
SCM Technology for EFM

**Solution for copper EFM based on Single
Carrier Modulation (SCM) technology**

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Agenda

- **Present solutions for Ethernet transport over copper for different deployment scenarios, service types and noise environments offered by Single Carrier Modulation (SCM) transmission technology.**
- **Demonstrate the main features of a standard SCM technology such as:**
 - **spectral compatibility**
 - **high performance**
 - **flexibility**
 - **robustness**
 - **reliability**



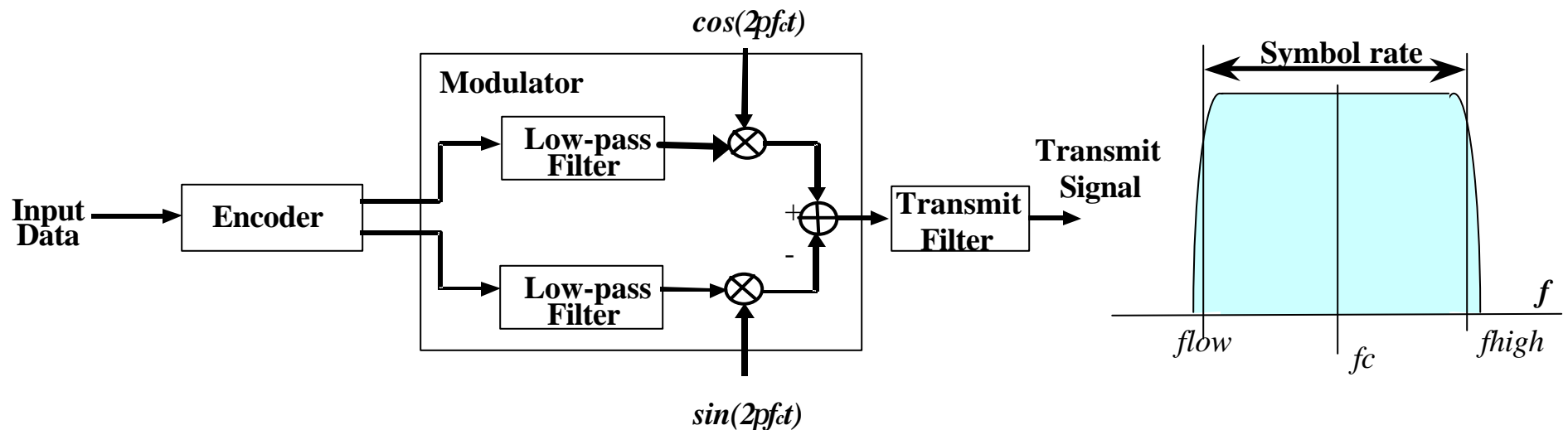
Background

- **This presentation is mostly based on the standard SCM technology specified in ETSI VDSL Technical specification TS 101 270-2 and T1E1 VDSL Trial-use standard**
- **It also demonstrates solution which might be useful to provide some specific features of EFM, such as loop aggregation, symmetric operation, using of alternative duplexing methods, and some others.**
- **All presented solutions are based on the currently available technology and intended for convenient and inexpensive implementations**



Basics of the SCM technology

- Modulation technique - traditional QAM solution:



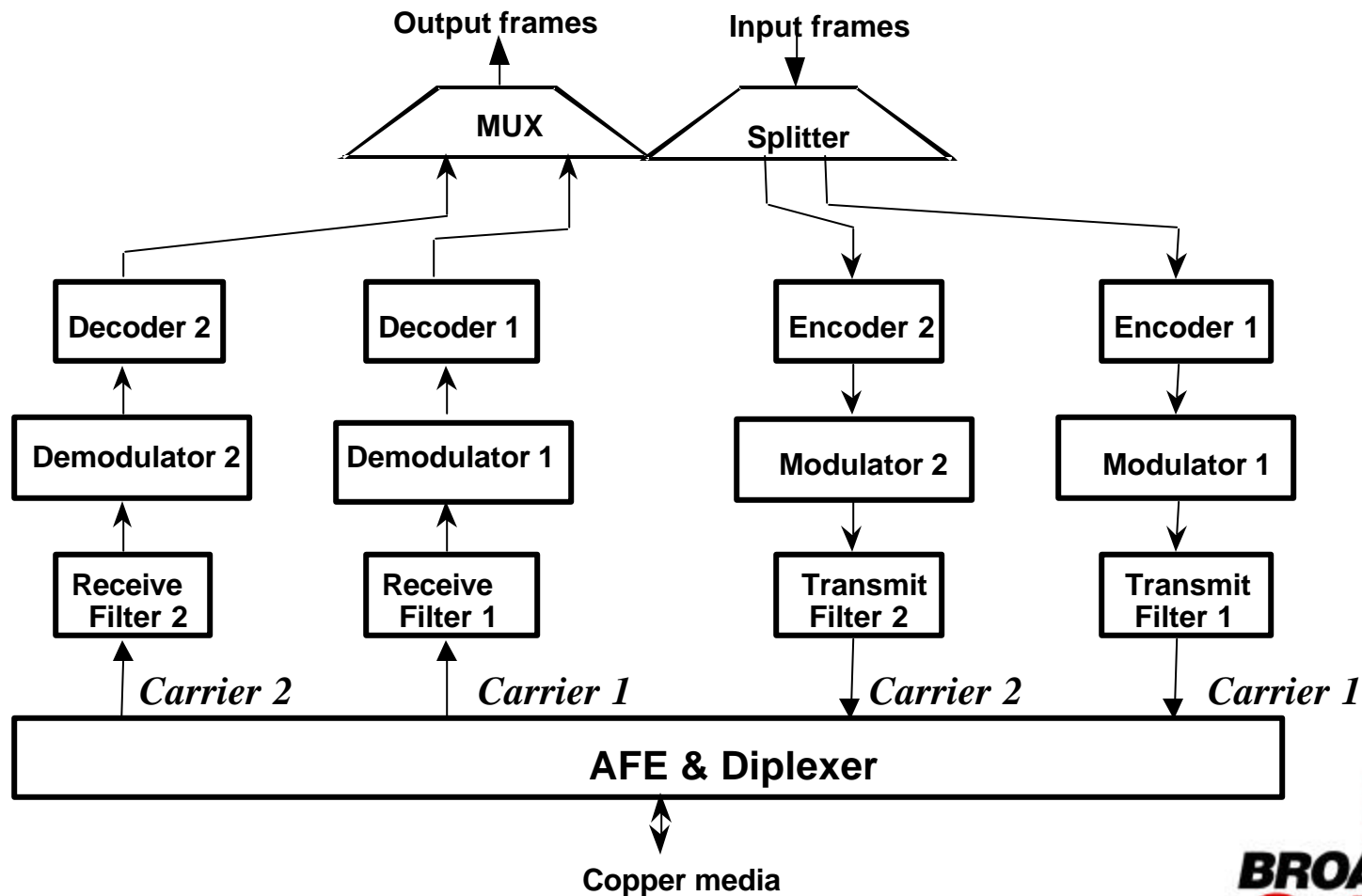
- Flexible parameters:

- center frequency: granularity of 33.75 kHz
- symbol rate: granularity of 67.5 kBaud
- constellation size: 4-256
- transmit filter: notches, PSD shaping (including upstream power back-off)



