802.3bz Link Segment Considerations
Waikola, HI
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Summary

- Development of baseline for 802.3bz Link Segments.
  - Within link segment – e.g., IL, RL, etc.
  - Between link segments – Alien
- Proposal for Link Segment specifications in Clause 126.

Supporters

- Ron Nordin, Bob Wagner – Panduit
- Paul Kish – Belden

Contributors

- Ron Tellas, Paul Wachtel – Panduit
- Paul Kish – Belden

802.3bz Objectives

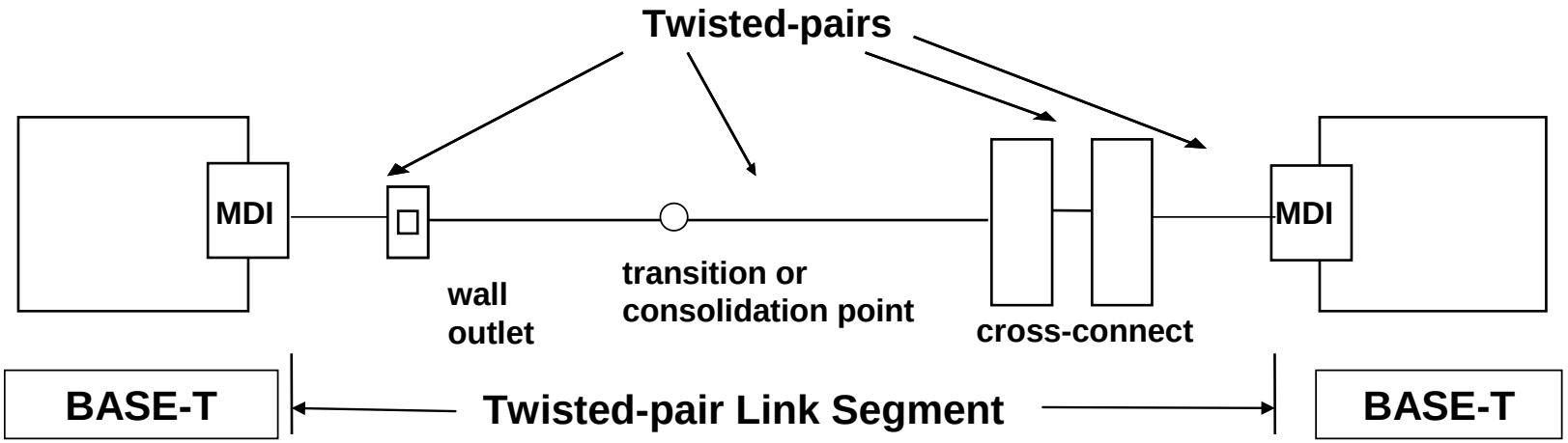
Next Generation Enterprise Access BASE-T PHY Objectives

- Support full duplex operation only
- Preserve the 802.3 / Ethernet frame format utilizing the 802.3 MAC
- Preserve minimum and maximum Frame Size of current 802.3 standard
- Support Auto-Negotiation (Clause 28)
- Support optional Energy Efficient Ethernet (Clause 78)
- Support local area networks using point-to-point links over structured cabling topologies
- Do not preclude meeting FCC and CISPR EMC requirements
- Support PoE (Clause 33)
  - including amendments made by 802.3bt "DTE Power via MDI over 4-Pair Task Force"
- Support MAC data rates of 2.5 Gb/s and 5 Gb/s
- Support a BER better than or equal to 10^{-12} at the MAC/PLS service interface (or the frame loss ratio equivalent)
- Select copper media from ISO/IEC 11801:2002, with any appropriate augmentation to be developed through work of 802.3 in conjunction with ISO/IEC JTC 1/SC 25/WG3 and TIA TR42
- Define a 2.5 Gb/s PHY for operation over
  - Up to at least 100m on four-pair Class D (Cat5e) balanced copper cabling on defined use cases and deployment configurations
- Define a 5 Gb/s PHY for operation over
  - Up to at least 100m on four-pair Class E (Cat6) balanced copper cabling on defined use cases and deployment configurations
  - Up to 100m on four-pair Class D (Cat5e) balanced copper cabling on defined use cases and deployment configurations

IEEE 802.3 NGEABT Objectives approved by IEEE 802.3, March 12, 2015 Berlin, DE 1

IEEE Cabling Topology

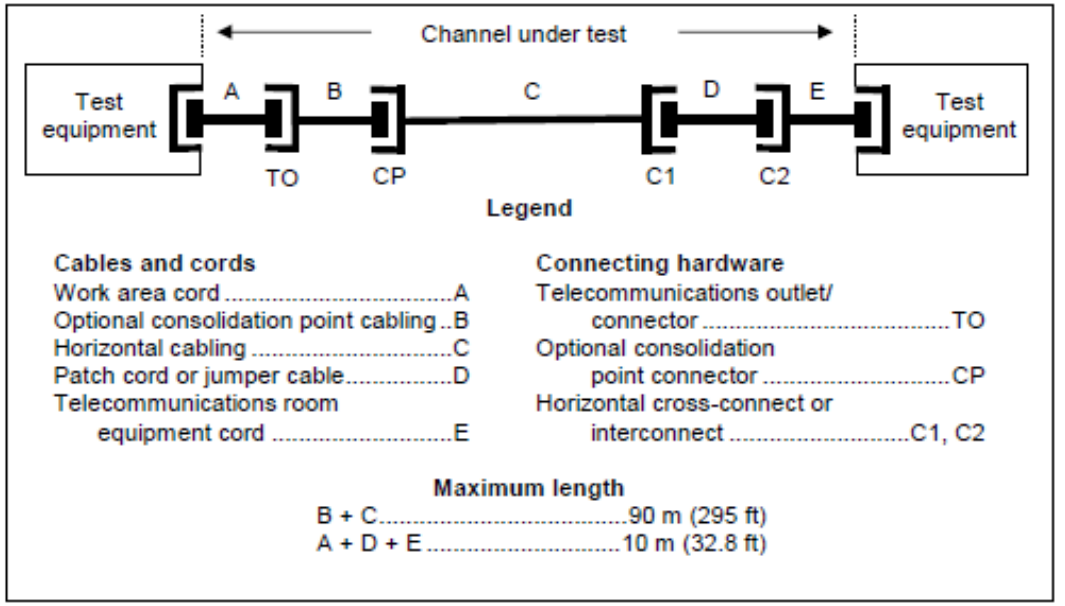
- **IEEE 802.3 Twisted-Pair Link Segment**



