APPENDIX L
STANDARDS ORGANIZATIONS

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An important concept that recurs frequently in this book is standards. This appendix provides some background on the nature and relevance of standards and looks at the key organizations involved in developing standards for networking and communications.

L.1 THE IMPORTANCE OF STANDARDS

It has long been accepted in the telecommunications industry that standards are required to govern the physical, electrical, and procedural characteristics of communication equipment. In the past, this view has not been embraced by the computer industry. Whereas communication equipment vendors recognize that their equipment will generally interface to and communicate with other vendors' equipment, computer vendors have traditionally attempted to monopolize their customers. The proliferation of computers and distributed processing has made that an untenable position. Computers from different vendors must communicate with each other and, with the ongoing evolution of protocol standards, customers will no longer accept special-purpose protocol conversion software development. The result is that standards now permeate all the areas of technology discussed in this book.

There are a number of advantages and disadvantages to the standards-making process. The principal advantages of standards are:

- A standard assures that there will be a large market for a particular piece of equipment or software. This encourages mass production and, in some cases, the use of large-scale-integration (LSI) or very-large-scale-integration (VLSI) techniques, resulting in lower costs.
- A standard allows products from multiple vendors to communicate, giving the purchaser more flexibility in equipment selection and use.

The principal disadvantages of standards are:

- A standard tends to freeze the technology. By the time a standard is developed, subjected to review and compromise, and promulgated, more efficient techniques are possible.
- There are multiple standards for the same thing. This is not a disadvantage of standards per se, but of the current way things are done. Fortunately, in recent years the various standards-making organizations have begun to cooperate more closely. Nevertheless, there are still areas where multiple conflicting standards exist.

L.2 STANDARDS AND REGULATION

It is helpful for the reader to distinguish three concepts:

- Voluntary standards
- Regulatory standards
- Regulatory use of voluntary standards

Voluntary standards are developed by standards-making organizations, such as those described in the next section. They are voluntary in that the existence of the standard does not compel its use. That is, manufacturers voluntarily implement a product that conforms to a standard if they perceive a benefit to themselves; there is no legal requirement to conform. These standards are also voluntary in the sense that they are developed by volunteers who are not paid for their efforts by the standards-making organization that administers the process. These volunteers are generally employees of interested organizations, such as manufacturers and government agencies.

Voluntary standards work because they are generally developed on the basis of broad consensus and because the customer demand for standard products encourages the implementation of these standards by the vendors.

In contrast, a regulatory standard is developed by a government regulatory agency to meet some public objective, such as economic, health, and safety objectives. These standards have the force of regulation behind them and must be met by providers in the context in which the regulations apply. Familiar examples of regulatory standards are in areas such as fire codes and health codes. But regulations can apply to a wide variety of products, including those related to computers and communications. For example, the Federal Communications Commission regulates electromagnetic emissions.

A relatively new, or at least newly prevalent, phenomenon is the regulatory use of voluntary standards. A typical example of this is a regulation that requires that the government purchase of a product be limited to those that conform to some referenced set of voluntary standards. This approach has a number of benefits:

- It reduces the rule-making burden on government agencies.
- It encourages cooperation between government and standards organizations to produce standards of broad applicability.
- It reduces the variety of standards that providers must meet.

L.3 STANDARDS-SETTING ORGANIZATIONS

Various organizations have been involved in the development of standards related to data and computer communications. The remainder of this document provides an overview of some of the most important of these organizations:

- Internet Society
- ITU
- IEEE 802
- ATM Forum
- ISO

Internet Standards and the Internet Society

Many of the protocols that make up the TCP/IP protocol suite have been standardized or are in the process of standardization. By universal agreement, an organization known as the Internet Society is responsible for the development and publication of these standards. The Internet Society is a professional membership organization that oversees a number of boards and task forces involved in Internet development and standardization.

This section provides a brief description of the way in which standards for the TCP/IP protocol suite are developed.

