X3T9.2/92-8
11 JAN 1992

An Introduction to X3T9 and I/O Interface Standards

William E. Burr
NIST
Bldg 225, Rm. A-216
Gaithersburg, MD 20899
(express package service: Quince Orchard Rd & I-270)
(301) 975-2914
Fax: (301) 590-0932
burr@csmes.ncsl.nist.gov

Abstract: More than a dozen published ANSI standards have been developed in Technical Committee X3T9, about a half dozen more are approved but not yet published or are nearing final approval, and more than 20 projects to create new standards or revise existing standards are in various stages of development. This document provides a summary of those I/O Interface standards and projects. For the current status of each standards project see the *Project Status Summary Sheet* which is updated at each X3T9 meeting and attached to the minutes of that meeting. A brief summary of how X3T9 meets and creates standards is also included.

I/O Interfaces for the 1990s

I/O interfaces are high bandwidth block transfer interfaces. They are used to connect computers to high speed peripherals, usually storage peripherals, and to other computers. Computing is a rapidly evolving area, and, like other aspects of computing, I/O interfaces have changed dramatically over the past two decades of X3T9's existence. While I/O interfaces have always been used to connect mainframes together, in this era of distributed computing, it is not always clear what is a computer and what is a peripheral. In fact, where once we had a central processor and peripheral storage, today we may have a central storage facility, and effectively peripheral processors. New types of high speed devices for image processing, motion video and the like must now be acommodated.

I/O interface are primarily storage device oriented. The physcal interconnection medium of an I/O interface is often accompanied by command sets for various storage devices. In early I/O interfaces the command processing logic was located in a separate controller which often controlled several drives and the earliest X3T9 I/O interfaces were highly specialized device controller to drive interfaces. In the SMD interface, for example, blocks of data are transferred over a high speed bit serial link between a controller and a drive, while a parallel bus provides a number of disk drive specific, real time control signals, which allow the controller to control a "dumb" disk drive with little internal logic.

As microprocessor technology progressed, it became possible to build controllers with powerful processors into storage peripherals. Newer interfaces, such as SCSI and IPI, implement command sets where the peripheral is a peer to the computer on the bus, and is given much higher level commands by the computer. While current SCSI and IPI command sets require "out of band" information provided by the interface (for example to distinguish a command transfer from a data transfer), they are evolving to "packetized" forms which minimize or eliminate out of band signals, allowing their use over any bit, byte or word serial transfer medium. They also are evolving to move more and more functionality into the storage peripheral, to manage its own affairs including its error recovery, to include large cache memories, to search data, to provide resource sharing features to allow access from multiple hosts and even to handle files directly, rather than storage blocks.

As distributed computing has evolved, it has become necessary to tie peripherals to many hosts distributed over a large area. At the same time, storage devices and computers have become much smaller, limiting space for connectors. Both trends encourage the development of bit serial fiber optic and electrical network oriented interfaces. X3T9 has anticipated these developments and pioneered them, particularly with FDDI, the first I/O interface and general purpose local network standard to use fiber optic media.

Paradoxically, while distributed computing has generated a need for interfaces which support large areas and connection to many systems, the empahsis on inexpensive desktop, laptop and notebook computers has also generated a need for very small internal storage device packages, with interfaces which minimize cost, weight and power consumption, while allowing easy integration into these sytems. The interfaces and packaging must allow nontechnical users to install storage devices in their systems. The ATA and DADI interface standards will address these needs.

A new generation of devices and applications oriented to image, motion video and multimedia applications are being developed. RAID (redundant array of inexpensive drives) disk technology provides bandwidth for image applications. Optical and moving head tape devices and automated libraries also provide the immense capacaties required for such applications. High performance scanners and page printers now frequently come with SCSI ports and are connected directly to disk drives which serve their storage needs. The bandwidth and storage capacities required for color image processing are immense.

These applications will require still more bandwidth, more storage and, in many cases, guarantees on bandwith and access delays, including fully isochronous services. X3T9 is anticipating these developments in such standards as FDDI, FDDI-II, FFOL, HIPPI and Fiber Channel, which offer both the bandwidth required and services which constrain delay jitter. "Real time" constraints are really not new to I/O interfaces, since the earliest unbuffered disk drive to controller interfaces (such as SMD) had very similar constraints, due to the lack of buffering in the drives.

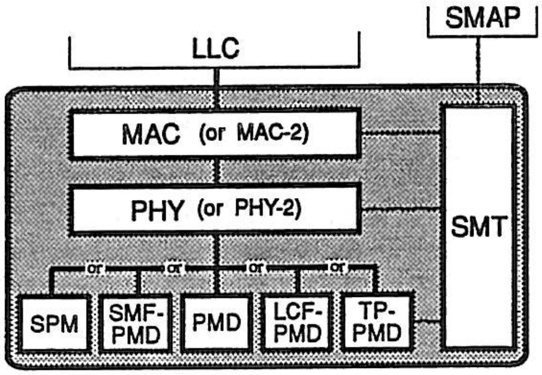
I/O interfaces are intended to support *open computing* in the commercial sense of allowing users and integrators to choose commodity peripherals from competing suppliers. I/O interface standards are a necessity of an open marketplace. I/O interface standards are not specifically intended to support *Open Systems Integration (OSI)*, that is a particular standard communications stack which facilitates networking of independent computer systems.

X3T9 recognizes, however, that the I/O interface is often the only high bandwidth external port offered by computers and "good citizenship" requires compatibility and interworking with OSI and other communications standards. FDDI and FDDI-II not only support storage peripherals and multimedia applications; they offer services which are highly compatible with established, much lower bandwidth, existing LAN standards and are easily integrated into extended networks with these LANs. They are as compatible with lower bandwidth LAN standards as those standards are with each other. FDDI-II offers services which are highly compatible with the existing long distance communications networks (particularly the DS1 and DS3 services). FFOL will interwork seamlessly with current packet LANs as well as emerging long distance communications technologies such as SONET and B-ISDN. When Gbps OSI wide area networks are available, they will find that among the features of HIPPI and Fiber Channel are specific provision for LLC PDUs, as well as support for SCSI and IPI device command sets. SCSI and IPI provide commands for attaching communications controllers to their busses.

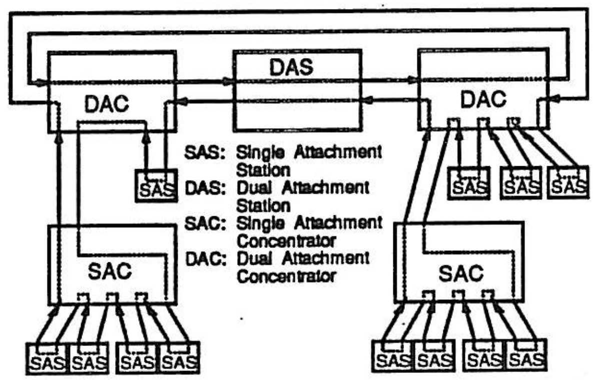
The 1990s will be an exciting and fast moving era in computer I/O interfaces. The market demands improved I/O interface standards and will not wait long for them. Timely development of interface standards in a fair, open forum helps markets to develop and reduces needless risks to both producers and users. X3T9 expects to meet the challenges of the future as it has met those of the past, although the sheer demands of the market and technology may make I/O interface standards development seem a hectic and bewildering, if exhilarating, process. Where higher level communications standards may hope to deliberately and carefully chart the development of standards over decades, physical technology development drives I/O interface standards development at a comparatively frantic pace.

This document provides an introduction to the published X3T9 standards as well as those under development, information on how to get copies, and a simplified description of the standards development process in X3T9, in the hope of making I/O interface standards more accessible to users, new participants in X3T9 and observers in the standards community.

Fiber Distributed Data Interface (FDDI)



Standards Architecture



Topology

Description

FDDI is a 100 Mbps token ring network which supports large configurations (more than 100 stations with 100 km of cable). It uses a timed token protocol which supports a *synchronous* service with preallocated bandwidth and strictly bounded access delays, an *asynchronous* service with no bandwidth preallocation but weak access delay guarantees, and a *restricted token* service for dedicated real time control applications. Unused synchronous bandwidth is available for asynchronous use. The protocol is fully distributed with no master station. The FDDI dual ring of trees topology combines both dual rings and concentrator based trees. FDDI's services are similar to the IEEE 802 LANs and supports the "universal" 48 bit MAC addresses and the IEEE 802.2 LLC sublayer.

