



311 East Carrillo Street
Santa Barbara, CA 93101
Telephone (805) 963-3853
Fax (805) 962-1541
Email: info@osta.org
<http://www.osta.org>

Data Interchange & Optical Standards

February 12, 1996
Revision 2

Data Interchange and Optical Standards

Optical disk media provides high capacity removable storage with an extremely long life. The removability of the media provides us with the opportunity to easily transport and interchange of large amounts of data. *The goal of data interchange is to have the ability to store files on optical media using any type of computer and then be able to access these files using any other computer system.* Removable media data interchange occurs at three different levels: sector, file and application.

Sector Level Interchange

Sector interchange is the ability to interchange data at the sector level. This level of interchange defines the ability to move media universally among different optical drives. The data being interchanged at this level is comprised of sectors. When it is stated that two different optical drives can interchange data at the sector level, it means that the drives can read and write sectors on media created by each other.

For example, assume you have two optical drives, one manufactured by company A and the other drive by company B, and you write to sectors 100 through 200 on an optical disk in drive A. With sector level interchange, you can place the disk in drive B and read sectors 100 through 200 that were written by drive A. You can then write to sectors 300 through 400 on the disk with drive B, and then move the disk back to drive A and read the sectors written by drive B. In this situation, drives A and B support sector level interchange between each other.

To assure sector level interchange, optical disk media is manufactured to specifications defined by several standards organizations. These organizations include the American National Standards Institute (ANSI), the European Computer Manufacturers Association (ECMA), and the International Standards Organization (ISO). The following table shows the different types of optical media and the associated physical media standards from the different standards organizations.

Media	ANSI	ECMA	ISO
5 1/4" WORM (650MB, 130mm)	None	None	ISO/IEC 9171 Format A
5 1/4" Rewritable (650MB, 130mm)	X3.2121/1992	None	ISO/IEC 10089 Format A
5 1/4" CCW (650MB, 130mm)	X3.2220/1992	ECMA 153	ISO/IEC 11560
5 1/4" 2X Rewritable & CCW (1300MB, 130mm)	None	ECMA 184	ISO/IEC 13549
5 1/4" 4X Rewritable & CCW (2600MB, 130mm)	None	None	DIS 14517
3 1/2" Rewritable (128 MB, 90mm)	None	ECMA 154	ISO/IEC 10090

3 1/2" Rewritable (230 MB, 90mm)	None	ECMA 201	ISO/IEC 13963
3 1/2" Rewritable (640MB, 90mm) (540MB, 90mm)	None	None	DIS 15041

In the above table CCW refers to continuous composite write-once. This type of media uses rewritable magneto optic (MO) media to emulate the write-once function. The recording technology used for this emulation is the same as that use for rewritable media. WORM refers to ablative write-once media.

Sector level interchange is a prerequisite for the next level of interchange, at the file level.

File Level Interchange

File level interchange is sometimes referred to as file system interchange. This level defines the ability to interchange files among different computers.

Perhaps the most common use for optical media is for online files. In this mode, the operating system typically stores files in its own native file system format, just as it does on magnetic disks. For example, OS/2 uses HPFS, while DOS uses FAT, and AIX uses JFS. This approach allows file interchange between computers running the same operating system. However, file interchange between dissimilar systems does not work. The operating systems must share the same file system format.

The International Standard

In the past a file system standard was developed for CD-ROM devices. This standard, ISO 9660, was created to support exchanging information among different operating systems. Compliance with this standard enabled the CD-ROM market to become successful because the ability to exchange information was assured.

During the past several years a new file system standard has been under joint development through, ANSI, ECMA, and ISO. The resulting International Standard is known as ISO/IEC 13346: "*Volume and File Structure for Write-Once and Rewritable Media Using Non-Sequential Recording for Information Interchange*". This standard is commonly referred to as the NSR standard, since it was designed for Non-Sequential Recording media. This standard is differentiated from ISO 9660 by providing the ability to write as well as read information among different operating systems. ISO 9660 was created as a read-only file system.

Implementation of ISO/IEC 13346 will enable information exchange on a variety of operating systems. ISO/IEC 13346 will spur acceptance and usage of non-sequential recorded optical media will occur in the same way ISO 9660 stimulated acceptance of CD-ROM read-only media.

The NSR file system standard offers several important benefits and features.

Operating System Independence

Recorded disks complying with the NSR file system standard can be read/written on a wide variety of operating systems that support the NSR standard. As the title of the standard states it was designed for *Information Interchange*. For example you can store files under DOS on NSR media, take these media to a system running AIX and update the files, then take the media to a machine running OS/2 and so forth. NSR provides you with file interchange among today's operating systems, as well as the operating systems of tomorrow.

Vendor Independence

The way data is written to optical media, even for native file system support, can vary among vendors. This causes problems with file interchange even among computers running the same operating system if they use different vendors for their storage subsystem. With NSR media, you will be able to exchange files with different computers even if the NSR software on the other computer was developed by a different vendor. Access to your data is not locked to any single vendor, but is vendor independent.

Massive Volume Support

Most native file systems were designed before the massive capabilities of today's storage subsystems and therefore have limitations such as a two gigabyte file system size. Also, no native file system was designed specifically to support jukebox type storage devices. Unlike native file systems NSR was designed for the massive storage needs of tomorrow, with availability today. This flexibility allows you to create volumes as large as you want, convenient when you consider the massive storage associated with the larger optical jukeboxes.