The Internet Organizations and RFC Publication

The Internet Society is the coordinating committee for Internet design, engineering, and management. Areas covered include the operation of the Internet itself and the standardization of protocols used by end systems on the Internet for interoperability. Three organizations under the Internet Society are responsible for the actual work of standards development and publication:

- **Internet Architecture Board (IAB):** Responsible for defining the overall architecture of the Internet, providing guidance and broad direction to the IETF

- **Internet Engineering Task Force (IETF):** The protocol engineering and development arm of the Internet
- **Internet Engineering Steering Group (IESG):** Responsible for technical management of IETF activities and the Internet standards process

Working groups chartered by the IETF carry out the actual development of new standards and protocols for the Internet. Membership in a working group is voluntary; any interested party may participate. During the development of a specification, a working group will make a draft version of the document available as an Internet Draft, which is placed in the IETF's "Internet Drafts" online directory. The document may remain as an Internet Draft for up to six months, and interested parties may review and comment on the draft. During that time, the IESG may approve publication of the draft as an RFC (Request for Comment). If the draft has not progressed to the status of an RFC during the six-month period, it is withdrawn from the directory. The working group may subsequently publish a revised version of the draft.

The IETF is responsible for publishing the RFCs, with approval of the IESG. The RFCs are the working notes of the Internet research and development community. A document in this series may be on essentially any topic related to computer communications and may be anything from a meeting report to the specification of a standard.

The work of the IETF is divided into eight areas, each with an area director and each composed of numerous working groups. Table L.1 shows the IETF areas and their focus.

Table L.1 IETF Areas

IETF Area	Theme	Example Working Groups
Applications	Internet applications	Web-related protocols (HTTP) EDI-Internet integration LDAP
General	IETF processes and procedures	Policy Framework Process for Organization of Internet Standards
Internet	Internet infrastructure	IPv6 PPP extensions
Operations and management	Standards and definitions for network operations	SNMPv3 Remote Network Monitoring
Real-time applications and infrastructure	Protocols and applications for real-time requirements	Real-time Transport Protocol (RTP) Session Initiation Protocol (SIP)
Routing	Protocols and management for routing information	multicast routing OSPF QoS routing
Security	Security protocols and technologies	Kerberos IPSec X.509 S/MIME TLS
Transport	Transport layer protocols	Differentiated services IP telephony NFS RSVP

THE STANDARDIZATION PROCESS

The decision of which RFCs become Internet standards is made by the IESG, on the recommendation of the IETF. To become a standard, a specification must meet the following criteria:

- Be stable and well understood

- Be technically competent
- Have multiple, independent, and interoperable implementations with substantial operational experience
- Enjoy significant public support
- Be recognizably useful in some or all parts of the Internet

The key difference between these criteria and those used for international standards from ITU is the emphasis here on operational experience.

The left-hand side of Figure L.1 shows the series of steps, called the *standards track*, that a specification goes through to become a standard; this process is defined in RFC 2026. The steps involve increasing amounts of scrutiny and testing. At each step, the IETF must make a recommendation for advancement of the protocol, and the IESG must ratify it. The process begins when the IESG approves the publication of an Internet Draft document as an RFC with the status of Proposed Standard.

The white boxes in the diagram represent temporary states, which should be occupied for the minimum practical time. However, a document must remain a Proposed Standard for at least six months and a Draft Standard for at least four months to allow time for review and comment. The shaded boxes represent long-term states that may be occupied for years.

For a specification to be advanced to Draft Standard status, there must be at least two independent and interoperable implementations from which adequate operational experience has been obtained.

After significant implementation and operational experience has been obtained, a specification may be elevated to Internet Standard. At this point, the Specification is assigned an STD number as well as an RFC number.

Finally, when a protocol becomes obsolete, it is assigned to the Historic state.

