The copper baseline: What, how and why

EFM May, 2002

Hugh Barrass (Cisco Systems),
On behalf of IEEE 802.3ah copper sub task force
Reviewed by...

- Dong Wei, SBC
- Michael Beck, Alcatel
- Behrooz Rezvani, Ikanos
- Howard Frazier, Dominet
- Barry O’Mahony, Intel
- Vladimir Oksman, Broadcom
- Krista Jacobsen, TI
- Amir Leshem, Metalink
- Peter Linder, Ericsson
- Steven Haas, Infineon
- ... and many Cisco people
Summary

- During the March meeting the copper sub task force adopted a baseline
  - 4 baseline presentations
  - Ethernet over VDSL with loop aggregation
- Main task force did not ratify the choice of the copper track
  - Confusion reigned (& still reigns)
  - Abstentions gained majority of votes
- This presentation will cover:
  - What the copper track has adopted
  - How this fits in with EFM
  - Why the choice was made
The Copper Objectives

- PHY for single pair non-loaded voice grade copper distance $\geq 750\text{m}$ and speed $\geq 10\text{Mbps}$ full-duplex
- Include a specification for combined operation on multiple copper pairs
- The point to point copper PHY shall recognize spectrum management restrictions imposed by operation in public access networks, including:
  - Recommendations from NRIC-V (USA)
  - ANSI T1.417-2001 (for frequencies up to 1.1MHz)
  - Frequency plans approved by ITU-T SG15/Q4, T1E1.4 and ETSI/TM6
Copper: Baseline

- Ethernet over VDSL
  - Re-use T1E1.4 VDSL, T1.424 – keeps alpha/beta i/f
  - Re-use ITU-T SG15/Q4, G.993 – keeps gamma i/f
  - Add MAC-PHY, Loop aggregation & PMD control
VDSL defined by ANSI T1E1.4 and ETSI TM6

EFMCu baseline references T1E1.4

There are 2 types of devices:

VTU-O: The master device, LT, located in the switch/line card

VTU-R: The slave device, RT, located in customer’s premises (such as a NIC or CPE)

Splitter allows the loop to be shared with POTS or BR-ISDN
EFM and Standards

EFM defines “a point in DSL space”

ITU-T SG15/Q4

EFM = subset of VDSL

Lower levels specified by T1E1 (& ETSI)

g.993

QAM vs DMT choice

MII to gamma adaptation

QAM

DMT

EFM PHY

VDSL

ANSI T1E1.4

ETSI TM6

IEEE802.3ah EFM
May 2002
Baseline components

- VDSL main part – references T1E1.4 and ITU SG15/Q4
  - Covers all of PMD, PMA & half of PCS layers
  - Some simplification (fewer options)
- MAC-PHY rate matching
- Loop aggregation
- PMD control
  - Includes some of MIB function
- Set of presentations from March
  - fosmark_1_03_02.pdf, marris_1_0302.pdf, simon_1_0302.pdf, rezvani_1_0302.pdf (with notes)
What is done…

• Almost all of PMA, PMD from T1.424
  > 5 years of work
  Some small refinement still ongoing
• PCS – TPS-TC sub-layer from g.993.1
• MAC PHY rate matching – fully defined
• Loop aggregation – main functionality
  Still some discussion
• Basic principles of PMD control
  Refers to g.994, g.997, RFC 2026 – interface to Ethernet MIB
What is to do…

• Choose line code
  QAM or DMT both fully specified in t1.424
  Silicon available for evaluation

• Some discussion ongoing
  Encapsulation, dual latency, power back off
  Loop aggregation – startup and failover

• Acceptance and test criteria
  How to prove baseline meets the objective
  Also will become conformance criteria

• MIB and OAM
  Details of objects, mechanisms and transport
  How to define bandplans and profiles
Bandplan background

- Some bandplans must be supported (e.g. 998, 997)
- Possibility of defining new bandplan (better for symmetric)
  - For private, or choice for regional regulators
- Use of “band 0” (crowded region)
  - How much must be specified in EFM (or refer to spectral regulations)
- How to specify in standard?
  - Flexible support required – or annex for each plan?
Flexibility

- Flexibility is both a solution and a problem!
  - The ability to solve multiple solutions
  - A headache for interoperability
- We will be required to support multiple bandplans
  - The standard will have to allow flexibility
  - One system may support a single bandplan or many
- We will be required to support many installation scenarios
  - VDSL has flexibility to support very high bit rates
    - > 50Mbps for short reach, clean wiring
  - VDSL may also support longer reach
    - > 6kft at low bit rates (with use of band 0)
- We will need to define profiles and control mechanisms
  - Plug and play must be supported – universal startup (g.994?)
  - This is new to Ethernet!
How does EFMCu fit in .3ah?

- Why 1 copper PHY amongst many optical?
- Why VDSL and not other DSL?
- We need to go back to “EFM basics”

Items presented and discussed in study group
EFM – why we love it

• Ethernet in the First Mile means bringing Ethernet home

  High bandwidth, simple networking, ubiquitous interfaces

  We all dream of Fibre to every home
Optical pipe dream: how do we get there?

