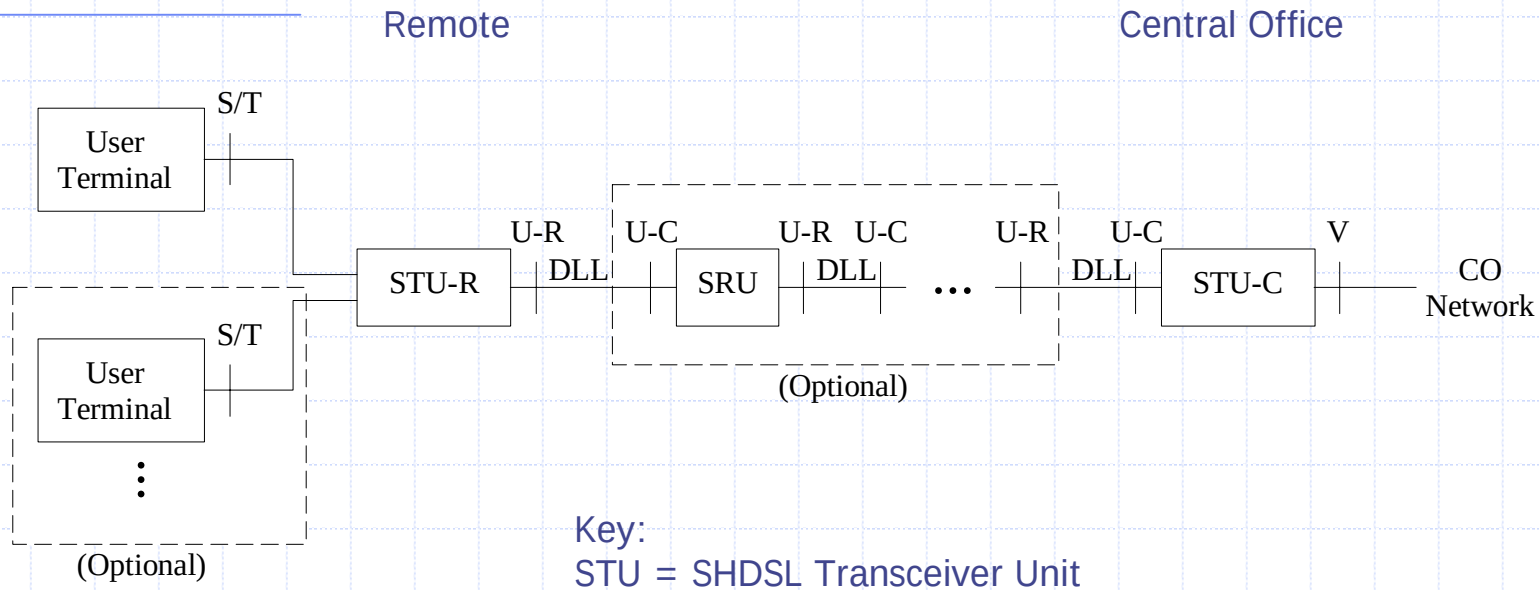


- **Loop Aggregation.**
  - **Covered in fosmark_1_0302.pdf**
- **Rate Matching.**
  - **Covered in marris_1_0302.pdf**
- **Framing and Encoding.**
  - **Covered in many other proposals.**

**** Using clear channel TPS-TC does not restrict us to HDLC framing and byte stuffing**

All functions happen above "bit pump" interface to clear channel TPS-TC

Reference Model



Key:
STU = SHDSL Transceiver Unit
SRU = SHDSL Regenerator Unit
STU-C = STU Central Office
STU-R = STU Remote
U = Loop Interface
U-C = U Central Office
U-R = U Remote
DLL = Digital Local Line
(Blatantly stolen from G.991.2)

Things to finish…

- Management (MIB, profiles)
  - Requires mapping to SHDSL PMD MIB
  - Profile use same as VDSL
  - Overhead Channel parallel for VDSL/SHDSL
- Management interface
  - Work in progress; OAM track provides direction & content
- Address 4-wire mode
- References to G994.1 for Ethernet handshaking

802.3ah PAR Recap

1. **Broad Market Potential**
2. **Compatibility**
3. **Distinct Identity**
4. **Technical Feasibility**
5. **Economic Feasibility**

Summary

- G 992.1 SHDSL Works!
  - Satisfies the new objective requirements
  - Satisfies the 802.3ah PAR requirements
  - Multi-vendor silicon available now
  - Proven, documented, and robust
- Does not ‘poach’ from the first Objective
  - Two distinct markets, two clear solutions
  - Equal time-to-market = Ethernet solidarity