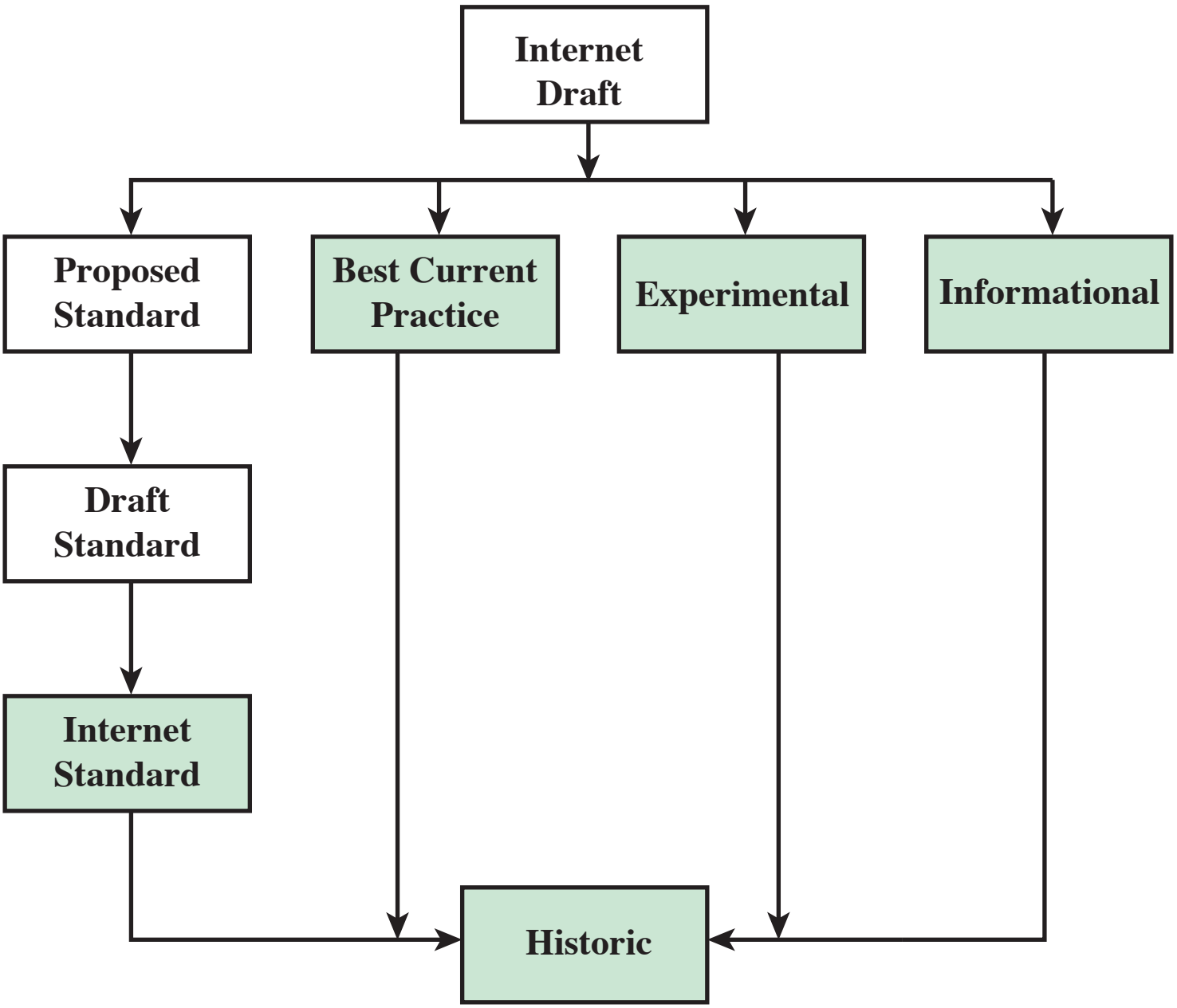

Figure L.1 Internet RFC Publication Process

INTERNET STANDARDS CATEGORIES

All Internet standards fall into one of two categories:

- **Technical specification (TS):** A TS defines a protocol, service, procedure, convention, or format. The bulk of the Internet standards are TSs.
- **Applicability statement (AS):** An AS specifies how, and under what circumstances, one or more TSs may be applied to support a particular Internet capability. An AS identifies one or more TSs that are relevant to the capability, and may specify values or ranges for particular parameters associated with a TS or functional subsets of a TS that are relevant for the capability.

