Alien Crosstalk Measurements and Performance in Conduit Configuration

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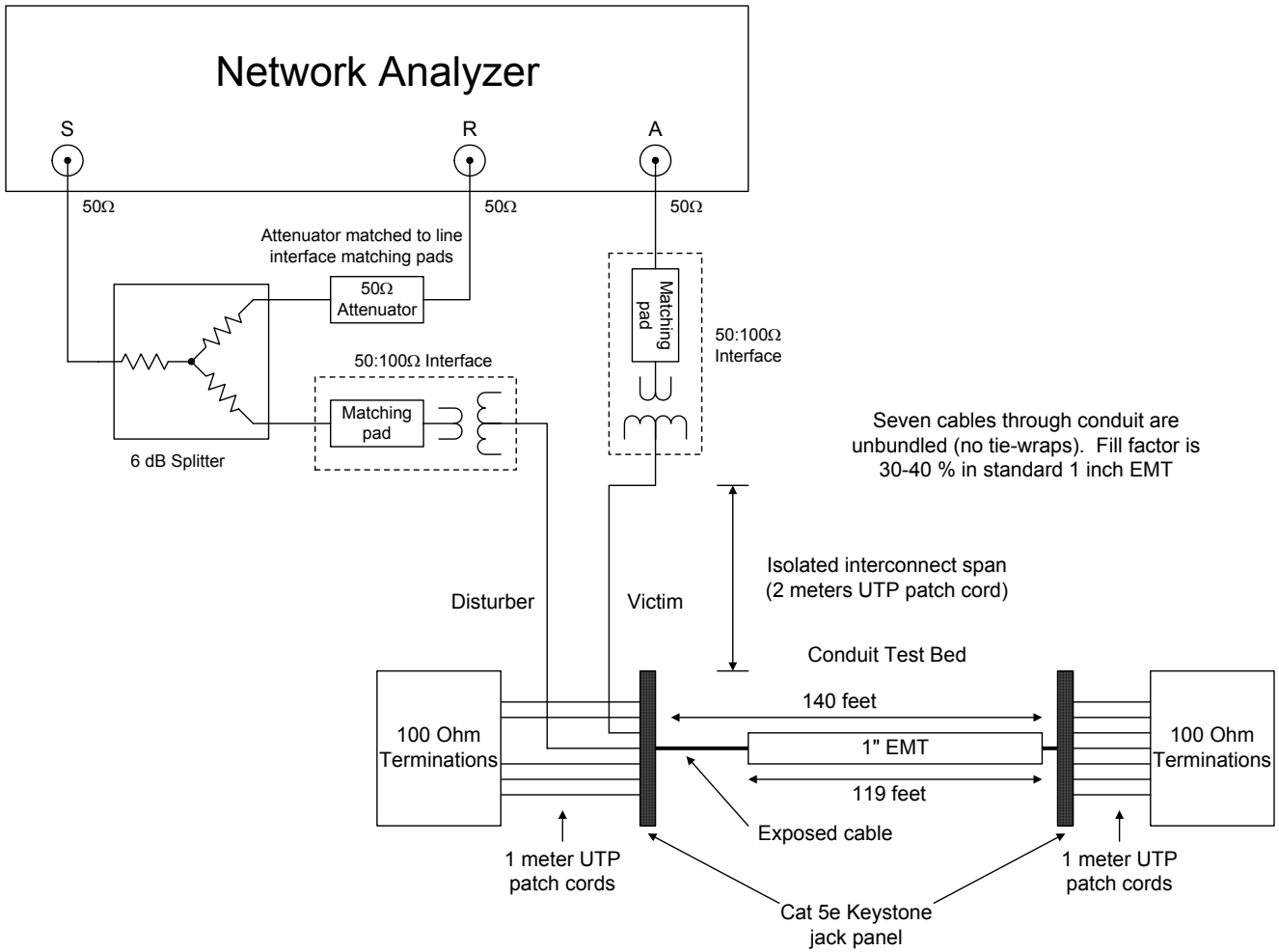
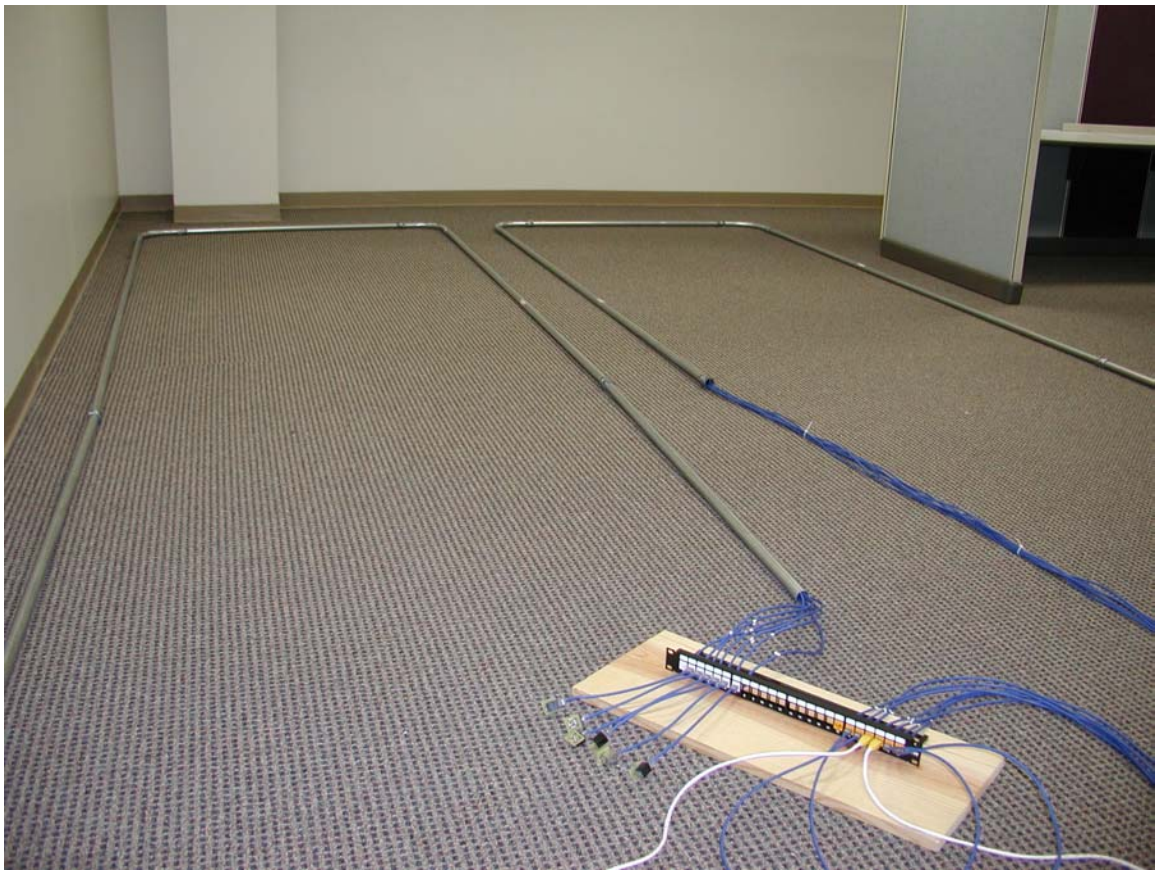
Overview

