802.3 EFM-Copper

EFM Copper

Market Potential, Technical and Economic Feasibility

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802.3 Objectives & Expanded Definition

- Ethernet over extended distance using copper
- Point to Point
- Results in a new 802.3 standard for Ethernet over copper for longer distances

- Expand Point to Point Copper Objective to include:
  - Full duplex capable
  - No impact on Ethernet MAC
  - Over single pair
  - Over voice grade copper (Category 1, 2, 3)
  - Must reach at least 3,000 feet

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The Market Potential

What is the Market for EFM-Copper (EFMC)?

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First Target Markets – Business and Business Like

- **Hotels**
  - **FTP (Email, Download), Browsing, Conference room Video transmission, 10Mbps Symmetrical or 20/10 Mbps**
- **Hospitals**
  - **Data, JPEG, MPEG4, Entertainment (VoD, MP3, Gaming) – 10Mbps Symmetrical or 20/10Mbps**
- **Campuses**
  - **Multi-building solution, Data and Video telephony – Symmetrical transmission 10Mbps or 100Mbps**

For the Applications above, NO ETSI/ANSI/ITU-T compliance required

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First Target Markets – Business and Business Like

- **Factories**
  - **Same as Campuses but "hard" environment demands (heat, EMI, RFI, etc.) on the shop floor – 10Mbps Symmetrical**
- **Schools**
  - **Data, collaborative groups, Video transmission, chat, FTP, Browsing - 10Mbps Symmetrical or 20/10 Mbps**
- **In Building Data Distribution**
  - **LMDS / MMDS**
  - **Two way satellite**

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Second Target Markets – MDU/MTU

- Urban Residential (25M nodes)
  - Large and mid-size apartment buildings
    - US – City centers and all of Europe, Korea, China, Japan
    - Browsing – 10/3 Mbps, FTP – 20/3 Mbps, Remote office - 10/10 Mbps, Video on Demand as additional channel to broadcast TV – 6 Mbps SDTV, 14 Mbps HDTV (Minimum pipe 8-9 Mbps for SDTV and 20-22Mbps for HDTV), Remote learning – 6/2 Mbps, Gaming – 10/10 Mbps
  - MTU space for office use (4M nodes)
    - Business applications – 10 Mbps Symmetrical & 20/10 Mbps
  - Conclusion: 10/10 Mbps & 20/10 Mbps cover MDU/MTU demands

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Compatibility

How does EFM-Copper fit Ethernet?

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Demands of EFMC solution (1)

- No changes to the MAC
  - New PHY with MII interfaces
  - Add support for RMII and SMII
- Bandwidth
  - 10 Mbps Symmetrical (Full Duplex)
  - 100 Mbps Burst Mode support
    - Lower speed on the line, but MAC compatible
  - 15/10 or 22/10 Mbps Asymmetric as an option

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Demands of EFMC solution (2)

- **Reach (based on figures from various Telcos)**
  - **Business application**
    - **3000 to 4200 feet (1000 to 1400 meters)**
  - **Residential application (non-rural)**
    - **Europe - 2400-3000 feet (800 to 1000 meters)**
    - **US - 3600-4200 feet (1200 to 1400 meters)**
    - **Far East - 3600-4200 feet (1200 to 1400 meters)**
    - **Japan - ?**

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Demands from EFM solution (3)

- Coexistence with ADSL, POTS, Digital Service
  - ADSL already exists at residential sites
  - POTS everywhere
  - Digital Service ISDN, T1/E1/J1, HDSL / SHDSL, Smart-Phones
- Coexistence between symmetric & asymmetric EFMC
- FDD, not TDD
  - TDD is not allowed by the standard bodies (ITU-T, ANSI, ETSI)
  - Has difficulties in bundled environment (e.g. Power back off)
  - Not efficient when coexisting with FDD.

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Demands from EFM solution (4)

- Management
  - Most critical issue – units managed from remote sites
  - Management should be out of band
  - Must have media control
    - Up and down line status & control
    - Provisioning
    - Configuration
    - Reporting