OTHER RFC TYPES

There are numerous RFCs that are not destined to become Internet standards. Some RFCs standardize the results of community deliberations about statements of principle or conclusions about what is the best way to perform some operations or IETF process function. Such RFCs are designated as Best Current Practice (BCP). Approval of BCPs follows essentially the same process for approval of Proposed Standards. Unlike standards-track documents, there is not a three-stage process for BCPs; a BCP goes from Internet draft status to approved BCP in one step.

A protocol or other specification that is not considered ready for standardization may be published as an Experimental RFC. After further work, the specification may be resubmitted. If the specification is generally stable, has resolved known design choices, is believed to be well understood, has received significant community review, and appears to enjoy enough

community interest to be considered valuable, then the RFC will be designated a Proposed Standard.

Finally, an Informational Specification is published for the general information of the Internet community.

The International Telecommunication Union

The International Telecommunication Union (ITU) is a United Nations specialized agency. Hence the members of ITU-T are governments. The U.S. representation is housed in the Department of State. The charter of the ITU is that it "is responsible for studying technical, operating, and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis." Its primary objective is to standardize, to the extent necessary, techniques and operations in telecommunications to achieve end-to-end compatibility of international telecommunication connections, regardless of the countries of origin and destination.

ITU Radio Communication Sector

The ITU Radiocommunication (ITU-R) Sector was created on 1 March 1993 and comprises the former CCIR and IFRB (founded 1927 and 1947, respectively). ITU-R is responsible for all ITU's work in the field of radio communications. The main activities of ITU-R are:

- Develop draft ITU-R Recommendations on the technical characteristics of, and operational procedures for, radiocommunication services and systems.
- Compile Handbooks on spectrum management and emerging radiocommunication services and systems.

ITU-R is organized into the following study groups:

- SG1 Spectrum management
- SG3 Radiowave propagation
- SG 4 Fixed-satellite service
- SG 6 Broadcasting service (terrestrial and satellite)
- SG 7 Science services
- SG 8 Mobile, radiodetermination, amateur and related satellite services
- SG 9 Fixed service
- SC Special Committee on Regulatory/Procedural Matters
- CCV Coordination Committee for Vocabulary
- CPM Conference Preparatory Meeting

ITU TELECOMMUNICATION STANDARDIZATION SECTOR

The ITU-T was created on 1 March 1993 as one consequence of a reform process within the ITU. It replaces the International Telegraph and Telephone Consultative Committee (CCITT), which had essentially the same charter and objectives as the new ITU-T. The ITU-T fulfils the purposes of the ITU relating to telecommunications standardization by studying technical, operating and tariff questions and adopting Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

ITU-T is organized into 14 study groups that prepare Recommendations, numbered as follows:

2. Network and service operation
3. Tariff and accounting principles
4. Telecommunications management network and network maintenance
5. Protection against electromagnetic environment effects
6. Outside plant

9. Integrated broadband cable networks and television and sound transmission
11. Signaling requirements and protocols
12. Performance and quality of service
13. Next generation networks
15. Optical and other transport networks infrastructures
16. Multimedia terminals, systems, and applications
17. Security, languages, and telecommunication software
19. Mobile telecommunications networks

SCHEDULE

Work within ITU-R and ITU-T is conducted in four-year cycles. Every four years, a World Telecommunications Standardization Conference is held. The work program for the next four years is established at the assembly in the form of questions submitted by the various study groups, based on requests made to the study groups by their members. The conference assesses the questions, reviews the scope of the study groups, creates new or abolishes existing study groups, and allocates questions to them.

