10 GbE Feasibility over Twisted Pair Copper

IEEE 802.3 HSSG - Dallas, TX

Vivek Telang
Cicada Semiconductor, Inc.
901 S. MoPac Expwy.
Austin, TX 78746
Phone: +1 512 327-3500 x114
Fax: + 1 512 327-3550
Email: vivek@cicada-semi.com

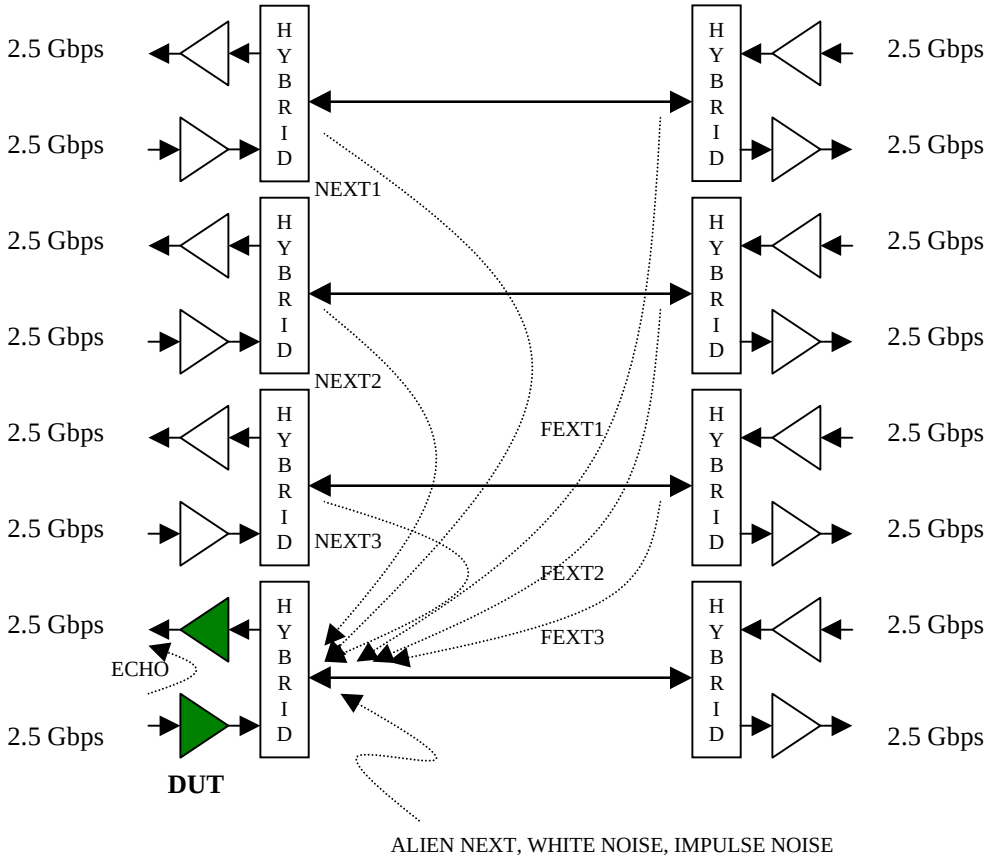
10 Gigabit Ethernet
UTP Feasibility Study

- Twisted Pair System Definition
- Category 6 Cable Characteristics
- Analysis
- Strawman Proposal
- Summary

