2 OPEN SYSTEMS STANDARDS

Both OSI and TCP/IP are guided by standards. The communities who develop standards for OSI and TCP/IP share some common practices. For example, both advance technology through a committee and consensus process using some form of parliamentary procedure. Both have a hierarchical infrastructure to coordinate work and enforce written (and unwritten) rules of conduct. Participation in both is international.

In other respects, these communities differ substantially, especially with respect to image and culture. To fully appreciate the differences, one must first understand the composition, scope, purpose, and practices of each community.

OSI Standards

In the late 1970s and early 1980s, the first OSI standards were developed under Technical Committee 97 (TC 97), Information Processing, of the International Organization for Standardization (ISO).

AHA *Why the acronym for* International Organization for Standardization *should be* ISO, *rather than* IOS, *is a mystery even to standards-committee insiders. The French version of the organization's name is* Organisation Internationale de Normalisation, *so the most common explanation for a mismatch between the name of an international standards organization and its acronym doesn't apply in this case. The best explanation the authors have heard is an analogy to the* Go Children Slow *traffic-sign con-*

vention: the most important word takes the place of honor (and in the case of traffic signs, of motorists' attention) in the middle.

As is the case with all ISO standards committees, the membership of TC 97 was composed of the national standards bodies of those countries that decided to participate: ANSI (the American National Standards Institute), for example, represented the United States; BSI (the British Standards Institute) represented the United Kingdom; AFNOR (the Association Française du Normalisation) represented France; and DIN (the Deutsches Institut für Normung) represented Germany. Within TC 97, which represented primarily the interests of computer manufacturers and users, Subcommittee 16 (TC 97/SC 16) was created for the express purpose of working on the new area of open systems interconnection.

Within Subcommittee 16, the OSI reference model and general architecture issues were studied in Working Group 1 (TC 97/SC 16/WG 1), and "layer-specific" activities were directed to the following WGs: transport and session to WG 6, application and presentation to WG 5, and sometime later, management of OSI systems to WG 4. Although most of OSI was brand new (and could therefore be assigned at will to the brand-new Subcommittee 16), its scope also encompassed aspects of telecommunications and data transmission for which standards work was already well under way. Responsibility for developing OSI-related standards for the network, data link, and physical layers were handed over to the existing Subcommittee 6 (Data Communications): physical interfaces to WG 3, data link layer to WG 1, and network layer to WG 2. This original committee structure for the development of OSI standards is illustrated in Table 2.1.

At the time, ISO TC 97/SC 6 and Study Group VII (SG VII) of the International Telegraph and Telephone Consultative Committee (CCITT)[1] worked closely on the development of public packet-switching standards (such as X.25, which is by far the best known). CCITT is a United Nations treaty organization and is composed primarily of telecommunication providers.[2] CCITT SG VII had begun work on a message handling service (which would eventually become the X.400-series rec-

1. In this case, the acronym makes sense even though it does not correspond to the English-language representation of the name: *CCITT* expands to the French *Comité Consultatif International Télégraphique et Téléphonique.* The name of this group changed to *International Telecommunications Union-Telecommunications Standardization Sector* in March 1993, whereupon CCITT was officially superseded by the acronym ITU-TS; throughout this book, however, we use the more familiar CCITT nomenclature.

2. Although there is nothing in the charter of either organization that says so, ISO has historically focused on the priorities of computer equipment manufacturers and users (the

TABLE 2.1 Original ISO OSI Standards Committees

Subcommittee	*Working Group*	*Responsibility*
16	1	OSI architecture
16	4	Management
16	5	Application,presentation
16	6	Session,transport
6	2	Network
6	1	Data link
6	3	Physical

ommendations), and ISO and CCITT agreed to coordinate their efforts to develop a single international reference model for Open Systems Interconnection.

Following an initial "feeling-out" period, these two standards bodies concluded that, as a parallel effort to the ISO standards for OSI, the CCITT would produce a corresponding series (the X.200 series) of CCITT recommendations. By 1984, the "joint" standards shown in Table 2.2 would be in place.