Based on these questions, each study group prepares draft Recommendations. A draft Recommendation may be submitted to the next conference, four years hence, for approval. Increasingly, however, Recommendations are approved when they are ready, without having to wait for the end of the four-year study period. This accelerated procedure was adopted after the study period that ended in 1988. Thus, 1988 was the last time that a large batch of documents was published at one time as a set of Recommendations.

IEEE 802 Committee

The key to the development of the LAN market is the availability of a low-cost interface. The cost to connect equipment to a LAN must be much less than the cost of the equipment alone. This requirement, plus the complexity of the LAN logic, dictates a solution based on the use of chips and very-large-scale integration (VLSI). However, chip manufacturers will be reluctant to commit the necessary resources unless there is a high-volume market. A widely accepted LAN standard assures that volume and also enables equipment from a variety of manufacturers to intercommunicate. This is the rationale of the IEEE 802 committee.

The committee issued a set of standards, which were adopted in 1985 by the American National Standards Institute (ANSI) as American National Standards. The standards were subsequently revised and reissued as international standards by the International Organization for Standardization (ISO) in 1987, with the designation ISO 8802. Since then, the IEEE 802 committee has continued to revise and extend the standards, which are ultimately then adopted by ISO.

The committee quickly reached two conclusions. First, the task of communication across the local network is sufficiently complex that it needs to be broken up into more manageable subtasks. Accordingly, the standards are organized as a three-layer protocol hierarchy: Logical Link Control (LLC), medium access control (MAC), and physical.

Second, no single technical approach will satisfy all requirements. The second conclusion was reluctantly reached when it became apparent that no single standard would satisfy all committee participants. There was support for various topologies, access methods, and transmission media. The response of the committee was to standardize all serious proposals rather than to attempt to settle on just one. The current state of standardization is reflected by the various working groups in IEEE 802 and the work that each is doing (Table L.2)

Table L.2 IEEE 802 Active Working Groups

Number	Name	Charter
802.1	Higher Layer LAN Protocols	Standards and recommended practices for: 802 LAN/MAN architecture, internetworking among 802 LANs, MANs, and other wide area networks, 802 overall network management, and protocol layers above the MAC and LLC layers.
802.3	Ethernet	Standards for CSMA/CD (Ethernet) based LANs
802.11	Wireless LAN	Standards for wireless LANs
802.15	Wireless Personal Area Networks	Personal area network standards for short distance wireless networks
802.16	Broadband Wireless Access	Standards for broadband wireless access
802.17	Resilient Packet Ring	Standards for RPR LAN/MAN for rates up to many gigabits per second
802.18	Radio Regulatory TAG	Monitor regulations that may affect 802.11, 802.15, and 802.16
802.19	Coexistence TAG	Standards for coexistence between wireless standards of unlicensed devices.
802.20	Mobile Broadband Wireless Access	Standards for mobile broadband wireless access
802.21	Media Independent Handoff	Standards to enable handover and interoperability between heterogeneous network types including both 802 and non 802 networks
802.22	Wireless Regional Area Networks	Standards for regional wireless networks using unused frequencies in the broadcast television band
82.23	Emergency Services	Media independent framework to provide consistent access and data that facilitate compliance to applicable civil authority requirements for communications systems that include IEEE 802 networks.

ATM Forum

The ITU-T is responsible, among other areas, for the development of standards for Broadband ISDN (B-ISDN), which is based on ATM technology. The ATM Forum also plays a crucial role in the development of ATM standards. In the ITU-T and the constituent member bodies from the participating countries, the process of developing standards is characterized by wide participation by government, users, and industry representatives, and by consensus decision-making. This process can be quite time consuming. While ITU-T has streamlined its efforts, the delays involved in developing standards are particularly significant in the area of B-ISDN, which is dominated by the rapidly evolving asynchronous transfer mode (ATM) technology. Because of the strong level of interest in ATM technology, the ATM Forum was created with the goal of accelerating the development of ATM standards. The ATM Forum is an international nonprofit organization, funded by over 600 member companies. End users are also represented within the Forum.

