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History of MPEG

About MPEG

MPEG (pronounced M-peg), which stands for Moving Picture Coding Experts Group, is the nickname given to a family of international standards used for coding audio-visual information in a digital compressed format. The MPEG family of standards includes MPEG-1, MPEG-2 and upcoming MPEG-4, formally known as ISO/IEC-11172, ISO/IEC-13818 and ISO/IEC-14496. MPEG is originally the name given to the group of experts that developed these standards. The MPEG working group (formally known as ISO/IEC JTC1/SC29/WG11) is part of JTC1, the Joint ISO/IEC Technical Committee on Information Technology. The convenor of the MPEG group is Leonardo Chiariglione, aka the father of MPEG, who founded the group in January 1988 with the first meeting consisting of about 15 experts on compression technology.

Organization

The Moving Picture Coding Experts Group was established with the mandate to develop standards for coded representation of moving pictures, audio and their combination. Starting from its first meeting in May 1988 when 25 experts participated, MPEG has grown to become an unusually large committee. Usually some 350 experts from some 200 companies and organizations from about 20 countries take part in MPEG meetings. As a rule, MPEG meets three times a year (in March, July and November) but meets more frequently when the workload so demands.

A large part of the MPEG membership is made of individuals operating in research and academia. Even though the MPEG environment looks rather informal, it has to be borne in mind standards can be of high strategic relevance. It should be no surprise that operation of ISO standards committees is carefully regulated by "Directives" issued by ISO/IEC and "Procedures for the Technical Work" issued by JTC1.

Process

MPEG exists to produce standards. Those currently produced by ISO are indicated by 5 digits (the ISO number for MPEG-1 is 11172 and for MPEG-2 is 13818). Published standards are the last stage of a long process that starts with the proposal of new work within a committee. These proposals of work (NP = New Proposal) are approved at the Subcommittee and then at the Technical Committee level (SC29 and JTC1 respectively, in the case of MPEG).

When the scope of new work has been sufficiently clarified, MPEG usually makes open requests for proposals. So far proposals have been requested for :

1. MPEG-1 Audio and Video (July 1989)
2. MPEG-2 Audio and Video (July 1991)
3. MPEG-4 Audio and Video (July 1995)
4. Synthetic/Natural Hybrid Coding (March 1996).

Depending on the nature of the standard, different documents are produced. For Audio and Video coding standards the first document that is produced is called a Verification Model (VM). In MPEG-1 and MPEG-2 this was called Simulation and Test Model, respectively. The VM describes, in some sort of programming language, the operation of the encoder and the decoder. The VM is used to carry out simulations to optimize the performance of the coding scheme. When MPEG has reached sufficient confidence in the stability of the standard under development, a Working Draft (WD) is produced. This is already in the form of a standard but is kept internal to MPEG for revision. At the planned time, the WD has become sufficiently solid and becomes Committee Draft (CD). It is then sent to National Bodies (NB) for ballot. If the number of positive votes is above the quorum, the CD becomes Final Committee Draft (FCD) and is again submitted to NBs for the second ballot after a thorough review that may take into account the comments issued by NBs. If the number of positive votes is above the quorum the FCD becomes Final Draft International Standard (FDIS). ISO will then hold a yes/no ballot with National Bodies where no technical changes are allowed. The document then becomes International Standard (IS).

A WD usually undergoes several revisions before moving to CD stage. A key role is played by "Core experiments" where different technical options are studied by at least two different partners. Each revision involves a large number of experts who draw the committee's attention to possible errors contained in the document. Moreover, depending on the nature of comments that usually accompany National Body votes, important changes may have to be made on documents when they progress from CD to DIS and from DIS to IS.

The net result is that standards produced by MPEG are of ***very high quality***. No single error was discovered in MPEG-1 and small errors, better described as items of text of dubious interpretation, were found in MPEG-2 Video and MPEG-2 Audio. In MPEG-2 Systems, Video and Audio it was found useful to introduce some new features that built upon the standards as originally released. This was done using the "amendment" procedure defined by ISO. For MPEG-2 Audio it has been found useful to produce a new revision of the standard.

