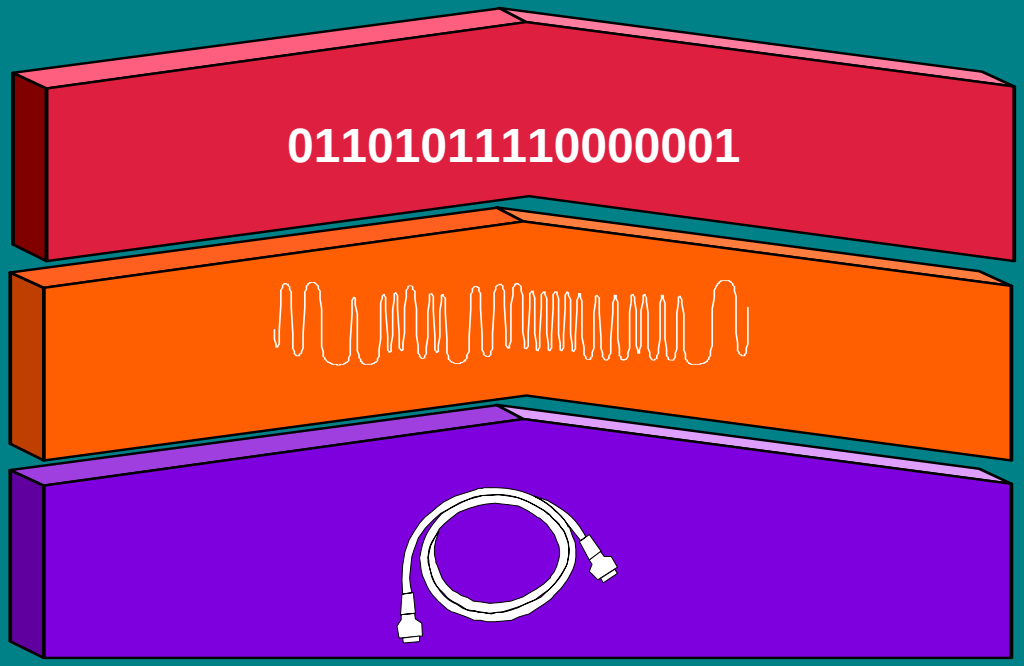
The Inter-Standard Gap

Fanny Mlinarsky



Throughput Depends on Bit Error Rate (BER)

- **Bit errors cause re-transmissions and slow down the rate of data throughput**
- **Network bandwidth is wasted when the same information is transmitted more than once**
- **Low BER maximizes data throughput**
- **Robust networks exhibit low BER in the presence of noise and distortion**

Physical Medium Dependent (PMD) Standards

100 VG-AnyLAN **10-100-1000 Base-T** **Token Ring** **ATM**

PMD Standard

Cabling Standard

ISO 11801 - Class B, C, D
TIA-568-A - Category 3, 4, 5

Modulation scheme
Data Rate
BER
Spectrum
Ambient Noise
etc.

