Premise: IT managers who are looking towards migrating business-critical enterprise networks to 1000Base-T (Gigabit Ethernet) are searching for cabling systems that deliver reliable, error-free transmissions in an active network. Copper cabling from a variety of vendors and connectivity hardware must be able to guarantee performance in compliance with IEEE 802.3ab standard for running Gigabit Ethernet over copper in switched LAN environments.

Hubbell Premise Wiring commissioned The Tolly Group to evaluate various combinations of the ClearBIT Cabling System, which consists of Hubbell’s SPEEDGAIN Category 5e and NEXTSPEED 670 Category 6 connectivity products (jacks, patch panels and cross-connects) with PlatinumPLUS 350 Category 5e and Command LINX 6 Category 6 cables from General Cable Industries, Inc. The ClearBIT Cabling System was developed through a formal alliance between Hubbell Premise Wiring and General with the objective of providing high performance Category 5e, Category 6 solutions.

Tests included traditional passive/static performance measurements such as ACR, NEXT and Return Loss; and dynamic active tests that include channel tests of 90 meters.

The Tolly Group devised a dynamic active test methodology that measured bit error rates (BERs) encountered when running Gigabit Ethernet traffic across the cabling plant under test. Engineers then compared the results from these tests to the allowable BER levels as defined in the IEEE 802.3ab Gigabit Ethernet over copper standard, which requires a maximum BER of $1\times10^{-10}$. Engineers went a step further and measured the BER levels to $10^{-13}$.

Engineers evaluated the cabling system in a channel configuration with both Category 5e and Category 6.
and Category 6 UTP cables of 90 meters. The active testing included measurements of CRC errors, and fragmented and missing packets.

Unlike earlier tests of the ClearBIT Cabling System, engineers included Gigabit Ethernet switches in the test bed configurations to demonstrate that the cabling system maintains its performance in a switched LAN environment. Testing was performed in October 2000.

Test results show that Hubbell/General’s ClearBIT system met or exceeded the IEEE 802.3ab Gigabit Ethernet requirements of a BER of $10^{-10}$ and maintained its performance at $10^{-13}$.

**Results**

**Category 5e Channel**

The Tolly Group verified that when testing the ClearBIT Category 5e structured cabling solution from Hubbell and General of Hubbell’s 110 wiring block and two SPEEDGAIN patch panels, SPEEDGAIN jacks and General’s PlatinumPLUS 350 Category 5e cable, results showed a BER of less than $10^{-10}$ with two Extreme Networks Gigabit Ethernet switches configured in the channel test bed. See figures 1 and 2.

**Category 6 Channel**

The Tolly Group tested the ClearBIT Category 6 structured cabling system consisting of Hubbell’s NEXTSPEED connectivity products, including their 110 wiring block and two patch panels and jacks with General’s Command LINX 6 cable in a 90-meter channel configuration. The test bed also included two Extreme Gigabit Ethernet switches and results verified a BER of less than $10^{-10}$, which meets the specified requirements in the IEEE 802.3ab objectives for 1000Base-T. See figures 1 and 2.

**Analysis**

In the latter part of 1999, Gigabit Ethernet over copper became a reality. Leading switch vendors either shipped or announced shipment dates for Gigabit Ethernet copper switch ports. The near-term availability of this product – and the significant "price per port" reductions associated with copper-based switching – ignited interest in this area.
Because of the tenfold speed increase associated with a move from Fast Ethernet to Gigabit Ethernet, cabling plant requirements are significantly more stringent. Every time a cable is connected and there is a point of termination and reconnection, there is a chance of disruption. At a billion bits per second, even a small half-second disruption can lose up to 500,000 bits. It is imperative that structured cabling solutions perform within the parameters of the IEEE 802.3ab for Gigabit Ethernet 1000Base-T. These parameters promise consumers a bit error rate that does not exceed 1*10^-10.

Test Configuration and Methodology

Category 5e Channel Tests

Prior to active testing, The Tolly Group engineers verified that all cabling systems met industry passive test standards, electrical performance as specified by TIA/EIA-568A-5 for Category 5e standard, and TIA/EIA proposed Category 6 standard (Draft 7). Engineers tested Category 5e and Category 6 installations with a Fluke Corp. DSP-4000 Digital CableAnalyzer version 3.2, standards version 3.26 and a Fluke DSP-4000 Smart Remote Cable Analyzer version 3.2.

For Category 5e channel tests of 90 meters, engineers utilized the ClearBIT Category 5e structured cabling system consisting of Hubbell SPEEDGAIN connectivity products and General Cable Industries, Inc. PlatinumPLUS 350. A 60-meter portion of the aforementioned cable connected to a Hubbell SPEEDGAIN HDSE Series Category 5e T568B Jack on one end and a Hubbell 110 Wiring Block model HPW 110BLK100BWL #OH081999 on the other end. A 30-meter portion of the cable connected to the wiring block on one end and continued to connect to a Hubbell SPEEDGAIN PSE Series 19" T568B Category 5e Patch Panel that connected to a second identical patch panel via a Hubbell patch cord.