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The Solution

Technology and Economic

Remember – Ethernet is Symmetrical 10 / 100 / 1000

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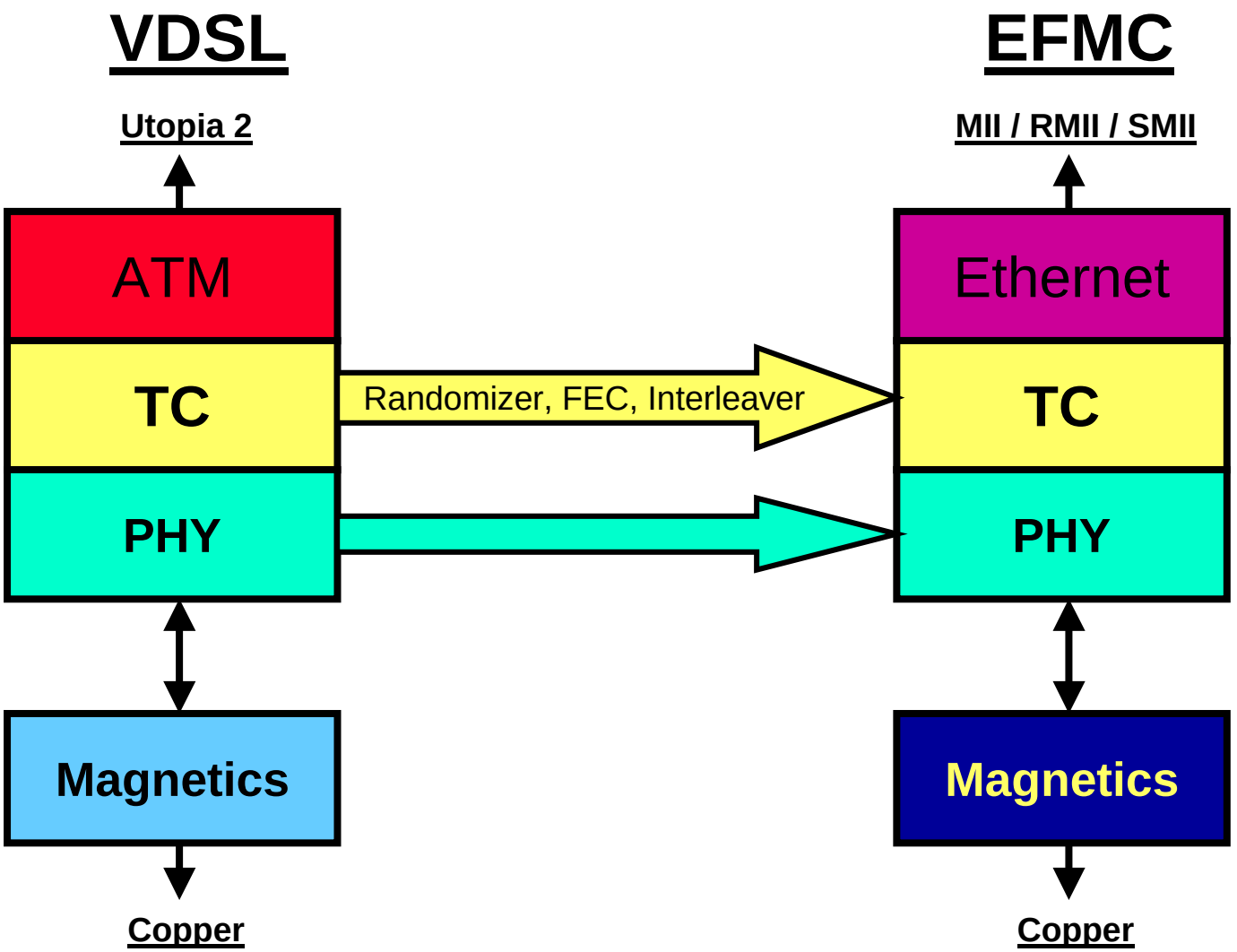
The EFMC solution – Ethernet over *VDSL!!!*



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Why VDSL technology?

- Based on extensive standard work
- All legacy xDSL technologies problems were fixed
- Mature technology
  - Tested by most of the leading Telcos
  - Systems, based on the technology, are under test
- Has a potential to be the lowest cost solution
  - Sharing the investments in ATM VDSL

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What We need to Do for “EFM-Copper?”

- Definition of data rates and structure suitable for EFM
  - Using VDSL PHY layer
  - Using VDSL TC layer (Randomize, Forward Error Correction, Interleaver)
  - Using the “slow” channel and removing the “fast”
- Definition of spectrum over the wire
  - Resolution 998 does not fit the requirements
  - We need spectrum that fits better to symmetrical 10 Mbps and HDTV Downstream 22/10.

