Accelerating copper up to a Gigabit in the Broadband Forum

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Broadband Forum

Engineering smarter & faster connections

Architecting a connected lifestyle

- Defining best practices for global networks
- Enabling multi-service and content delivery
- Establishing technology migration strategies
- Engineering critical device & service management tools
- Redefining Broadband

● Who are we?

- Industry consortium made up of approximately 170 service providers, vendors, consultants, academia and test labs
- Predominant broadband industry forum since **1991**
- Engineer technology solutions to help service providers achieve standards based, economical and effective broadband deployments

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BBF work to accelerate access speeds

- VDSL2 and Bonding

- Vectored VDSL2

- G.fast

- FTTdp

- BBF also addresses Fiber PON certification

VDSL2 and Bonding

- ITU-T G.993.2 specifies VDSL2
- ITU-T G.998 specifies Bonding of multiple lines
- BBF develops testing specifications:
  - TR114: performance
  - TR115: functionality
  - TR138: accuracy
  - TR273: bonding
  - TR286: testing of line diagnostics in modems
- BBF facilitates interoperability with plugfests for VDSL2 and bonding
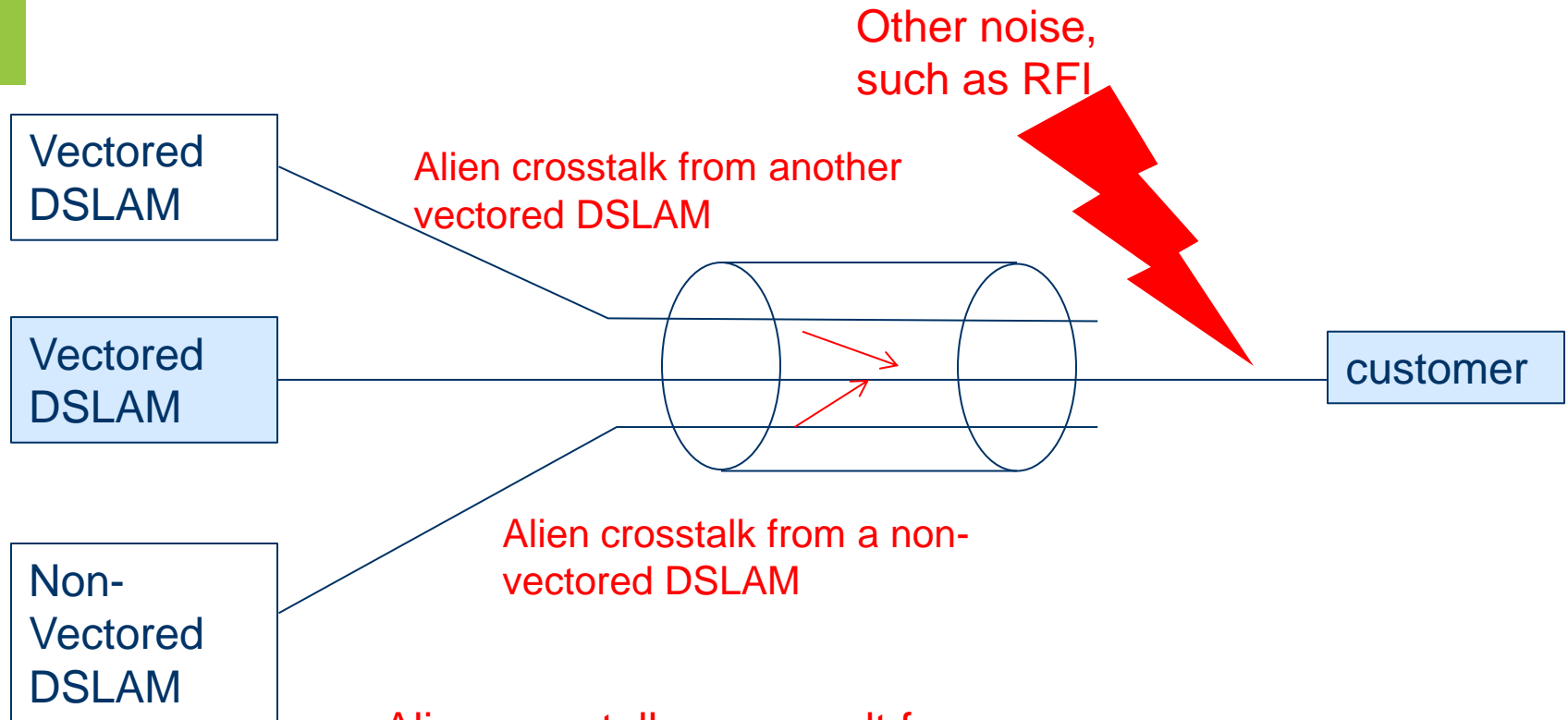- Testing performed at BBF Approved Testing Laboratories (ATLs)

