

Development of Optical Disks from the Viewpoint of International Standardization

Tomoyuki Toshima
NTT Electronics Corporation, Japan
Chairperson, ISO/IEC JTC 1/SC 23

1. INTRODUCTION

Nearly 20 years have already passed since Laser Disc and Compact disc were developed. Both discs were developed for the purpose of consumer use for Video and Audio. In 1985, the first specifications for CD-ROM were determined in order to store and distribute digital data or software for personal computer use. As the price-reduction in both of the media and disc-drives has been intensively preceded, CD-ROM became to be installed commonly into personal computers gradually. CD-R was developed in 1987 as a write-once optical disc. As the CD-family becomes prosperous, demand for optical discs with higher capacity has been raised, and this led to the development of phase change media and DVD-family. Rewritable Magneto Optical(MO) and Write-Once disks having diameter of 130mm were developed for mass storage use in latter half of 1980s and MO disk with diameter of 90mm was developed in early 1990s for personal computer use. Nowadays, most of high performance personal computers in the market are featured with DVD-ROM drives and CD-R/RW drives. DVD players are widely used at home in the world to enjoy movies or high quality music. DVD-RAM/R/RW and +RW drives came onto market as a successor of VCR. Mass storage systems using 130mm MO and DVD-RAM discs are used in LAN and WEB server systems for archiving the various digital data. The number of Internet users in the world has exceeded over 5 hundred millions in 2001 and by the year-end of 2005 the number will be doubled to 1.12 billions. Accompanying with the expansion of Internet users, the demands for larger-capacity and lower-cost network storages and storages for personal computers are still increasing. The importance of optical disks in computers, archives and network systems will increase more and more in the future. Optical disks are exchangeable media. Therefore, interchangeability of each optical disk must be guaranteed. In order to maintain the interchangeability of optical disks, the physical parameters of optical disks have been released as the international standard and respective manufacturers are fabricating optical disks according to these international standards. Therefore, the international standardization activity is very important for development and prevalence of optical disks. The author has been engaged in the international standardization of optical disks as a chairperson of ISO/IEC JTC 1/SC 23. In this paper, development of optical disks will be described from the viewpoint of the international standardization.

2. INTERNATIONAL STANDARDIZATION ORGANIZATION AND ITS ACTIVITIES

In the first half of 1980, the basic technologies on write-once and magneto optical disks had been established and mass storage systems using these optical disks were required from various business sectors. As stated in the introduction, International standards were necessary to commercialize and to spread the mass storage system using the optical disks. However, there was no appropriate sub-committee (SC) in ISO that was responsible for International Standardization of information technology at that time. Therefore, an SC, that was responsible for international standardization of optical disks, was proposed by several countries, and ISO/TC97/SC 23 was established in 1984. ISO/TC97/SC 23 was reorganized as ISO/IEC JTC 1/SC 23, when Joint Technical Committee 1 was established by ISO and IEC in 1986. Original Chairperson of the sub-committee was Dr. Junichi Shimada and the next chairperson was Dr. Yoshinobu Mitsuhashi from Electrotechnical Laboratory in Japan. Specifications for write-once optical disk cartridge (ODC) with capacity of 650MB and with diameter of 130mm were proposed in 1985 and two international standards were published in 1990. Specification for rewritable 130mm MO ODC with capacity of 650MB was proposed in 1987 and international standard was published in 1991. For mass storage system using the write once ODCs with diameter of 300mm and 356mm were also developed. Specifications of these optical disks were proposed in 1988 and two international standards for 300mm ODC were published in 1995 and an the international standard for 356mm ODC was published in 1993. For personal computer use, a specification of 90mm MO ODC with capacity of 128MB was proposed in 1988, and the international standard was published in 1992. Corresponding to development of information technology in 1990s, there was an increasing demand for large-capacity and low-cost storage devices. Users had requested development of next generation ODCs. SC 23 had been developing international standards for ODCs that had a larger storage capacity than the first-generation ones but remained the same cartridge case size for compatibility. In case of 130mm rewritable ODCs, SC 23 first developed the standard for ODCs that had a 650MB capacity, and then for ones that had a double of this capacity. Further development doubled it again and then again to give the 5.2GB capacity. As for the 90mm rewritable ODCs, ones that had a capacity of 128MB were first developed. Development has been continued and ODCs that had a capacity of 230MB and 640MB were introduced successively. In this development process, the industry applied several new advanced technologies each time to achieve higher storage capacity. Industry has developed new recording material in addition to magneto optical material for rewritable optical disk. Commercialization of rewritable optical disk that used phase change (PC) material had been started in Japan. Japanese researchers on rewritable optical disk using PC material gathered together at the first Phase Change Optical Recording Symposium (PCOS) in 1990. Volunteers from many companies established Phase Change Optical Disc Workshop in 1992 and the movement toward commercialization of phase change optical disk started. At that time the commercialization of MO