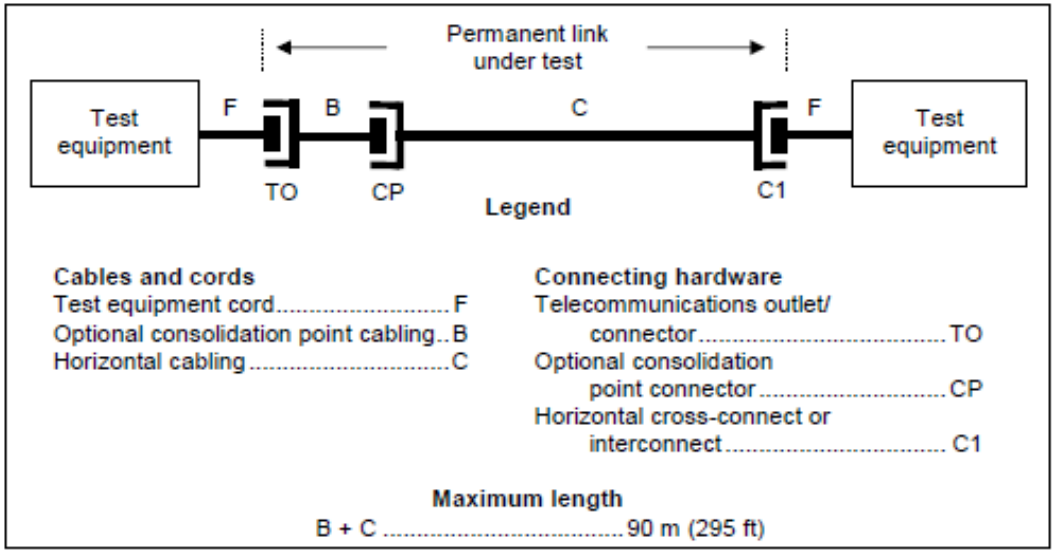
10BASE-T/100BASE-T/1000BASE-T/10GBASE-T

Channel and Permanent Link

•Channel test configuration to emulate IEEE link segments enabling IEEE to reference cabling standards .



•Channel and permanent link transmission requirements developed from cables, cords, and connecting hardware transmission requirements



Deployment configuration objectives

- Define a 2.5 Gb/s PHY for operation over
  - Up to at least 100m on four-pair Class D (Cat5e) balanced copper cabling on defined use cases and deployment configurations
- Define a 5 Gb/s PHY for operation over
  - Up to at least 100m on Class E (Cat6) balanced copper cabling on defined use cases and deployment configurations
  - Up to 100m on Class D (Cat5e) balanced copper cabling on defined use cases and deployment configurations

1) Use cases and deployment configurations for 2.5 Gb/s PHY for operation over
   - Up to at least 100m on four-pair Class D (Cat5e) balanced copper cabling

2) Use cases and deployment configurations for a 5 Gb/s PHY for operation over
   - Up to at least 100m on Class E (Cat6) balanced copper cabling

3) Use cases and deployment configurations for a 5 Gb/s PHY for operation over
   - Up to 100m on Class D (Cat5e) balanced copper cabling

- Use case based deployment configurations not required for PHYs demonstrating operation over “worse case” cabling configurations (4 connector with cable (6x1) tie wrapped every 8”).

1

IEEE P802.3bz™/D0.1 - 8023bz_D0p1.pdf

126.7 Link segment characteristics

2.5G/5GBASE-T is designed to operate over ISO/IEC 11801 Class D 4-pair balanced cabling that meets the additional requirements specified in this subclause. Each of the 2.5GBASE-T four pairs supports an effective data rate of 626 Mb/s in each direction simultaneously. Each of the 5GBASE-T four pairs supports an effective data rate of 1626 Mb/s in each direction simultaneously. The term "link segment" used in this clause refers to four twisted-pairs operating in full duplex. Specifications for a link segment apply equally to each of the four twisted-pairs. All implementations of the balanced cabling link segment specification shall be compatible at the MDI. It is recommended that the guidelines in TIA TSB-XX, ISO/IEC TR X, ANSI/TIA-568-C.2, and ISO/IEC 11801:2002/Amendment 1 be considered before the installation of 2.5/5GBASE-T equipment for any cabling system.

126.7.1 Cabling system characteristics

2.5/5GBASE-T requires 4 pair Class D cabling with a nominal impedance of 100 Ω, as specified in ISO/IEC 11801:2002. Operation on other classes of cabling may be supported if the link segment meets the requirements of 126.7.

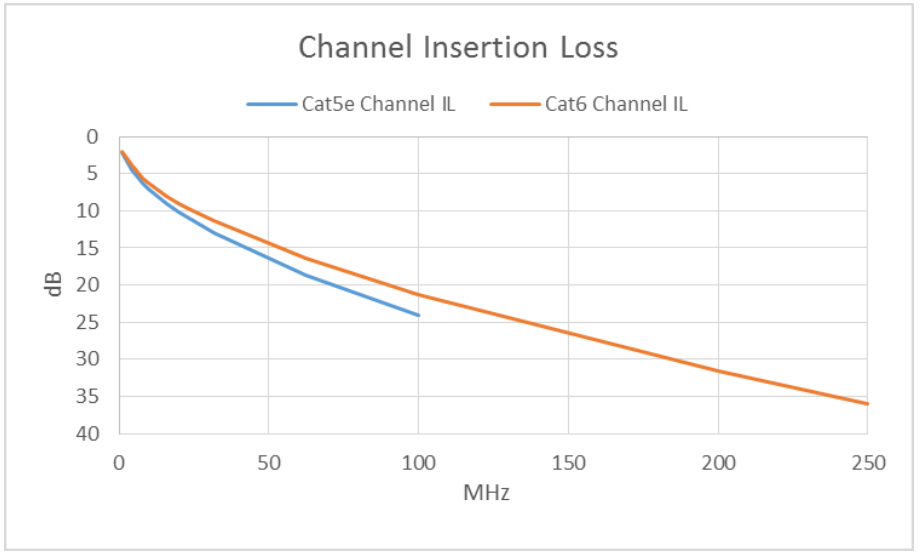
Additionally:

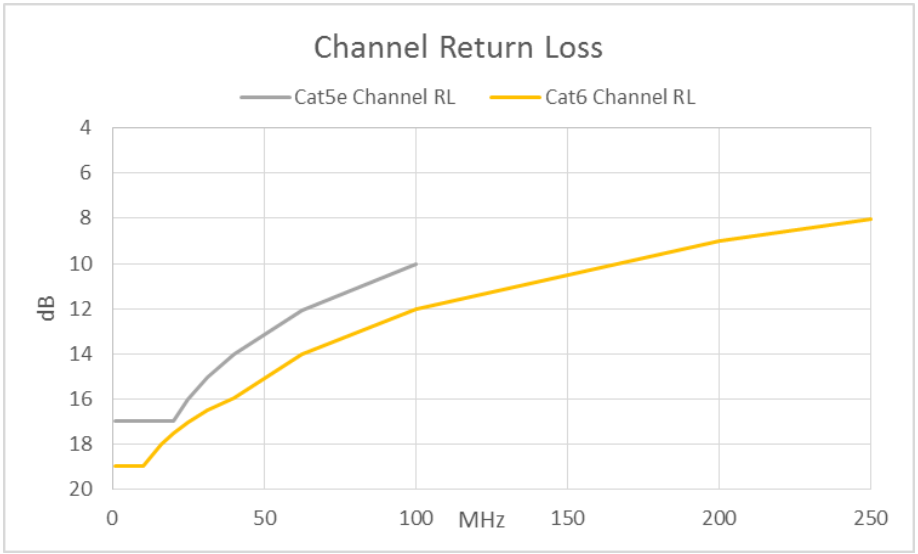
a) 2.5GBASE-T is an ISO/IEC 11801-2002 Class D application, with additional installation requirements and transmission parameters specified in this clause.

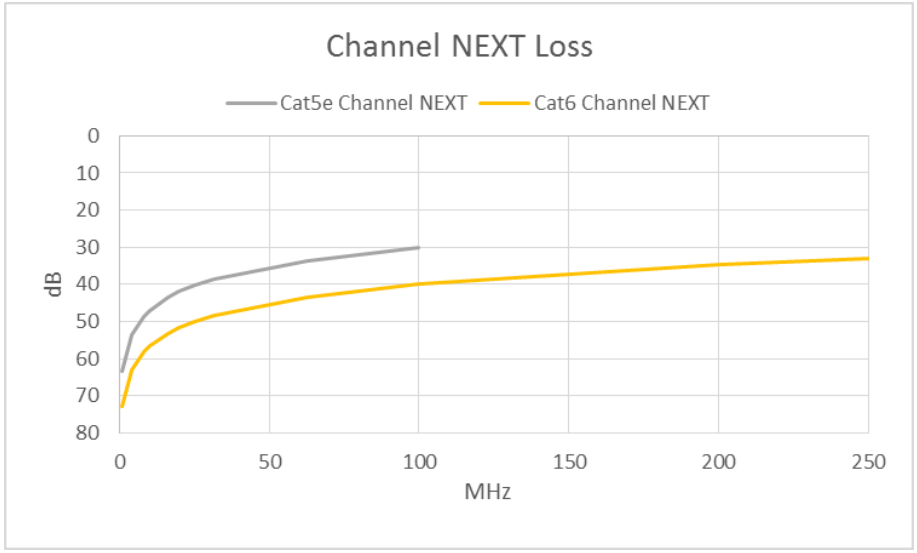
b) 5GBASE-T is an ISO/IEC 11801-2002 Class D application, with additional installation requirements and transmission parameters specified in this clause, including extended frequency performance beyond that specified for Class D Channels.

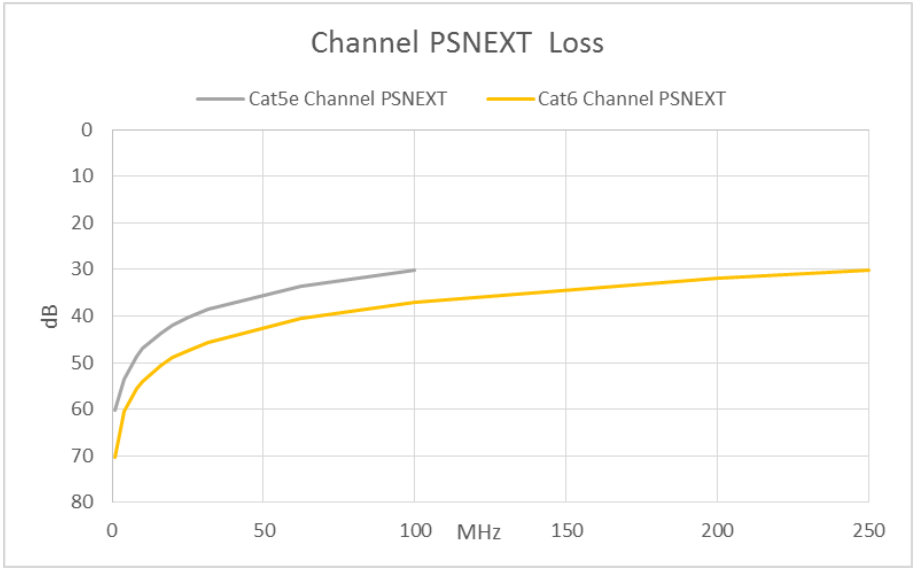
c) The use of shielding is outside the scope of this specification.