Rewritable and Write-Once Support

NSR is a file system standard that supports both rewritable and write-once media. Native file systems such as FAT, HPFS, JFS, etc., were designed for magnetic media. Native file systems always expect the ability to rewrite a sector on the media. Write-once does not allow sector rewrites, a sector may only be written to once. Therefore, if you wanted to use write-once media, it could not be done through the native file system. Until NSR was available every write-once implementation used some form of a proprietary format, since this was the only way to support write-once. With proprietary formats the ability to interchange files is lost. The NSR standard provides a file system for write-once media that supports file interchange.

The NSR standard is robust and has been designed to support an extensive array of features. It is intended to encompass all possible existing file system requirements and to provide a growth path for the future. The design goal necessarily made the NSR standard complex, requiring extensive resources to

bring a fully-compliant implementation to market. In addition, the fact that NSR is an international standard prevents it from specifying operating system behavior. A standard cannot specify how specific information from a commercial operating system---such as the Macintosh OS---is to be treated, since this violates the principals of independence. This inability presents an impediment problem to complete information interchange.

The OSTA Universal Disk Format Specification

OSTA has developed a file system format specification to address these problems of complexity and full data interchange. The goal of the OSTA *Universal Disk Format (UDF)* specification was to develop a practical subset of the NSR standard that would be much easier to bring to market, while also addressing how data is to be interchanged between systems. OSTA specifically defines what information shall be recorded on disk for a particular operating system and how other systems are to treat this information.

UDF was developed by an industry consortium of leading companies in the optical storage industry. Numerous experts have invested significant time in developing a document that would meet the above objectives. As an industry consortium OSTA is not hampered by the restrictions placed on ISO standards. This fact has allowed OSTA to develop a specification that is a significant advancement towards the goal of data interchange between operating systems.

UDF is:

- ◆ Built on the foundation of the ISO/IEC 13346 standard:
 - A practical subset of the ISO/IEC 13346 standard;
 - Fully compliant with ISO/IEC 13346.
- ◆ Simple and universal, defining support for multiple operating systems:
 - Defines what information must be stored on disk by all operating systems;
 - Defines what information must be stored on disk for each particular operating system;
 - Defines how information stored on the disk by one operating system is to be processed by another operating system;
 - Provides support of, and data interchange among, the major commercial operating systems, including:
 - DOS
 - OS/2
 - Macintosh
 - POSIX [UNIX]
 - Expandable to include support for future operating systems.

UDF has been selected as the file system for 2nd generation high capacity CD-ROM, CD Recordable and CD Erasable disks. This includes Digital Video Disc (DVD), the first consumer application use of 2nd generation CD-ROM. Through the use of UDF, DVD entertainment based and computer based content can reside on the same disk and be accessed by a wide variety of computer systems as well as the consumer DVD player in the home.

UDF was designed to meet the mass storage needs of a global community well into the future.

Application Level Interchange

Once you have sector and file interchange you can move data among different optical drives on different computers with different operating systems. File interchange allows you to see the same directories and files on the different computers. The next level of data interchange is *Application Interchange* which deals with the *file formats* supported by the individual application.

For example, assume that you have sector and file interchange between a PC running DOS, and a Macintosh running MacOS. You can copy files to an optical disk on the Macintosh, bring that disk over to the PC and see the Macintosh files when listing the appropriate directories. Assume further that you used a database application called ALPHA on the Macintosh to create the files on the disk, and you wish to read access those files on the PC using a database application called BETA. Unless ALPHA and BETA use the same file format, you will not be able to read the data written by ALPHA with the BETA program. To have interchange between applications, they must use the same application standards and the same file format.

There currently exists a wide variety of file format standards that allow application interchange. There are database file format standards such as DBF, DIF and RTF. There are image file format standards such as TIFF, PCX, GIF and JPEG. There are audio file format standards such as WAV and VOC. Applications that support standard file formats will be able to interchange data at the application level.

Conclusion

Ask yourself these questions:

What operating system will I be using 10 or 20 years from now?

What hardware platform will I be on?

If I store massive amounts of data today, what will I do if I can't read it on my machine of tomorrow?

ISO standard optical media gives the assurance that you can access your data in a wide variety of different optical drives. The ISO standard NSR file system gives the assurance that you can have data interchange among today's wide variety of different operating systems and the operating systems of tomorrow. *Optical storage standards provide assurance that today's data will be available beyond tomorrow.*

References

For further information on optical standards, contact the following organizations:

ANSI and ISO Documents	Global Engineering Documents 15 Inverness Way East Englewood, CO 80112 Phone: (303) 792-2181 Fax: (303) 792-2192
ECMA Documents	European Computer Manufactures Assoc. 114 Rue du Rhone CH 1204 Geneva Switzerland Phone: +44 22 735 36 34 Fax: +44 22 786 52 31 http://www.ecma.ch
OSTA Documents	Optical Storage Technology Association 311 E. Carrillo Street Santa Barbara, CA 93101 Phone: (805) 963-3853 Fax: (805) 962-1542 Email: info@osta.org http://www.osta.org

NOTE: ISO standards have precedence over ECMA and ANSI standards. Therefore, whenever possible, the ISO document should be used as a reference.