A large part of the technical work is done at MPEG meetings, usually lasting one full week. Several hundreds contributions are submitted by members by electronic means to the MPEG FTP site. Delegates are then able to come to meetings without having to spend precious time to study other delegates' contributions at the meeting. The meeting is structured in Plenaries (4 hours on Monday morning, 2 hours on Wednesday morning and all the afternoon of Friday) and in subgroup meetings.

About 150 documents are produced at every meeting that capture the agreements reached. Of particular importance are "Resolutions" which document the outline of each agreement and make reference to the documents produced, and "Ad-hoc groups", groups of delegates working on some specified area of work, usually until the following meeting. Ad-hoc groups work by e-mail and in some exceptional cases they are authorized to hold physical meetings. Output documents, too, are stored on the MPEG ftp site. Access to input and output documents, however, is restricted to MPEG members.

Joining MPEG

MPEG has attracted a large number of researchers from both industry and academia because it has succeeded to respond to the needs for standards coming from industry with the enthusiasm and dedication of MPEG delegates. Its friendly and stimulating environment has been instrumental to this achievement. Joining MPEG, means attending and participating in the MPEG meetings. Attendance at MPEG meetings requires accreditation by a National Standards Body or standards committee in liaison. Experts attending MPEG not representing a committee in liaison must be members of a National Delegation. Heads of Delegation are appointed by the corresponding National Bodies and meet during the week to address matters of general interest to the group. A member can submit a document to MPEG by registering the document and then after editing the document number into the text and naming the document according to the wishes of the registrar, upload it to an ftp server. Any MPEG member can retrieve MPEG and WG11 documents from the main ftp site (in U.S.) or from the 2 mirror sites (in Japan and in U.K.).

Achievements and Dominance

MPEG has gained a wide audience across the globe rapidly. It has been adopted by leading multimedia technology firms like Philips, Samsung, Intel, and Sony for their products.

The National Academy of Television Arts and Sciences (NATAS) awarded its 1995-1996 Engineering Emmy for Outstanding Achievement in Technological Development to ISO/IEC for the development of the MPEG and JPEG standards. It was a recognition of the MPEG compression technology as a cost-effective means of delivering high quality audio and video programming to consumers by reducing the bandwidth necessary to carry the signal to homes and businesses across the globe. Other success stories for MPEG standards include :

- Today's computer systems are already supporting MPEG-1 audio and video. MPEG encoded files are available from a growing number of platforms, including CD-ROM and the Internet.
- The MPEG-1 technology learning curve is established. CD-i and Video-CD will be supported by the new DVD players, leading to MPEG-1 decoding capabilities being included.
- MPEG-2 is the video standard for DVD players.
- For DVD multichannel audio, MPEG-2 is the standard audio format for PAL/SECAM countries, and an option for NTSC countries.
- An increasing number of broadcasting applications are based on MPEG technology, e.g. DSS (Digital Satellite System), DAB (Digital Audio Broadcast), DVB (Digital Video Broadcast), ADR (Astra Digital Radio), Satellite feeds to cable networks, etc.
- MPEG is used more and more over ISDN to provide very high quality audio and video.
- MP3 has moved onto the mainstream music radar, car players have arrived, and hybrid stereo components are the next MP3 devices on the horizon.

The MPEG technology provides high end compression for digital media while still preserving its quality. This, coupled with the non-proprietary policy of the MPEG standard, has led to a strong support for the format by the customers as well as grass root developers. The ease in creating and transmitting the MPEG coded audio/video over the internet has led to a music revolution on the web. More than that, its wide acceptance has led to more copyright violation issues than any other standard by far, making the path to acceptance littered with turbulence.

Despite MPEG's rocky road to standardization and acceptance, lower hardware prices for both encoding and decoding have made MPEG video more accessible. Meanwhile, the unanticipated demand created by streaming audio over the internet has continued to increase MPEG's acceptance. Expect to see more and more boards on the market, which will probably start to distinguish themselves with more intricate and more fully-featured user interfaces. MPEG-2 will continue to find wider acceptance in the broadcast community as satellite broadcast and video-on-demand grows, but MPEG's major vindication will come with DVD, so don't hold your breath. Meanwhile, MPEG-4 is still being discussed, so keep an eye on bandwidth developments for the internet as the standards become defined. Essentially, MPEG's battle for acceptance seems to have been won, so now the real work can be done by talented compressionists and dedicated MPEG content providers.