Goals

- Investigate 10GbE Feasibility over 25m Cat6 cable
- Propose Strawman Line Code

Twisted Pair Environment



10GBase-T System Environment

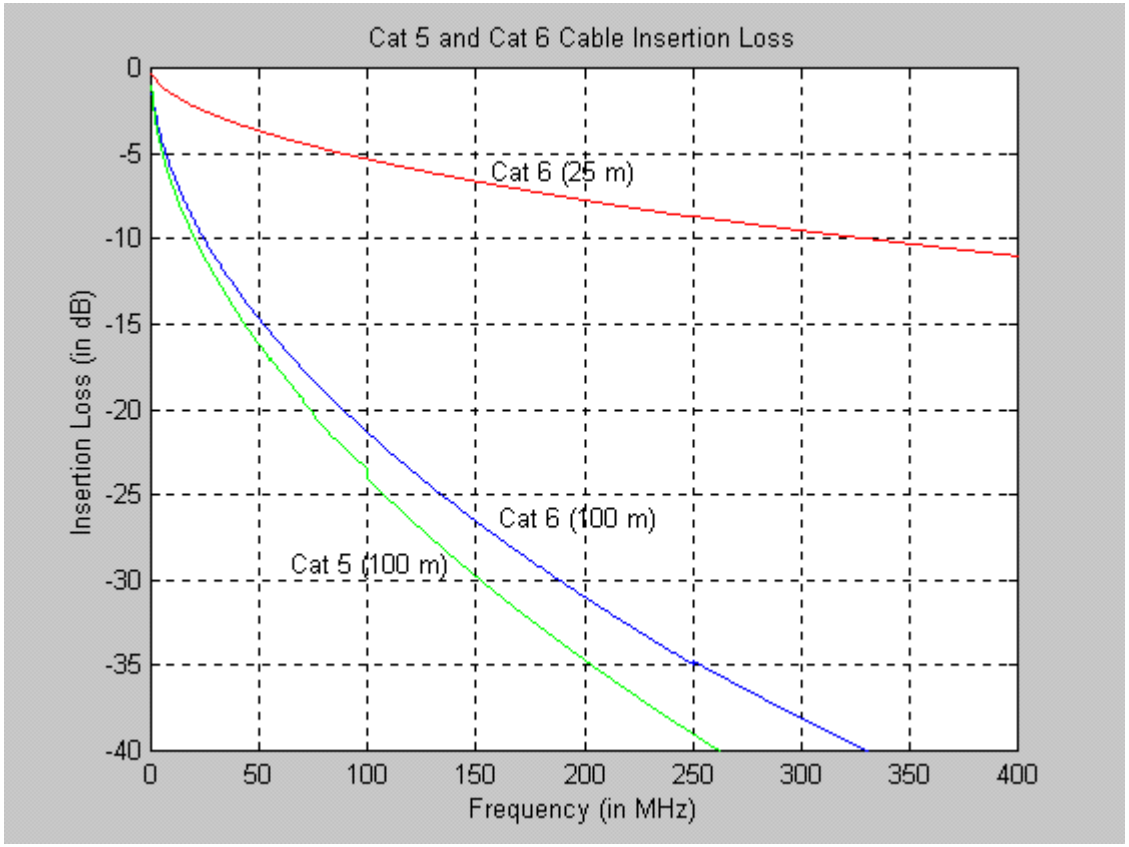
Cabling target:

- up to 25 meters (Wiring Closet, box-to-box, SAN)