Over the years, an inordinate amount of time and energy would be devoted to ensuring that the contents, even the wording, of the two sets of what can be called "core OSI standards" would be identical. (It should be noted that the core set of standards expanded nearly exponentially from this modest beginning. The "References" list provides a cross reference of all ISO and OSI standards to their CCITT counterparts.)

Since 1984, the players, the process, and the number of OSI-related standards have grown, and the committee infrastructure itself has changed. ISO now carries out information technology standardization, including all of the work labeled "OSI," jointly with the International Electrotechnical

"host people"), whereas CCITT has focused on the priorities of the "common carrier" organizations (which, in many countries, are government-owned and -operated postal, telephone, and telegraph agencies) such as, in the United States, AT&T, Sprint, MCI, and the regional telephone operating companies. These two perspectives on how data networking should be organized are vastly different, as will be seen in later chapters.

TABLE 2.2 Cross-Reference of Initial ISO/CCITT OSI Standards

OSI Standard	*ISO Standard Number*	*CCITT Recommendation*
Reference model	ISO 7498	X.200
Service conventions	ISO TR 8509	X.210
Network service definition	ISO 8348	X.213
Transport service definition	ISO 8072	X.214
Session service definition	ISO 8326	X.215
Transport protocol	ISO 8073	X.224
Session protocol	ISO 8327	X.225

Note: The standards depicted here are those contained in the 1984 CCITT Red Book, Volume VIII, Fascicle VIII.5. Many other standards that are OSI related were jointly developed; notably, X.25/ISO 8208 at the network layer, as well as data link and physical layer standards too numerous to mention here.

Commission (IEC) in Joint Technical Committee 1 (ISO/IEC JTC 1), which has replaced TC 97. ISO/IEC still cooperates with CCITT. The TC 97 Subcommittee 16 has been replaced by Subcommittee 21 (Information Retrieval, Transfer, and Management for Open Systems Interconnection), and Subcommittee 6 has been renamed Telecommunications and Information Exchange between Systems. Typically, the participants in CCITT (officially, the governments of countries that are signatories to the United Nations treaty that established the International Telecommunications Union ITU) and ISO/IEC "national bodies" have their own national committees, which submit national positions and contributions to the international standardization process represented by CCITT and ISO/IEC. In the United States, ANSI delegates the responsibility for actually producing standards to accredited standards committees (ASCs): Accredited Standards Committee X3 (Information Technology), for example, has responsibilities within the United States that are roughly equivalent to those of Joint Technical Committee 1, and within X3, X3T5 (OSI) and X3S3 (Data Communications) feed into SC 21 and SC 6, respectively. The Electronic Industries Association (EIA), Accredited Standards Committee T1 (Telecommunications), and the Institute of Electrical and Electronics Engineers (IEEE) also contribute to OSI standardization.

The OSI Standards Process

ISO OSI standards are initially introduced or created in committee as *working documents* that contribute to an existing *work item*. (In some cases, working drafts instigate new work items.) After some number of cycles of review, discussion, debate, and revision, working drafts are advanced through a committee vote to the status of *committee draft* (CD).[3] Committee drafts typically have a 60-day ballot period that offers national bodies the opportunity to review the material within their respective national committees. If a CD ballot fails, the document is revised according to comments submitted by members. (Loosely stated, the rules are as follows: a national body can't say "no" without providing comments that, if accepted, would enable that national body to change its ballot to a "yes"; i.e., in a CD ballot response, a national body can't really say, "This is a bad idea" [it happens, but with no effect]; if a national body really hates an idea, it should vote "no" on the original new work item ballot.) When a CD ballot is approved—i.e., a document is considered mature and stable—the CD is balloted as a *draft international standard* (DIS). Usually, although not always, a DIS represents a "substantially complete and accurate" specification, and folks are encouraged to implement it. A DIS ballot lasts six months, and in an ideal world, practical implementation experience *could* be obtained, although this has not historically been the case.