MPEG Formats and Applications

MPEG - 1

The MPEG-1 standard, established in 1992, is designed to produce reasonable quality images and sound at low bit rates. MPEG-1 consists of 4 parts:

- IS 11172-1: System describes synchronization and multiplexing of video and audio.
- IS 11172-2: Video describes compression of non-interlaced video signals.
- IS 11172-3: Audio describes compression of audio signals using high performance perceptual coding schemes.
- CD 11172-4: Compliance Testing describes procedures for determining the characteristics of coded bit-streams and the decoding process and for testing compliance with the requirements stated in the other parts.

MPEG-1, IS 11172-3, which describes the compression of audio signals, specifies a family of three audio coding schemes, simply called Layer-1,-2,-3, with increasing encoder complexity and performance (sound quality per bit-rate). The three codecs are compatible in a hierarchical way, i.e. a Layer-N decoder is able to decode bit-stream data encoded in Layer-N and all Layers below N (e.g., a Layer-3 decoder may accept Layer-1,-2 and -3, whereas a Layer-2 decoder may accept only Layer-1 and -2.). MPEG-1 Layer-3 is more popularly known as MP3 and has revolutionized the digital music domain.

MPEG-1 is intended to fit the bandwidth of CD-ROM, Video-CD and CD-i. MPEG-1 usually comes in Standard Interchange Format (SIF), which is established at 352x240 pixels NTSC at 1.5 megabits (Mbits) per second, a quality level about on par with VHS. MPEG-1 can be encoded at bit rates as high as 4-5Mbits/sec, but the strength of MPEG-1 is its high compression ratio with relatively high quality. MPEG-1 is also used to transmit video over digital telephone networks such as Asymmetrical Digital Subscriber Lines, Video on Demand (VOD), Video Kiosks, and corporate presentations and training networks. MPEG-1 is also used as an archival medium, or in an audio-only form to transmit audio over the internet.

MPEG-2

The MPEG-2 standard, established in 1994, is designed to produce higher quality images at higher bit rates. MPEG-2 is not necessarily better than MPEG-1, since MPEG-2 streams at lower MPEG-1 bit rates won't look as good as MPEG-1. But at its specified bit rates between 3-10Mbits/sec, MPEG-2 at the full CCIR-601 resolution of 720x486 pixels NTSC delivers true broadcast quality video. MPEG-2 was engineered so that any MPEG-2 decoder will play back an MPEG-1 stream, ensuring a side-grade path for users who enter into MPEG with the lower priced MPEG-1 encoding hardware. MPEG-2 has also ousted MPEG-3 as the standard for HDTV, and has also received a lot of attention because it's the standard specified for DVD. The primary users of MPEG-2 are broadcast and cable companies who demand broadcast quality digital video and utilize satellite transponders and cable networks for delivery of cable television and direct broadcast satellite.

MPEG-3

MPEG-3 was initially intended to cover HDTV, providing larger sampling dimensions and bit rates between 20-40Mbits/sec. It was later discovered that MPEG-2 can be finessed to cover the requirements of HDTV, so the

MPEG-3 standard was dropped.

MPEG-4

The MPEG-4 standard was initiated in 1995 and reached a committee draft status in March 1998 (ISO 14496) and was finalized in end of 1998. This standard was initially specified for very low bit rates but now it supports up to 4Mbps. MPEG-4 specifies sampling dimensions up to 176x144 pixels at the comparatively low bit rates between 4800 and 64,000 bits per second (not megabits, but bits). It has six parts :

1. Systems
2. Visual
3. Audio
4. Conformance testing
5. Software
6. Delivery Multimedia Integration Framework (DMIF)

MPEG-4 is designed for use in broadcast, interactive and conversational environments. The way MPEG-4 is built allows MPEG-4 to be used in television and Web environments, not just the one after the other, but also facilitates integration of content coming from both channels in the same multimedia ‘scene’. Its strong points are inherited from the successful MPEG-1 and -2 standards (broadcast-grade synchronisation and the choice of on-line/off-line usage) and VRML (the ability to create content using a ‘scene description’).