Both the second patch panel and the aforementioned Hubbell jack connected to the following two switches respectively: an Extreme Networks 10/100/1000 Base-T Summit 5i model 11502 version 6.1.4 Build 12 with 12 ports; and an Extreme Networks 10/100/1000 Base-T Summit 7i model 11702 version 6.1.4 Build 12 with 28 ports. Both switches were configured with Spanning Tree Protocol and Extreme Discovery Protocol, both disabled.

Each of the Extreme switches connected to a Netcom Systems, Inc. SmartBits 2000 Advanced Multiport Performance Tester/Analyzer/Simulator, model SMB-2000, 1000Base-T traffic generator firmware version 6.61 equipped with two GX-1420B Gigabit Ethernet interfaces. SmartWindows 7.00 running on an IBM PC clone with 32 Mbytes of RAM with a PCI Bus card and a Compaq Computer Corp. Netelligent 10/100TX network adapter controlled the SmartBits. The controller was running Microsoft Corp. Windows NT Workstation 4.0 SP5 operating system. See figure 3.

Category 6 Channel Tests

For Category 6 channel tests, The Tolly Group engineers used the same configuration as above but replaced the Hubbell SPEEDGAIN connectivity products with Hubbell NEXTSPEED Category 6 connectivity products and General's Command LINX 6 Category 6 UTP copper cable. A 60-meter portion of the Command LINX 6 cable connected to a Hubbell NEXTSPEED HD670 Series Category 6 T568 Jack on one end and a Hubbell 110 Wiring Block model HPW 110BLK100BWL #OH081999 on the other end. A 30-meter portion of the cable connected to the wiring block on one end and continued to connect to a Hubbell NEXTSPEED P670 Series Category 6 19" T568 Patch Panel. An identical patch panel connected to one of the Extreme Summit switches on one end, and to the aforementioned patch panel on the other end. The second Extreme switch connected to the NEXTSPEED jack. Finally, the Netcom SmartBits connected to each switch via Hubbell patch cords. See figure 4.

Functionality and Performance

A Hubbell Premise Wiring/General Cable Industries, Inc. Alliance ClearBIT™ Cabling Systems Product Specifications*

Category 5e cabling system
- PS ACR channel headroom of 15dB at 100 MHz and positive ACR beyond 200 MHz (ETL verified worst case)
- Channel Return Loss margin of 8dB at 100 MHz (ETL verified worst case)
- Third-party performance verification of component and channel
- Backward compatible
- Patented staggered contact configuration
- Patent-pending multilayer printed circuit connector technology
- Easy to terminate
- 25-year system warranty

Category 6 cabling system
- PS ACR channel headroom of 3.9dB at 250 MHz and positive ACR beyond 275 MHz (ETL verified worst case)
- Channel Return Loss margin of 8dB at 250 MHz (ETL verified worst case)
- Third-party performance verification of channel performance
- Patent-pending Tri-plane staggered contact configuration
- Patent-pending multilayer printed circuit connector technology
- Patent-pending Pair-Lock™ cord termination process
- Balance system design
- Round or Flat High Performance Cable Construction Types
- 25-year system warranty

For more information contact:
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Fax: (860) 535-5304
URL: http://www.hubbell-premise.com

*Vendor-supplied information not verified by The Tolly Group
For both Category 5e and Category 6 channel tests, engineers generated a minimum of 10 billion 64-byte packets, including the 4-byte Cyclical Redundancy Checksum (CRC), of bidirectional traffic across each of the structured cabling system configurations. SmartBits controller verified the number of received packets across the system and engineers reported any missing packets, CRC errors, and fragmented packets. Engineers tested the cables in each test for one iteration and verified that there was a bit error rate of less than or equal to $10^{-10}$ as specified in the IEEE 802.3ab objectives for 1000Base-T. Engineers also verified that for all tests there was a bit error rate of $10^{-13}$.

The Tolly Group gratefully acknowledges the providers of test equipment used in this project.

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<tr>
<th>Vendor</th>
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<td>Fluke Corp.</td>
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<tr>
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<td>DSP-4000 Smart Remote</td>
<td><a href="http://www.fluke.com">http://www.fluke.com</a></td>
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Since its inception, The Tolly Group has produced high-quality tests that meet three overarching criteria: All tests are objective, fully documented and repeatable. We endeavor to provide complete disclosure of information concerning individual product tests, and multiparty competitive product evaluations.

As an independent organization, The Tolly Group does not accept retainer contracts from vendors, nor does it endorse products or suppliers. This open and honest environment assures vendors they are treated fairly, and with the necessary care to guarantee all parties that the results of these tests are accurate and valid. The Tolly Group has codified this into the Fair Testing Charter, which may be viewed at http://www.tolly.com.

Project Profile

Sponsor: Hubbell Premise Wiring, a division of Hubbell, Inc.
Document number: 200231
Product class: Structured cabling systems
Products under test:
- Hubbell Premise Wiring, a division of Hubbell Inc. SPEEDGAIN™ Category 5e System
- Hubbell Premise Wiring, a division of Hubbell Inc. NEXTSPEED® 670 Category 6 System
- General Cable Industries Inc. PlatinumPLUS 350 and Command LINX 6

Testing window: October 2000

For more information on this document, or other services offered by The Tolly Group, visit our World Wide Web site at http://www.tolly.com, send E-mail to info@tolly.com, call (800) 933-1699 or (732) 528-3300.