Category 5e and Category 6 Cabling

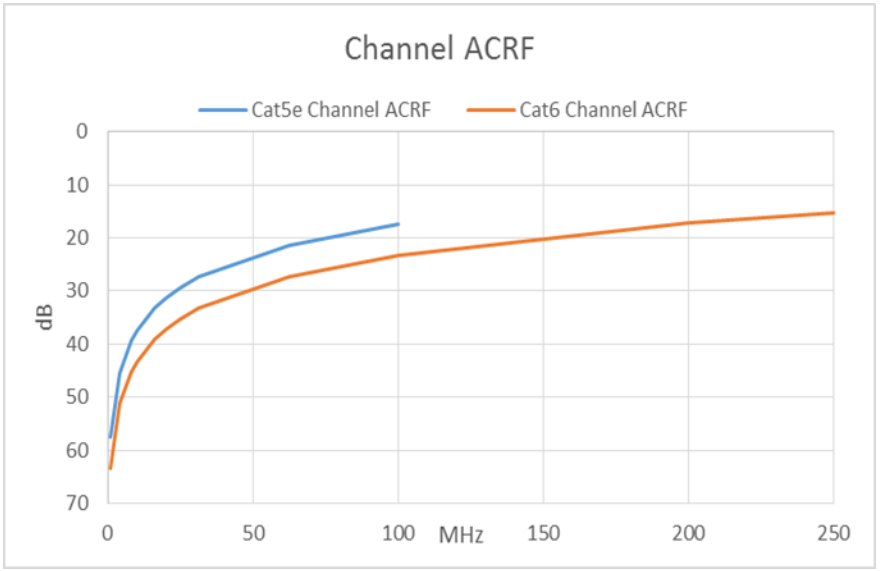


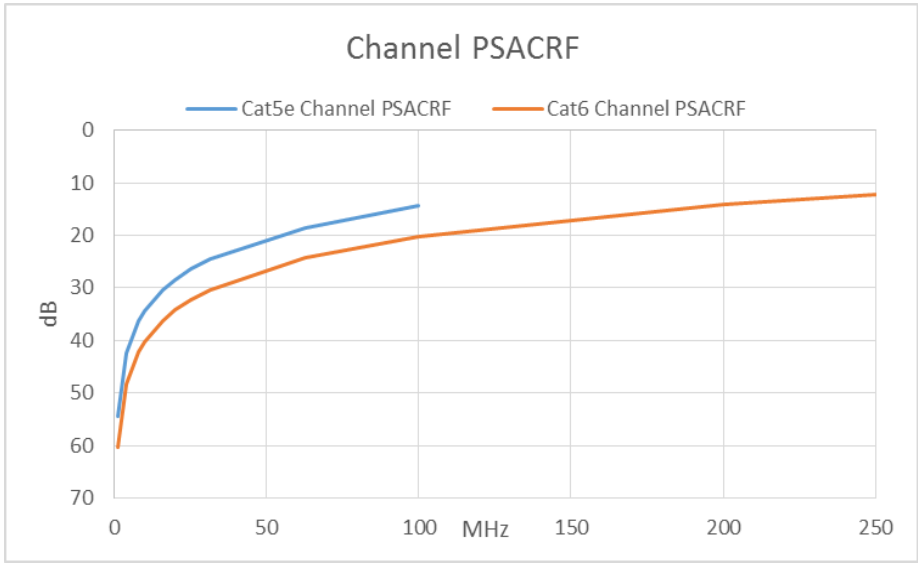






Category 5e and Category 6 Cabling





126.7 Link Segment Specification

- **Define a 2.5 Gb/s PHY for operation over**
  - **–Up to at least 100m on four-pair Class D (Cat5e) balanced copper cabling on defined use cases and deployment configurations**
    - **Link Segment option**
      - ✓ **Category 5e Cabling**
- **Define a 5 Gb/s PHY for operation over**
  - **–Up to at least 100m on Class E (Cat6) balanced copper cabling on defined use cases and deployment configurations**
  - **–Up to 100m on Class D (Cat5e) balanced copper cabling on defined use cases and deployment configurations**
    - **Link Segment options**
      - ✓ **Category 5e cabling with appropriate augmentation**
      - ✓ **Category 6**

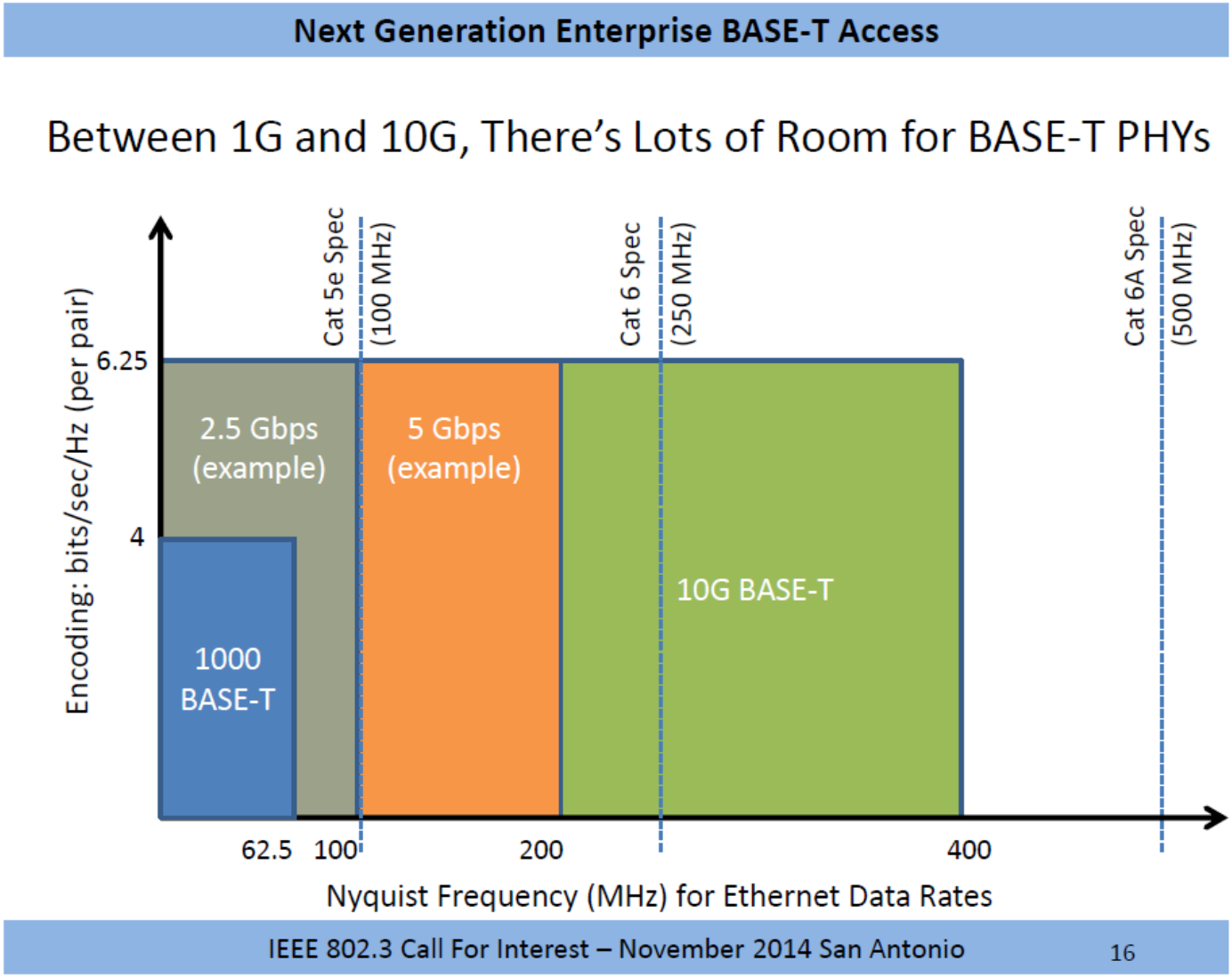
126.7 Link Segment Specification Options