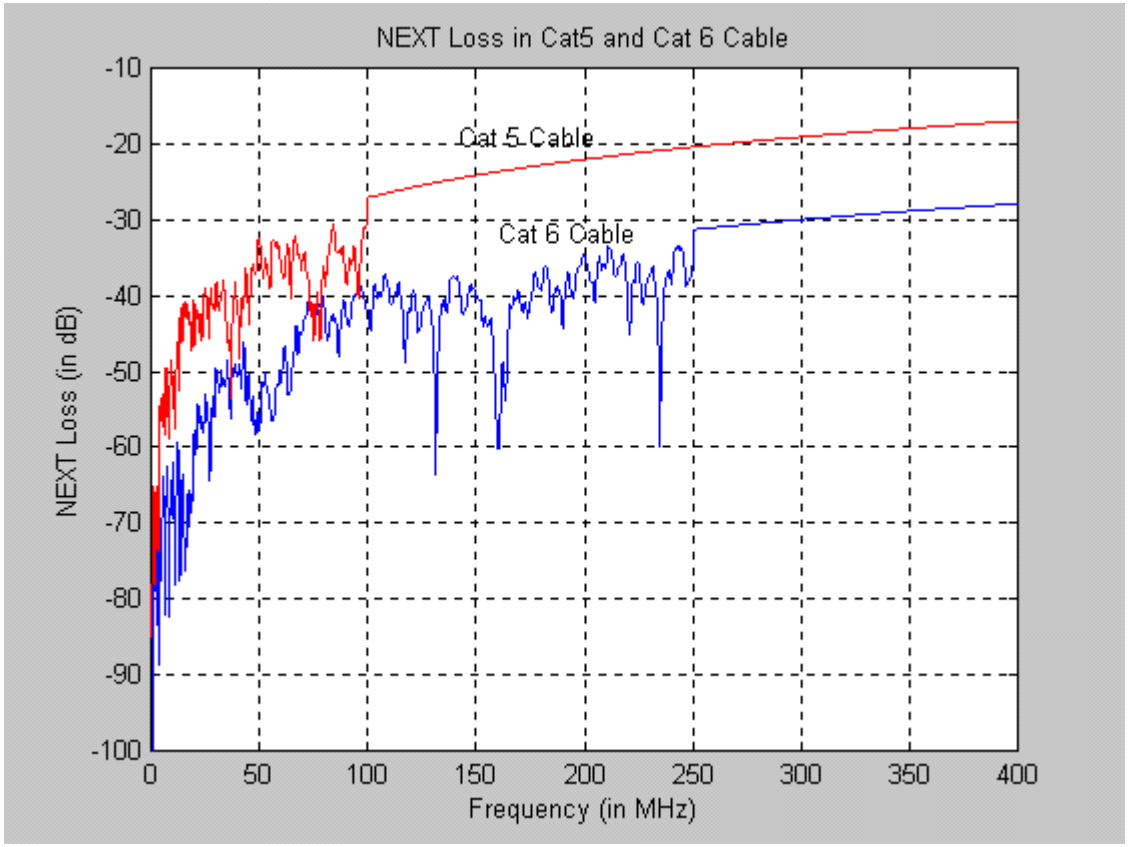
Design Challenges

- Electromagnetic Emissions & Interference
- Self-NEXT
- FEXT
- Echo
- Alien NEXT

