National Institute of Standards and Technology

Convergent Information Systems Division (CISD) Current Research

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use. This wide range of characteristics creates a challenge to interoperability. How is a user to know which file format is best for them? **CISD Response Strategy:** NIST can assist the industry by providing an inventory of digital content types and formats. This page is intended as a reference to inform the public of what is out there - primarily, each format's particular characteristics and issues when converting. It is

also only an introduction to the basics of the standards, not a detailed technical resource. For

more detailed information, please follow the links at the end of each section.

Critical Issue: There are hundreds of file formats for representing media online or in print, for

proprietary or nonproprietary, native to one particular software program or useable in a number of

programs, and each has its own characteristics, making one "better" than another for its desired

medical imaging, homeland defense, and countless other applications. Formats may be

Digital Media File Types: Survey of Common Formats

Several standards are discussed on this page. Inclusion of a standard or product is not an endorsement. Conversely, omission is not intended to deprecate its use. If there are any terms mentioned here that you are unfamiliar with, please refer to the <u>glossary</u>.

Web Links <u>CISD Resource Center</u> This document will continue to change as more information is added and corrected. We encourage

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AUDIO v1.1

Format	Support	Uses	Advantages	Disadvantages	Bitrate	Standards
AAC (Advanced Audio Coding)	Decoder implementations are available from ARM, Cirrus Logic, Fraunhofer IIS, and Texas Instruments	High-quality audio much smaller than MP3; used for all digital broadcasting (SDTV, HDTV, digital radio) in Japan	Claims to be 30% more efficient at encoding than MP3, so a 128kbps AAC file would have the same perceivable quality as a 192kbps MP3; no royalties for content distribution	There is currently no commercial software codec, but the hardware is gaining momentum (Rio, the first maker of portable MP3 players, has bought a license); expensive Dolby licenses	Up to 48 channels with a maximum sample rate of 96kHz	ISO and IEC as part of the MPEG-2 specification
AC3	The standard in DVD audio	High-quality multi- channel audio	Converts 6 channel surround sound into 2, making really high bitrate mp3s; much smaller than aiff and wav;		Up to 448kbps	Dolby

			quality			
MIDI (Musical Instrument Digital Interface) *.mid	All music composing software, most music editing software, and nearly all synthesizers, though support in computer audio programs is not as widespread	Designed for synthesizers and digital equipment to talk to each other, later developed for the computer	Very small size; if creating from a synthesizer or music composing software, the music will sound the same on all computers since it doesn't take into account different tracks and channels	Lacks specific sound control so though it will sound the same on all computers,after converion it may not sound the same as what you originally wrote	8-bit serial transmission, 31.25kbps data rate	General Midi (GM) by MIDI Manufacturers Association; GS by Roland; XG by Yamaha
MP3 (MPEG-1 layer 3)	Playable in portable MP3 players, or in programs like Winamp, RealPlayer or Windows Media Player; recent audio CD and DVD players	The most widespread form of audio on the Internet; usually downloaded directly, though it can be streamed	Maintains high quality at low bitrates, compressing to 12:1 of waveform audio; streamable	Most audio CD players will not play MP3s burned onto a CD - a separate program is needed to decompress the files into WAV before burning	The bitrate is variable, but typically files are saved at 128kbps - about 1mb per 1min music	Developed under sponsorship by MPEG, formalized by ISO
RealAudio *.ra, *.ram	Playable through the free RealPlayer as well as other players and editors from RealNetworks that are available for purchase	Most widespread form of streaming audio	Streamable	Since it is compressed so much, the audio may sound like radio or telephone- quality	File is saved according to bandwidth preferences since it is usually streamed: 20kbps for dial-up modems, and as much as 220kbps for T1 lines	RealNetworks
Waveform *.wav	Now readable on Macs (Apple's AIFF format is equivalent to WAV as it is also uncompressed); most systems come with a basic music program that supports WAVs	This is the format audio must be in to be burned for an audio CD	When ripped from CD, it retains all audio data	Since it is uncompressed raw data, very liarge files result	44.1kHz, 16- bit, stereo	Microsoft
WMA (Windows Media Audio)	Windows Media Player; becoming increasingly widespread on the web	Steaming or downloaded	64kbps files sound just as good as 128kbps MP3 files and are half the size; streamable	Not all audio software and portable devices recognize this format, or will be allowed to due to proprietary restrictions	48kHz, stereo	Microsoft