- **2.5/ 5 Gb/s PHY Link Segment**
  - **–Category 5e cabling with appropriate augmentation on defined use cases and deployment configurations**

- **2.5 Gb/s PHY Link Segment**
  - **–Category 5e cabling on defined use cases and deployment configurations**

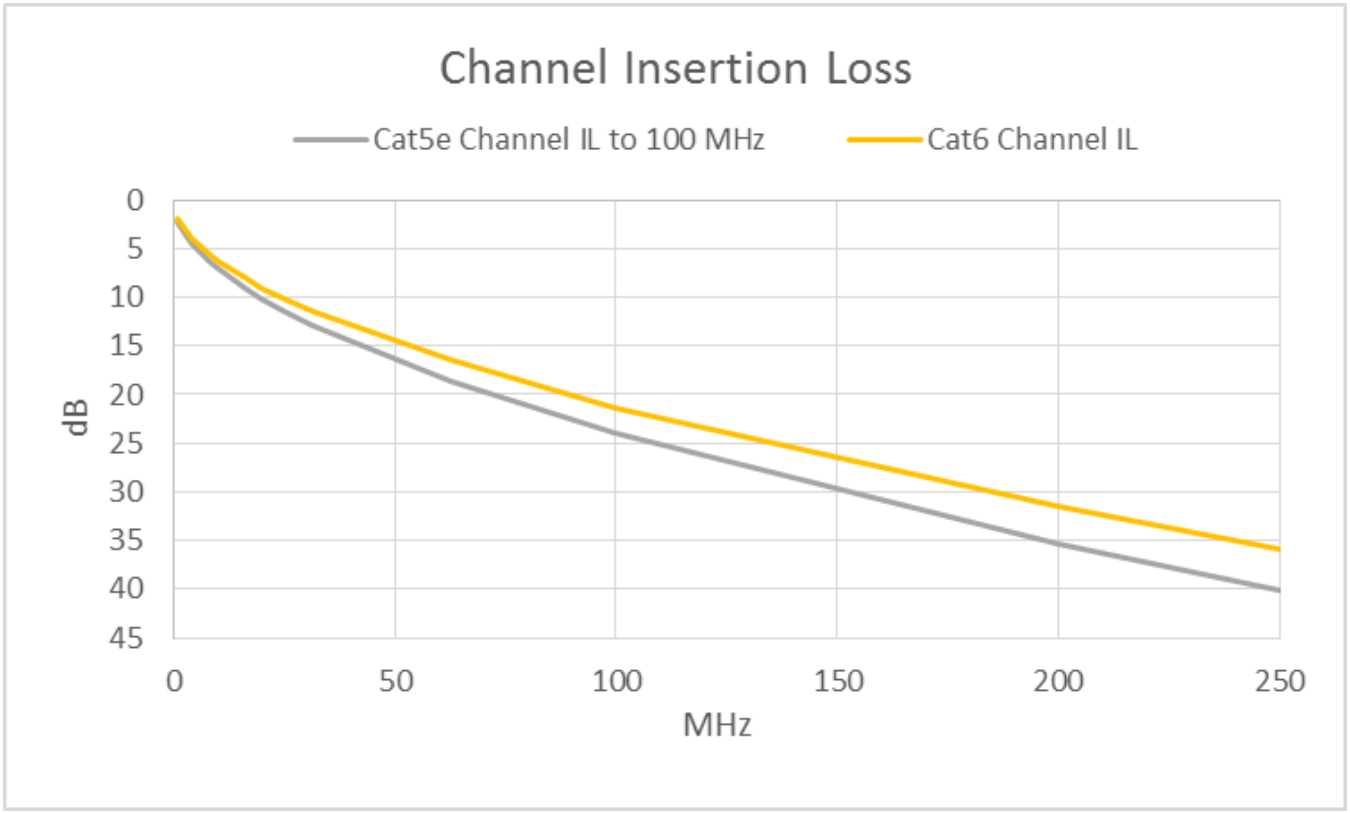
- **5 Gb/s PHY Link Segment**
  - **–Category 6 on defined use cases and deployment configurations [satisfies up to 100m Class D (Cat5e) m(TBD)]**