155 Mb/s ATM PMD Standard

ATM Forum
AF-PHY-0015.000
September, 1994

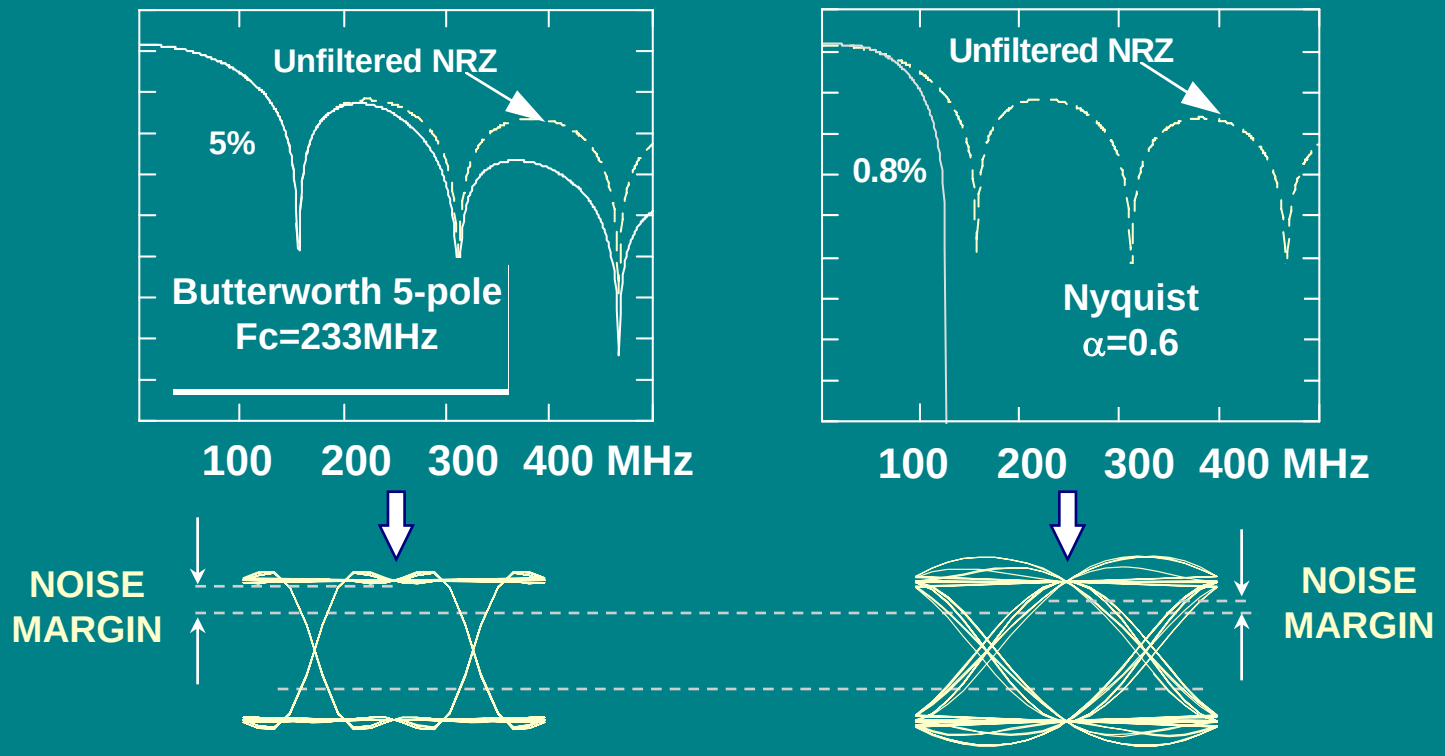
Cabling Standards

TIA-568-A Cat 5 UTP
TIA-568-A 150 Ohm STP
ISO 11801 120 Ohm STP

Modulation: NRZ
Data Rate: 155 Mb/s
BER: 10^{-10}
Spectrum: Indirect spec
$1.5ns < T_{r/f} < 3.5ns$
Self NEXT: 20 mV ptp