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VDSL2 vectoring overview

- Specified by ITU-T G.993.5
- **Why is vectoring so important?**
  - Far-end crosstalk (FEXT) is usually the most significant VDSL2 impairment, vectoring effectively removes the FEXT
  - Vectoring pre-codes the transmitted signal to counteract the effects of crosstalk from other lines in the same vectored group
  - Vectoring does not address crosstalk from lines outside the vectored group and other types of noise such as RFI
- **What can you achieve with VDSL2 vectoring?**
  - **Aggregate bit-rates up to 200 Mb/s with vectored VDSL2**
  - **Up to 400 Mb/s with bonding and vectoring**

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BBF work on Vectored VDSL2

- [MR-257i2](#): Overview of Vectoring
- Vectored VDSL2 plugfests held at recognized independent test labs
- Oct 2013: Hosted first multi-vendor public demonstration of VDSL2 Vectoring
- *New!* TR-320: Techniques to Mitigate Uncancelled Crosstalk on Vectored VDSL2
- TR-249: performance testing of vectored VDSL2

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Most of the vectoring gain can be lost if there is out-of-domain noise

Vectored DSLAM

Vectored DSLAM

Non-Vectored DSLAM

Alien crosstalk from another vectored DSLAM

Other noise, such as RFI

customer

Alien crosstalk from a non-vectored DSLAM

Alien crosstalk may result from:
-Sub-loop unbundling (multiple SP in the same cable)
-One SP connecting more than one DSLAM to a cable
-Not cancelling the crosstalk from some lines in a DSLAM

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Addressing degradation of vectoring performance

- **There is no guarantee that full vectoring performance can be restored but here are performance improvement techniques**
    - Measure alien noise to diagnose trouble
    - Advanced VDSL2 coding and re-transmission
    - Avoid inside wire, place modem at entry to house
    - Receiver-based noise cancellation
    - Condition cable or reassign cable pairs *
    - Firmware upgrade legacy VDSL2 modems to be "vectoring friendly" (allowing vectoring engine to cancel crosstalk from the legacy VDSL2 lines) *
    - Dynamic Spectrum Management (DSM) *

    * techniques for mitigating alien VDSL2 crosstalk

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Alien crosstalk mitigation - Dynamic Spectrum Management (DSM)

- To enable vectored lines to achieve a significantly higher proportion of their theoretical performance, DSM can reduce the crosstalk from non-vectored lines by reducing the transmit power in various ways
  - However, doing this can lead to some degradation of the performance of the non-vectored lines
- DSM techniques that can help against alien noise are:
  - Limit bit-rates
  - Adjust vector processing priority
  - Reduce crosstalk by reducing excess margin
  - Adjust transmitted power spectral density (PSD) – i.e. legacy lines could reduce power at higher frequencies
- To achieve the benefits for vectoring, DSM has to be applied to the non-vectored lines, which may not be operated by the same service provider and who may have no incentive to apply DSM for this purpose

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BBF G.fast testing program

- G.fast is specified in ITU-T G.9700/9701, providing up to 1 Gb/s on short copper lines
- BBF Plugfests help vendors identify interoperability issues
  – Performance testing with specified loops and noise
  – Functional testing, may include reverse power feeding, vectoring, retransmission, PHY management
- Testing performed at BBF approved test labs

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FTTdp (Fiber to the distribution point)

One FTTdp architecture benefit is that the DPU equipment typically serves 8-20 lines, making it small enough to place on a pole, in a hand-hole or in a small pedestal

Central office   HON   DPU

DPU backhaul options:
-G-PON, XG-PON1
-EPON, 10GEPON
-Point-to-Point fiber
-bonded VDSL2 copper

Copper drop options:
-G.fast *
-VDSL2
-Vectored VDSL2
-IEEE 802.3 BASE-T

*may include reverse power feed from RG to DPU

HON: Higher order node, such as G-PON OLT
DPU: Distribution point unit
RG: Residential gateway

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BBF FTTdp/G.fast project

- BBF has four groups working on the FTTdp/G.fast Project
  - Fiber Access Network
  - Metallic Transmission
  - End to End architecture
  - Operations & NM
- BBF WT-301: Fiber to the Distribution Point
  - Specifies architecture for FTTdp for various deployment models:
    - Outdoor DPU serving multiple homes
    - Indoor unit for MDUs
    - Single-line, fiber-to-copper unit
    - Reverse power feed (DPU powered via current from RG)
  - Addresses the following contexts:
    - TR-156 G-PON from HON to DPU (managed by OMCI)
    - TR-167, DPU is dual managed (OMCI and IP)
    - TR-101 Point-to-Point Ethernet from HON to DPU
    - TR-200 EPON from HON to DPU
    - TR-178/145 multiservice and logical unbundling

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Additional FTTdp deliverables expected

- BBF WT-318 "Management Architecture & Requirements for FTTdp"
  - addresses management of FTTdp, including the PME (persistent management entity), and use of OMCI and SNMP.
  - Zero touch OAM: service provisioned without dispatching a technician
  - FTTdp management must address various backhaul and drop technologies.

Copper related work

- BBF SD-285 "Copper Transmission Models for Testing above 30 MHz"
- Will also include updates to TR-114/115
- G.fast performance & functional test plans
- Remote Power Feed test plans
- Plugfests & Private test events at BBF ATLs

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Thank you

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