better than CD

This is not an all-inclusive list of audio file types. Dozens more are out there, but these seem to be the most popular, or those "on the cutting edge." Some formats would be worth looking at due to their superior compression, but only appeal to a small sector because they are native, proprietary formats. In the case of MDLP formatted audio, it is only used by Sony MiniDisc's Net MD Walkman series. (More about MDLP formats and usage.) Others work similarly to other, more popular file types, like AIFF (Mac) to WAV (PC). (More about AIFF.)

As audio copyright infringement becomes more of a concern to record companies, some are encrypting their CDs to make them unreadable in home computers. Thus, converting your CD

collection to a digital music library is impossible with these CDs. Even so, additional software - programs called rippers and encoders or de-encoders - are necessary to extract the data from the CD. A simple search on a software download site will yield hundreds of results.

Listed below is the interoperability of the formats already looked at, with links to more information about the file format.

AAC: Encoding used by Universal, BMG and Liquid Audio, but due to different encryption may not be compatible with some software and hardware players; increased interoperability hindered by AAC Licensing Agreement. <u>More</u>.

AC3: Since AC3 is primarily used for DVD audio, it is not as common on a user-level or on the Internet, but that is changing as many are realizing its superior quality over even CD audio without massive file sizes. A few programs exist to convert AC3 into more popular user-level formats like MP3 and WAV. <u>More</u>.

MIDI: Designed for interoperability between different synths, but its interoperability with other audio formats is limited. <u>More</u>.

MP3: A number of independent programs exist to de-encode MP3 to WAV very simply. <u>More</u>. **RealAudio:** As a proprietary format, conversion programs are limited. <u>More</u>.

Waveform: Numerous freeware and shareware programs exist to convert WAV to MP3 and vice versa, other file formats more limited.<u>More</u>.

WMA: Available programs most commonly convert to WAV, MP3, and OGG. (OGG is an openformat file format from <u>Vorbis</u> that is still in its infancy. It supports 48kHz, 16-bit, multi-channel high-quality audio.) <u>More</u>.

IMAGE v1.0

Format	Support	Uses	Advantages	Disadvantages	Bitrate	Standards
Bitmap *.bmp	Browsers, various image viewing and editing programs (freeware, shareware, and proprietary)	Works well cross-platform	Flexible image format	Very little is compressed leaving large files	1 bit to 24 bits-per- pixel color data	Microsoft
GIF (Graphics Interchange Format) "jif"	All browsers, most image viewing and editing programs - low to high-end	Images with broad areas of flat color such as comics or logos	Interlacing; transparancy; compression ratio of 4:1 to 10:1; lossless of 256- color images; animated GIFs; palettes	Vertical patterns are not converted well; posterization may occur if the color-depth is too low	8 bits-per- pixel	GIF89a; Unisys retains royalties
JPEG (Joint Photographic Experts Group) "jay-peg"	All browsers, most image viewing and editing programs - low to high-end	Photographs, or any image with transitional tone	Doesn't prejudge how many colors to use, displaying a truer image on any computer; up to 100:1 compression; progressive display	Image quality is compromised with greater compression, resulting in artifacts; doesn't handle straight edges or text very well	24 bits-per- pixel color data	IS 10918-1 (ITU-T T.81)
JPEG 2000 *.jp2	The W3C is not yet behind it, but there are a number of other projects trying to increase its support	Web images, pre-press, medical imaging, security	All of the advantages of JPEG; lossy or lossless compression; security features like watermarking; wavelet compression; Regions of Interest coding	Limited support	Variable, up to 24 bits- per-pixel	Joint Photographic Experts Group; Migrator 2000 developing Intellectual Property Right protection, access control, and