Basics of the SCM technology

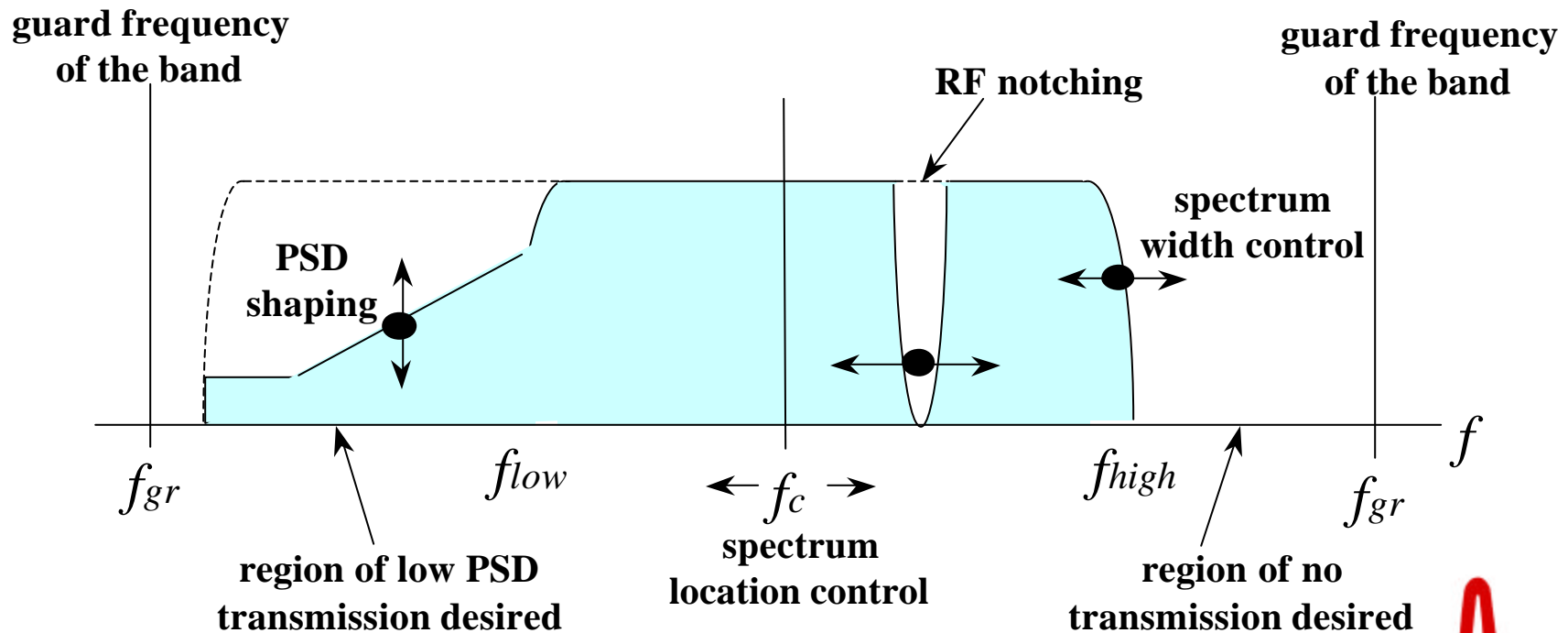
- The basic SCM solution covers a two-band utilization in each transmission direction



Getting spectral compatibility

- **Spectrum management tools:**

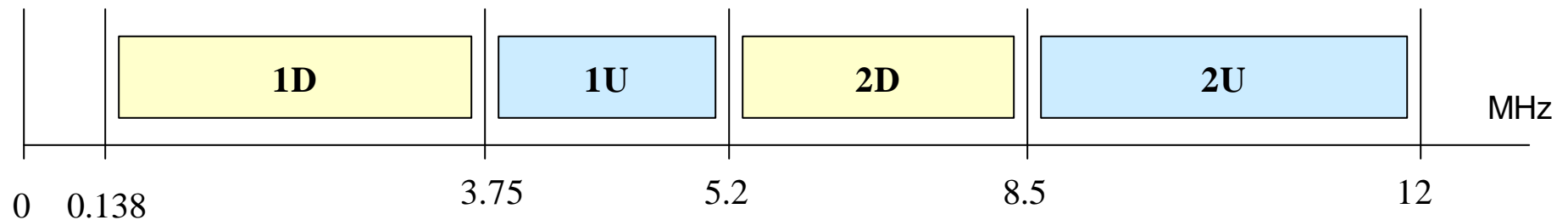
- control of the carriers location
- control of the spectrum width
- shaping the PSD