- Purpose:
  - Evaluate 10GBase-T capacity in a conduit alien crosstalk environment
- Measurement method and test setup
- Measurement results
- Channel capacity results
- Summary

Alien NEXT Measurement Setup



Alien Crosstalk Conduit Test Bed

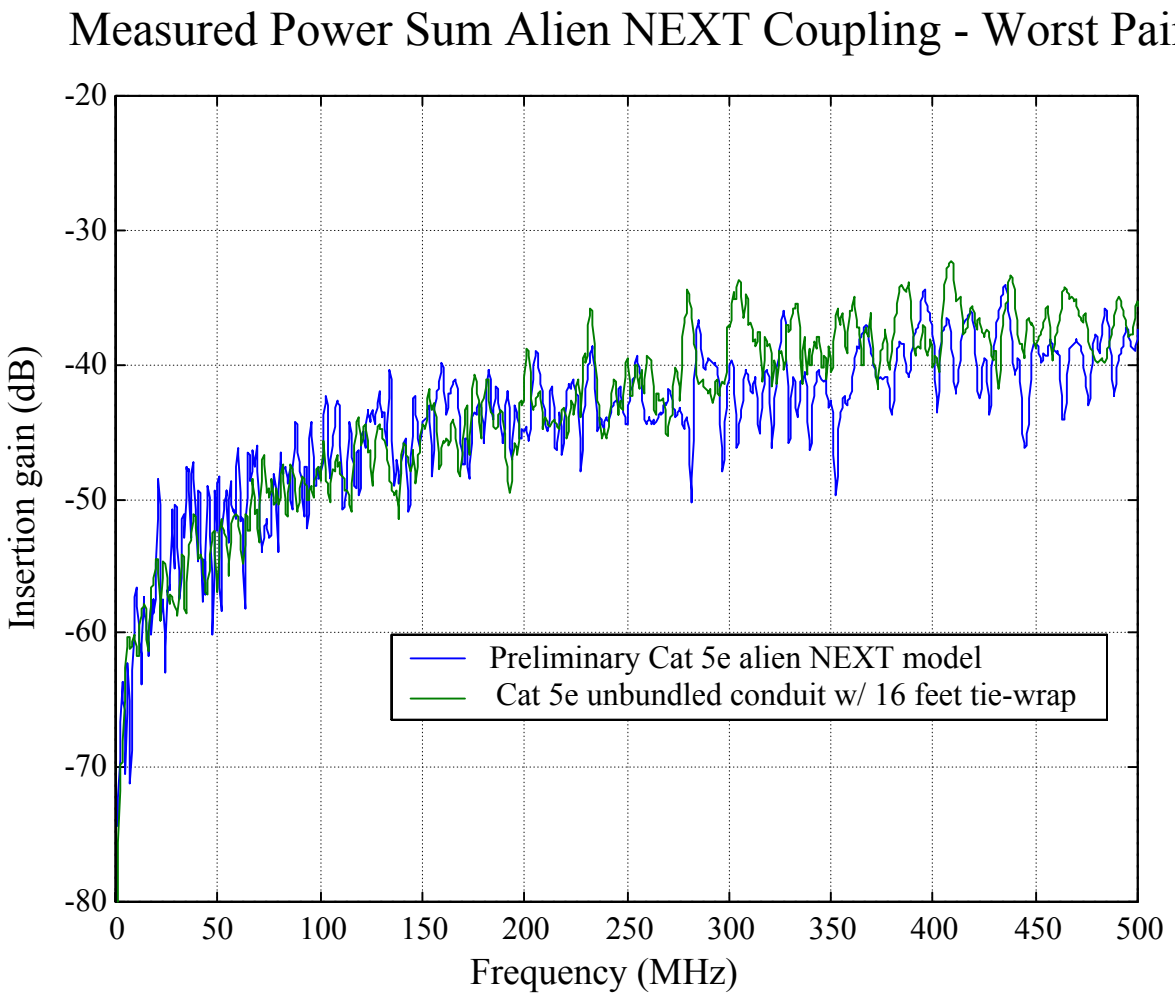


- Actual setup used “closed course” configuration; very large number of bends.
- 7 cables in 1” EMT provided 40% fill factor
- 5 meters of exposed cable at near end tie-wrapped every 3 ft

Test Procedure

- Measure pair-to-pair coupling between all wire pairs of victim and six disturber cables (96 total measurements)
- Calculate channel capacity of victim cable using power sum coupling into each victim pair from the six surrounding disturber cables
- Test case is 140 feet of cable in 119 feet of conduit; 5 meters of exposed cable tie-wrapped at 3 foot intervals

Measurement Results



- Result significantly better than hybrid bundle specification
- Worst-case pair (Pair 3, connector pins 3-6) are much worse than other pairs.