Link Segment 2.5/5 Gb/s PHY considerations

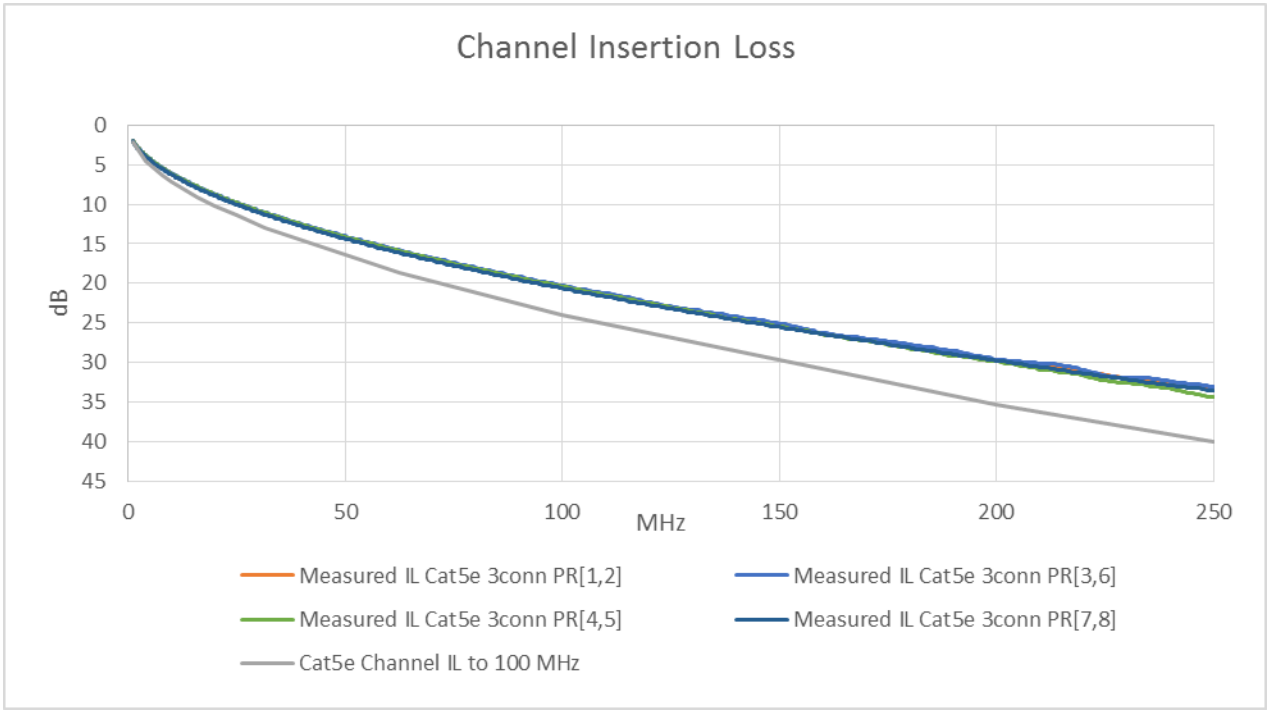


Link Segment 5 Gb/s PHY considerations

- **5 Gb/s PHY Link Segment BW > 200 MHz**
  - **–Cat 6 - ~4 dB margin at 200 MHz from Cat5e extended to 250 MHz**

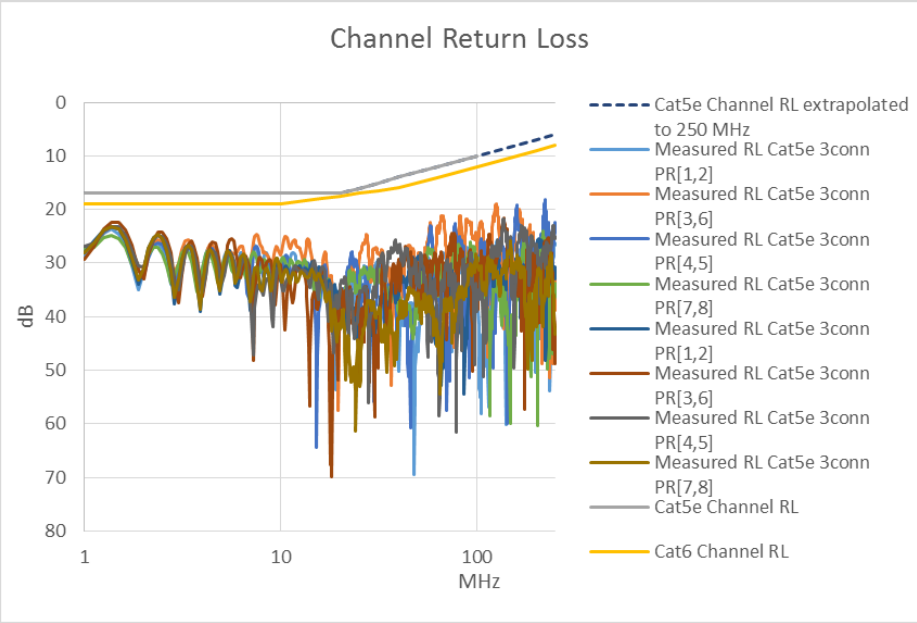


Proposal: Link Segment IL



Link Segment =1.02(1.967*SQRT(f)+0.023*(f)+0.05/SQRT(f))+4*0.04*SQRT(f) 1 < /= f </= 250 MHz*

Proposal: Link Segment RL



RL =- 17 1 </= f < 100 MHz

*17- 10*log(f/20) 20 < /= f </= 250 MHz*

Proposal: Link Segment RL

- *ANSI/TIA-568-C.2 Annex I (informative) – Development of channel and component return loss limits*

I.3 Return loss modeling results

A reasonable worst case channel configuration used to develop the return loss limits is shown in figure I.1. All flexible cable segments are assumed to have a asymptotic fitted characteristic impedance value of 95 Ω. The solid core cable segments are assumed to have a 105 Ω asymptotic fitted characteristic impedance. All connecting hardware is assumed to have return loss performance at the return loss limit for connecting hardware.

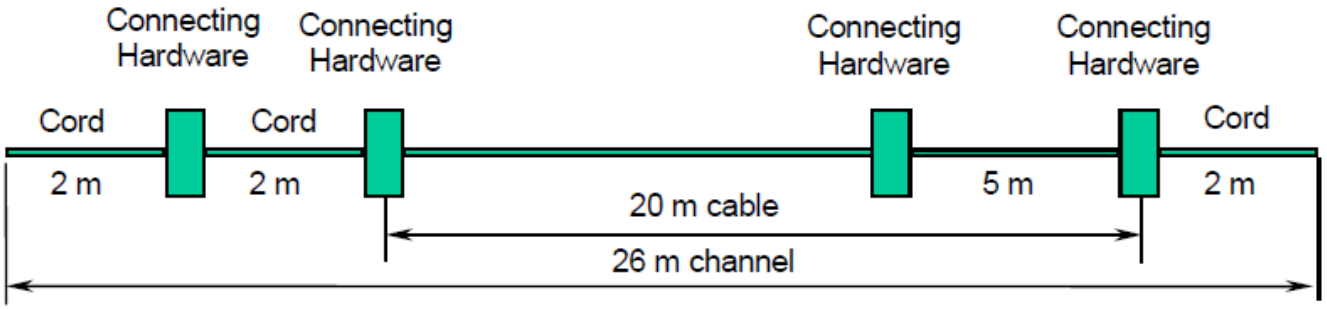


Figure I.1 - Modeling configuration

Proposal: Link Segment RL

Channel Configuration Connectors: c1, c2, c3, c4 Patch cord lengths: dx1, dx3, dx9
Cable lengths: dx5, dx7 Connector equivalent length: xc