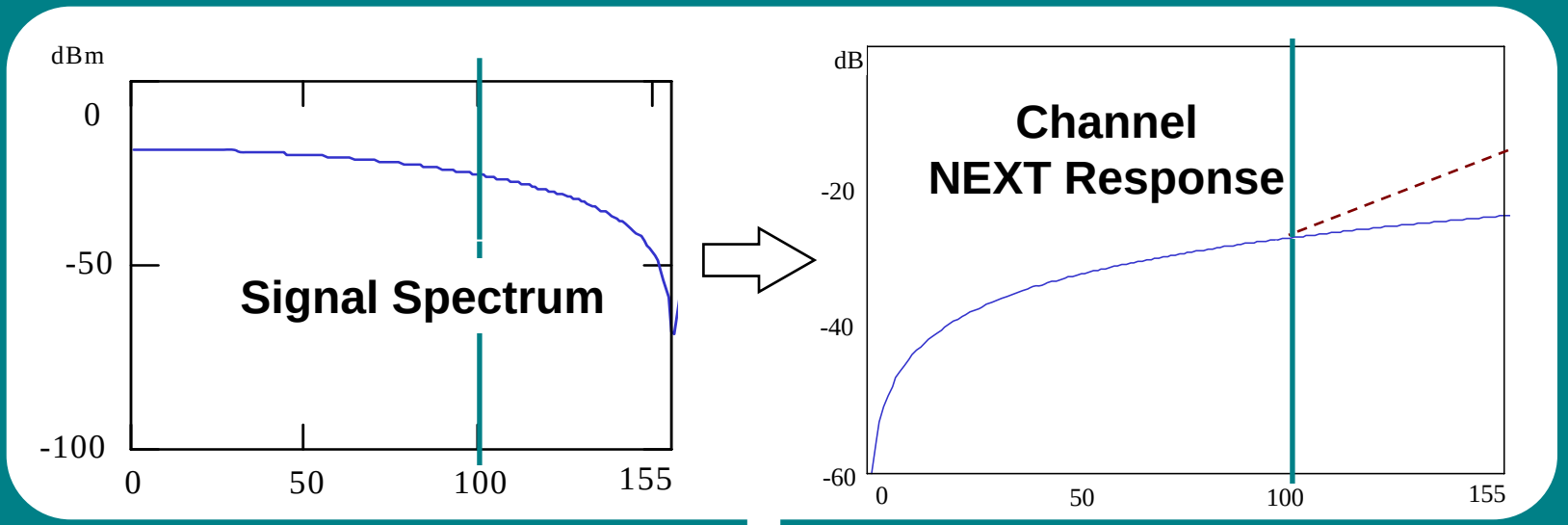
Spectrum Vs. Rise/Fall Time

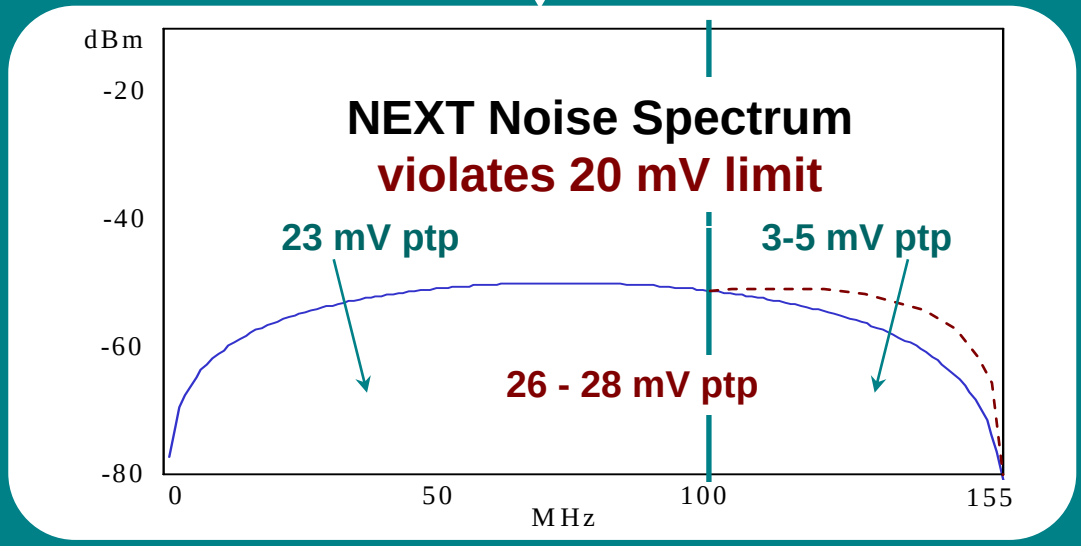
$$F_{3dB} = 0.35 / T_{r/f}$$



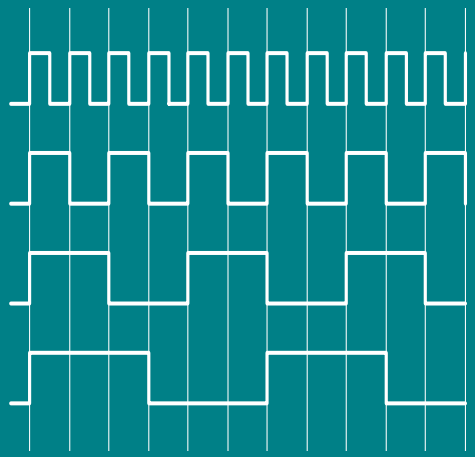
$$1.5\ ns < T_{r/f} < 3.5\ ns$$

NEXT Noise Spectrum



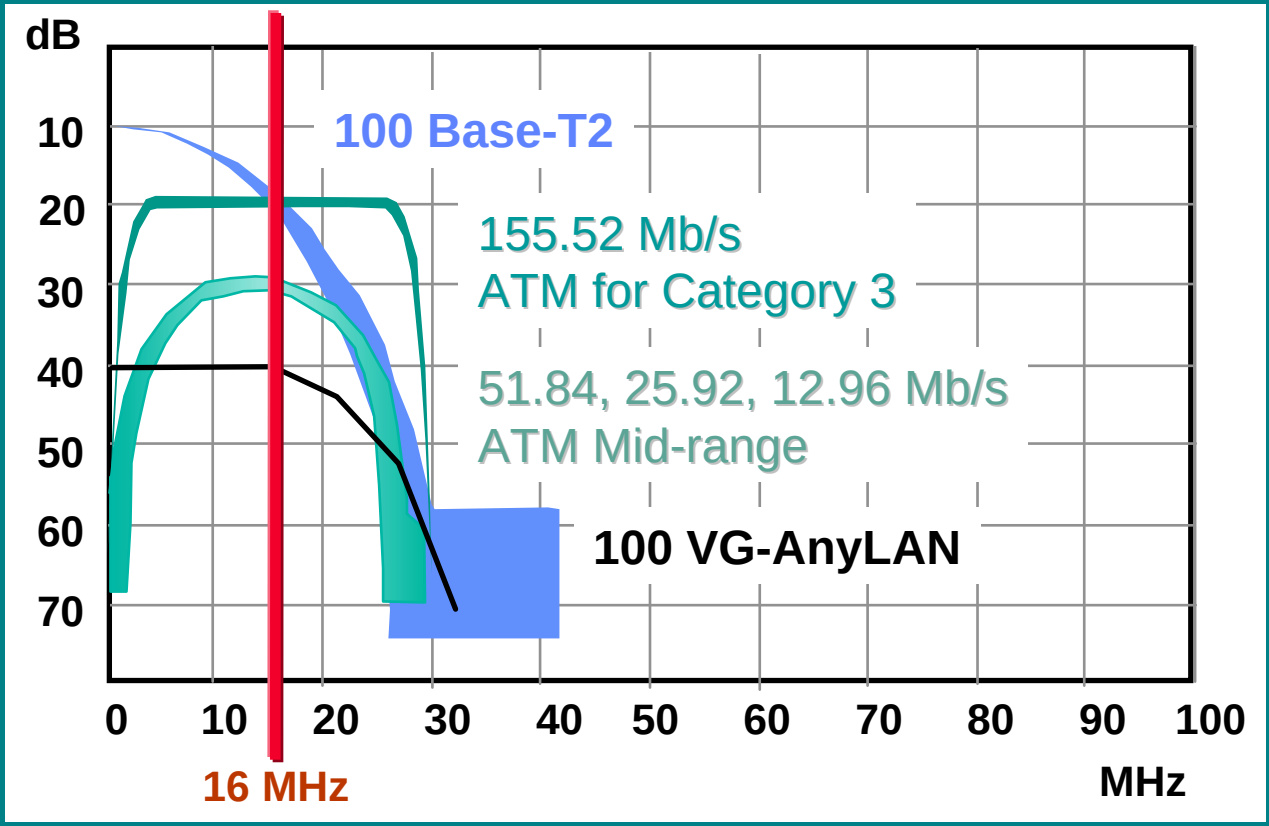