AHA *There is a cautionary statement on a draft international standard that indicates that it may change. This has the unfortunate but practical effect among many organizations of inhibiting serious development until the document has become an international standard—unfortunate because it is at this very stage that the most serious implementation and testing should take place, so that what eventually becomes an International Standard is, in fact, implementable and highly likely to be useful.*

If a DIS ballot succeeds, the editor of the specification is assigned the responsibility of cleaning up the document and forwarding it to the ISO Central Secretariat in Geneva for processing as an *international standard*. The process is illustrated in Figure 2.1.

Of course, if one asked a hard-core Internetter, the perception of the process might be described more cynically, as is suggested in Figure 2.2.

CCITT operates somewhat differently. During a four-year *study period*, CCITT addresses new work items and performs revisions to recommendations made during the previous study period. At the end of the

3. This step in the ISO standards process was, until a few years ago, called the "draft proposal" (DP) stage.

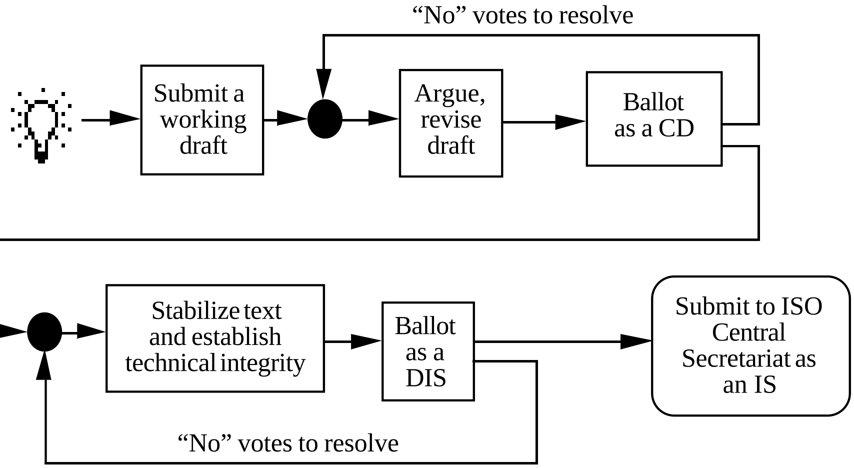


FIGURE 2.1 ISO OSI Standards Process

study period, a plenary assembly is held, during which CCITT *considers* (in the terminology that is common to all CCITT recommendations) specifications and, after careful consideration, grandly and *unanimously declares its view* that a specification benefits humanity (at least, that part of humanity that is involved in telecommunications) and directs editors to submit approved recommendations for publication in a series of books, fascicles, and volumes. Before the close of the plenary assembly,

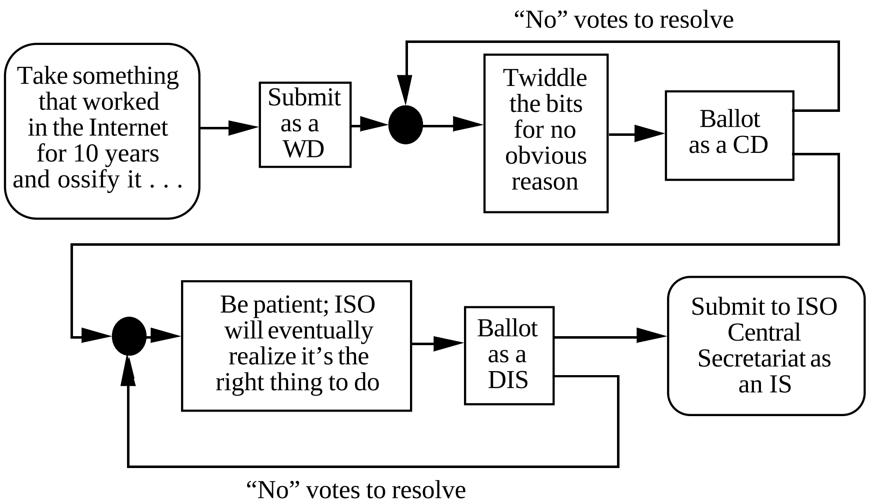


FIGURE 2.2 Internetters' View of ISO Standards Process

CCITT selects a pretty color for the entire series of books: thus far, primary (yellow in 1980, red in 1984, blue in 1988) and secondary (orange in 1976) colors have been selected. The 1992 recommendations will be published (sometime in 1993) in the White Books.

