Frequently Asked Questions (FAQs) — 10G Ethernet Applications

Q: What is 10G Ethernet?

10G Ethernet is part of the family of IEEE applications standards developed for copper and fiber optic cabling that support 10 Gigabit per second (Gb/s) transmission rates.

The published IEEE 802.3ae Standard is specified for fiber optic media and supports 10 Gb/s transmission rates for multiple fiber optic types. This new standard offers a straightforward upgrade path for Gigabit Ethernet backbones and makes provisions for linking Ethernet Local Area Networks (LANs) to Metropolitan and Wide Area Networks (MANs and WANs). The four most commonly referenced fiber optic 10G Ethernet cabling options specified in the IEEE 802.3ae standard are:

IEEE 802.3ae 10G Ethernet Fiber Optic Applications			
Fiber Optic 10G Ethernet Application	Wavelength	Fiber Type	Maximum Distance Supported
10GBASE-SX	850nm	50/125µm laser-optimized multimode*	300m
10GBASE-LX	1310nm	singlemode	10km
10GBASE-EX	1550nm	singlemode	40km
10GBASE-LX4	1310nm	50/125µm multimode** 62.5/125µm multimode**	300m
		singlemode	10km

*50/125mm laser-optimized multimode fiber transmission requirements are specified in TIA/EIA-568-B.3.1 and ISO/IEC 11801:2002 2nd Ed.
**500 MHz-km model bandwidth @ 1300nm required for 300m distance.

The pending IEEE 802.3an standard describes the 10GBASE-T application for operation over category 6/class E, augmented category 6/class E, and class F twisted-pair copper cabling. It is interesting to note that the project objectives for 10GBASE-T support reduced lengths of operation over category 6/class E cabling. 10GBASE-T is not targeted for operation over category 5e/class D cabling.

IEEE 802.3an 10GBASE-T Twisted-Pair Application Distance Support		
Media	Standards Reference	Maximum Distance Supported
Category 6/Class E	TIA/EIA-568-B.2-1 ISO/IEC 11801:2002 2nd Ed.	Up to at least 55 meters
Proposed Augmented Category 6/Class E	Pending TIA SP-3-4426-AD1 (to be published as TIA/EIA-568-B.2-10) Pending ISO/IEC JTC 1/SC 25 N 981 A (to be published as amendment 1 to ISO/IEC 11801:2002 2nd Ed.)	100 meters
Class F	ISO/IEC 11801:2002 2nd Ed.)	100 meters

In addition, the published IEEE 802.3ak 10GBASE-CX4 standard specifies 10G Ethernet operation on twinaxial cabling over distances of up to 15 meters. This standard should not be confused with applications such as 10GBASE-T that operate over balanced twisted-pair cabling.

Q: What is driving the demand for 10G Ethernet?

There are four major drivers that are spurring demand for 10G Ethernet:

1. Enterprise data centers and server consolidations — 10G Ethernet will facilitate large amounts of data to be processed very quickly. A critical capability considering that a delay of even one second in transmission time can result in million dollars losses for many time-critical applications such as automated trading and other financial transactions.

2. Low-cost campus backbones for future expansion — It is often more cost effective for public and private enterprise campuses, such as education institutions and hospitals, to build out their own fiber backbones between buildings and between campuses. For example, a Voice over IP (VoIP) system can reduce the number of external lines leased from the phone carrier and deliver high-quality voice over the same networks that are used for data, while improving system performance and quality, increasing network management flexibility, and reducing telephone and leased line charges.

3. Metropolitan Area Networks — The MAN has traditionally been capable of handling 10G services in the form of SONET/SDH OC-192/STM-64. Now, with adoption of the newly published 10G Ethernet standards for singlemode fiber, Ethernet in the MAN is becoming even more popular and

delivery of IP services over the MAN is growing rapidly. As companies like Cisco, Nortel, Lucent, Extreme and Foundry continue to build 10G Ethernet cards for their optical switches, Ethernet will flow seamlessly across the MAN and the entire WAN opening wide the opportunities for even greater IP-based Virtual Private Network (VPN) services.

4. IP-Based Security — Historically, most security systems operated over a dedicated network that was separate from the data network and costly to operate. Today's new security systems are Internet Protocol (IP) based and utilize addressable components that deliver high-quality video, voice and data over the same network as the current data system. In this new approach, each security device (e.g. retina scanners, X-ray machines, etc.) becomes an addressable node on the data network, thereby allowing voice, data and video applications to converge onto a single platform. Clearly, the security market and the emphasis on reliability is a driving factor for increased bandwidth services like 10G Ethernet. In fact, projections for 10G Ethernet are staggering; with analysts predicting that by 2006, over 750,000 10G Ethernet ports will have shipped and the total market will be in excess of US $4 billion.

Q: Will my IT network really need to support 10Gb/s throughput in the next 5 years?