ATM Self NEXT Noise Gap

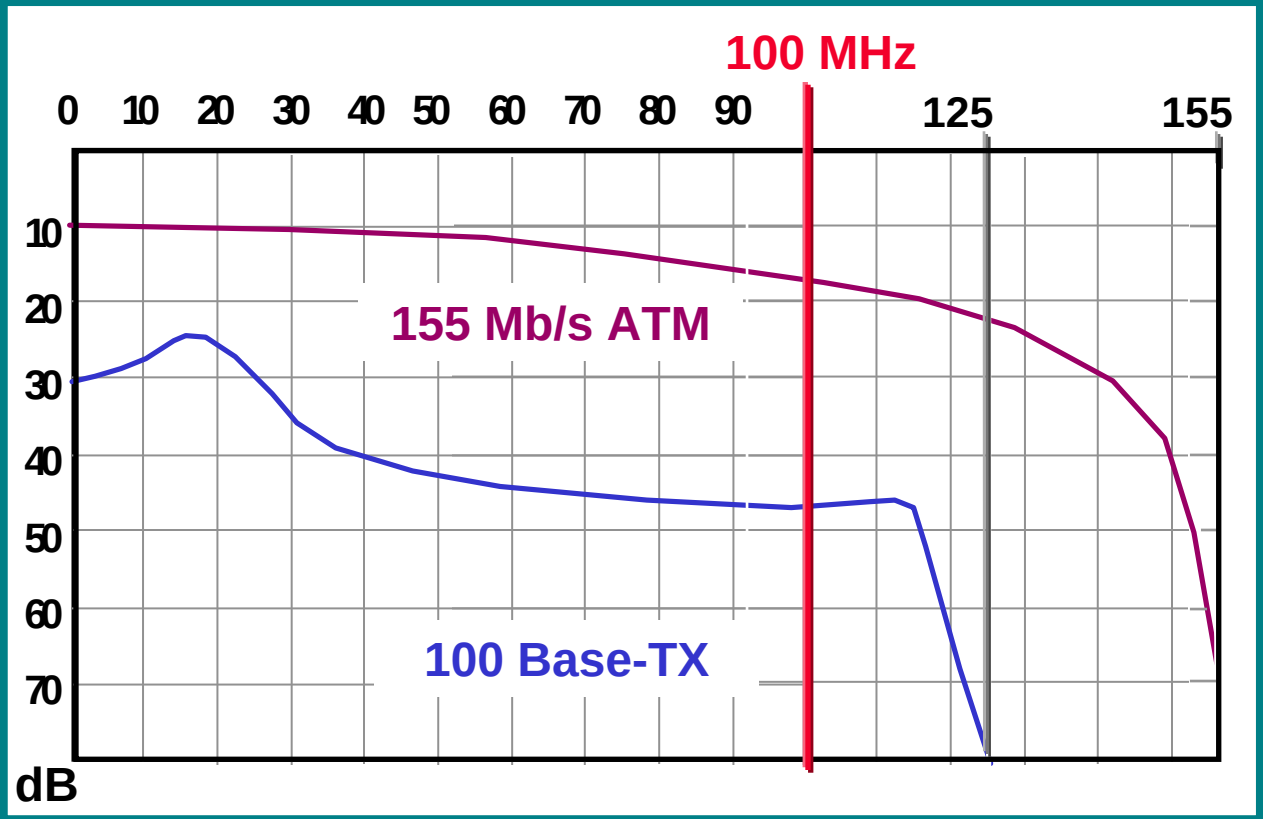
155 Mb/s ATM Clock and Data Signals	TSB67 Channel NEXT Limit	mV of Self NEXT TX = 1060 mV *
		Violates 20 mV limit **
Ck 155.52 MHz		
77.76 MHz	**29.0 dB**	**37.6 mV**
38.88 MHz	**34.1 dB**	**20.9 mv**
25.92 MHz	**37.1 dB**	**14.8 mV**