MPEG-4 adds to MPEG-1 and -2:

- Integration of natural and synthetic content, in the form of ‘objects’. Such objects could represent 'recorded' entities (a person, a chair) or synthesised material (a voice, a face, an animated 3D model)
- Support for 2D and 3D content
- Support for several types of interactivity
- Coding at very low rates (2 Kbit/s for speech, 5 Kbit/s for video) to very high ones (5 Mbit/s for transparent quality Video, 64 Kbit/s per channel for CD quality Audio)
- Support for management and protection of intellectual property

MPEG-4 adds to VRML:

- Native support for natural content and real-time streamed content, using URLs
- Efficient representation of the scene description

Several forms of scalability support usage over networks with a bandwidth that is unknown at the time of encoding.

MPEG-4 preserves compatibility with major existing standards: MPEG-1, MPEG-2, ITU-T H.263, and VRML.

While the full MPEG-4 toolbox is very rich and powerful, it will be too expensive to implement in full for many applications. That is why MPEG has defined 'Profiles', which group the capabilities in useful subsets. This means that the standard is useful for simple applications now, but can still be used with Web content getting richer and set top boxes getting more powerful. Note that e.g. an 'Audio-only' device can be a perfectly valid MPEG-4 appliance; you don’t need to use all 4 parts if you don't want to.

MPEG-7

MPEG-7 is the latest proposal in the family of MPEG standards and will be formalized into a standard by September 2000. MPEG-7 will be a standardized description of various types of multimedia information. This description will be associated with the content itself, to allow fast and efficient searching for material that is of interest to the user. MPEG-7 is formally called ‘Multimedia Content Description Interface’.

The increasing availability of potentially interesting audio/video material makes its search more difficult. This challenging situation led to the need of a solution to the problem of quickly and efficiently searching for various types of multimedia material interesting to the user. MPEG-7 wants to answer to this need, providing this solution.

The people taking part in defining MPEG-7 represent broadcasters, equipment manufacturers, digital content creators and managers, transmission providers, publishers and intellectual property rights managers, as well as university researchers.

MPEG-7 will not replace MPEG-1, MPEG-2 or MPEG-4. It is intended to provide complementary functionality to these other MPEG standards, representing information about the content, not the content itself ("the bits about the bits"). This functionality is the standardization of multimedia content descriptions. MPEG-7 can be used independently of the other MPEG standards - the description might even be attached to an analog movie. The representation that is defined within MPEG-4, i.e. the representation of audio-visual data in terms of objects, is however very well suited to what will be built on the MPEG-7 standard. This representation is basic to the process of categorization. In addition, MPEG-7 descriptions could be used to improve the functionality of previous MPEG standards.

There are many applications and application domains which will benefit from the MPEG-7 standard. A few application examples are:

- Digital libraries (image catalogue, musical dictionary,…)
- Multimedia directory services (e.g. yellow pages)
- Broadcast media selection (radio channel, TV channel,…)
- Multimedia editing (personalized electronic news service, media authoring)

Benefits of Standards

The first generation MPEG-1 and MPEG-2 audio-visual communication standards have been produced by a collaborative effort, involving all stakeholders, among which are the main players in the affected industries.

The Affected Industries

The MPEG-1 standard, the coding of audio-visual signals at a bitrate of less than 1.5Mbit/s, was motivated by the prospect of storing video signals on a compact disk while maintaining the quality of VHS cassettes. Therefore the first industry affected by the standard is the consumer electronics industry, as well as content providers. The latter has to provide information that is compliant with the standard whereas the former is compelled to manufacture electronic devices able to play this standardized content. Also involved is the computer industry in the manufacturing of MPEG-compliant decoders.

As seen before, MPEG-2 was created by the broadcast industry’s need for higher bitrates. The broadcast industry encompasses both television and video. Immediately, broadcast television makers realized the potential of MPEG technology to increase the channel efficiency of satellite transponders and cable networks. It also understood the potential expansion of video services that digital video can bring about. Digital TV, High Definition TV and DVDs are traditional products whose development and market acceptance have been made possible thanks to the MPEG algorithms. The parties affected by the MPEG-2 standard are both in the television and video industries, ranging from content providers to cable operators and electronic manufacturers. Even telephone companies are affected In fact, Bell Atlantic has started to use MPEG-2 encoders to transmit digitally compressed cable programming, which enables the carrier to provide video dial-tone services commercially.