The ATM Forum has seen more active participation from computing vendors than has been the case in ITU-T. Because the forum works on the basis of majority rule rather than consensus, it has been able to move rapidly to define some of the needed details for the implementation of ATM. This effort, in turn, has fed into the ITU-T standardization effort.

The International Organization for Standardization

The International Organization for Standardization, or ISO,[1] is an international agency for the development of standards on a wide range of subjects. It is a voluntary, nontreaty organization whose members are

[1] ISO is not an acronym (in which case it would be IOS), but a word, derived from the Greek *isos*, meaning "equal."

designated standards bodies of participating nations, plus nonvoting observer organizations. Although ISO is not a governmental body, more than 70 percent of ISO member bodies are governmental standards institutions or organizations incorporated by public law. Most of the remainder have close links with the public administrations in their own countries. The United States member body is the American National Standards Institute.

ISO was founded in 1946 and has issued more than 12,000 standards in a broad range of areas. Its purpose is to promote the development of standardization and related activities to facilitate international exchange of goods and services and to develop cooperation in the sphere of intellectual, scientific, technological, and economic activity. Standards have been issued to cover everything from screw threads to solar energy. One important area of standardization deals with the Open Systems Interconnection (OSI) communications architecture and the standards at each layer of the OSI architecture.

In the areas of data communications and networking, ISO standards are actually developed in a joint effort with another standards body, the International Electrotechnical Commission (IEC). IEC is primarily concerned with electrical and electronic engineering standards. In the area of information technology, the interests of the two groups overlap, with IEC emphasizing hardware and ISO focusing on software. In 1987, the two groups formed the Joint Technical Committee 1 (JTC 1). This committee has the responsibility of developing the documents that ultimately become ISO (and IEC) standards in the area of information technology.

The development of an ISO standard from first proposal to actual publication of the standard follows a six-step process. The objective is to ensure that the final result is acceptable to as many countries as possible. Briefly, the steps are:

1. **Proposal stage:** A new work item is assigned to the appropriate technical committee, and within that technical committee, to the appropriate working group.
2. **Prepatory stage:** The working group prepares a working draft. Successive working drafts may be considered until the working group is satisfied that it has developed the best technical solution to the problem being addressed. At this stage, the draft is forwarded to the working group's parent committee for the consensus-building phase.
3. **Committee stage:** As soon as a first committee draft is available, it is registered by the ISO Central Secretariat. It is distributed among interested members for balloting and technical comment. Successive committee drafts may be considered until consensus is reached on the technical content. Once consensus has been attained, the text is finalized for submission as a Draft International Standard (DIS).
4. **Enquiry stage:** The DIS is circulated to all ISO member bodies by the ISO Central Secretariat for voting and comment within a period of five months. It is approved for submission as a Final Draft International Standard (FDIS) if a two-thirds majority is in favor and not more than one-quarter of the total number of votes cast are negative. If the approval criteria are not met, the text is returned to the originating working group for further study and a revised document will again be circulated for voting and comment as a DIS.
5. **Approval stage:** The Final Draft International Standard (FDIS) is circulated to all ISO member bodies by the ISO Central Secretariat for a final yes/no vote within a period of two months. If technical comments are received during this period, they are no longer considered at this stage, but registered for consideration during a future revision of the International Standard. The text is approved as

an International Standard if a two-thirds majority is in favor and not more than one-quarter of the total number of votes cast are negative. If these approval criteria are not met, the standard is referred back to the originating working group for reconsideration in the light of the technical reasons submitted in support of the negative votes received.

6. **Publication stage:** Once a Final Draft International Standard has been approved, only minor editorial changes, if and where necessary, are introduced into the final text. The final text is sent to the ISO Central Secretariat, which publishes the International Standard.

The process of issuing an ISO standard can be a slow one. Certainly, it would be desirable to issue standards as quickly as the technical details can be worked out, but ISO must ensure that the standard will receive widespread support.