* Max. transmit voltage = 1060 mV ptp, AF-PHY-0015.000, Section 3.2
** Max. Self NEXT noise = 20 mV ptp, AF-PHY-0015.000, Section 5.3.1

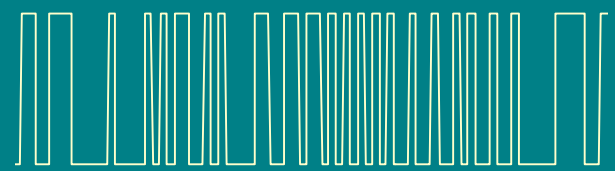
Category 3 Networks

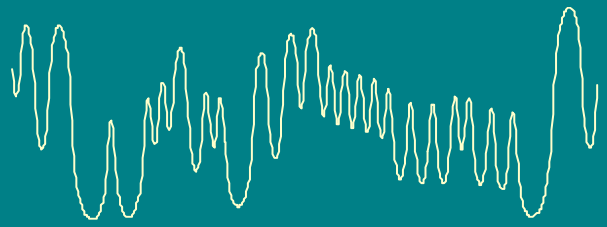


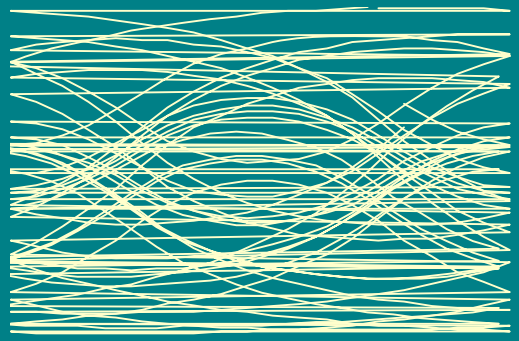
Category 5 Networks



Distortion in the Channel