more

MNG (Multiple- Image Network Graphics) "ming"	No browser integration yet, but since the W3C is behind PNG it is likely not too far in the future	It is the animated version of PNG, just like GIF supports multiple- image animation	All of PNG's advantages; beats GIF compression ratios by factors of 10 to 100; much smaller file sizes compared to GIF due to sprites and loops	Limited support		Developing a subset of MNG - JNEG (JPEG Network Graphics) for single-image lossy compression
PNG (Portable Network Graphics) "ping"	Varies widely among browsers and programs (<u>list</u> of <u>supporting</u> <u>applications</u>)	Designed to replace GIF, as well as TIFF to some extent	Greater compression than GIFs; alpha channels for variable transparency; gamma correction for system- independent color; 2D interlacing; lossless; patent- free	Not widely supported, though the W3C is behind it	24-bit, grayscale and 8-bit per pixel (where it works best)	PNG Specification 1.2, non- proprietary open-source
SVG (Scalable Vector Graphics)	It is described in XML; Adobe provides a plug-in for Netscape and MSIE, but there are many programs for viewing/ editing; W3C supported	Web, wireless devices (with subsets of SVG called SVG Basic and SVG Tiny)	Very small file sizes with mathematical equations; gradients are possible, as are a number of other effects like drop shadows through filters	Few programs, but expected to grow		SVG 1.0 Specification, as recommended by the W3
TIFF (Tagged Image File Format)	Supported by many applications; cannot be embedded into a webpage	Most accepted type for printing	Lossless; colors can be stored in RGB or CMYK and IBM or Mac bit- order	Large files	1 to 64-bit integer signed or unsigned; 32 or 64-big IEEE floating point	TIFF 6.0

There are dozens of different image formats, and these are only a small sampling. They are however, those most widely used, or those primed to become most widely used. Plenty of formats that seemed to have potential didn't, or haven't, gotten off the ground, such as <u>JPEG-LS</u> (see section 2.3). There are also numerous formats that are native to only one particular program, such as <u>Adobe Photoshop</u>'s PSD.

As many formats as there are, there are even more programs to create, edit, and convert them. A list of some freeware/shareware optimization and conversion programs is available <u>here</u>.

Listed below is the interoperability of the formats already looked at, with links to more information about the file format.

Bitmap: Converts well to other image formats. More.

GIF: GIFs are bad source images for JPEGs because images are color-reduced. <u>More</u>. **JPEG:** Old decoders may not handle progressive JPEG; does not convert well to GIF; some software does exist for lossless compression. <u>More</u>.

JPEG 2000: There are a few plug-ins that have been produced for PhotoShop, in which files can be saved in other formats. More <u>here</u> and <u>here</u>.

MNG: List of applications that support MNG. More.

PNG: Easy conversion to other image formats due to lossless compression; <u>list of applications</u> that support PNG. <u>More</u>.

SVG: Increasing numbers of drawing tools export to SVG; can be viewed on many platforms from desktops to handheld devices. More <u>here</u> and <u>here</u>.

TIFF: Flexible with multiple formats. More.