Beyond Base Standards: Profiles, Implementers' Agreements, and Conformance Testing

OSI standards offer *choices* in places where choices aren't always best for guaranteeing the interoperability of different implementations—which is presumably the purpose of having open systems in the first place. Shortly after it became evident that some of the choices in the OSI "stack" would result in serious noninteroperability, *profile groups* were established to whittle down the number of implementation possibilities from a frighteningly large number of combinations to a manageable few.

Profiles are combinations of protocol and service standards with (almost) all options either prescribed or proscribed. There are:

- ***International standardized profiles*** *(ISPs):* ISO Technical Report 10000 defines the framework and taxonomy of profiles for internationally recognized (and recommended) stacks.
- ***Functional standards****:* The European Committee for Standardization/European Committee for Electrotechnical Standardization (CEN/CENELEC) develops profiles for the European Economic Community (EEC).
- ***Nationally standardized profiles****:* Government (e.g., U.S., U.K.) OSI profiles (GOSIPs) identify nationally recommended stacks (U.S. GOSIP is illustrated in Figure 2.3).
- ***Commercially standardized profiles****:* Forums and consortia such as the OSI Network Management Forum and the North American Directory Association (NADA) identify stacks, services, and features for specific application services.

The problem with profile groups, and the entire ISP standards process, is that they remain corrupted by the same political maneuvering that gave us too many standards and choices in the first place. Rather than making the hard choices—i.e., defining one, mandatory OSI stack—they continue to permit many to coexist; seriously, now, is having four really that much better than having nine?

OSI implementation advances almost in spite of all this activity, although the result of the political in-fighting is that OSI offers islands—continents, really—of interoperability and must endure an embarrassing and seemingly endless stream of carping and abuse, even as it struggles to clean up its act. The National Institute of Standards and Technology (NIST) OSI Implementers' Workshop (OIW) and the European (EWOS)