Though MPEG-4 compliant products are scarce at the moment, the project starts to have an impact on certain players of the industry, such as digital camera manufacturers. In fact, Sharp Corp. has developed an MPEG-4 camera and demonstrated it at a recent CEBIT show in Hannover, Germany.

Fruits Reaped by the Standard Adopters

All the industries evoked above benefited from having chosen the MPEG standard:

- Cost savings--The compression standards allow better leverage of digital technology. The use of compressed digital over analog video allows for lower video distribution costs, increases the quality and security of video, and allows for interactivity. For example, digital compression allows a cable television system operator to carry four to ten television signals on one cable television channel that typically carries one service. Secondly, the expensive cost of satellite transponder rent can be decreased significantly (75% per channel). Finally the noise collected by analog video as it travels, both over the air and through cable, can be reduced significantly. As a consequence, it is the potential growth rate of digital video that bolstered the adoption of the standard among the different players of the broadcast industry, with positive feedback for the latter.
- Integration of multiple industries--The MPEG standards fulfill the need of a cross-industry standard given the multi-industry nature of multimedia communication. Each of the entertainment, telecommunication and computer industries have tried, and are still trying to achieve complete control of the content-transport-equipment chain (vertical integration). For instance, MSG Networks purchased Sony's HDCAM solution for providing digital HDTV sports broadcasts of New York Yankees and Mets baseball games this spring. A unique standard across all those industries facilitates this integration process. It also helps the different stakeholders to take advantage of the network externalities, e.g. the more DVDs become accepted in the market place, the more equipment manufacturers are eager to produce DVD players.

Cases - *MPEG Gains*

DVDs

In December 1997, that is to say roughly a year after the first introduction of DVDs in the Japanese market, more than 200,000 DVD-video players had been sold in the US. This was an impressive adoption rate, compared to other new systems, and was mostly due to the acceptance of the DVD standard (and the MPEG one on which it relies) by the main players involved in the industry. In fact, it brought about customer confidence, and allowed positive feedback, almost all major Hollywood studios introduced DVD video titles in order to reach the market of DVD players early adopters. Europe suffered from delays in terms of disc production. This was linked to the fact that production of PAL discs was far more complex than production of NTSC discs. Therefore, the existence of 2 video standards (PAL/NTSC) reduced the rate of adoption of such a new technology in Europe, but the power of MPEG standard succeeded in overcoming this hardship. For instance, companies like Philips played a determinant role in the adoption of the standard by putting the pressure on the software community to have the disks launched on time. This is a well-known characteristic of standard communities where early adopters motivate complementors to join them in the standard adoption and improve their service (quality and/or price), so that everybody can cash in on the network externalities benefits.

Digital TV

The potential rapid adoption of digital TV is correlated with the development of the MPEG compression technology, which gives cost saving incentives to suppliers, and improved quality of service to customers. A "Grand Alliance" including AT&T, Zenith, General Instruments, Sarnoff Laboratories and others, the main actors in the industry sub-segments, was created in order to set up the DTV standards. Adopted by the FCC in 1996, they include Standard Definition TV (SDTV) and High Definition TV (HDTV) standards. One of the main differences is the number of horizontal lines of resolution delivered (480 in a SDTV mode versus 1080 in a HDTV mode).

Most of the TV manufacturers (Sony, RCA, Philips, Sharp, Pioneer, Toshiba, JVC, Zenith, Hitachi, and Samsung) are either already selling or announced early in January 1999 plans to market digital television sets. This raises two typical issues in a standard adoption situation: critical mass and backward compatibility. The prohibitive cost of those digital TV sets can be a strong barrier to digital TV, and could prevent reaching critical mass fast enough. But the large installed base of analog TV set owners can receive digital channels via the addition of a much less expensive digital-analog converter. Moreover, the SDTV set are fully backward compatible with analog broadcasts, which should also support the adoption. On the contrary, HDTV sets are not backward compatible, and HDTV transfer standards are not compliant with analog sets. Therefore, the rate of adoption might be slower. This is not because the MPEG standard failed in bringing together all the stakeholders in the industry, but because the new technology had a different impact on each player in terms of cost. Thus, the manufacturers' offers are not yet competitive, and can only target the customers with a high willingness to pay.