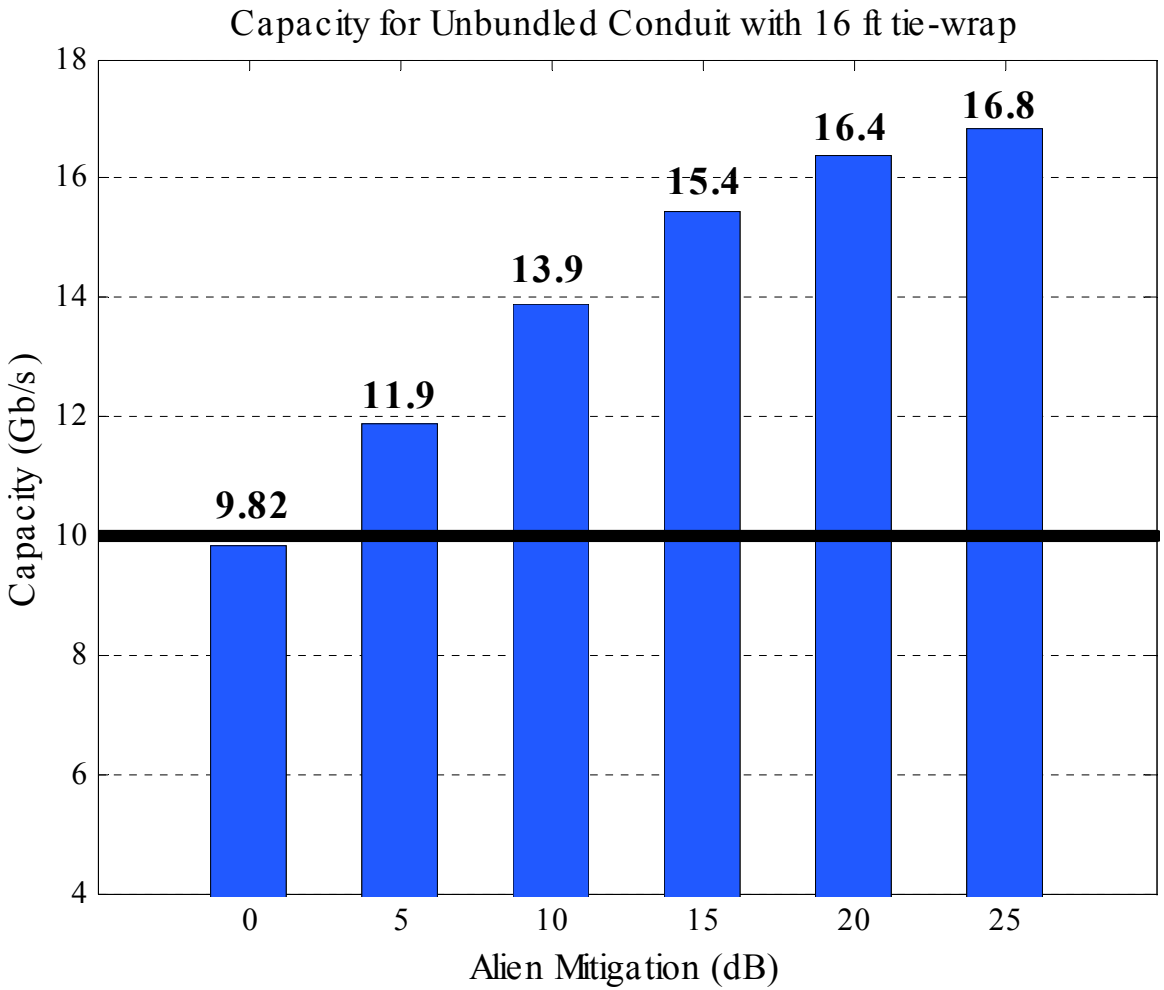
Capacity Calculations

- 10GBase-T Cabling Ad Hoc Channel Models:
  - Established models for Category 5e Insertion Loss, Return Loss, self NEXT and self FEXT (April 17, 2003).
- Alien crosstalk model for Cat5e based on coupling measurements in the conduit environment
- Background Noise
  - Upper bound noise level of -150 dBm/Hz appears consistent with actual data center noise.[2,3]
- Launch power of 10 dBm.

Capacity Calculations

- Self-Impairment Cancellation:
  - 55 dB Return Loss Cancellation (15 dB Hybrid, 40 dB PHY)
  - 40 dB NEXT Cancellation
  - 25 dB FEXT Cancellation
- No Established Level for Alien NEXT Mitigation. Mitigation of 0 dB to 25 dB Realized through Combination of One or More Alternatives:
  - PHY (0 dB to 10 dB)[4]
  - Improved Installation Practices (0 dB to 10 dB)[1]
  - Enhanced Cable Design/Specification (0 dB to 25 dB)[5]

Channel Capacity Results



Summary

- Capacity greater than 10 Gbps can be achieved with:
  - Ad hoc Cat 5e models and alien crosstalk measurement models in the conduit environment
  - Reasonable levels of impairment cancellation

References

[1]Cohen, L., “Alien Crosstalk Measurements,” IEEE802.3 Contribution, Jan. 2003.

[2]Pagnanelli, C., “Data Center Background Noise Measurements,” IEEE802.3 10GBASE-T Contribution, May 2003.

[3]Cobb, T., “Background Noise,” IEEE802.3 10GBASE-T Contribution, May 2003.

[4]Solarflare Communications, “10GBASE-T Tutorial,” IEEE802.3 Contribution, Nov. 2002.

[5]Cobb, T., “Experimental Cat6 Cable Developed with Improved Alien NEXT,” IEEE802.3 Contribution, March 2003.