$c1 := 1$ $c2 := 1$ $c3 := 1$ $c4 := 1$

----------|<xc>|----------|<xc>|----------|<xc>|----------|<xc>|----------

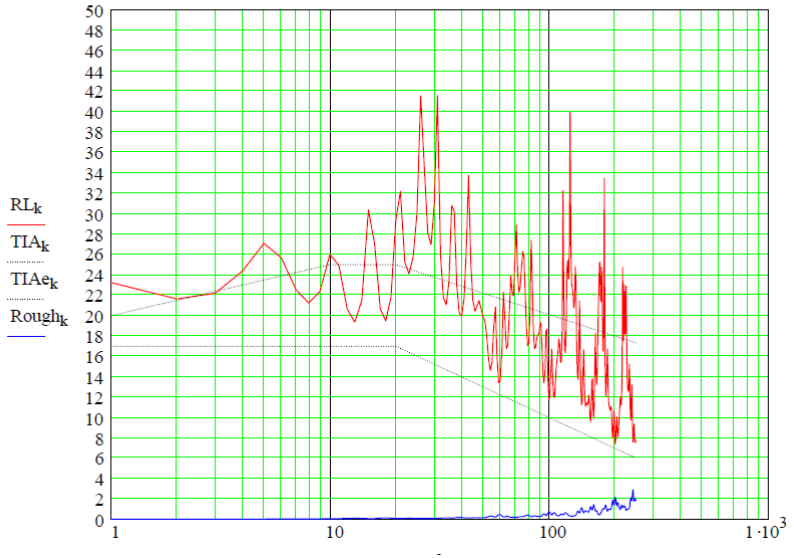
$dx_2 := c1 \cdot xc$ $dx_4 := c2 \cdot xc$ $dx_6 := c3 \cdot xc$ $dx_8 := c4 \cdot xc$

$dx_1 := 2$ $dx_3 := 2$ $dx_5 := 15$ $dx_7 := 5$ $dx_9 := 2$

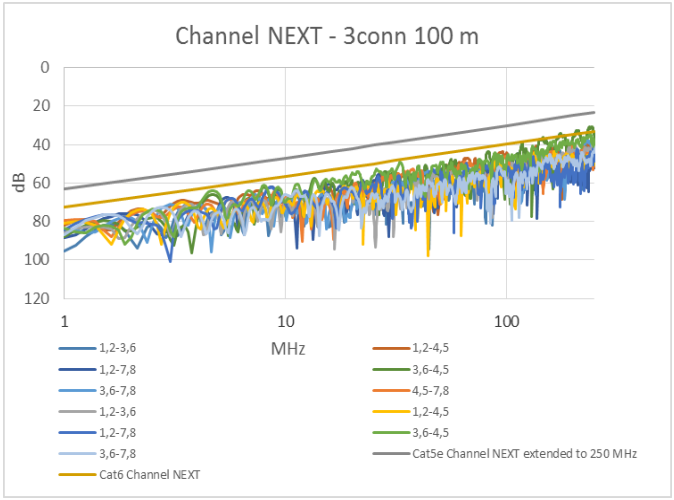
$x_0 := 0$ $x_i := x_{i-1} + dx_i$ $x_9 = 26.16$