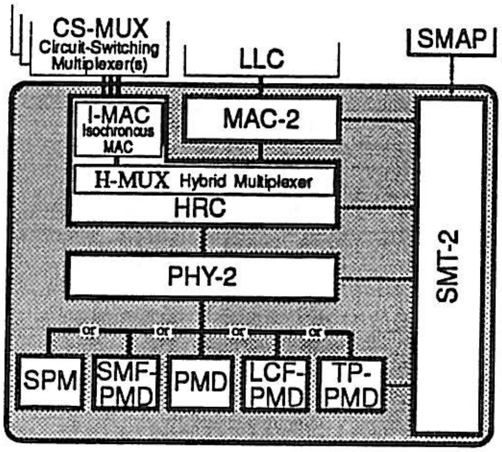
The MAC standard defines FDDI frames (packets) and the token pasing medium access protocol. The PHY standard describes the FDDI 4 of 5 bit code and clocking; FDDI reclocks data to a local oscillator in every station. The SMT standard defines the FDDI *Management Information Base (MIB)* and the detailed management facilites and procedures.

FDDI links may use a variety of physical media. The various *Physical Medium Dependent (PMD)* standards and projects are described under FDDI Media on page 6.

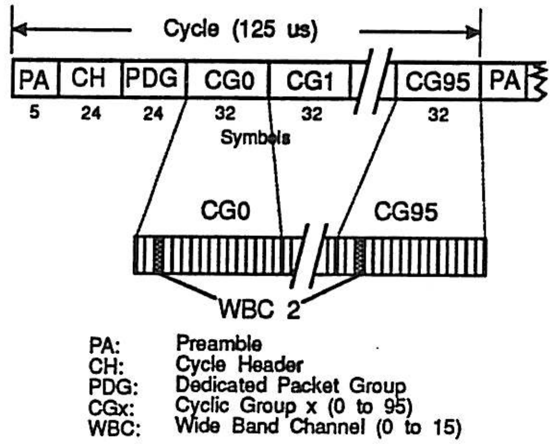
Standards

- Medium Access Control (MAC), X3.139-1987, Project 380D, ISO 9314-2.
- Physical Layer Protocol (PHY), X3.148-1988, Project 379D, ISO 9314-1.
- Station Management (SMT), Project 840D, 9413-7.

FDDI-II Hybrid Ring Control (HRC)



Standards Architecture



Cycle Structure

Description

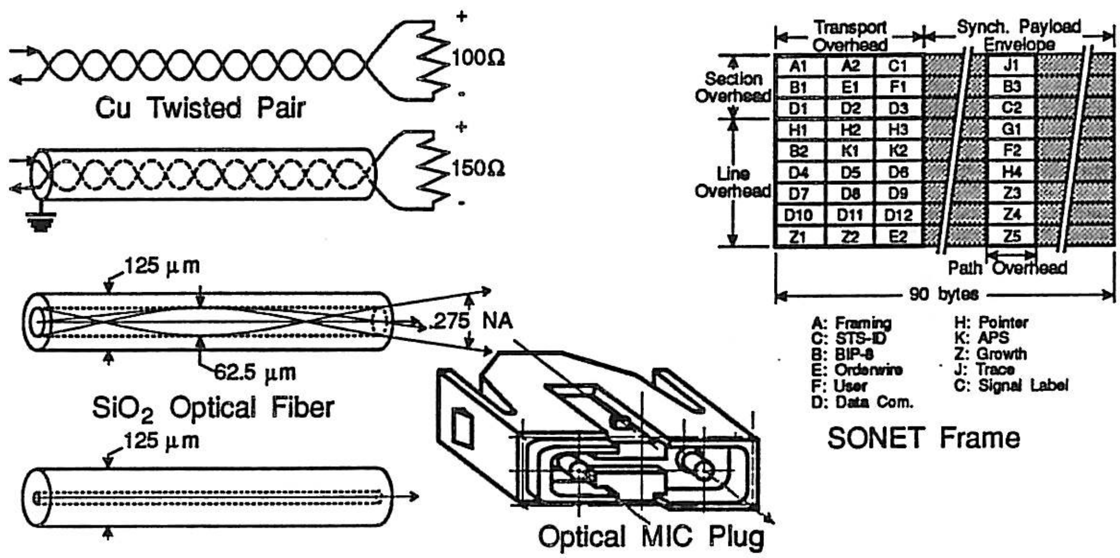
FDDI-II provides an integrated services LAN, supporting multimedia applications. It uses the FDDI dual ring of trees topology and the FDDI PMD alternatives and preserves the token ring packet service of FDDI. FDDI-II adds a circuit switched isochronous service compatible with the circuit switched carriers of public networks. FDDI-II rings start out in *basic mode* with only the packet service. Using the basic mode packet service a *cycle master* is determined and the ring transitions to *hybrid mode.* In hybrid mode the cycle master issues 125 us (8 kHz) cycles and the bandwidth is divided into 0 to 16 isochronous 6.144 Mbps *Wide Band Channels (WBC),* plus a token ring packet service. Bandwidth not allocated to the isochronous service is available to the packet service. Management is via the packet service, and a packet service of .768 Mbps remains when all 16 WBCs are allocated.

FDDI-II stations are interoperable with FDDI stations in basic mode. MAC-2 and PHY-2 are upward compatible extensions of FDDI MAC and PHY and may be substituted for them in FDDI stations. For a ring to operate in hybrid mode all stations must implement MAC-2, PHY-2 and HRC. FDDI-II uses the same PMD standards for its links as FDDI; they are described on page 6.

Standards

- Medium Access Control (MAC-2), X3T9.5/88-139, Project 684D, 9314-8.
- Hybrid Ring Control (HRC), X3.186-199X, Project 573D DIS 9314-5.
- Physical Layer Protocol (PHY-2), X3T9/91-047, Project 761D, CD 9314-7.

FDDI Media Standards



Description

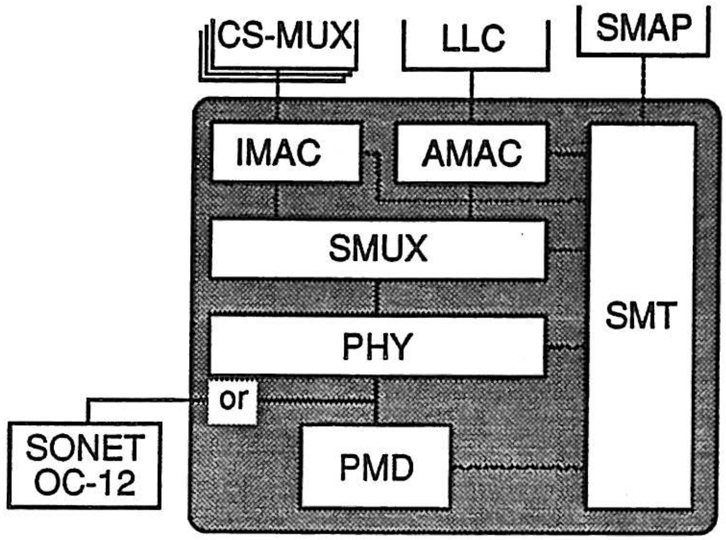
FDDI has established Physical Medium Dependent (PMD) standards for both multimode fiber and single mode fiber media, and projects are under way to develop a lower cost multimode fiber PMD standard, an electrical twisted pair PMD standard and a mapping of FDDI onto SONET telephone trunks. Their characterists are summarized below:

Name	Medium	Maximum Distance	Power Budget	Transmitter
PMD	62.5/125 µm multimode optical fiber, NA: 0.275	2 km	11 dB	1300 nm LED
LCF-PMD		500 m	7 dB	
SMF-PMD, Cat. I	125 µm cladding single mode fiber	20 km	10 dB	1300 nm laser
SMF-PMD, Cat. II		64 km	32 dB	
TP-PMD	150Ω shielded Cu twisted pair or 100Ω data grade type 5 unshielded Cu twisted pair	100 m	dispersion & EMI limited.	electrical
SPM	SONET STS-3	unlimited	N/A	N/A

Standards

- Physical Layer Medium Dependent (PMD), X3.166-1990, Project 541D, ISO-9314-3.
- Single-Mode Fiber Physical Layer Medium Dependent (SMF-PMD), X3.184-199X, Project 651D, CD 9314-4.
- Twisted-Pair Physical Layer Medium Dependent (TP-PMD), Project 833D, 9314-10.
- Low Cost Fiber Physical Medium Dependent (LCF-PMD), Project 834D, 9314-9.
- SONET Physical Mapping (SPM), Project 530D, 9314-12.