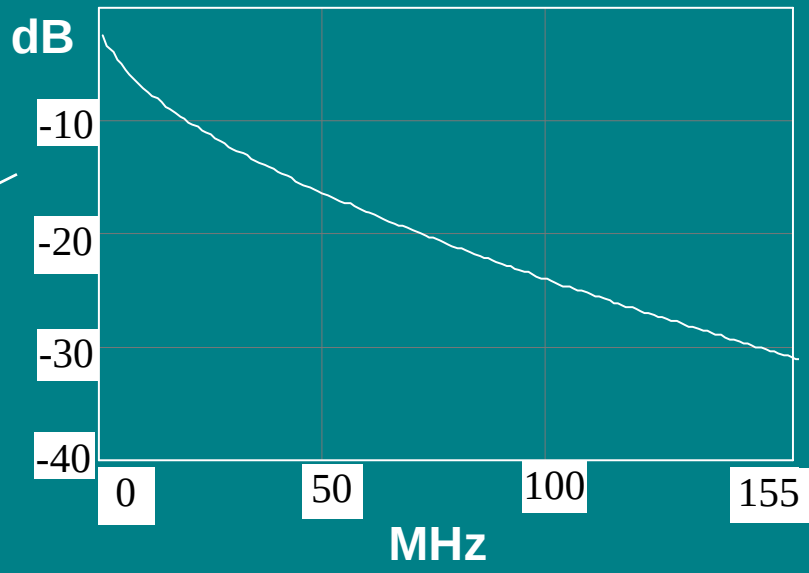




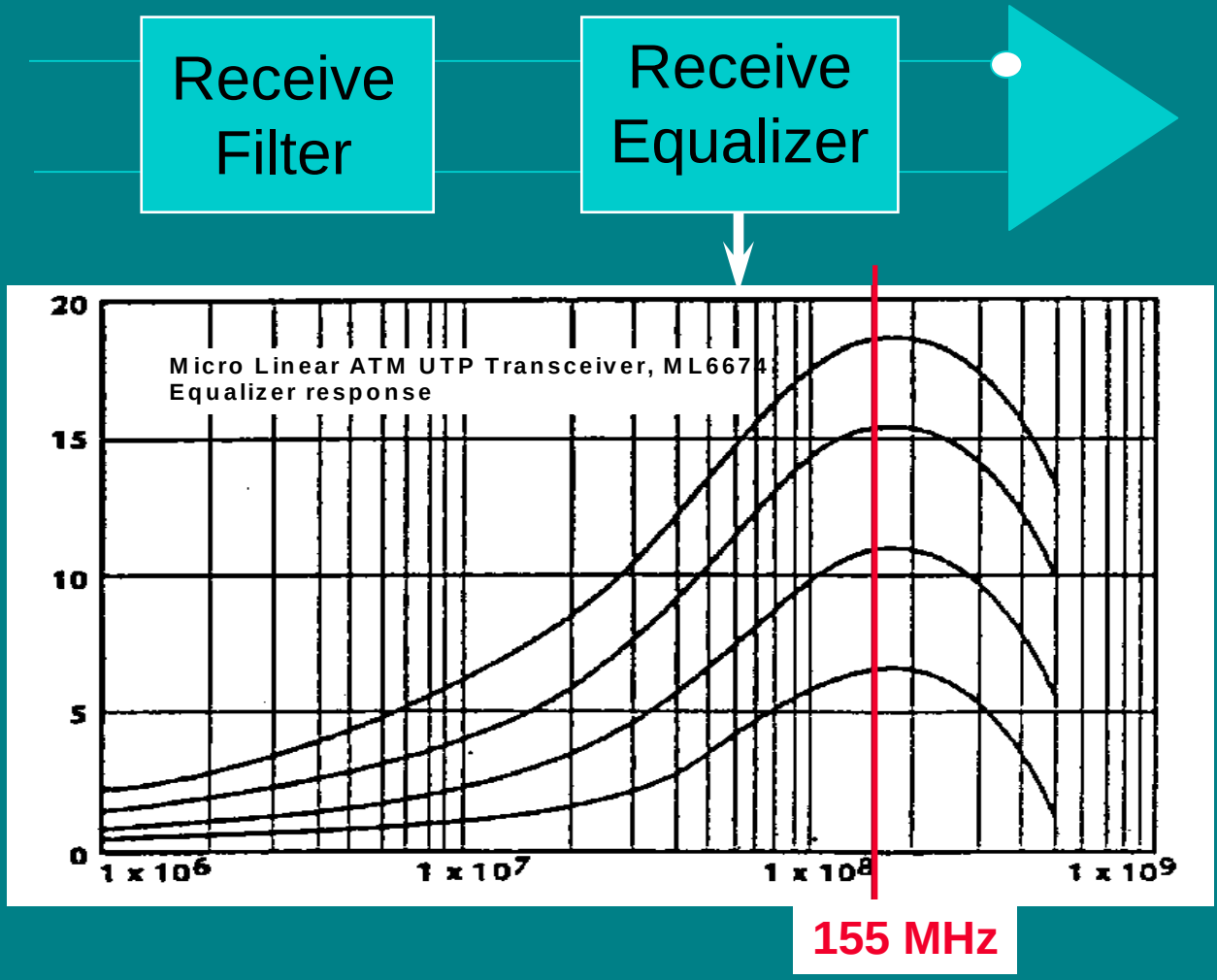


Eye Pattern

TSB-67 Channel Attenuation
Extended to 155 MHz

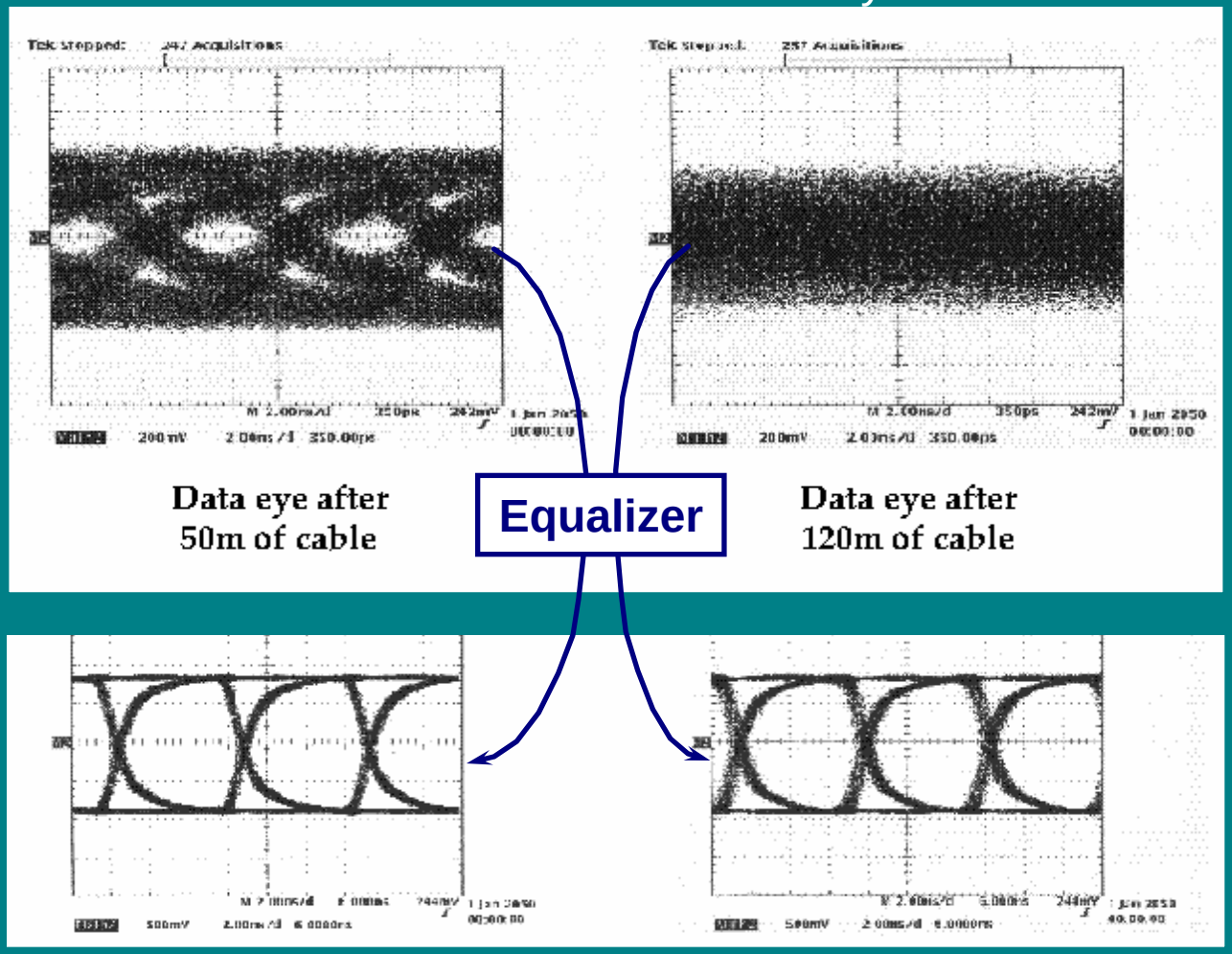


Signal Equalization

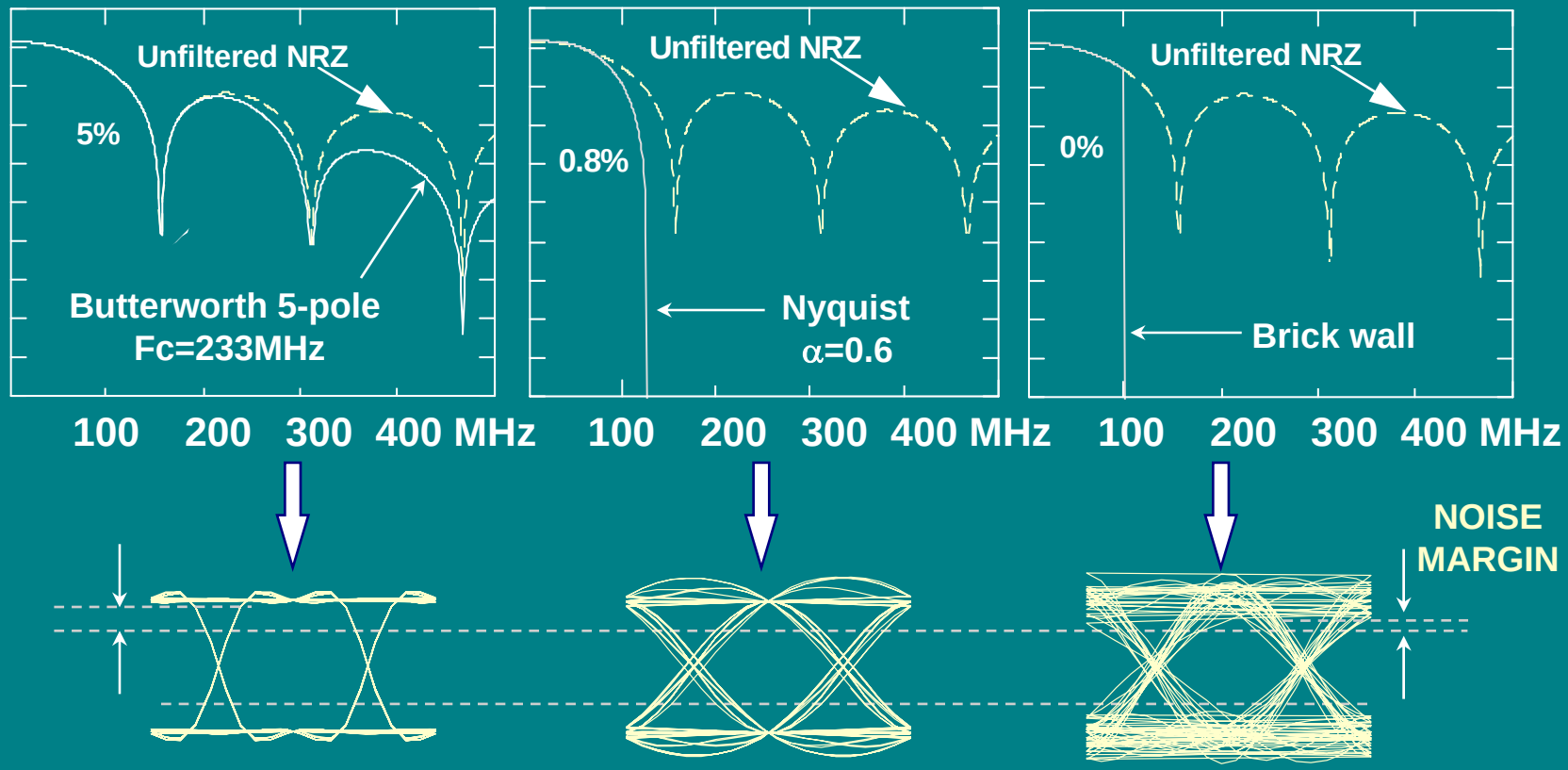


Data Restored By an Equalizer

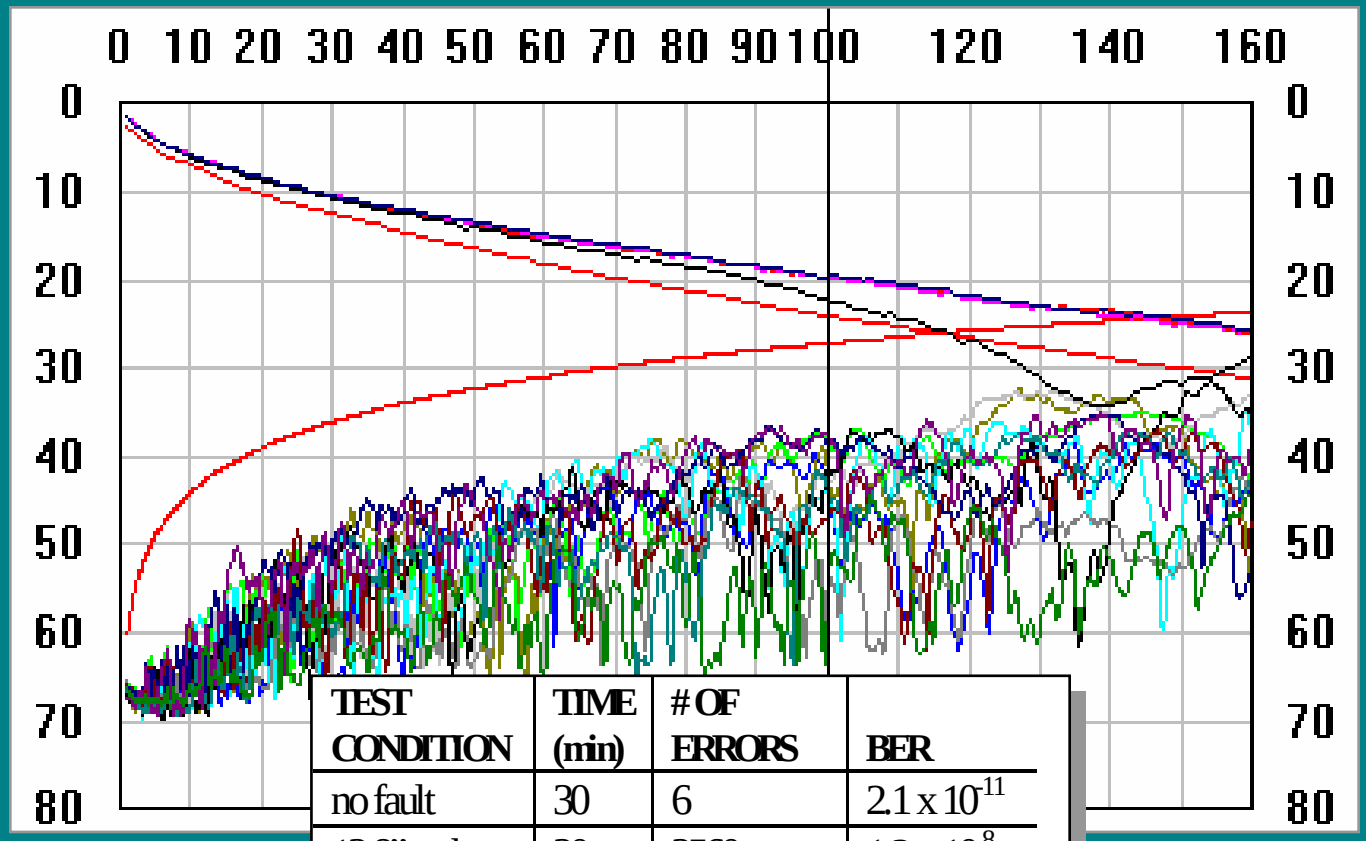