TEXT v1.1

Format	Support	Uses	Advantages	Disadvantages	Bitrate	Standards
ASCII *.txt	Any text editor or word processor will open it, the most simple of which are Notepad or SimpleText	Common format for text files in computers and on the net; can be written in ASCII but saved as another type	Extremely small file sizes	Limited formatting capabilities (basically spaces, tabs and returns) and character set	128 possible characters represented by 7bit binary numbers	American National Standards Institute
DOC (Microsoft Word Document)	Microsoft Word, but can be opened by WordPerfect and other higher-end word processing apps	Word processing	Great flexibility in designing the look of a document from varying margins and indentations to tables and bullets	If pictures are included, they are embedded rather than linked, increasing file size		Microsoft / Corel
EBCDIC	IBM OS/390 systems	Text files for IBM S/390 servers; corporations use for and databases.	Supports more characters than ASCII; most common alternate character code	IBM's PCs and workstations don't use it, nor do other OSes; proprietary	256 characters represented by 8bit binary numbers	IBM
HTML (Hypertext Markup Language)	All browsers support HTML, though the advanced features are implemented differently in each and provide non- standard extensions	For view in internet browsers on the World Wide Web, though can be viewed offline	Allows a great deal of control over the look and layout of a document, including animations (dynamic HTML) and interactivity; can combine several computer languages seamlessly; pictures are linked to rather than embedded	In order to take advantage of all the capabilities, learning the coding language is necessary - a WYSIWYG editor will not do it all; older browsers do not support all tags		HTML 4.0 by the World Wide Web Consortium
OEBPS (Open eBook Publication Structure)	Used by a variety of electronic publishing systems and reading devices	Based on XML, HTML, CSS, and Unicode, among others, to define content, structure, and presentation of eBooks	Can embed r ich media but there must be an alternate version (either XML, CSS, JPEG, or PNG) in case the device cannot read it; incorporates accessibility features from HTML; non- proprietary			Open eBook Publication Structure 1.0.1 maintained by the Open eBook Forum
RTF (Rich Text Format)	Can be opened, edited, and saved using MS Word	Allows for more control over the look of the document than ASCII	Since RTF uses ANSI, PC-8, Mac and IBM PC character sets, you can exchange text files between different word processors and different operating systems	Not as much control as MS Word and WordPerfect		RTF Specification
Unicode	NT and Win2000	Documents to be	A unique number for		34,168 characters	Unicode Worldwide

	systems; required by modern standards such as XML, SQL, etc.	distributed to users on multiple platforms and countries	every character, independent of platform, program, or language - the text will display correctly		in 24 languages	Character Standard, Version 3.0
WPD (Word Perfect)	Windows only	Word processing	Supports hyperlinks and watermarks, HTML, CSS, XML, SGML; customizable macros	Proprietary		Corel
XML (Extensible Markup Language)	Opera browser has most complete implementation, DocZilla has even more, but is still in the alpha phase; MSIE 5.5 and Netscape 6 support also	Used on the Web, but can store any structured info	Non- proprietary; can design own document types (more control); removes complexities of SGML (Standard Generalized Markup Language) while retaining flexibility; more linking capability than HTML			SGML approved by International Standards Organization; XML specification 1.0 approved by World Wide Web Consortium

The majority of digital information is stored textually, so naturally, there are many different text formats. However, in order to increase interoperability between different systems the file types are more flexible than other media types, so the list is shorter. Still, this is not meant to be representative of every text format out there.

Listed below is the interoperability of the formats already looked at, with links to more information about the file format.

ASCII: Unix and DOS-based systems use it; programs to convert to Unicode or EBCDIC exist. More.

DOC: HTML can be copied and pasted from web browsers, hiding the code while retaining the look; Word allows you to import/save to a number of other different text formats including HTML, RTF, and TXT. <u>More</u>.

EBCDIC: Programs to convert to ASCII or Unicode exist. More.

HTML: HTML code can be opened in any text editor or word processor, with all the tags exposed; copied and pasted directly into MS Word from web browsers retains much of the original page's look. <u>More</u>.

OEB: More.

RTF: Designed for use on multiple systems. More.

Unicode: Programs exist to convert into ASCII or EBCDIC. More.

WPD: Import/export MS Word, Excel, and PowerPoint; PDF. More.

XML: Can enclose info to pass between systems otherwise unable to communicate. More.

VIDEO v1.1

Note: General information about MPEG is listed below. If you would like more detailed information, please <u>click here</u>.