FDDI Follow-On LAN (FFOL)



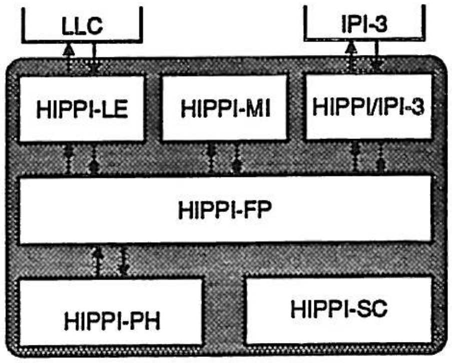
Description

FFOL is a follow-on to FDDI and FDDI-II. It will be able to use existing FDDI cable plants. It will offer an FDDI compatible packet service (although not necessarily based on token passing). FFOL will offer an isochronous service and will be capable of transporting FDDI-II WBCs as well as interworking efficiently with SONET. Support for Broadband Integrated Services Data Network (B-ISDN) Asynchronous Transfer Mode (ATM) cells will be considered. FFOL will support a data rate of at least 600 Mbps.

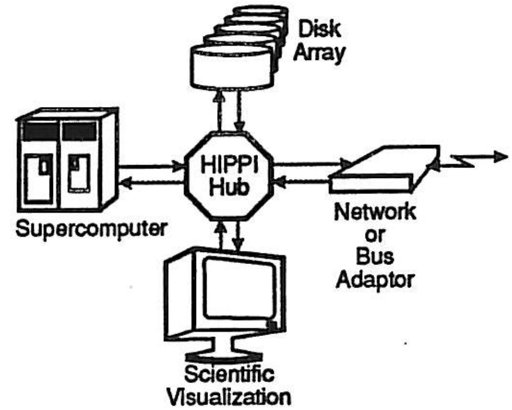
Standards

- *Isochronous Media Access Control (IMAC)*, Project 839D, 9314-23.
- *Asynchronous Media Access control (AMAC)*, Project 838D, 9314-24.
- *Service Multiplexer (SMUX)*, Project 837D, 9314-22.
- *Physical Layer Protocol (PHY)*, Project 836D, 9314-21.
- *Physical Medium Dependent (PMD)*, Project 835D, 9314-20.
- *Station Management (SMT)*, Project 840D, 9314-25.

High Performance Parallel Interface (HIPPI)



Standards Architecture



Example Configuration

Description

HIPPI is a high-performance point-to-point interface which supports very high performance computing. HIPPI may be simplex or duplex. For duplex operation HIPPI uses two 32 (or 64) bit wide unidirectional, point-to-point electrical paths to obtain an 800 (or 1600) Mbps transfer rate. The maximum distance supported is 25 m with copper twisted-pair cables. A 32 (or 64) bit *word* is transferred on every 40 ns cycle; words are grouped into *bursts* and bursts are grouped into *packets*. Four (or 8) parity lines provide byte parity for each word, while a vertical parity word protects each burst. Bursts contain 256 words (or fewer). Packets consist of 1 or more bursts; the first burst contains a 64-bit HIPPI-FP packet header.

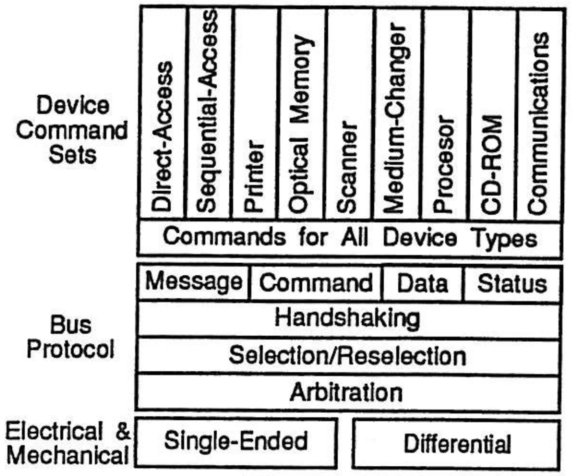
HIPPI supports both circuit and packet switching. Physical level switches provide circuit switched connections between several devices. A 32 bit I-field is provided during connection establishment which can be used to control the switch.

There is a mapping for IEEE 802.2 LLC frames (including FDDI frames) on HIPPI. There is another mapping for IPI-3 command sets over HIPPI. A protocol defining memory read, write and lock operations is provided.

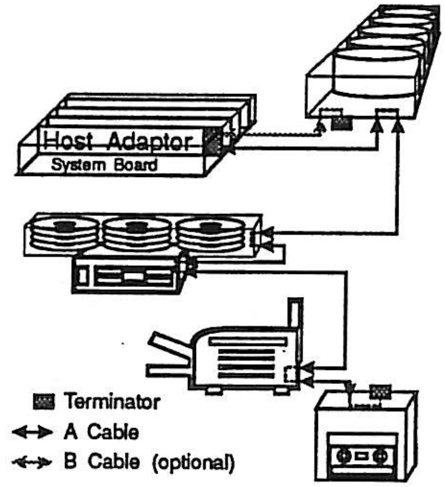
Standards

- *Mechanical, Electrical and Signalling Protocol Specification (HIPPI-PH)*, X3.183-1991, Project 667D, 11 518-1.
- *Framing Protocol (HIPPI-FP)*, X3.210-199X, Project 702D, 11 518-2.
- *Encapsulation of ISO 8802-2 (IEEE Std 802.2) Logical Link Control Protocol Data Units (HIPPI-LE)*, X3.218-199x, Project 825D, 11 518-3.
- *Mapping to IPI-3 Command Sets (HIPPI/IPI-3)*, Project 782D, 11 518-4.
- *Memory Interface (HIPPI-MI)*, Project 788D, 11 518-5.
- *Switch Control (HIPPI-SC)*, Project 818D, 11 518-6.

Small Computer System Interface (SCSI & SCSI-2)



SCSI-2 Architecture



Example SCSI-2 Configuration

Description

Since its introduction in 1986 SCSI has become the nearly universal I/O interface for engineering workstations and for the attachment of external storage devices to all small computers. It is widely used on magnetic disk drives and is the common interface for small OEM tape drives and optical disk drives. SCSI-2, which is a revision and generally compatible extension of SCSI, is illustrated above. Today, new products are generally designed to the SCSI-2 draft standard.

SCSI-2 is an 8-bit parallel bus with an optional extension to 16/32 bits via a separate cable. Two electrical variants are defined, single-ended (lengths up to 6 m) and differential (lengths up to 25 m). Up to 8 devices can be attached to the bus. Two transfer modes are defined: *asynchronous*, capable of rates up to 12 (or 24/48)* Mbps and *synchronous*, capable of transfer rates up to 40 (or 80/160) Mbps. SCSI is a distributed protocol; bus devices capable of being *initiators* (usually a host computer) arbitrate bus access then select a *target* (usually a peripheral). More than one initiator is permitted. Each target can control up to 8 *logical units*.

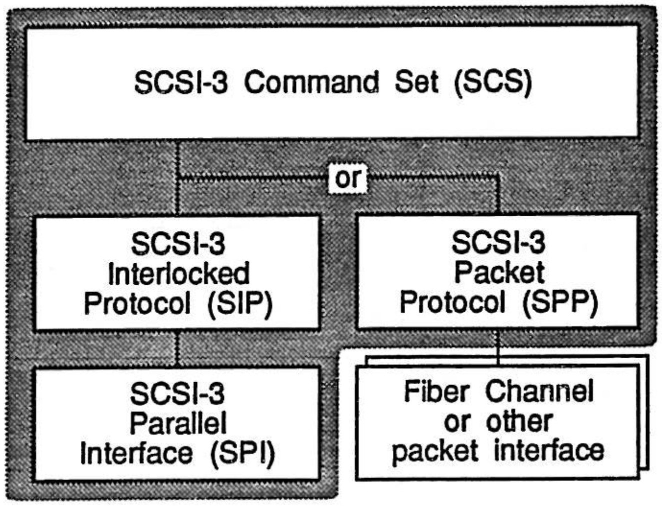
A *host adaptor* is a device attaching the SCSI I/O bus to a host computer's internal bus. SCSI does not define the host adaptor software interface. In systems where SCSI is the "native I/O interface," the SCSI host adaptor software interface is often well established. Where SCSI has not been supported by the OS vendor, chaos has reigned. The *Common Access Method (CAM)* standardizes the UNIX, DOS and Novell host adaptor software interface.