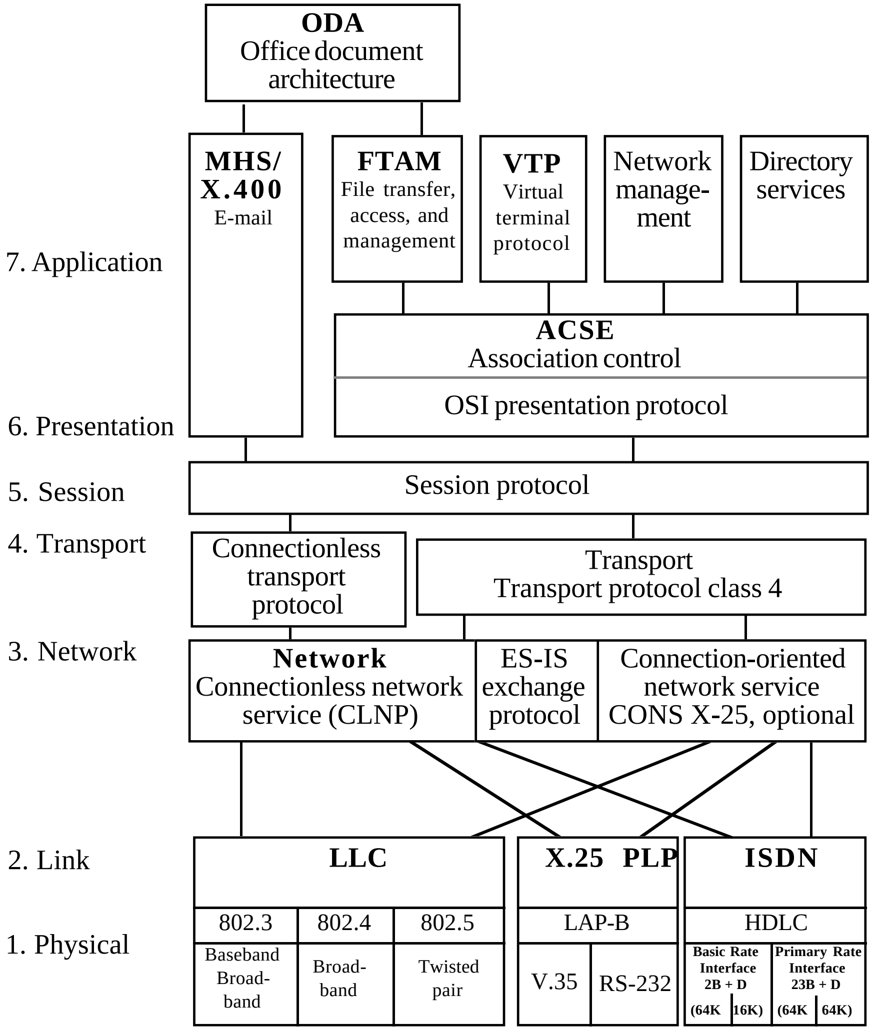


FIGURE 2.3 U.S. GOSIP (Version 2)

and Asian (AOWS) OSI workshops provide forums in which the base OSI standards are augmented by precise specification of the details that make for efficient and interoperable implementations and offer networks such as OSINET to allow vendors to test OSI equipment in a multivendor environment. The implementers' agreements that are produced by these forums are the raw material of the international standardized profile approval process.

Finally, there are organizations that define and provide *conformance* *testing*, a process in which vendors demonstrate compliance to an OSI profile and completeness of implementation against a "black-box" implementation. Organizations like the Corporation for Open Systems (COS) and the Standards Promotion and Applications Group (SPAG), although not strictly the analogues of Underwriters' Laboratory, provide such services.

Internet Standards

The development of standards for the Internet traces its ancestry to a research advisory group established by DARPA in 1980, the Internet Configuration Control Board (ICCB). For a time, the ICCB controlled all aspects of the development of the DARPA protocols. In 1983, DARPA restructured the ICCB and formed a central administrative committee called the Internet Activities Board (IAB). The IAB coordinated the design, engineering, and daily operational aspects of the Internet, which remains formally described as "a loosely-organized international collaboration of autonomous, interconnected networks, [that] supports host-to-host communication through voluntary adherence to open protocols and procedures defined by Internet Standards (RFC 1310, 2)." In 1986, the IAB delegated responsibilities for the actual development of Internet standards to the Internet Engineering Task Force (IETF) and responsibilities for longer-term (hard-core) research to the Internet Research Task Force (IRTF) (see Figure 2.4). Until recently, the IAB had the final say in all Internet standards and research activities. With the formation of the Internet Society in 1992, the Internet Activities Board became the Internet Architecture Board and continued its role as a central coordinating body for Internet activities. The IAB now reports to the Internet Society board of trustees and supervises the Internet standards and research infrastructure. The composition of this infrastructure, and its relationship to other Internet Society activities, may be seen in Figure 2.5.

Like other standards bodies, the IETF is itself made up of working groups, which are composed of engineers and scientists from the academic, computer, and telecommunications communities. The working groups in the IETF are more fluid in nature than most standards bodies and tend to focus on one subject—perhaps a very specific one, such as extensions to a protocol, managed objects for a specific transmission facility, or a single routing protocol—and may meet, complete their work, and disband in less than a year. This is quite a contrast to the durability and longevity of, say, an ANSI-accredited working group such as X3S3.3, which has existed virtually forever and, after nearly 15