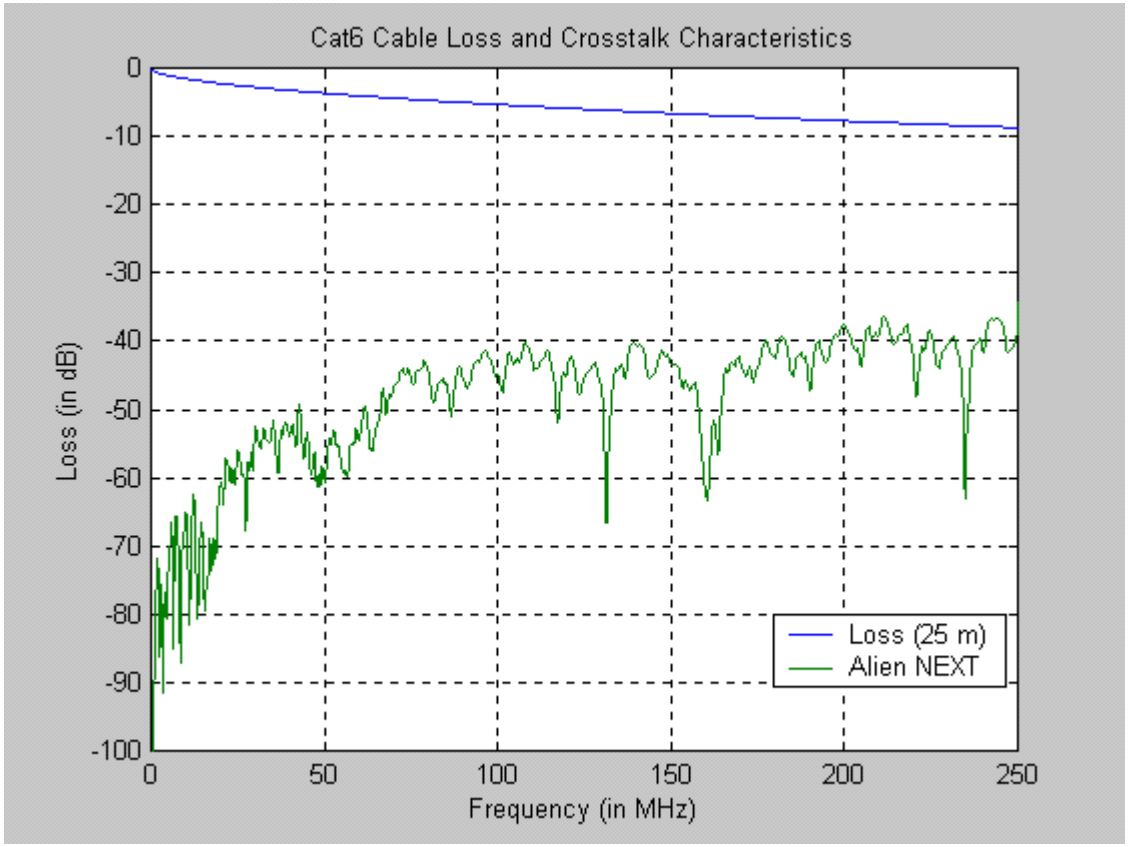
Category 6 Cable
Insertion Loss



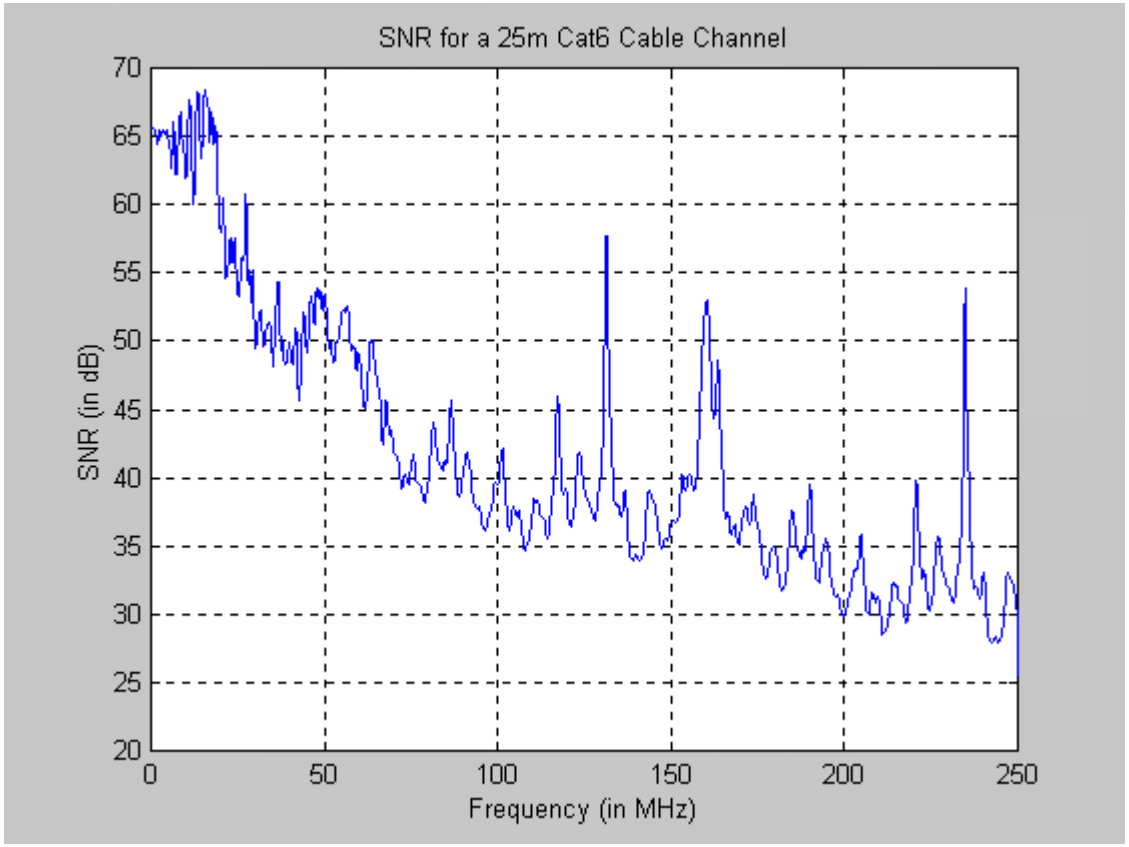
Category 6 Cable
NEXT Coupling



Category 6 Cable
Signal versus Noise



Category 6 Cable
SNR



Assumptions
(Used in Analysis)

- Transmitter spectrum:100BaseTX, Vpp = 2V
- BER < 1e-12
- Alien NEXT curves assumed to be 3dB lower than Self-NEXT curves with the same shape
- Alien interferer: 100Base-TX/1000Base-T/10GBase-T
- –140 dBm/Hz white noise background
- Insertion Loss was extrapolated beyond 250 MHz:

  $IL\ (dB) = 2.1*f^{0.508} + 0.4/f$ (f in MHz)
- NEXT loss was extrapolated beyond 250 MHz:

  $NL(dB) = 38 - 16.8*\log10(f/100)$ (f in MHz)
- Connector loss: 0.02 *sqrt(f)
- Cancellers for Echo, Self-NEXT, and FEXT

Performance Limits

Shannon Channel Capacity: 33.7 Gbps

PAM with Optimum DFE Receiver: 13.8 Gbps

Strawman Line Code for 10GbE 25m UTP PHY

- Line Code: 17-PAM/4D
- Symbol Rate: 625 Mbaud
- Trellis Coding: 18-PAM/8D
- SNR Margin: **8.0 dB**

Design Challenges

- 8-bit ADC @ 625 Msps (Magnetic Read Channels ship 6-bit ADC @ 600 Msps)
- 18-PAM Receiver (HDSL-2 uses 16-PAM)
- 625 MHz Receiver operation (Magnetic Read Channels)

Summary

- 10GbE over 25m Twisted Pair Cat6 Cable is feasible
- Limiting impairment is Alien NEXT
- Sheathed Cat6 cable (60dB Alien NEXT rejection) significantly reduces computational complexity
- Short-haul UTP standard will complement fiber 10GbE standard
- Need to make economic comparison with CX wrt connectors, PHY complexity, cable costs, etc.
- Need feedback for future direction