Format Support Uses

Advantages Disadvantages Bitrate Standards

AVI (Audio Video Interleave)	Windows Media Player (now for Mac too) and RealPlayer; most widely used compressor is Cinepak, free with Video for Windows, though dozens of others are available	Most common format for audio/ video data on the PC, as well as very common on the Internet	Data is arranged in chunks, lowering file size; every option is definable from display size and frames per second to bit depth for audio and video; some compressors can achieve up to 100:1 compression	Unless a good compressor is used, transmitting raw files over the Internet is impractical as files are very large	Typically 8 or 16-bit waveform sound in stereo or mono, sampled at 11, 22, or 44.1kHZ; 24-bit color is usual	Microsoft; Open Digital Media (OpenDML) Consortium has defined extensions to support additional features for a more professional video production
DV and Mini-DV	Digital video cameras and non-linear video editing applications	Intraframe compression of digital video	High-quality, raw footage	A range of DV standards have emerged, all based on one format. But they continue to diverge, creating some incompatibilities. This can complicate interfacing and system integration.	On average, 25Mbits/s for video, up to 44.1kHz and 16bit for audio; the HDCAM format records video as high as 100Mbits/ s	Each manufacturer has their own particular version of the format.
MPEG (Motion Picture Experts Group) *mp4, *.mg4, * mp2, among others <i>MPEG has</i> produced multiple standards, each with different applications	Numerous applications, including Windows Media Player and QuickTime	MPEG-4 could become the video standard for the web, like MP3 is for audio; MPEG-2 used for DVD codecs generally, and web, satellite and terrestrial broadcast; VCDs use MPEG-1	Maintains impressive quality over very constrained bandwidth; streamable; MPEG-4 compresses at a ratio of up to 10:1 of original DVD-quality size, with little loss; MPEG-4's object-based coding allows interactivity	Was not available for Mac users until recently; MPEG-4 charges licenses for de/encodes under the MPEG LA plan	Varies per standard	All developed by Motion Picture Experts Group; open format distributed by ISO; Joint Video Team still working on MPEG-4
QuickTime *.mov	Requires free download of QuickTime Movie Player to view; QuickTime Pro can be used for creating and editing	Multimedia tool offering the most creativity and flexibility; many believe it to be the best quality	Can layer up to 99 tracks of audio, video, 3D, text, Flash, HTML, VR; simply embedded into a webpage; superior compression; maintains good quality over constrained bandwidth	Inconsistencies in playback can occur because unlike AVI which bundles audio/ video data per frame, QuickTime in larger .5 to 1 second blocks		Apple
RealMedia and RealVideo *.rm, *.rv	RealPlayer; RealNetworks provides a number of apps for editing, streaming, capturing, and creating	Streaming or direct- downloadable multimedia on the Internet	High compression rate, allowing for small files	Not always backwards compatible with older players; quality can be greatly reduced due to the compression, resulting in artifacts or motion that is not smooth	Handles up to 16bit sound, 24bit color	RealNetworks
Flash and Shockwave *.swf	Requires free download of Macromedia Flash or	Integrate interactive content into webpages, or use as movies like the other formats	To each other: D simpler, Flash fil streamlined. Flas almost immediat gives you an ad.	Director's interface is es are more sh content loads ely, Shockwave . Director can be		Macromedia

Shockwave Player to view, purchase of Macromedia Flash or Director to create, though free 30-day trial versions exist extended with Lingo for interactivity, and can embed Flash content.

To other types: Vector graphics have smaller file sizes; plug-in distributed with every major browser so the majority of your audience should have it (77% and 69% respectively), many print resource guides are available; integrates with all other Macromedia products

The world of video, particularly online, does not seem to be changing as rapidly as still images, but the above list is still not all-inclusive. New formats are still emerging, however. <u>VP5</u> by On2Technologies, released in February 2002, for example, claims to deliver higher quality at lower bit rates than MPEG-2, MPEG-4, Real 8, Windows Media, and QuickTime, but has yet to take hold.

Listed below is the interoperability of the formats already looked at, with links to more information about the file format.

AVI: More.

DV and Mini-DV: More.(PDF)

MPEG: Since MPEG is an open standard, all major multimedia players support this format, in many including conversion capabilities. More on <u>MPEG</u>. More on <u>Joint Video Team</u>. **QuickTime:** QuickTime Pro can create MPEG-4 files, and can be exported as a DV file in order to work with it in a video editing program such as iMovie. <u>More</u>.

RealMedia and RealVideo: More.

Flash and Shockwave: Only playable with Flash or Shockwave player in a browser or within the editing program itself; Flash 5 can export files for RealPlayer or QuickTime. More <u>here</u> and <u>here</u>.

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