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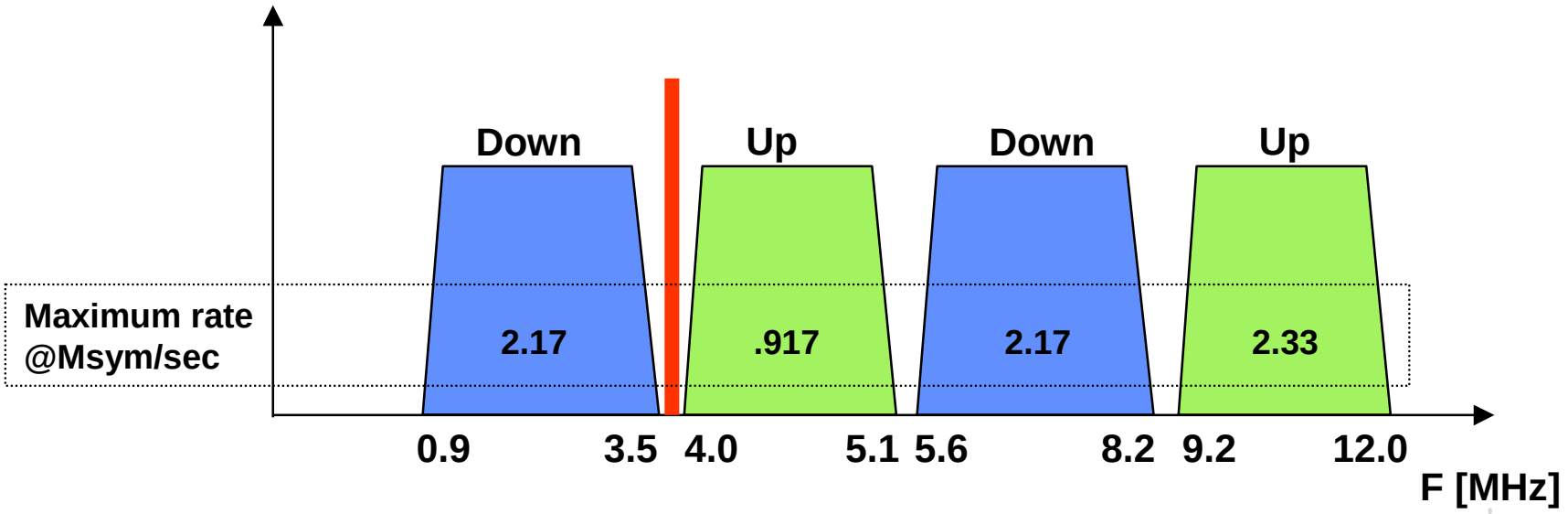
VDSL Plan 998 (ANSI and ETSI)



This band allocation was optimized for 26/3 & 6/6 Mbps, and was designed for an asymmetric application

This band allocation does not fit Ethernet (10/10 Mbps)!!!

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Spectrum & Performance Analysis - 998

	0.5mm US cable (TP2)									
Band Name	Frequency Band	Gross Line Rate	Constellation	Reach A (ft)	Reach B (ft)	Reach C (ft)	Reach D (ft)	Reach E (ft	Reach F (ft)	Reach N (ft)
UpStream 1	4 - 4.84 MHz	2.8 Mbps	16QAM	3849	3849	2603	3445	3645	2485	3866
		3.5 Mbps	32QAM	3170	3170	2215	2884	3028	2112	3180
		4.2 Mbps	64QAM	2039	2039	1700	1981	2015	1635	2040
Upstream 2	9.1 - 12 MHz	4.8 Mbps	QPSK	2746	2746	2375	2391	2551	2289	2784
		7.2 Mbps	8QAM	2117	2117	1908	1922	2018	1853	2134
Downstream 1	0.9 - 3.48 MHz	12.9 Mbps	64QAM	4670	4706	1990	2662	3722	1749	5098
		15.05 Mbps	128QAM	3908	4008	1541	1506	2368	1285	4351
		17.2 Mbps	256QAM	2712	2930	1090	837	1359	848	3140
Downstream 2	5.5 - 8.1 MHz	4.33 Mbps	QPSK	3522	3522	2823	3262	3445	2726	3653
		6.5 Mbps	8QAM	3153	3153	2477	2915	3082	2385	3274
		8.67 MHz	16QAM	2554	2554	2064	2402	2511	1990	2624
		10.83 MHz	32QAM	1613	1613	1473	1585	1666	1439	1623

Note: Includes 6db Margin, 23 FEXT

Type “A” model (Cabinet) is intended to represent a mixed scenario including full rate ADSL where the VDSL system under test is placed in a distribution cable (up to tens of wire pairs) that is filled with many other transmission systems deployed from the exchange (FTTCab). The considered alien disturbers are: 10 ADSLs, 16 ISDN-BA, 4 HDSL, 2T1.

Type”N” model is intended to represent no other DSL types in the bundle (e.g. only VDSL in the bundle).

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Spectrum Allocation – Guidelines for EFMC

- Use of Two bands for 10/10 and 15/10
  - For most of the users this is the maximum needed
  - Two bands are always less expensive versus 3 or more
    - Filters cost
    - DSP Capabilities
- 3rd band for additional downstream bandwidth, if necessary (HDTV)
- Avoid using other DSL spectrum
  - ADSL - 0.138Mhz – 0.9Mhz
  - HDSL, SHDSL, Smart-Phones

Select the band allocation with maximum performance and minimum cost

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Summary & Recommendations

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Summary (1)

- There is a broad market potential for Ethernet over single pair Copper
- The market window is already open
- Infineon already seeing high market potential demand for MTU/MDU/Hospitality and campus

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Summary (2)

- No changes to 802.3 Full Duplex MAC
- Use of VDSL technology as a starting point
- EFMC bandwidth:
  - Symmetrical 10 Mbps,
  - Asymmetrical 15 / 10 Mbps & 22 / 10 Mbps
- Use optimal band allocation for the solution
  - 2 bands (10/10 Mbps & 15/10 Mbps) and 3 bands (22/10)
- Reach distance is 3,500 ft or more

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Recommendations

- Adopt VDSL TC & PHY as EFMC TC & PHY
- Create WG for:
  - EFMC data rates
  - EFMC band allocation optimized for the decided data rates
  - EFMC data structure
  - Transparent Media requirements
  - OAMP access to the circuit for management, etc.

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