Standards

- *Small Computer System Interface (SCSI)*, X3.131-1986, Project 375D, ISO 9316.
- *Small Computer System Interface - 2 (SCSI-2)*, X3.131-199x, Project 375R, DIS 9316-1.
- *SCSI-2 Common Access Method Transport and SCSI Interface Module (CAM)*, X3T9.2/90-143, Project 792D, 9316-2.

* NOTE: Higher rates are possible with buses which are less than maximum length.

SCSI-3



Description

SCSI-3 continues the evolution of the SCSI and SCSI-2 standards. It will extend peripheral device command sets as required by the evolution of peripheral device technology. It will support more than the present 8 directly addressable devices and dual port operation. Perhaps most significantly, SCSI-3 will divide the SCSI standard into four separate standards with three layers: Command Set, Protocol and Interface.

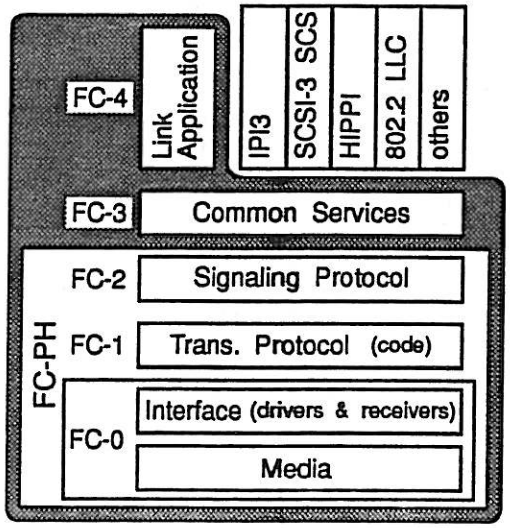
It will be possible to use the SCSI device command sets over two alternative Protocol/Interface "stacks":

- An extension of the existing interlocked parallel bus protocol, extended from 8 to at least 16 bus devices and to allow optional 16-bit transfers with one cable.
- A "packetized" stack suitable for bit serial media such as Fiber Channel or HIPPI, as well as the SCSI-3 Parallel Interface.

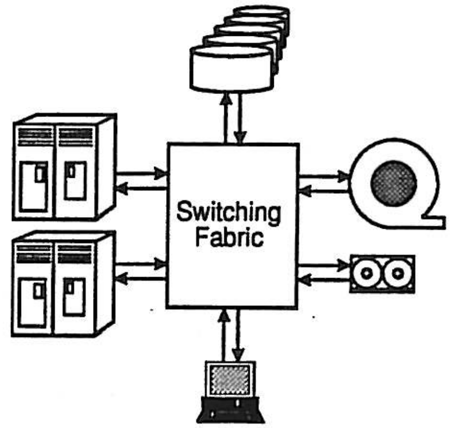
Standards

- *SCSI-3 Command Set (SCS)*, Project 854D, 9316-3.
- *SCSI-3 Interlocked Protocol(SIP)*, Project 856D, 9316-4.
- *SCSI-3 Parallel Interface(SPI)*, Project 855D, 9316-5.
- *SCSI-3 Packetized Protocol(SPP)*, Project 881D, 9316-6.

Fiber Channel (FC)



Standards Architecture



Example Configuration

Description

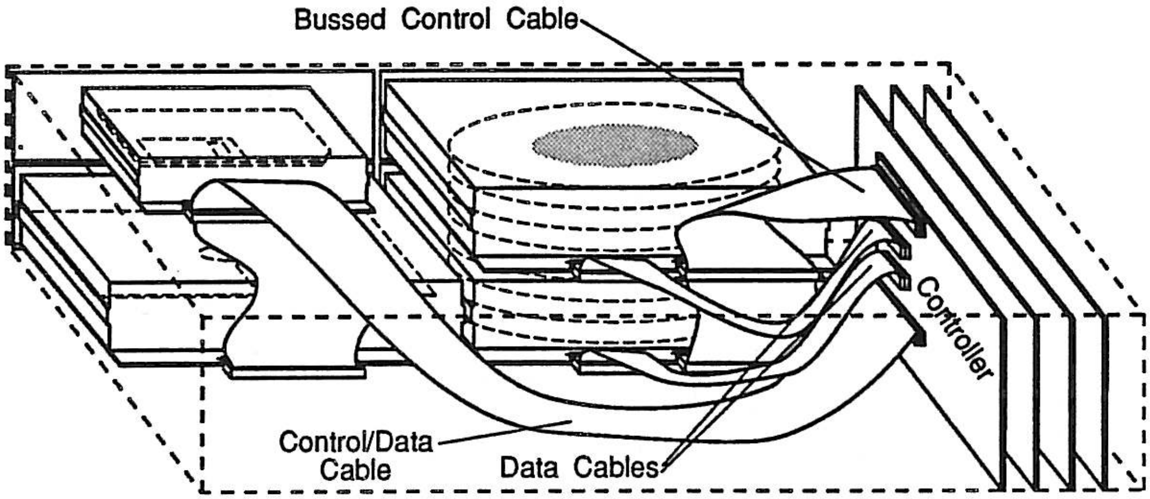
The Fiber Channel provides a transport vehicle for the IPI-3 and packetized SCSI command sets as well as the HIPPI data framing. Fiber Channel defines an interface which is used with a Switching Matrix to interconnect many ports which may be spread over a campus or larger area. FC is layered as follows:

- FC-0 defines the media, connectors, transmitters and receivers. Data rates of 12, 25, 50 and 100 Mbyte/s are supported. Various combinations of media, transmitter/receiver and rates are defined. Three optical media (62.5/125 and 50/125 um multimode fiber and single mode fiber) are used with 1300 nm LED and laser transmitters or 780 nm lasers. Optical links of up to 10 km are supported. Electrical interfaces are defined using co-axial cables. The links in a FC fabric need not use the same technology or rate.
- FC-1 defines the transmission protocol including a DC balanced 8 of 10 code.
- FC-2 defines the variable length (up to 2112 information bytes) FC frame. Addressing uses 24 bit source and destination addresses. A signaling protocol provides connections through the fabric and flow control for fabric to port links.
- FC-3 defines common services which support FC-4.
- FC-4 defines the mapping between the FC and the higher level device command sets (*e. g.* IPI or SCSI-3 SCS) supported by FC or the HIPPI data framing.
- FC-F defines the requirements for FC fabrics.

Standards

- *Fiber Channel Physical Layer (FC-PH)* (includes FC-0, FC-1 & FC-2), Project 755D.

Device Interfaces



Description

Device level interfaces connect a drive to a controller. Typically the drive and the controller are contained within the same enclosure and the electrical design does not permit external drives. For hard disk interfaces, two cables are typically used; a control cable which may be bussed to several drives and data cables which are radial to each drive, because of their much higher rates. The flexible disk and streaming cartridge tape drive interfaces bus control and data in one cable.

SMT has been widely used with 14 inch and 8 inch hard disk drives for minicomputer systems. ESDI is an enhanced version of the de facto standard ST-506 interface, which was for many years the dominant interface for 5.25 inch and 3.5 inch hard drives. ESDI offers higher transfer rates than ST-506 and is primarily used for higher capacity 5.25 inch drives.

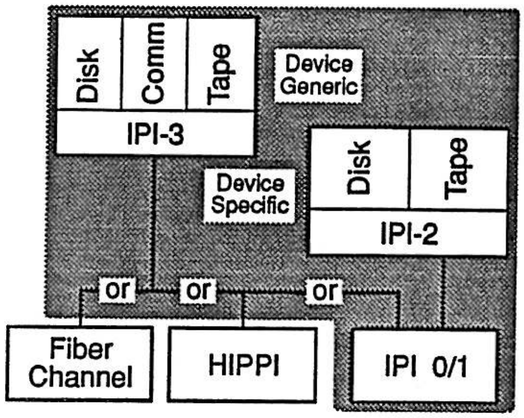
Device level interfaces for disks have generally used bit serial data transfer. IPI-2 implements device level interfaces with a parallel bus, providing higher transfer rates than are practical with conventional bit serial transfer interfaces, and allow the drive to be in a separate enclosure. See the following section on IPI for a desctiption of the physical level and other IPI levels.