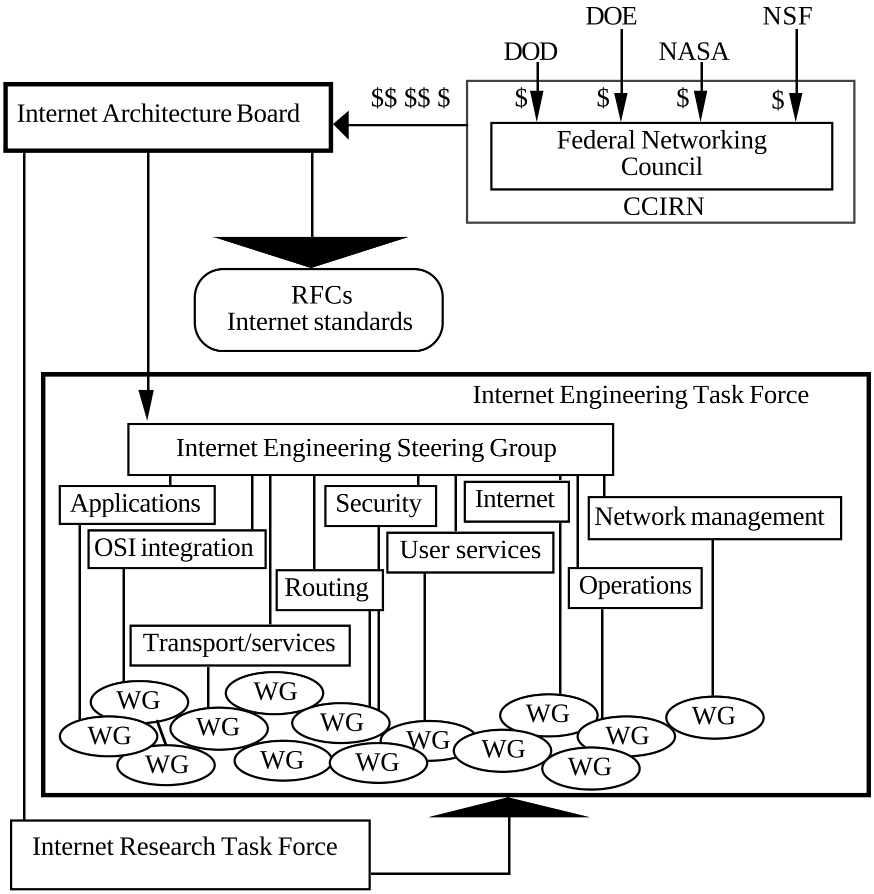


FIGURE 2.4 Organization of Internet Standards Committees (1986–1992)

years, continues to have responsibilities for providing U.S. national positions and contributions covering every aspect of the OSI transport and network layers. (To be sure, there are working groups in the IETF, such as the SNMP WG, that have had long lifetimes; the point is that they do not exist in perpetuity.)

IETF working group activities are organized into specific disciplines: applications, Internet, network management, operational requirements, routing, security, service applications, transport, user services, and standards management. These *areas* of activity are supervised by directors; the directors, together with the IETF chairperson, comprise a review and advisory committee called the Internet Engineering Steering Group (IESG). IESG now makes all final decisions regarding Internet