disk had already started in Japan. Therefore, there was an atmosphere in Japanese industry to make oppose against the commercialization of PC optical disk. Members of Phase Change Optical Disk Workshop provided further insights into necessary technologies for commercialization. In parallel with technology investigation, they made effort to have the management personnel of each company, contributory person in foreign countries and organization of standardization be interested in PC technology and the highness of percentage completion. By their efforts, PC optical disk technology began to be accepted in industry and in standardization organization college. Matsushita Electric Industrial Co., Ltd. commercialized 130mm PC optical disk (PD) in 1994. New proposal item on 90mm PC ODC with capacity of 1.3GB/both-sides was proposed from Japanese National Body to ISO/IEC JTC 1 in November 1994 and was approved by ISO/IEC JTC 1 and a new project started operations in ISO/IEC JTC 1/SC23 in April 1995. After many twists and turns, the international standard of 90mm PC ODC was published as ISO/IEC 14760 in December 1997. Before that, international standardization process used to take more than three years from proposal of new work item to publication of international standard. This is the shortest term concerning international standardization at ISO/IEC JTC 1/SC 23. Although unfortunately, 90mm PC ODC was not successful evaluating from the view point of business, newly developed technologies such as phase change media, substrate made by gluing two substrates with thickness of 0.6mm together, object lens with NA=0.6 and short-wave length LD played an important roll for development of DVD-RAM that was put forward parallel with that of 90 mm PC ODC.

Explaining international standardization procedure, there are two different procedures. One is the five-stage procedure or so called as consensus procedure. In the five-stage procedure, international standards are completed through five stages from new work item proposal to the publication. Consensus is formed through discussions at each stage so that participants can deeply understand the newly developed technology, background and details of proposed specifications. However, this procedure tends to require relatively long time until publication. At the early activity in JTC 1/SC 23, publication of international standard required more than five years from the new work item proposal. Another is the fast-track procedure. **Any primary members of JTC 1 or organization in Category A liaison with JTC 1 (organization such as ECMA) may propose that an existing standard from any source be submitted without modification directly for vote as a Draft International Standard (4th stage in the five-stage procedure).** This procedure can shorten the term that is required for completion of international standard. As stated previously, SC 23 had been trying to shorten the term for completion of international standardization and the term was shortened to one half comparing one at the early stage of SC 23. However, advance in information processing and communication technologies has become so rapid in recent years that even faster standardization activity is required, especially for consumer applications.

As optical disk and its technology were accepted widely by consumer, manufacturers began to think it was much more effective to commercialize new optical disks first and to promote international standardization after they had checked the reaction and reputation to new optical disks by consumer. Therefore, the fast-track procedure has been used for international standardization of optical disk in the last six years. As for standardization of DVD, related manufacturers and users established DVD forum that is responsible for making specifications and promotion of prevalence of DVD. Nowadays, Japanese Industrial Standard (JIS) of DVD on parallel with ECMA standard is constituted based on specification established by DVD Forum and then Japanese National Body sends the JIS to JTC 1 using the fast-track procedure. When the DIS is approved by ballot by the primary members in JTC 1/SC 23 the international standard will be published. Until now JTC 1/SC 23 had developed 30 international standards including ones that were standardized by the fast-track procedure and 4 related technical reports.

3. FUTURE DEVELOPMENT OF INTERNATIONAL STANDARDS

JTC 1 continues reorganization in order to make the international standardization more efficient. However, there are various SCs that are responsible for international standardization of different field of the information technologies in JTC 1 and the 5-stage procedure is still favorable for a lot of SCs except SC 11 and SC 23. Therefore, the bald reorganization to shorten the term of the IS completion seems to need a little longer time. This means that the international standardization of optical disks will be done by using the fast-track procedure for a while. So far, being accepted as the international standard has been related to the success of business. Therefore, competitions and conflicts between manufacturers often happened during process of standardization. Such examples were competition between two different formats at the early stage of development of ODCs and competition between MO and PC technologies at the development of 90mm ODCs. It is certain that such competitions and conflicts led to the progress of optical disk technologies, but also led to the complaints of public users. There are surely criticisms from public users about that several ODCs with similar capacity were developed and they have been puzzled which ODC they should buy. It becomes very important to bring in requirements of wide range of users as for the standardization by the fast-track procedure because it is basically done at the initiative of manufacturers.

CONCLUSION

About 20 years ago, there were no optical disks and optical disk industry in the world but nowadays optical disk industry sells an enormous amount of optical disks, drives and mass storage systems all over the world. For example, sales amount of optical disk industry of Japan is estimated to have achieved approximately 12B\$ in the 2002 fiscal year. The author would like to express much

respect to all the forerunners and present pursuers in optical disk academic community and industry. The specifications of next generation DVD that uses blue laser have already proposed and the maximum capacity of those discs are from 20 to 30GB/layer. These capacities are sufficient for consumer use such as back-up of data in personal computer and replacement of VCR. However the amount of information stock is estimated to increase with at least 8% annual growth rate and will attain at least 1700EB in 2010. Here the amount of information stock is defined as the amount of information stored for more than 1 year for the purpose of reutilization. In order to respond to this forecast the development of various memories including optical memory with larger capacity will be required continuously. As for optical memories, development of future technologies such as ultra high precision pit writing, multi-layered ROM and RAM, 3 dimensional magneto-optical memory and holograph memory are being progressed worldwide. After a lapse of several years, new optical memories based on such new technologies will appear in the market as removable large capacity memories. The five-stage procedure might play important role again for the standardization of those new memories in order to bring in the requirement of users around the world.