Absolutely! The education, finance, government, healthcare, and industrial markets all have initiatives mandating the manipulation of extremely large files at the desk top within the near future. Typical file sizes associated with the initiatives and other applications needs are:

Typical File Sizes Associated with Large-Scale Computing Needs	
HIPAA — Health Insurance Portability and Accountability Act of 1996 This Act requires improved efficiency in healthcare delivery by standardizing electronic data interchange, of electronic patient health records	Teleradiology and magnetic resonance imaging (MRI) files are typically compressed; fused files can be in excess of 100 Megabytes.
Sarbanes-Oxley Act (SEC Rule and Regulations) Following a series of high profile scandals, the objective of this Act is to protect investors by improving the accuracy and reliability of corporate disclosures made pursuant to the securities laws.	1 – 10 Megabyte
Petro-Chemical and Energy Company Disaster Recovery files	10 – 30 Megabyte
Typical Backup Files	1 Gigabyte to 100 Megabyte
Backup file for Redundancy	Up to 1 Terabyte
Emergency 911 Initiatives and Satellite Imagery Downloads	10 – 30 Megabyte
Scientific Grids for Open Computing	10 – 30 Megabyte
Large CAD/CAM and Graphics files	1 – 30 Megabyte

Moore's law and Gate's law demonstrate just how quickly IT development progresses. Network speeds increased from 10Mb/s to 100Mb/s in 5 years and from 100Mb/s to 1Gb/s in only 3 years. The migration to 10Gb/s is anticipated to occur just as quickly, especially since today's active equipment manufacturers, such as Cisco, Extreme, Foundry, Lucent, and Nortel, are driving the technology forward.

Q: What is the transfer time for a 30 Megabyte file for various Ethernet applications?

30 Megabyte file transfer times*		
Application	Throughput	Transfer Time
10GBASE-T	10,000 Mb/s	24 seconds
1000BASE-T	1,000 Mb/s	4 minutes
100BASE-T	100 Mb/s	40 minutes
802.11g Wireless	54 Mb/s	148 minutes

*Approximation excluding encoding bits

Since Ethernet is a shared network, only one user may access the server at a time. In disaster or triage situations, transfer times must be multiplied by the number of users who need to access the information in order to calculate accurate file delivery times. Clearly, the need to support 10GBASE-T already exists today.

Q: How will the 10GBASE-T application support 10Gb/s transmission rates over twisted-pair copper cabling?

The 10GBASE-T application will utilize a 12-level, pulse amplitude modulation (PAM-12) encoding scheme to transmit data at a rate of 825 million symbols per second (825 Mbaud). Transmission will employ full-duplex (transmitting and receiving information at the same time) operation over all 4-pairs for a data rate of 2.5 Gb/s per twisted-pair. Sophisticated crosstalk (both near-end and far-end) and return loss cancellation technology will be employed to increase available signal-to-noise margins.

Q: When will the 10GBASE-T standard publish?

The IEEE 802.3an standard is anticipated to publish in July 2006.

Q: When can I expect 10GBASE-T equipment to become commercially available?

Applications equipment, including hubs, switches, routers, and switched interfaces on work area equipment, typically become commercially available 18 months after an applications standard publishes. It is anticipated that 10GBASE-T equipment will be as commercially available as 1000BASE-T equipment is today by December 2007. It is anticipated that the per-port cost of 10GBASE-T equipment will be double that of 1000BASE-T equipment.

Q: What is the usable life expectancy for my cabling system, network equipment, and applications software?

For planning purposes, an acceptable guideline is to calculate network ROI (return on investment) using life expectancies of 10 years for the cabling plant, 5 years for network equipment, and 18 months for applications software. For high performance category 7/class F cabling, it is recommended to use a life expectancy of 15 years in ROI calculations for the cabling plant.

Q: There are so many 10GBASE-T acronyms. What do they mean?

DSP (Digital Signal Processor) — The device responsible for converting high frequency analog signals into digital form.

DTE (Data Terminal Equipment) — Any end-user device that converts information into data bits for transmission or converts received signals into end-user information.

MAC (Media Access Control) — A means for converting data into a form that can be sent over the network and for ensuring that data is being sent to the correct address. Data conversion involves cutting the data into sections (also called frames) and then adding error detection and recovery information. A MAC address is a numeric identifier that is unique to each device attached to a network.

OSI (Open Systems Interconnect) — A model developed by the ISO International Standards Organization to allow computer systems made by different vendors to communicate with each other. The purpose of OSI is to create a worldwide open systems networking environment where all systems are interoperable.

PHY (Physical Layer Interface) — The chip responsible for putting the signal onto the copper twisted-pair or fiber optic cabling channel. The PHY defines operational features such as transport medium, data rate, type of modulation, signaling specifics, transmit and receive synchronization, etc.