155 Mb/s NRZ measurements made by PMC-Sierra



Distortion Due To Filtering



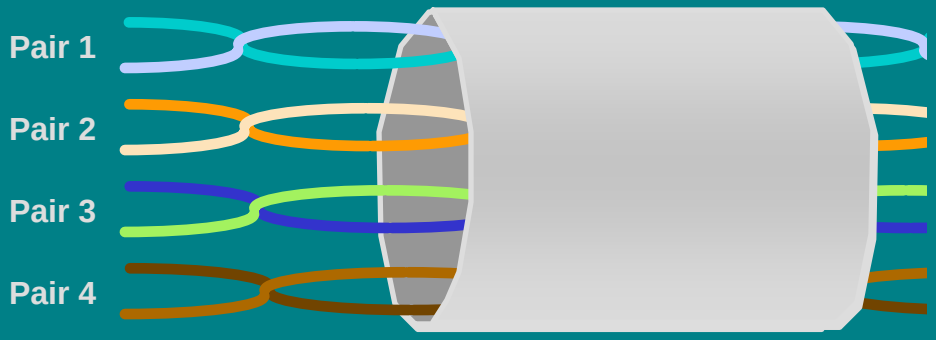
ATM Bit Error Rate Experiment



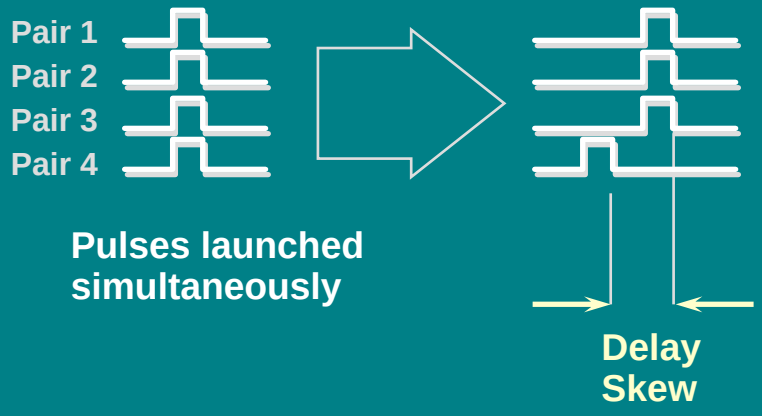
TEST CONDITION	TIME (min)	# OF ERRORS	BER
no fault	30	6	2.1×10^{-11}
13.8" stub, representing a bridge tap	30	3560	1.2×10^{-8}