Standards

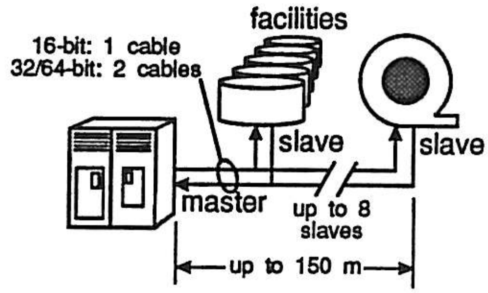
- *Flexible Disk Interface*, X3.80-1988, Project 52R, ISO 9315:1989.
- *Storage Module Interface (SMD), X3.91M-1987, Project 53R, DIS 9324.*
- *Enhanced Small Drive Interface (ESDI)*, X3.170-1991, Project 578D, ISO 10222.
- *Streaming Cartridge Tape Drive Interface*, X3.146-1987, Project 378D, ISO 9317.
- *Intelligent Peripheral Interface - Device-Specific Command Set for Magnetic Disk Drives*, (IPI-2 DSK), X3.130-1986, Project 467D, ISO 9318-2:1990.*
- *Intelligent Peripheral Interface - Device-Specific Command Set for Magnetic Tape Drives*, (IPI-2 TAPE), X3.176-1990, Project 591D, ISO 9318-5.

* *NOTE: Enhancement Project (789D) approved.*

Intelligent Peripheral Interface (IPI)



Standards Architecture



Example Configuration

Description

The IPI has three levels:

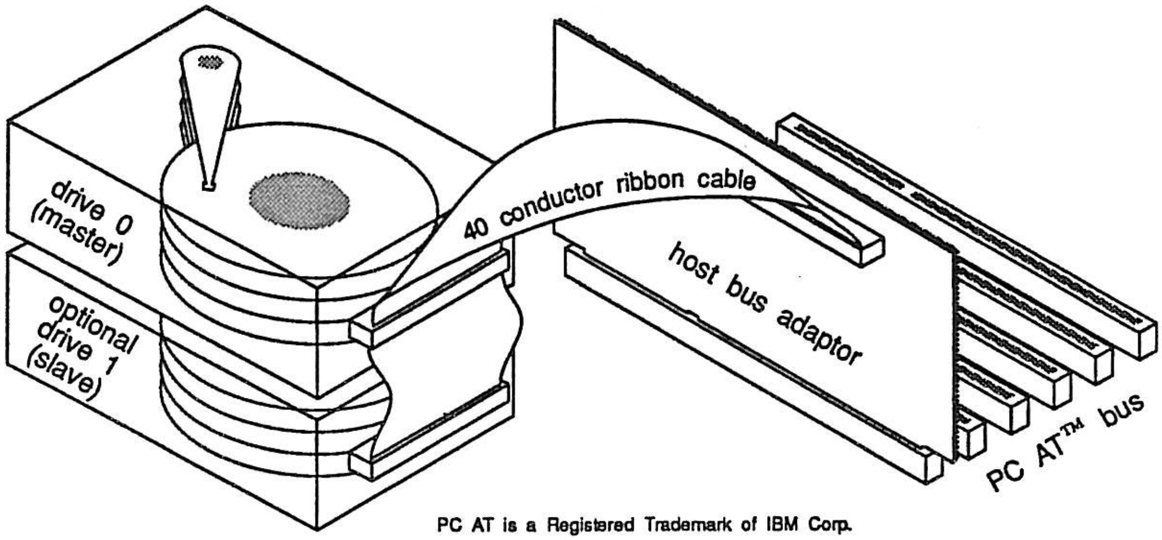
- Physical Level (IPI-0/1), which defines a 16, 32 or 64-bit, parallel, master/slave electrical bus, with transfer rates up to 200, 400 or 800 Mbps. The maximum bus length is 150 m.
- Device Specific Level (IPI-2), which are relatively "low level" controller to device command sets for peripherals that depend upon features of the IPI-1 bus. They are listed in the previous section on Device Interfaces.
- Device Generic Level (IPI-3), which are "packetized" command sets for direct host computer to "intelligent" peripheral device communication; IPI-3 does not depend upon IPI-1 features and can be used with other channels (*e. g.*, HIPPI & Fiber Channel).

Standards

- *Intelligent Peripheral Interface - Physical Level*, (IPI-0/1), X3.129-1986, Project 370D, ISO 9318-1.
- *Intelligent Peripheral Interface - Enhanced Physical Level*, (IPI-1E PHY), X3.201, Project 790D, ISO 9318-6.
- *Intelligent Peripheral Interface - Device-Generic Command Set for Magnetic and Optical Disk Drives*, (IPI-3 DSK), X3.132-1987*, Project 496D*, ISO 9318-3:1990.
- *Intelligent Peripheral Interface - Device-Generic Command Set for Magnetic Tape Drives*, (IPI-3 TAPE), X3.147-1987*, Project 505D*, ISO 9318-4:1990.
- *Intelligent Peripheral Interface - Device-Generic Command Set for Communications*, (IPI-3 COM), X3.177-1990, Project 504D.

* Note: ANSI version to be replaced with ISO version, which includes revisions to the standard.

ATA (AT Attachment)



Description

The ATA interface connects a disk drive with an integral controller to the industry de facto standard PC AT bus (sometimes called the *Industry Standard Architecture* or *ISA* bus), and emulates the disk controller of the original PC AT. This allows the drives to be compatible with existing software and BIOS. However, since the controller is integrated with the drive, it is possible to employ advanced features, such as zoned bit recording and cache buffers, which are not easily supported with a traditional separate controller. The ATA interface is becoming the most popular interface for internal disk drives in generic PC "clone" systems. It is often called the *Integrated Drive Electronics* or *IDE* interface.

In addition to providing a standard definition of the interface signals, the standard provides for consistent defininition of new enhancement features not found in the original PC AT hard disk controller.

Newer PC motherboards often provide an ATA port connector on the motherboard. A simple host bus adaptor card is used to connect the ATA interface to a PC AT bus slot on motherboards without an integral ATA port. Some host bus products also include a flexible disk controller, allowing for a one for one swap with PC AT disk controller cards which also contain a flexible disk controller.

Standards

– *ATA (AT Attachment)*, X3T9.2/90-143, Rev 2.6 June 12, 1991, Project 791-D.

Additional Information about X3T9

Attending Meetings

X3T9 meetings are open to all. No prior arrangements are necessary to attend meetings. There is usually no fee. X3T9 and its task groups meet six times a year in February, April, June, August, October and December, usually in the third week of the month (the December is usually the second week). Meetings are held in large hotels in various cities around the country and last one week. The task groups meet on Monday through Thursday, while the X3T9 plenary is held on Friday. Meetings are scheduled more than a year in advance and schedules are included in the minutes of the task groups and of X3T9.

In addition to the six plenary meetings each year, there are many ad hoc or working meetings on specific subjects. Some of these occur during the week of the plenary; others occur between plenaries. X3T9.3 and X3T9.2 generally hold a joint session of ad hoc meetings between plenary meetings. Although the dates and locations for ad hoc meetings may be fixed some time in advance, the specific meetings, and their subjects is generally decided at the preceding plenary. TG chairs are the best source of information about scheduled ad hoc meetings. Information may also be available on the SCSI bulletin board. While plenary meeting minutes will list the schedule and subjects for the ad hoc meetings determined at the plenary, this may arrive too late to be useful for meetings scheduled between plenaries.

Those who attend X3T9 meetings need not stay in the meeting hotel, however doing so does help the meeting host to meet guarantees to the hotel and avoid an extra charge for meeting rooms and the like. It is also generally much more convenient, particularly since important ad hoc meetings are often held in the evenings.

Membership and Voting

Membership on X3T9 and its TGs is also open to all and may be either individual or organizational. To summarize, there are five main rules about membership and voting:

- Only one employee of an organization may be a member and only he (or a designated alternate) may vote. Other employees of the same organization may not become individual members. A member may have one or more alternates.
- Only members representing US domiciled organizations may participate in determining positions in international matters.
- Regular attendance is required to retain membership . Although the attendence rule is complex, a member who attends every other meeting will retain membership.
- Members must vote on ballots to forward documents and on technical issues during meetings. They may abstain on procedural issues. Some X3T9 TGs count absence during a roll call ballot as nonattendance, even when a member has signed the attendance roll; others rely on the attendance list only.
- A service fee must be paid to the X3 secretariat.