Cases - *MPEG Losses*

As widely accepted as MPEG standards may be, all of the products have not been successful, and some have to face powerful competitors in the market place.

1. Certainly, the video quality of MPEG-2 technology is superior to MPEG-1. But MPEG-1 remains useful and is still being used because it serves its own purposes. The two standards are designed to address the needs of different industry segments in terms of data transfer rate. MPEG-1 is for example designed to provide higher quality at CD data rates. Moreover, it can remain adequate and very cost-effective for certain applications that MPEG-2 targets. In that case it appears to be somehow a low-end product in the MPEG product line. Therefore MPEG-2 does not cannibalize the MPEG-1 market. In addition, MPEG-2 is backward compatible with MPEG-1: since MPEG-1 is a subset of MPEG-2, any MPEG-1 video is compatible with MPEG-2 decoders. The MPEG-3 project, launched in order to address the needs of the raising market of High Definition TV, was a failure. In fact, people realized further on that MPEG-3 features overlapped the ones of the two previous versions. The risks of cannibalization and non-compatibility between standards within a given industry were too high. Moreover, the already installed base of MPEG users in the industry could be leveraged in order to speed up the HDTV adoption rate; starting without an installed base for MPEG-3 would have endangered industry acceptance.
2. The MPEG audio standard is not as widely accepted as its video cousins are. In fact, the delivery systems (cable, satellite, etc) converged on the MPEG-2 standard for video, but no similar choice has been made for audio standards. Some systems use MPEG, some others Dolby Digital, or both. Hence MPEG has not managed yet to impose itself as the leader on the field. There are a number of reasons:

- MPEG and Dolby Digital released their specification at different times, so that adopters became locked in the choice they made. When MPEG-1 was introduced, there was no Dolby Digital. Later on, when Dolby introduced 5.1-channel audio, MPEG had only a stereo solution.
- Each delivery format has its own performance criteria, which hinders fair comparisons.
- The poor quality of MPEG standard for certain types of applications:

> MPEG-1 is a two-channel audio system. Multichannel extensions were added afterwards, in MPEG-2, in order to provide the 5.1-channel audio capability requested by the U.S. HDTV format. MPEG-2 bitstreams again, are backward compatible with MPEG-1 decoders. The MPEG-2 bitstream consists of 2 separate parts. The first contains the MPEG-1 data compatibility, whereas the other is MPEG-2-specific. MPEG-1 decoders only read the first components, and MPEG-2 decoders can read both. This compatibility can cause audio quality limitations. This situation is very characteristic of a standard situation where backward compatibility can hamper performance. The decision to be made can be one of the following. Either allow customers using a new version to take advantage of the old version, with all the economy of scale on the demand side it entails, or propose a product that addresses new needs and/or targets new customers using a non-backward compatible technology to do so.

MPEG - Opportunities

Record companies had not seen the huge opportunity of MP3 and did not ally with the MP3 player manufacturers when the MPEG-1 layer 3 standard was released. Web hosting services and on-line stores would have allowed them to sell music in that format across the Internet without the need for CD's. For some reason however, the record companies seemed to ignore MP3 technology until it had become the domain of fans to allow them to post music for free on the network and bootleg out of the jurisdiction of the record companies. Probably, they had a monopoly on the distribution of music and recorded media for so long that they never thought anyone could take it away. If they had been more forward-looking they would have seen the advantages of the Internet with MP3 and other new ways of distributing their product and would have been able to hold on to their monopoly.