Testing audited by

Delay Skew

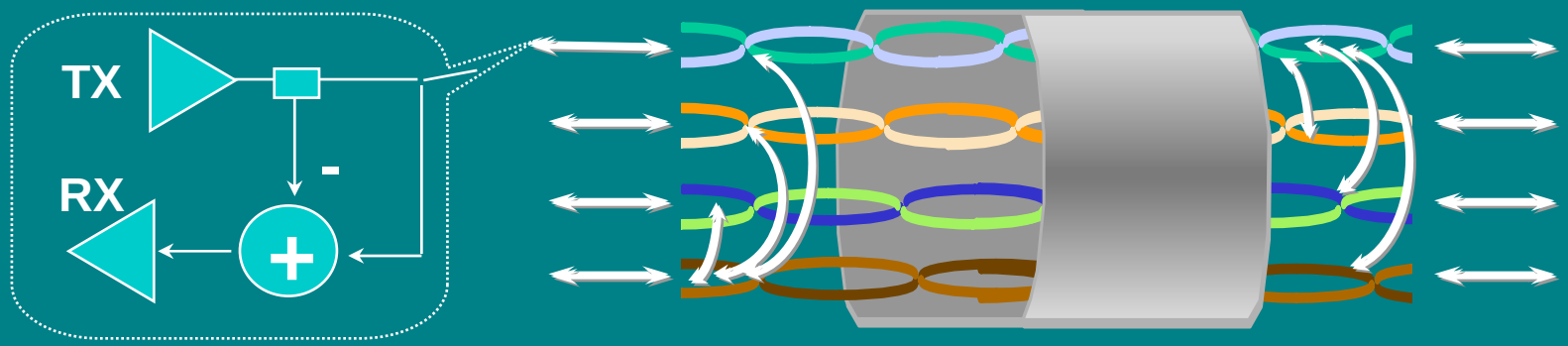


Insulation Material	NVP Per Pair
FEP*	74 %
FEP	74 %
FEP	74 %
Non-FEP	70 %



* Flourinated Ethylene Propylene

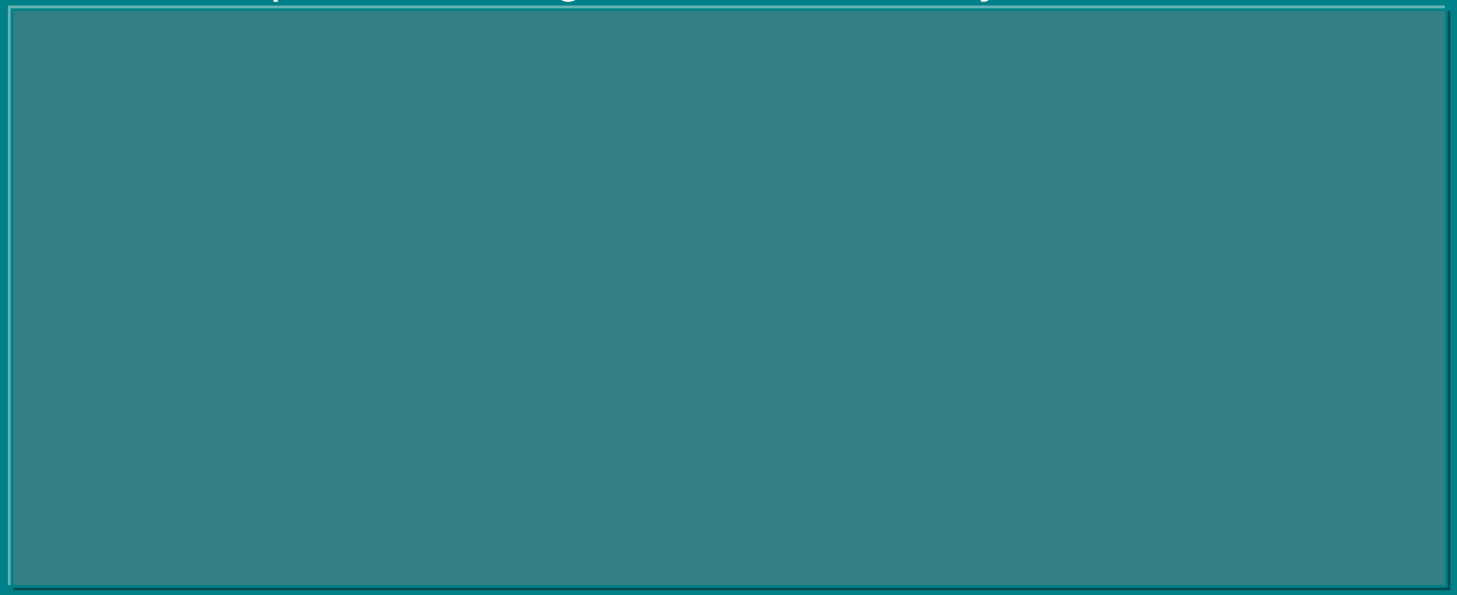
DSP Based 1Gb/s Ethernet Signaling Schemes

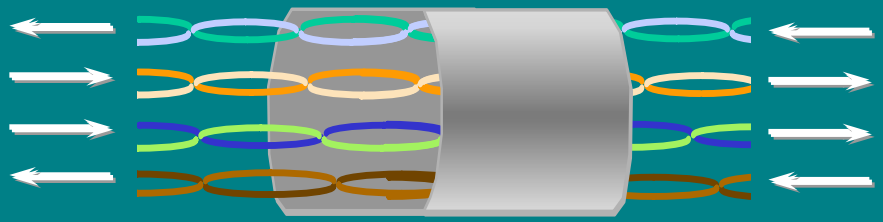


- **DSP-based dual-duplex schemes**
  - **Pulse Amplitude Modulation PAM 5x5 or 3x3**
  - **Quadrature Amplitude Modulation QAM 6x6 , 5x5 or 3x3**
- **Potential candidates for the inter-standard gap:**
  - **Delay skew of already installed category 5**
  - **Powersum NEXT from near and far ends**

4LZS* 1Gb/s Ethernet Signaling Scheme

Proposal and diagrams contributed by PMC-Sierra





50 m - 1 cat 5 cable
100 m - 2 cat 5 cables
? 100 m - 1 cat 5+ cable ?

*** 4 Levels with Zero State**

Summary

- **Data rates over twisted pair medium are increasing**
  - **1990 - 10 Base-T (802.3i)**
  - **1995 - 100 Base-T (802.3u)**
  - **1998(?) - 1000 Base-T (802.3z)**
- **The choice for next generation twisted pair PMD is:**
  - **More complex and expensive transceivers or ...**
  - **Better cabling systems**
- **Cabling standards have been lagging networking standards**
- **When field testing twisted pair installations, it may be prudent to:**
  - **Certify compliance to a generic cabling standard**
  - **Perform network specific tests**

Imperfect Equalizer