• Fibre to every home needs massive investment
  
  Reasonable for greenfield sites
  
  Full coverage requires proof of return on investment (and revenue stream)

• More fibre buildout = better
  
  The closer fibre gets to the user, the better the service
  
  Steps closer to all fibre architecture
Step by step

- Stepwise approach bridges the optical gap
  - Caters for differences in geography
  - Demand varying according to infrastructure architecture, economic cycle, local competition, regulatory peculiarities
  - Early deployments act as proving ground for service

- Some areas (regions, countries etc.) deploy earlier
  - Fibre to the building – copper in-building
  - Fibre to the curb – copper last (1/2) mile

- Some areas (regions, countries etc.) non-homogenous
  - Copper for short loops – early adopters (easy geography)
  - Fibre buildout follows
High bandwidth connections enable services
- Data, voice, video
- Next gen applications
- Premium services = premium revenues

Bottom line: Copper needed now to enable future fibre
What sort of copper solution?

- EFM is about next generation, high speed architectures

  Copper solution should fit in with that
  Minimum 10Mbps – higher if possible
  High d/s bandwidth for entertainment – client/server
  For stepwise buildout to work, EFMCu must support NG applications

Pt-pt GigE or 100Mbps

Shared Gig ~ 1000/32 Mbps

EFMCu – 10Mbps and up
What about other applications?

- VDSL clearly meets the needs of EFM, but there are other DSL applications – particularly longer reach
  
  Service from RT or CO – distances >= 12kft

- Problem with Physics…
  
  Longer distances mean lower bit rates
  Lower speed PHYs don’t fit with EFM
  Reduced services, no promotion of fiber buildout

- Does not fit within EFM
  
  How is it handled elsewhere?
We are not alone…

• All networking good – Ethernet networking better!
  
  **Always support Ethernet everywhere!**
  
• More Ethernet over xDSL possible – outside EFM
  
  **Use ITU framework (g.993/4/5)**
  
  **Other body reuses EFM work – or new PAR for new TF**
  
• Maximize common ground
  
  **Liaise, liaise, liaise!**
  
  **Other standards will (probably) follow later**
Liaisons

- Two main (copper) liaisons
  T1E1.4
  ITU-T SG15/Q4
- Indirect liaisons
  ETSI TM6 and FSAN, FS-VDSL
  Liaise through other groups and common membership
- Industry consortia
  EFM Alliance – formed for 802.3ah
  DSL Forum – covers all DSL (including EFMCu!)
• All EFM-Cu baselines reference T1 VDSL trial use std.
  Some simplifications (less flexibility)
  Possibility of minor changes (none known yet)
  Close liaison with T1E1.4 to maintain compatibility
• Group demarcation
  EFM is short-lived body, focus on high rate (short reach) application
  T1E1.4 has long term view, look at generic xDSL – including “unified PHY”
  EFM will define a point solution, T1E1.4 remains owner of voice grade copper application space
ITU-T SG15/Q4

• All EFM-Cu baselines include Gamma interface
  - Compatibility with G.993.1 maintained
  - Possible modifications to TPS-TC for Ethernet
  - Other “Ethernet over” devices could reuse .3ah definitions
  - Close liaison with SG15/Q4 vital

• Loop aggregation
  - Relation with g.bond to be defined – expected to be orthogonal
  - Ethernet aggregation may be re-used by any G.995 PHY

• More liaison
  - EFM codepoints to be defined for G.994
  - EFM management relation to G.997
In conclusion…

• EFM needs copper track for complete story
• High speed (>= 10Mbps) copper objective is necessary – copper track has chosen VDSL
• EFM copper standard should maximize compatibility to allow reuse for non-EFM standards
• EFM Copper!
EoVDSL – the copper baseline

• Questions?
Motion to adopt (2nd half)

- Adopt presentation rezvani_1_0302.pdf (with addition of comments document, “notes_to_editor_1_0302.doc”, with the exception of note 13) as the basis of the first draft
The Copperheads march on…

- Spare slides
The approved PAR authorizes the EFM Task Force to specify these layers.

“Minimal changes” are allowed here if necessary.
**Architectural layers (ITU & T1E1 view)**

Above the scope of ITU – adaptation layer to be defined by EFM

- **γ-C interface**: Defined by ITU (g.993.1)
- **α interface**: U-C interface

Packet Entity:
- PTM-TC
- PMS-TC
- PMD

Packet Entity:
- PTM-TC
- PMS-TC
- PMD

- **γ-R interface**: Defined by T1E1 (T1.424)

- **β interface**: U-R interface

voice grade Cu

IEEE802.3ah EFM
May 2002
EFMCu Architecture

MAC Control

MAC – Media Access Control

Reconciliation

MII →

Ethernet-over-VDSL

PCS →

PTM-TC

PMA →

PMS-TC

PMD →

PMD

MDI →

voice grade Cu

Unchanged by EFMCu

New work added here

From existing VDSL standards