Now that MP3 players have been released (http://www.mpman.com/), the danger is even closer for the record companies. Some artists deliberately decide to release their album with the MPEG standard first, bypassing the record industry value chain and putting the middleman (record companies) out of the picture. Thus, both content providers and customers seem ready to accept MPEG in the record industry. A recent report by Andy Patrizio, TechWeb, showed that the 15- to 24-year-old age demographic accounted for 28 percent of overall record sales for 1998. That was down 4 percent compared to 32.2 percent in 1996. "Potentially, the rise of the Internet as a free entertainment center, and the accompanying availability of free MP3 music files, could be contributing factors," said the report.

The way MPEG deals with legal issues will determine how widely and successfully accepted it will be in that industry. One proposed solution, according to GoodNoise, is to make MP3 as readily available as possible and selling the right to download it rather than giving for free the right to listen to it. The price would be 99 cents per song or $8.99 per album.

The fruits of two years' work by IBM Corp.'s Internet Advanced Technology Group took center stage recently when IBM and five major record companies announced a market trial of a secure system for downloading digital music files over the Internet. If it succeeds, this attempt could lead the path to a totally secure and legal distribution of MP3 format content, protecting author rights and intellectual property. In that case, the record industry will be wide-open to the MPEG standard, and the potential impact on the market place will be tremendous.

Competing Bodies and Standards

MPEG is not an independent organization but an ISO/IEC/ITU working group. All three of these international organizations are involved in this area. ISO collaborates with its international standardization partner, the IEC, whose scope of activities complements ISO's. In turn, ISO and the IEC cooperate on a joint basis with the ITU. Like ISO, the IEC is a non-governmental body, while the ITU is part of the United Nations Organization and its members are governments. The three organizations have a strong collaboration on standardization in the fields of information technology and telecommunications.

ISO (International Organization for Standardization) promotes the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity.

IEC (International Electrotechnical Commission) is the world organization that prepares and publishes international standards for all electrical, electronic and related technologies. It promotes international cooperation on all questions of electrotechnical standardization and related matters, such as the assessment of conformity to standards, in the fields of electricity, electronics and related technologies.

The ITU (International Telecommunication Union) is an international organization within which governments and the private sector coordinate global telecom networks and services.

MPEG also has a Liaison Subgroup which maintains communications between MPEG and other standards bodies on topics of common interest. A few such bodies are :

- ITU-T International Telecommunications Union - Telecom Sector
- ITU-R International Telecommunications Union - Radio Sector
- EBU European Broadcast Union
- ATSC Advanced Television Systems Committee
- SMPTE Society of Motion Picture and Television Engineers
- ISO International Organization for Standardization
- CEN
- DAVIC Digital Audio Video Integration Consortium
- JPEG Joint Photographic Experts Group, aka ISO/IEC JTC1 SC29/WG1

- VRML Virtual Reality Modeling Language
- W3C World Wide Web Consortium
- DVB Digital Video Broadcast
- FIAPF International Federation of Film Producers Associations
- INTELSAT International Telecommunications Satellite Organization
- AES Audio Engineering Society

MPEG, the ISO, IEC and ITU govern the standards, but not the patents for the technology used to apply these standards. There can be competition between various standards, as for instance is the case in audio compression. MPEG-2, for example, must compete with audio standards such as AC-3, developed by Dolby Digital. MPEG also incorporates outside technologies such as AudioMP3 for its own MPEG-1 Layer-3 standard. AudioMP3 was mainly developed by Fraunhofer, an organization specialized in applied research.

The AC-3 standard is considered to be among the most technologically advanced, with a higher compression rate than MP3. However, the earlier release of MP3 has enabled MP3 to gain a substantial market share of audio compression applications and it has become the de facto standard for music files transfers over the Internet. This is despite the concerns of the music industry to copyright protect the MP3 format. Since the standards are not backwards compatible, AC-3 decoders cannot read MP3-encoded files. The relevance is that although better is available and has been standardized it will not be successful against an incumbent standard unless it represents a major performance enhancement. As a result we keep using the less superior technology.

Many companies try to differentiate themselves after adopting MPEG standards by adding special operating features or customizing the touch and feel of the hardware and software. The strength of the MPEG standard is that it is instituted in these three international organizations where any country or company with an interest in the development of this technology can participate. The MPEG group does not seem to be directly involved in the politics through which the different standards or levels or layers of a standard get accepted. At least the politics do not appear to bog down the process. MPEG is more a place where the track is defined where runners for different companies can compete.