To become a member two meetings must be attended (some TG chairs require consecutive meetings - others may be more permissive). At the second meeting attended an individual may become a member by giving the chair a letter requesting membership. The X3 secretariat charges a service fee of all members and nonpayment causes termination of membership. Write your letter to the chair of the group you wish to join, then pay the bill when it comes from X3.

All who attend, member or not, are free to participate in meetings, to make presentations and to speak on issues, however only members or their alternates may vote at the plenaries. Most ad hoc meetings adopt the policy that all attendees may vote on issues, whether they are members of the parent TG or not, but ad hoc meetings may sometimes hold votes on a per organization basis.

Getting Documents

Published ANSI and International Standards are available from:

American National Standards Institute
11 West 42nd Street, 13th Floor
New York, NY 10036
Sales Department: (212) 642-4900

Drafts of many working documents and minutes of past meetings are available from:

Global Engineering Documents
2805 McGaw
Irvine, CA 92714
(800) 854-7179; outside the US and Canada (714) 261-1455

Many ANSI standards are also available from Global. There is a surcharge, but their sales people are quite helpful. Many documents and information about meetings, etc., can be downloaded from the SCSI Bulletin Board (316) 636-8700.

The mailings of X3T9 and its TGs are available from the X3 secretariat. There is one mailing for each committee following each plenary meeting and the mailings may be voluminous, generally containing a copy of every document or presentation discussed at the meeting. The X3 Secretariat charges a Membership or Observer service fee (which is the same for members and observers on all X3 TCs and TGs) plus a subscription fee, which depends on the size of the mailings for the specific group. For specific information about mailings contact:

Katrina Gray
X3 Secretariat, CBEMA
311 First St. NW
Washington,DC 20001-2178
Phone: (202) 626-5741.

The X3T9 Process

The organization of X3T9 is depected below. X3T9 is a *Technical Committee (TC)* of Acredited (by ANSI) Standards Committee X3. X3T9 consists of the X3T9 *TC and* three subordinate *Task Groups (TGs)* : X3T9.2, X3T9.3 and X3T9.5. Development work takes place in the TGs, while X3T9 oversees TG activities and approves projects and standards for submission to X3.

The standards development process is specified in X3 Standing Document 2, *Organization, Rules and Procedures of X3*, usually called the *SD-2*. In the jargon of X3, sending a document to the next higher level for approval is called *forwarding* the document and a vote to forward requires a 2/3 majority. In some cases this can be done by a simple meeting vote, in other cases a roll call vote is required and in many cases a 30 day letter ballot is required. Where letter ballots are taken a "no" vote must state the reason, and the committee must address the reason and respond to the voter (although the committee and the voter need not agree).

The formal standards development process begins with the drafting of a Project Proposal by a Task Group (TG). The rules for drafting a project proposal are found in X3 Standing Document 3, and the proposal itself is usually called an *SD-3*. The SD-3 is forwarded by the TG to X3T9, which may the then vote to forward it to X3. Before X3 gets the SD-3, however, it is reviewed by *SPARC*, a subcommittee of X3. SPARC makes a recommendation to X3 on the disposition of the SD-3, and, in practice, that recommendation is generally followed by X3. Next X3 conducts a letter ballot on the SD-3. Assuming that the SD-3 passes, X3T9 must respond to the comments accompanying any negative votes, then the X3 Secretariat issus a *Project Number*, by which it will be identified in the future, issues a press release and publishes a notice announcing the project in *Standards Action*, the publication of record for ANSI.

Formal standards development may now begin. When a draft standard is completed by a TG, it is first forwarded to X3T9, which takes a letter ballot. If the 2/3 majority required to forward a proposed standard is met, then the draft standard is called a *draft proposed American Nationa Standard* or *dpANS* and it is forwarded with any unresolved negative ballot comments and the X3T9 response to them. The dpANS first undergoes a SPARC review for compliance with the SD-3, then goes through a public review of four months, which is announced in Standards Action, and is finally balloted by X3. Before the first public review the document is given a "BSR Number" of the form X3.999-199X, which will become the number of the final standard, and by which the document is now known.

Public review and letter ballot comments are respoded to by X3T9; this may cause "substantive changes" to the dpANS. If so, the process restarts at the TG and new votes to forward are held, a new public review (usually 2 months) is held and so on. The public review is normally repeated at least once to resolve either public review comments or X3 letter ballot comments. Finally, X3 approves the dpANs, all comments are either resolved or addressed by X3T9, and the dpANS is is sent to the ANSI *Board of Standards Review (BSR)*, which reviews the record to be sure that due process was followed. The standard is then published.

X3T9 normally also sends drafts to ISO (through X3 and ANSI) at the same time it forwards them for domestic processing. X3T9 has a policy of publishing standards in ISO format; a technical editor is appointed when the document is forwarded and a "pre-edit" takes place with the editorial staff at the ISO secretariat in Geneva during the first X3 public review. By the time the dpANS is balloted by X3 it is now expected that it will be nearly final editorial form and can be published without the further delay for editing.

International Meetings and Standards

The international committee corresponding to X3T9 is *ISO/IEC JTC1 SC25 WG4 (Working Group 4 of Subcommittee 25 of the Joint Technical Committee 1 of the International Standards Organization and International Electrotechnical Committee)*. People usually refer to just SC25 or WG4. X3T9 draft standards are usually also submitted to SC25 when they are forwarded from X3T9 to X3. They become first a *CD (Committee Draft)*, then a *DIS (Draft International Standard)* and, finally, an *IS (International Standard)*.

Unlike X3T9 meetings, WG4 and SC25 meetings are not open meetings. To attend an international meeting you must be appointed a member of a delegation. To become a member of the US delegation at an SC25 or WG4 meeting you should talk to the X3T9 *International Representative (IR)*. The members of the delegation are refered to as "experts." Voting is by country, and a chief delegate is appointed to head the delegation.

Committee Officers

X3T9.2 Chair
Mr. John B. Lohmeyer
NCR
3718 N Rock Rd.
Wichita KS 67226
Phone: (316) 636-8703
FAX:(316) 636-8889
Net: john.lohmeyer@wichitaks.ncr.com

X3T9.2 Vice Chair
Mr. I. Dal Allan
ENDL
14426 Black Walnut Court
Saratoga, CA 95070
(408) 867-6630

X3T9.3 Chair
Mr. Don Tolmie
Los Alamos National Laboratory
C-5, MS-B255
Los Alamos, NM 87545
Phone: (505) 667-5502
Fax: (505) 667-1754
Net: det@lanl.gov

X3T9.3 Vice Chair
Mr. Roger Cummings
StorageTek
2270 South 88th St.
Louisville, CO 80028-4257
Phone: (303) 673-6357
Fax: (303) 673-5019

X3T9.5 Chair
Mr. Gene Milligan
Seagate
MS OKM 151
P. O box 12313
Oklahoma City, OK 73157
Phone: (405) 324-3070
Fax: (405) 324-3794
Voice Mail: (800) 553-3557 3 4370