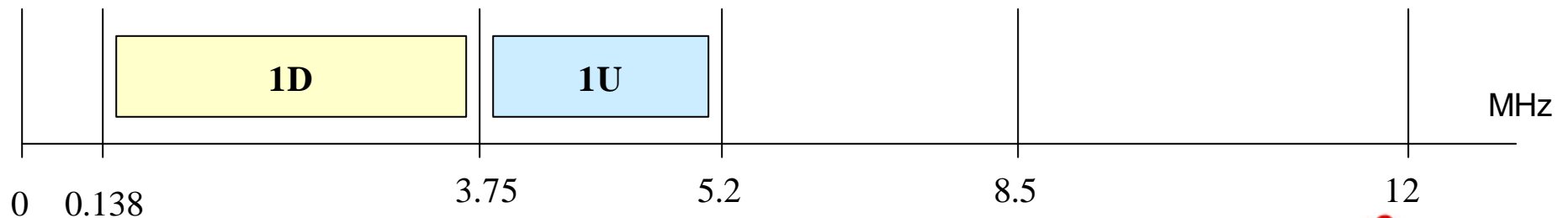
Accommodating of long and short loops (example for 998)

- By re-allocation of carriers and changing constellation

Short loops: < 2.5 kft @ 26 AWG



Short-Medium loops: 2.5 - 3.5 kft @ 26 AWG

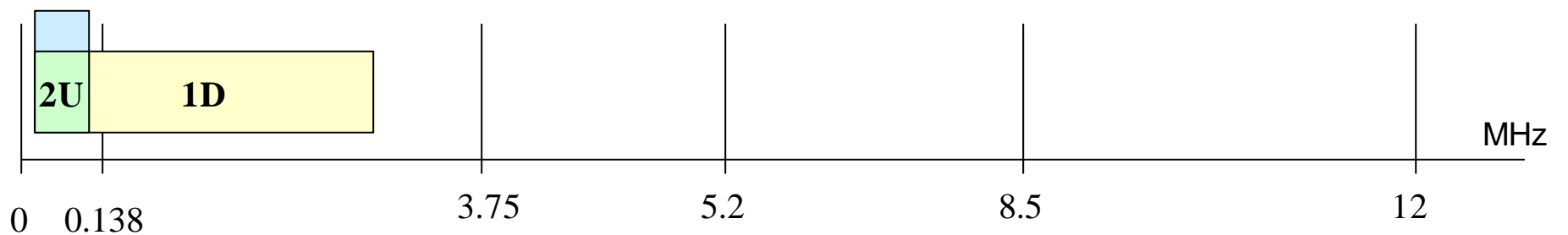


Accommodating of long and short loops (example for 998)

