Converging on an ACT Modulation

Contribution to 802.3dm Task Force

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Introduction

- There were three modulation schemes proposed in the 802.3dm meeting in Hamburg:

Title	Presenter(s)	Affiliation(s)
Proposed Asymmetrical Modulation	William Lo	Axonne
Asymmetric modulation scheme	Ragnar Jonsson	Marvell
Echo in asymmetric duplex system with spreading	Hossein Sedarat	Ethernovia

- While these were clearly different proposals, they had several things in common
- This presentation looks at commonalities between the three presentations and proposes compromise where they differ

What is Common?

- All three consider some form of Asymmetric Concurrent Transmission (ACT)
- All three presentations favor using 802.3ch modulation for the high data rate direction
- All three propose some form of low data rate modulation with frequency spreading

What is different?

- The main difference between the different proposals are related to the low data rate modulation
- The presentations from Ragnar and William proposed different framing scheme
- The presentations from Ragnar and William proposed Differential Manchester Encoding (DME) as possible modulation scheme, while Hossein’s presentation proposed a more general frequency spreading that has DME coding as a special case

Converging on a Proposal

High Level Description

- The proposed ACT modulations support asymmetric data rates with 2.5Gbps, 5Gbps, and 10Gbps in the High Data Rate (HDR) direction and 100Mbps in the Low Data Rate (LDR) direction
- The proposed modulation scheme is based as much as practical on 802.3ch (Clause 149)
- The HDR modulation is the same as defined in 802.3ch (Clause 149)
- The LDR modulation is based on modulation with Frequency Spreading (for example DME)
- The intent is to leverage existing 802.3 standards as much as practical

High Data Rate (HDR) Modulation

- **The HDR modulation is identical to the 802.3ch modulation described in Clause 149**
- The modulation includes the following components:
  - PCS service interface (XGMII) according to Clause 46
  - PCS Transmit function according to Clause 149.3.2.2, including RS-FEC, RS-FEC superframe, round-robin interleaving , Scrambler, Gray Mapping, Selectable Precoder, and PAM4 Mapping
  - PCS Receive function according to Clause 149.3.2.3
  - Test-pattern generators according to Clause 149.3.3
  - Side-stream scrambler polynomials according to Clause 149.3.4
  - PMA training frame according to Clause 149.3.4
- New clauses/text, to reflect asymmetric data rates and coax cables, are needed for
  - Clause 149.3.7 on Detailed functions and state diagrams
  - Clause 149.3.8 on PCS management
  - Clause 149.7 on Link segment characteristics
  - Transmitter power spectral density (PSD) and power level according to Clause 149.5.2.4

Note: Sub-clauses of 149 not listed above need to be reviewed to identify any necessary updates.

Low Data Rate (LDR) Modulation

- The LDR modulation uses frequency spreading modulations
  - This could be based on Differential Manchester Encoding (DME) or other similar scheme with more level transitions per symbol
- The modulation consist of
  - Constant carrier signal
  - The symbol rate is either 117.1875 Mbps (1406.25/12) or 140.625 Mbps (1406.25/10), depending on which FEC frame is chosen
  - Side-stream scrambler polynomials according to Clause 149.3.4
  - PCS uses Reed-Solomon FEC with TBD FEC code, with TBD bits per RS symbol
  - RS-FEC frame consisting of TBD data blocks, TBD OAM bits, and TBD parity bits

Summary

- It is proposed use Asymmetric Concurrent Transmission (ACT) modulation for 802.3dm
- It is proposed use 802.3ch modulations as much as practical for the 802.3dm HDR modulation
- It is proposed to use low line rate (117.1875 Mbps or 140.625 Mbps) with frequency spreading for the LDR modulation
- It is proposed to use Reed-Solomon FEC with TBD bits per RS symbol
- The frequency spreading method needs further discussion, but DME is prime candidate
- The exact Reed-Solomon code and FEC frame structure needs more discussion

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