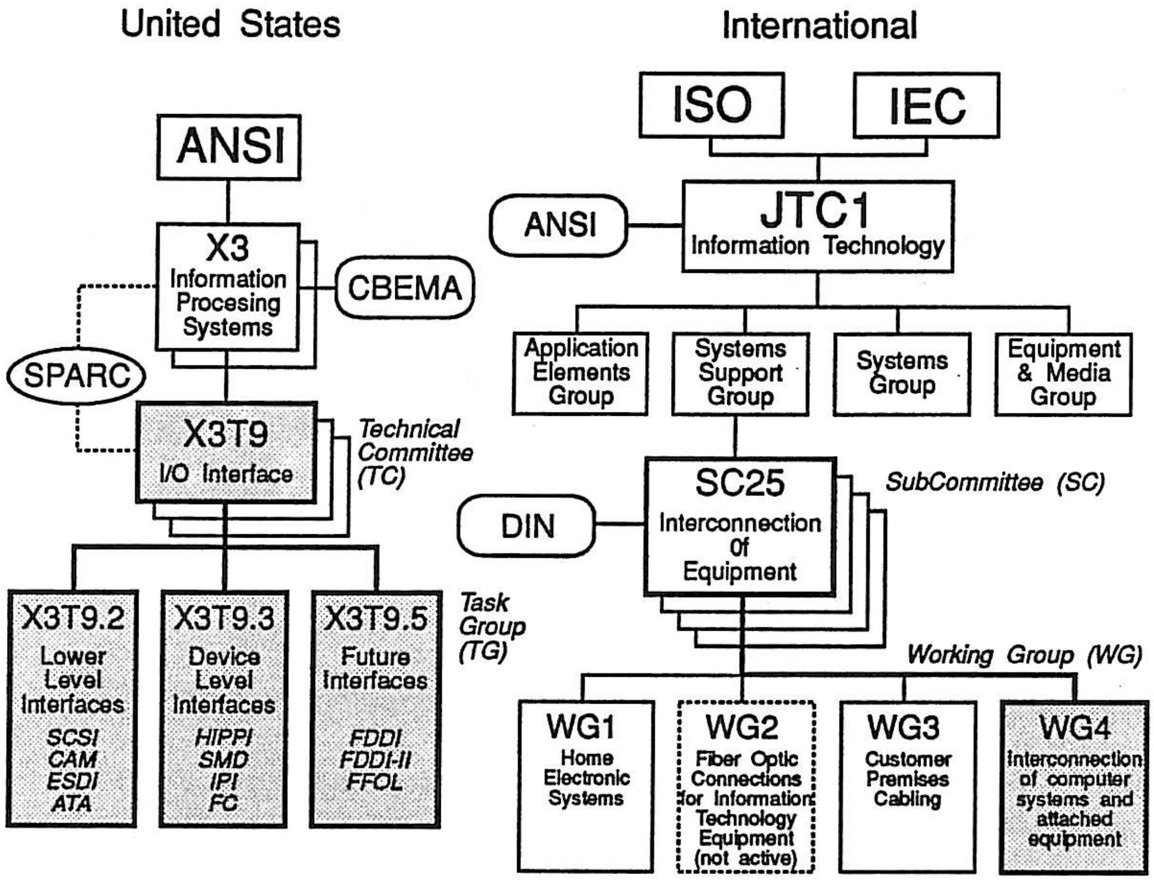
X3T9 Chair
Mr. Del Shoemaker
Digital Equipment Corp.
1331 Pennsylvania Ave., N. W.
Suite 600, MS:WNP
Washington, DC 20004
Phone: (202) 383-5622
Fax: (202) 383-5024

X3T9 Vice Chair
Mr. Robert L. Fink
Lawerence Berkeley Laboratory
MS 50B-2258
Berkeley, CA 94720
Phone: (415) 486-5692
Fax: (415) 486-6363

X3T9 International Representitive
Mr. Gene Milligan
see X3T9.5 Chair listing above

SC25 Chairman and
WG4 Convener
Prof. Popovic
Universität Bremen
FB 2
BW-2800 Bremen
Germany
Phone: +49 421 218 3580
Fax: + 49 421 218 3601

SC25 Secretary
Mr. Rudolph Barth
Siemens Nixdorf AG
Postfach 83 09 51
Otto-Hahn-Ring 6
W-8000 München 83
Germany
Phone: + 49 89 636 82683
Fax: + 49 89 636 82682



ANSI - American National Standards Institute. ANSI approves and Publishes American National Standards, accredits standards development committees & organizations, is the secretariat of JTC1 and the US member body of ISO.

CBEMA - Computer Business Equipment Manufacturers Association. CBEMA is the secretariat of X3.

DIN - Deutches Institut fur Normung. German national standards organization & the secretariat of SC 25.

IEC - International Electrotechnical Committe. IEC is an International voluntary (non-treaty) standards organization.

ISO - International Standards Organization. ISO is an International voluntary (non-treaty) standards organization which approves and publishes International Standards.

JTC1 - Joint Technical Committee (of ISO & IEC) One.

SPARC - Standards Planning and Requirements Committee. SPARC reviews project proposals & makes recommendations to X3 and then reviews proposed standards for their compliance with the original project proposal.

X3T9 and Standards Development Organization Chart

U83

Alphabet Soup

X3T9 meetings and documents are replete with a numbing array of acronyms, some general to the computer industry, some from the telephone and data communications industry, some specific to the standards community and some peculiar to the world of I/O interfaces and X3T9 itself. This somewhat eclectic list may help the newcomer. Where acronyms are ordinarily pronounced as words rather than letters an attempt is made to define the pronunciation.

ACSE	Association Control Service Element (OSI)
AMAC	Asynchronous Media Access Control; pronounced ā′ mac (FFOL standard).
ANS	American National Standard (ANSI).
ANSI	American National Standards Institute; pronounced an′ sē (standards body)
ASC	Accredited Standards Committee (accredited by ANSI, X3 is an ASC).
ASN.1	A Syntax Notation 1 (ISO standard notation for defining data elements in directories and MIBs).
ATA	AT Attachment (X3T9 standard; same as IDE).
ATM	Adobe Type Manager (commercial software product).
ATM	Asynchronous Transfer Mode (B-ISDN).
ATS	Abstract Test Suite (OSI conformance test jargon).
BELLCORE	BEll COmmunications REsearch (technical coordinating organization for RBOCs).
B-ISDN	Broadband ISDN (new CCITT/T1 standards superfamily).
BIOS	Basic Input Output System; pronounced bī′ ōs (PC jargon; code provided on ROM chips to interface DOS & the hardware).
BSR	Board of Standards Review (ANSI subgroup).
CAM	Common Access Method; pronounced cam (for SCSI-2; X3T9 standard).
CASE	Common Application Service Element (OSI)
CCITT	Consultative Committee on International Telephony and Telegraphy (standards body).
CD	Committee Draft (ISO).
CDB	Command Data Block (SCSI).
CLNP	ConnectionLess Network Protocol (ISO 8473; with TP4 is the rough OSI equivalent of TCP/IP).
CMIP	Common Management Information Protocol; pronounced see′ mip (OSI).
CSMA	Carrier Sense Multiple Access (LAN media access protocol)
CSMA/CD	Carrier Sense Multiple Access with Collision Detection (LAN media access protocol / IEEE 802.3 standard)
CS-MUX	Circuit Switched Multiplexor (FDDI-II & FFOL).
CRC	Cyclic Redundancy Code (industry jargon).
DAC	Dual Attachment Concentrator (FDDI).

DADI	Directly-Addressable Device Interface; pronounced daddy (X3T9 standards project).
DAS	Dual Attachment Station (FDDI).
DCE	Data Communications Equipment (X.25)
DES	Data Encryption Standard (FIPS 46-1).
DIS	Draft International Standard (ISO).
DOS	Disk Operating System; pronounced dos (PC jargon; also MS DOS, PC DOS or DR DOS).
dpANS	draft proposed American National Standard; pronounced dee′ pans (ANSI).
DS1	1.536 Mbps telephone trunk circuit (US telephone industry jargon; equivalent to T1).
DS3	43.008 Mbps telephone trunk circuit (US telephone industry jargon; equivalent to T3
DTE	Data Terminal Equipment (X.25).
ECC	Error Correction Code (industry jargon).
ECMA	European Computer Manufacturers Association; pronounced eck′ ma (standards body).
EIA	Electronics Industry Association (standards body).
EISA	Enhanced Industry Standard Architecture (industry jargon)
EMI	Electronic EMIssions (industry jargon)..
ESDI	Enhanced Small Drive Interface; pronounced ezz′ dy (X3T9 standard)
ESD	ElectroStatic Discharge (industry jargon).
FC	Fiber Channel (X3T9 standard family).
FC-0	Lowest part of FC-PH; defines media (FC).
FC-1	Part of FC-PH, defines line code (FC).
FC-2	Part of FC-PH; defines frame (FC).
FC-3	Part of FC-PH; provides common services (FC).
FC-4	Part of FC; maps command sets to FC (FC).
FC-PH	Fiber Channel Physical Level (X3T9 standard).
FCC	Federal Communications Commission; often used in reference to regulations for RFI *FCC Regulations Part 15, Subpart J* (government agency).
FCS	Frame Check Sequence (industry jargon).
FDDI	Fiber Distributed Data Interface; sometimes pronounced fi′ dy (X3T9 standards family).
FDDI-II	enhancement of FDDI (X3T9 standards family).
FIPS	Federal Information Processing Standard; pronounced fips (issued by NIST).
FM	Frequency Modulation (for interfaces refers to an old disk drive recording code; indu try jargon).
FTAM	File Transfer, Access and Management; pronounced eff′ tam (X.500/ISO 8571-4; OSI application);
FTP	File Transfer Protocol (TCP/IP application).