Medium-Long loops: 3.5 - 15 kft @ 26 AWG

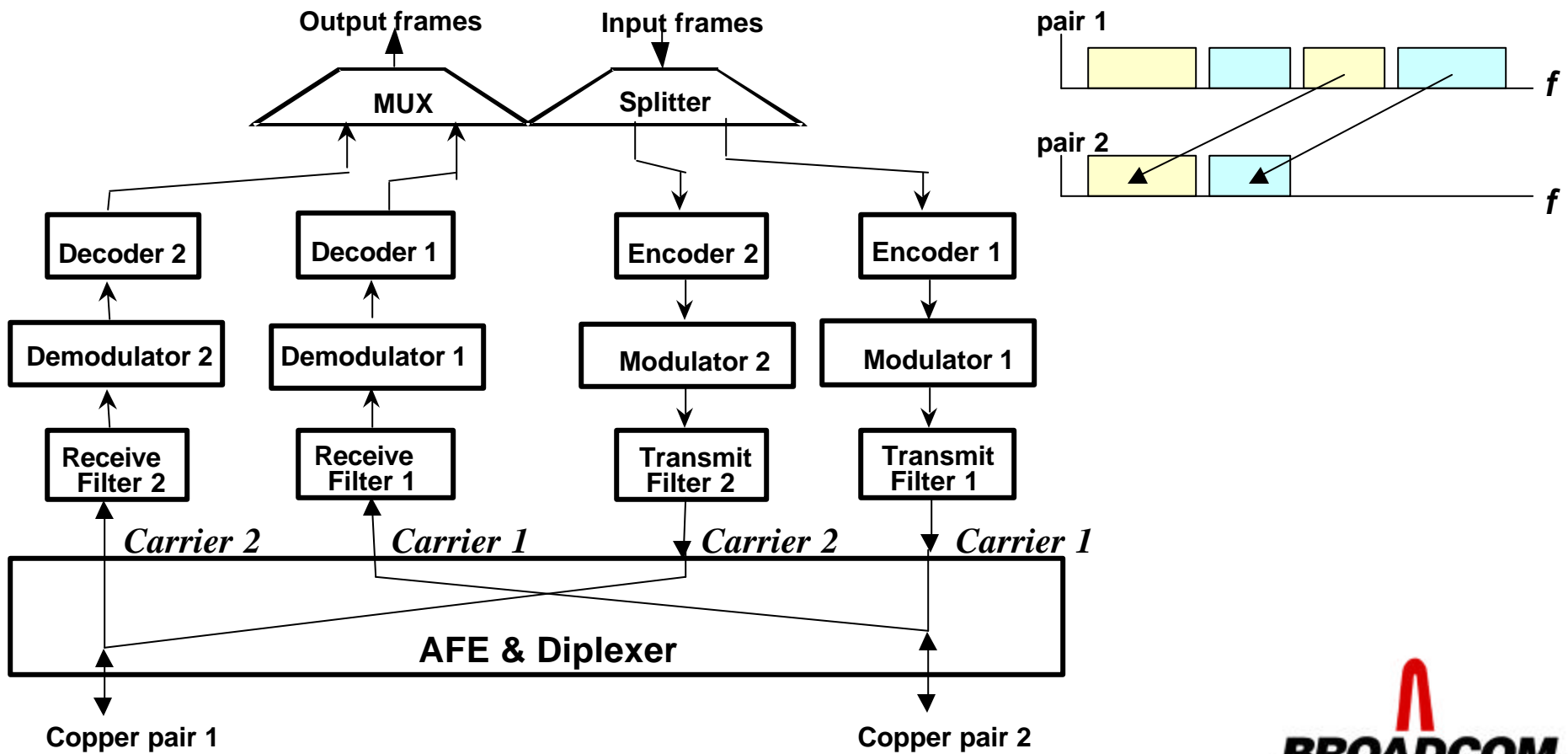


Long and very long loops - turning to TDD burst mode



A free 2-pair operation

- A simple re-configuration of the AFE provides 2-pair operation on the PMD sublayer



Dual mode operation

- **SCM technology, primarily intended for FDD, allows accommodation of Agile TDD by insignificant changes. The latter include introduction of a super-frame containing several standard FDD transmission frames and some changes in filters (for more details see stanley_2.pdf, Raleigh)**



Special performance features

- **High utilization of the SNR** - SNR integration over the whole band results in almost no SNR loss even with constellation size ≤ 8
- **High immunity to the impulse noise** - QAM symbols are short and erasures don't propagate over too long
- **Narrow-band notch filters** - prevent RFI egress and protect of RFI ingress
- **Flexibility of spectrum allocation and shaping** - makes SCM robust in different line conditions and noise environments
- **The pass-band nature of SCM** - simplifies line sharing with narrow-band services (POTS, BR-ISDN)
- **Blind equalization** - provides quick loop acquisition



Low complexity and power consumption

- The complexity of SCM technology follows the complexity of the environment. For basis environment the complexity is very low; for special line conditions additional filtering required. More flexibility may be achieved by adding more elements
- A good balance between complexity and flexibility is the important feature of SCM
- Doesn't require high ADC/DAC resolution due to limited dynamic range of the signal - short way to digital duplexing
- Doesn't require high implementation accuracy to support very high constellations (due to SNR integration)
- Low power consumption is a result of lower complexity and limited dynamic range of the transmit signal



Some more features

- **Well known, mature technology, widely and successfully used in telecommunication industry for symmetric and asymmetric data applications:**
 - voice-band modems
 - cable modems
 - home networks
 - DSL
- **More that 4 years of VDSL field experience and high speed data access (ATM and Ethernet in FTTN/FTTB)**
- **Standardized in ETSI TM6 and T1E1.4 for VDSL applications**
- **Ready to be widely used today**



Conclusion

- It seems to be what we are looking for