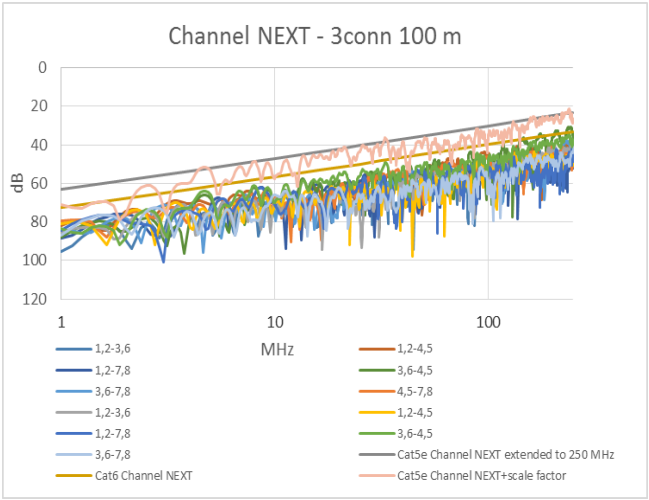
0 ----------->$\sum dx$

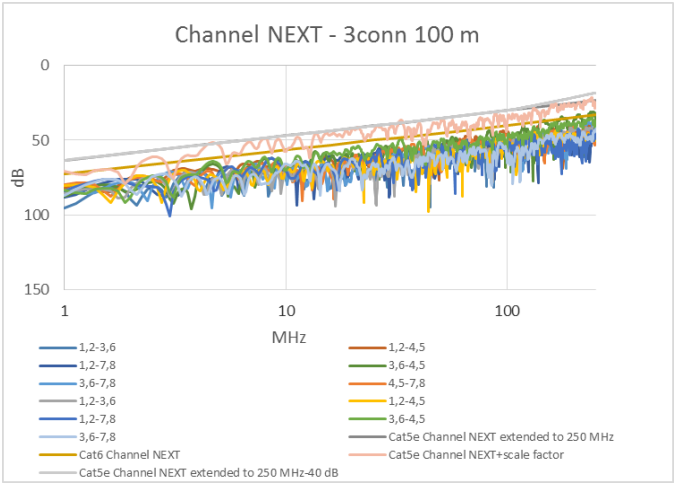
Channel Return Loss & Roughness



Proposal: Link Segment NEXT/PSNEXT



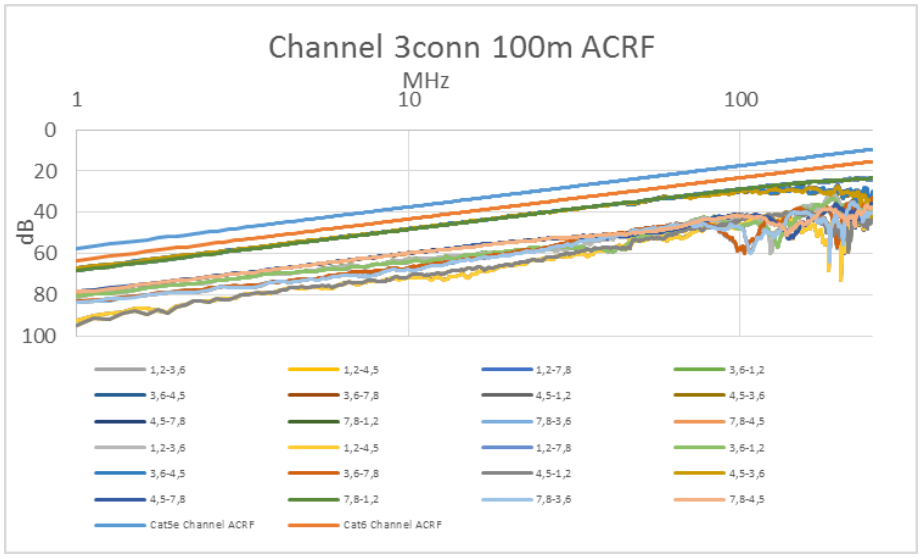


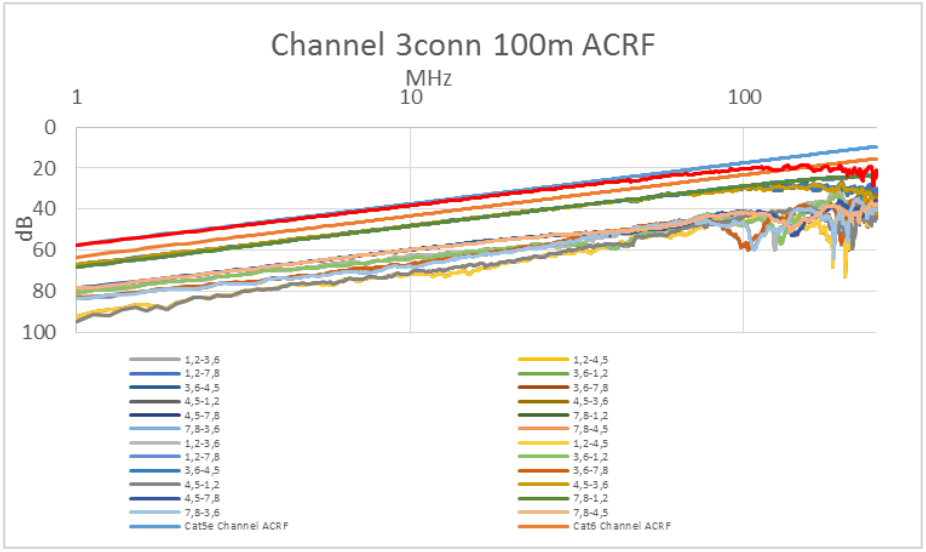


*NEXT =--20*LOG(10^(-(35.3-15*LOG(f/100)) /20) +2* 10^(-(43-20*LOG(f/100)) /20)) 1 </= f </= 100 MHz*
*-20*LOG(10^(-(35.3-15*LOG(f/100)) /20) +2* 10^(-(43-40*LOG(f/100)) /20)) 100 < f </= 250 MHz*

*PSNEXT =--20*LOG(10^(-(32.3-15*LOG(f/100)) /20) +2* 10^(-(40-20*LOG(f/100)) /20)) 1 </= f </= 100 MHz*
*-20*LOG(10^(-(32.3-15*LOG(f/100)) /20) +2* 10^(-(40-40*LOG(f/100)) /20)) 100 < f </= 250 MHz*

Proposal: Link Segment ACRF/PSACRF





*ACRF = -20*LOG(10^(-(23.8-20*LOG(f/100)) /20) +4* 10^(-(32.1-20*LOG(f/100)) /20)) 1 </= f </= 250 MHz*

*PSACRF = -20*LOG(10^(-(20.8-20*LOG(f/100)) /20) +4* 10^(-(32.1-20*LOG(f/100)) /20)) 1 </= f </= 250 MHz*

Alien Crosstalk – 10GBASE-T

55.7.3 Coupling parameters between link segments

- **55.7.3.1.1 Multiple disturber power sum alien near-end crosstalk (PSANEXT) loss**
  - **55.7.3.1.2 PSANEXT loss to insertion loss ratio requirements**
  - **PSANEXT limits specified in 55.7.3.1.1 [Equation (55–23) and Equation (55–25)]**
- **55.7.3.2 Multiple disturber alien far-end crosstalk (MDAFEXT) loss**
  - **55.7.3.2.1 Multiple disturber power sum alien equal level far-end crosstalk (PSAELFEXT)**
  - **55.7.3.2.2 PSAELFEXT to insertion loss ratio requirements**
  - **PSAELFEXT limits specified in 55.7.3.2. [Equation (55–32) and Equation (55–34)]**

Alien Crosstalk – 10GBASE-T

- **55.7.3.3 Alien crosstalk margin computation**

The alien crosstalk margin computation can be applied in the event that the PSANEXT limits specified in 55.7.3.1.1 [Equation (55–23) and Equation (55–25)] or the PSAELFEXT limits specified in 55.7.3.2. [Equation (55–32) and Equation (55–34)] are not met. T he alien crosstalk margin is specified for each of the individual 4-pairs as well as the average “across the 4-pairs”.

Proposal: Alien Crosstalk

- **Use Salz SNR as basis for link segment alien crosstalk specifications (alternative to ACMC)**
- **Alien crosstalk cabling limits are not specified for Cat5e or Cat6**
- **Normative alien crosstalk cabling limits are not necessary to consider PHY performance**
- **Salz SNR is used among PHY developers (and others of course) to assess link performance**