GOSIP	Government Open Systems Interconnection Profile; pronounced gossip (FIPS issued by NIST).
GCR	Group Code Recording (industry jargon).
HIPPI	High Perfomance Parallel Interface; pronounced hip′ ē (X3T9 standards family).
HIPPI-FP	HIPPI Framing Protocol (X3T9 standard).
HIPPI-LE	HIPPI encapsulation of IEEE 802.2 LLC frames (X3T9 standard).
HIPPI-MI	HIPPI Memory Interface (X3T9 standard).
HIPPI-PH	HIPPI Physical Level (X3T9 standard).
HIPPI-SC	HIPPI Switch control (X3T9 standard).
I/O	Input/Output (industry jargon).
IDE	Integrated Drive Electronics (industry jargon; same as ATA).
IEC	International Electrotechnical Commission (standards body).
IEEE P802	Institute for Electrical and Electronics Engineers Project 802 (LAN network standards body).
IMAC	Isochronous Media Access Control; pronounced ī′ mac (FDDI-II; FFOL standard).
IPI	Intelligent Peripheral Interface (X3T9 standard family).
IPI-0/1	Intelligent Peripheral Interface Physical Level (X3T9 standard).
IPI-2	Intelligent Peripheral Interface, Device Specific Level (X3T9 standard).
IPI-3	Intelligent Peripheral Interface, Device Generic Level (X3T9 standard).
IR	International Representative (X3T9 Committee Office).
IS	International Standard (ISO).
ISA	Industry Standard Architecture (a bus compatible with the original IBM PC AT bus; dustry jargon).
ISP	International Standardized Profile (OSI jargon).
ISDN	Integrated Services Digital Network (CCITT/T1 telephone & data communications standards superfamily).
ISO	International Standards Organization; pronounced ī′ so (standards body).
JTC/1	Joint Technical Committee 1 (ISO and IEC subgroup on Information Technology).
LAN	Local Area Network; pronounced lan (for computers; industry jargon).
LATA	Local Access Tariff Area; pronounced la′ ta (telephone industry jargon).
LCF	Low Cost Fiber (one of the FDDI PMD standards).
LED	Light Emitting Diode (industry jargon).
LLC	Logical Link Control (IEEE 802.2 standard).
LUN	Logical Unit Number (SCSI).
MAC	Medium Aces Control; pronounced mac (FDDI & general LAN jargon).
MAC-2	enhancement of FDDI MAC (FDDI-II standard).
MAN	Metropolitan Area Network; pronounced man (industry jargon).

MFM	Modified Frequency Modulation (a disk drive recording code; sometimes used to mean the ST506/ST412 interface; industry jargon).
MHS	Message Handling System (X.400; OSI application; CCITT standard);
MIB	Management Information Base; pronounced mib (OSI).
MIC	Media Interface Connector; pronounced mic (FDDI PMD).
NBS	National Bureau of Standards (US government agency, now NIST).
NIST	National Institute of Standards and Technology; pronounced nist (US government agency; formerly NBS).
NRZ	NonReturn to Zero (data transmission coding method; industry jargon).
NRZI	NonReturn to Zero Inverted; pronounced nur' $\overline{\text{zee}}$ (data transmission coding method; industry jargon).
OA&M	Operations, Administration & Maintenance (telephone industry jargon).
OIW	OSI Implementors Workshop (pseudo standards body).
OSI	Open System Interconnection (plan for families of standards).
PABX	Private Access Branch Exchange (same as PBX; telephone industry jargon).
PBX	Private Branch Exchange (telephone industry jargon).
PC	Personal Computer (industry jargon).
PC AT	IBM PC using 80286. Basis of PC clone industry. PC AT is TM of IBM Corp.
PDU	Protocol Data Unit (OSI).
PHY	Physical Layer Protocol, pronounced $\bar{\text{fi}}$ (FDDI, FDDI-II & FFOL standards).
PHY-2	enhancement of FDDI PHY (FDDI-II standard).
PICS	Protocol Implementation Conformance Statement; pronounced pix (OSI).
PMD	Physical Medium Dependent (FDDI, & FFOL standards)
RAID	Redundant Array of Inexpensive Drives (industry jargon).
RBOC	Regional Bell Operating Company (telephone industry jargon)
RFI	Radio Frequency Interference (industry jargon).
RLL	Run Length Limited (refers to disk drive recording codes; industry jargon).
RSA	Rivest, Shamir and Aldeman (public key criptography algorithm)
SAC	Single Attachment Concentrator (FDDI).
SAP	Service Access Point; pronounced sap (OSI)
SAS	Single Attachment Station (FDDI).
SASE	Specific Application Service Element (OSI)
SCS	SCSI-3 Command Set (X3T9 standard).
SCSI	Small Computer System Interface; pronounced scu' zy (X3T9 standard).
SCSI-2	First enhancement of SCSI (X3T9 standard).
SCSI-3	Second enhancement of SCSI (X3T9 standards family).
SC	SubCommittee (ISO standards development jargon).

SC25	SubCommittee 25(ISO standards committee on Interconnection of Equipment).
SC25 WG4	SubCommittee 25, Working Group 4 (ISO standards committee on I/O interfaces).
SD	Standing Document (X3).
SD-2	X3 Rules and Procedures document (X3).
SD-3	X3 Project Proposal document (X3).
SDH	Synchronous Digital Hierarchy (CCITT standard telephony transmission system; equivalent to SONET).
SIP	SCSI-3 Interlocked Protocol (X3T9 standard).
SMAP	System Management Application Process; pronounced smap (OSI jargon).
SMF	Single Mode Fiber (fiber industry jargon & one of the FDDI PMD standards).
SMT	Station Management (FDDI, FDDI-II and FFOL standards).
SMUX	Synchronous Multiplexor (FDDI-II and FFOL).
SNMP	Simple Network Management Protocol (TCP/IP).
SONET	Synchronous Optical Network; pronounced sonnet (T1 family of standards for public network trunks).
SPARC	Standards Planning and Requirements Committee; pronounced sparc (X3 subgroup).
SPI	SCSI-3 Parallel Interface (X3T9 standard).
SPP	SCSI-3 packetized protocol (X3T9 standard).
SPM	SONET Physical Mapping (for FDDI; X3T9 standards project).
ST412	Seagate Technology 412 (de facto standard industry winchester disk interface; approximately equivalent to ST506).
ST506	Seagate Technology 506 (de facto standard winchester disk interface; predecessor of and approximately equivalent to ST412).
T1	(ANSI accredited standards body for public networks).
T1	1.536 Mbps telephone trunk circuit (US telephone industry jargon; equivalent to DS-
T3	43.008 Mbps telephone trunk circuit (US telephone industry jargon; equivalent to DS
TAG	Technical Advisory Group; pronounced tag (ANSI).
TC	Technical Committee (X3 subgroup; X3T9 is a TC).
TCP/IP	Transport Control Protocol / Internet Protocol (OSI alternative protocol).
TG	Task Group (X3 TC subgroup; X3T9.2, X3T9.3 and X3T9.5 are TGs).
TIA	Telecommunications Industry Association (standards body).
TLSP	Transport Level Security Protocol (OSI Security).
TP	Twisted Pair (one of the FDDI PMD standards).
TP4	Connection-oriented Transport Protocol Class 4 (ISO).
TR	Technical Report (document issued by BELLCORE; often effectively a telephone industry standard in North America).

TTCN	Tree and Tabular Combined Notation (OSI standard language for defining protocol conformance tests).
TTRT	Target Token Rotation Time (key FDDI parameter).
VAN	Value Added Network; pronounced van (industry jargon).
WAN	Wide Area Network; pronounced wan (rhymes with van) (industry jargon).
WBC	Wide Band Channel (FDDI-II HRC).
WG	Working Group (ISO standards development jargon).
X.25	DTE to DCE packet interface; pronounced exx dot 25 (CCITT Standard).
X.400	Message Handling System; pronounced exx dot 400 (CCITT standard & OSI application).
X.500	File Transfer, Access and Management; pronounced exx dot 500 (CCITT standard & OSI application).
X3	(ANSI accredited standards body for computers & information systems).
X3T9	(X3 technical committee on I/O Interfaces).

489