PMD (Physical Medium Dependent) — The quality and type (i.e. balanced twisted-pair or fiber optic) of the actual hardware that has to be used for data transmission. Hardware may include cables, connectors, transmitters, receivers, and optical bypass switches.

Q: What is the OSI Model?

OSI defines a framework for network communications that has seven layers as follows:

7 — the application layer,
6 — the presentation layer,
5 — the session layer,
4 — the transport layer,
3 — the network layer,
2 — the data link or MAC layer (which is broken into two sections, Data Link and Logical Link Control),
1 — the physical layer.

Control is passed from one layer to the next and is initiated at either layer 1 (the physical layer) or layer 7 (the application layer). For example, network communication may be initiated at the application layer by a work-station user opening an application and typing a request. Communication is then passed through each of the seven layers down to the physical layer (where the actual transmission of data occurs). Each layer adds the information that it needs and removes that same information off at the receiving end. Layer 7 packet sizes are the smallest and layer 1 packet sizes are the largest. On the receiving end, control passes back up the hierarchy in reverse order.

Q: What is the development status of the proposed augmented category 6/class E cabling standards?

Both proposed draft TIA/EIA-568-B.2-10 and draft amendment 1 to ISO/IEC 11801:2002 2nd Ed. standards are targeted to publish before the July 2006 publication date of the IEEE 802.3an standard.

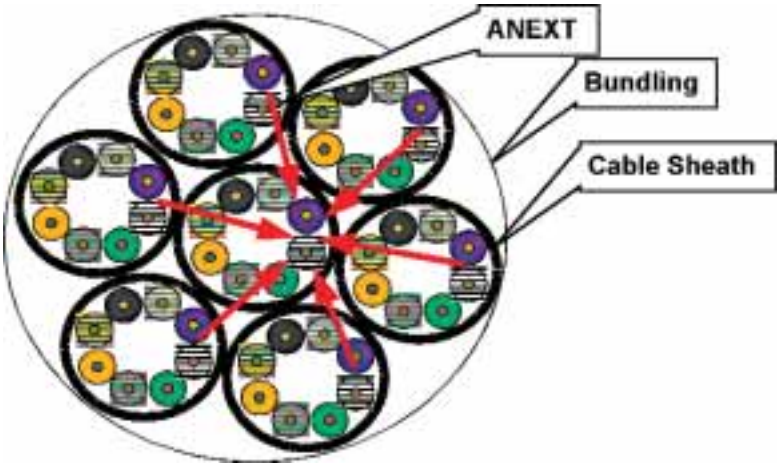
Q: What are the main differences between the specifications for category 6 and augmented category 6?

Augmented category 6/class E cabling requirements will extended the frequency characterization of existing category 6/class E cabling requirements to 500 MHz, specify increased insertion loss headroom (equivalent to class F performance), and include new requirements for the parameter of alien crosstalk.

[1]For more information, see 2004 IWCS Savi white paper titled, "10G Ethernet over Structured Copper Cabling"

Q: What is alien crosstalk?

Since proposed IEEE 802.3an 10GBASE-T is the first balanced twisted-pair Ethernet application to support both near-end and far-end crosstalk cancellation, the differential noise contribution from within the cable is virtually zero. For the first time, differential noise sources from outside of the cabling channel will have the greatest impact upon the signal-to-noise ratios. Alien crosstalk is undesired crosstalk coupling from a pair within a cable to another pair external to the cable's jacket. Power sum alien crosstalk is a mathematical computation of the total alien crosstalk present when all disturbing pairs are energized. Typically, the worst alien crosstalk coupling occurs between pairs with similar pair twists or lays.



Alien crosstalk effects can be measured on the same end as the transmitter (ANEXT) or the opposite end of the transmitter (AFEXT). ANEXT, power sum ANEXT, AFEXT, and power sum AFEXT should be characterized to ensure support of the 10GBASE-T application.

Q: Will there be field testers capable of determining augmented category 6/class E performance?

At a minimum, field testers that comply with the level IIIe accuracy requirements specified in proposed TSB-155 will be required to assess installed cabling performance for all cabling parameters (except alien crosstalk) up to 500 MHz. It is under consideration that alien crosstalk may be assessed in the field via an auto-negotiation algorithm built into network equipment and initiated during equipment start-up.

Q: How can I be assured that the cabling system that I install today will support the 10GBASE-T application?

To ensure support of the 10GBASE-T application over 100-meter, 4-connector topologies prior to the ratification of the IEEE 802.3an standard, cabling designers should request a warranted solution from their cabling system partner. A complete warranty should provide:

- Guaranteed support of 10GBASE-T over 100-meter, 4-connector topologies
- Guaranteed product performance and applications assurance coverage
- Comprehensive link and channel coverage
- Parts and labor coverage on cable and connecting hardware
- One point of contact