MPEG's Future Outlook

Strengths of MPEG standards

An important aspect of MPEG standards is that they allow a range of operating conditions to suit the needs of various users. For example, video bitstreams as high as 10 Mbits/s are easily encompassed by the MPEG-2 standard. MPEG-2, however, can still be used for occasional applications requiring lower bitrates of 1.5 Mbits/s. For users mainly focused on these lower bitrates, MPEG-1 offers better-optimized performance. At the same time, MPEG-1 still allows these users to scale performance needs to as high as 4-5 Mbps. This scalability and flexibility in the standards addresses the needs of various users in numerous industries. It also addresses inevitable changes and improvements to technology to a reasonable degree. All this flexibility lends power to MPEG and its standards.

Not only are MPEG standards flexible, but they are also open. They are open in that the underlying technologies are readily accessible. They are also open in the sense that MPEG standards, in particular MPEG-1 and MPEG-2, define the bitstream format, describing only what encoders need to encode and what decoders need to decode. Decoding bitstreams is a relatively simple process, and manufacturers of decoders compete today to drive the cost of systems downward. Encoding systems, being more demanding, offer more options along which component and systems manufacturers can compete. Manufacturers can differentiate with regard to performance, user interfaces, and other features.

So it is important to note that the existence of MPEG standards does not greatly limit areas of competition within affected industries. The standards merely change the nature of the competition. Competition increases down at the component level. At the same time, the standards allow a multi-industry interoperability that generates competition and cooperation far above and beyond the system level. Only those business directly involved in creating competing audio-visual compression standard are hurt by the existence MPEG. Meanwhile, the benefits MPEG provides to its numerous affected industries far outweigh the losses.

Progressiveness of MPEG

MPEG seeks to create a future role for itself though the progressive nature of its latest standards. For example, MPEG-4 includes provisions for integrating various forms of content (2D and 3D, natural and synthesized) and support for interactivity and scene description. MPEG-7 reaches even further, seeking to create a complementary support platform for the other MPEG standards. As mentioned earlier, MPEG-7 represents information about the content and not the content itself. This has far-reaching implications. New industries even remotely tied to information search and retrieval will be affected in addition to those already affected by MPEG. The base of participants to MPEG can only increase as a result.

Outlook on MPEG's future power as a Standards body

MPEG is currently powerful as a standards body because of the technical superiority of its standards and the broad applicability of the standards. The standards' extensive reach generates widespread participation among industry members. MPEG draws upon the broad range of technical expertise from its members for ideas and inputs on proposed standards. Widespread participation leads to a high probability that new ideas for new standards will be captured by the MPEG standards body, generating positive feedback which results in increased power for MPEG over time.

Although MPEG will likely grow to be more successful because of momentum and current successes, there are still potential pitfalls. As new standards begin to cover broader areas and more industries, MPEG could become bogged down trying to satisfy too many interests. MPEG could become another slow, overly-political standards body, too big to approve any standard within a reasonable timeframe. MPEG would need to narrow its scope or splinter off newer standards into separate committees to remain effective.

As MPEG standards continue to proliferate, the issue of backward compatibility will also grow in importance. The first MPEG standards were minimally encumbered by compatibility issues. The compatibility of new emerging standards with old will require both more technical and political consideration.

Convergence of all forms of digital data in the future can easily bring new players to compete with MPEG's position as a standards body. No other emerging competing standards bodies are seen on the horizon, however. Perhaps the greatest threat is for a strong market leader or group of powerful companies attempting to establish their own standard independent of MPEG or in direct conflict with MPEG.

MPEG also must watch out for market forces such as initially high prices for hardware for new technologies. These hinder the adoption of standards. MPEG must make sure new standards are still economically feasible over the short term, even if there are significant benefits over the long term. The ability for MPEG-4 to be implemented in partial form, rather than always in full, shows how this issue might be addressed.

Finally, copyright violation issues have been known to complicate the path to acceptance of MPEG standards. Content providers are an obvious critical party to the success of MPEG and the industries it serves. Their concerns must be acknowledged in upcoming standards whether justifiable or not.

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