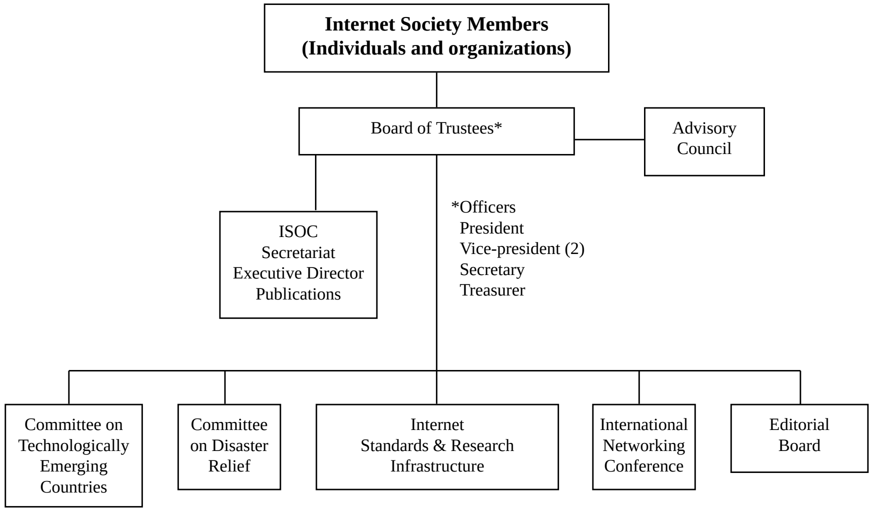


FIGURE 2.5 Internet Society Infrastructure

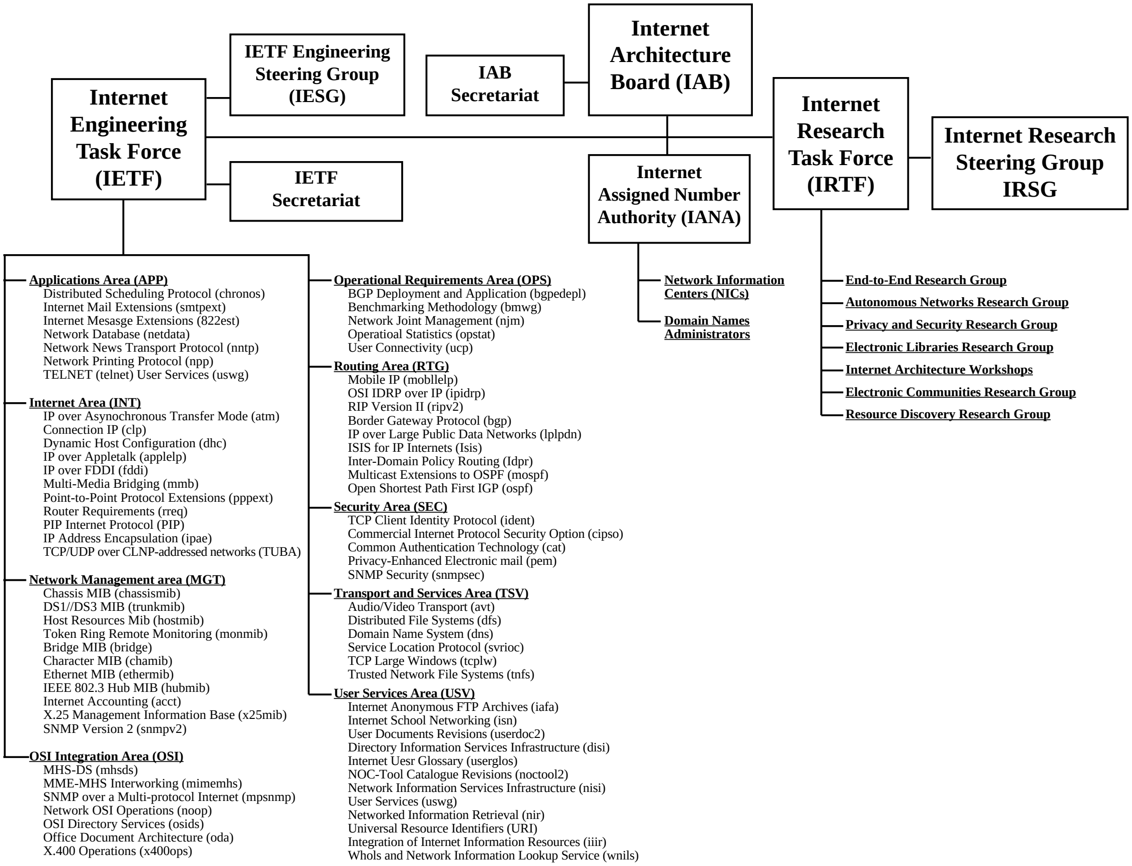
standardization. The Internet Standards Organization (not to be confused with ISO!) is depicted in Figure 2.6.

IETF "Friends and Family"

TCP/IP remains a predominantly U.S.-influenced protocol suite. However, with the growth in popularity of TCP/IP, and with the increased interest in expanding the Internet to accommodate OSI, international organizations have demonstrated a keen interest in contributing to the understanding, development, and deployment of internetworking technology. *RIPE* (Réseaux IP Européens) is a forum in Europe that nurtures expertise on IP networking. Working groups of *RARE* (Réseaux Associés pour la Recherche Européene) assist the IETF in integrating OSI application services and protocols into the Internet. RARE is loosely structured along IETF/IESG/IAB lines of control. Much of the message handling, directory, and internetworking protocol (CLNP) field experience obtained thus far on the Internet has been the result of cooperation between the IETF and RARE.

The Internet Standards Process

The core method of specification in the Internet is the *request for comment* (RFC). RFCs began as a means of documenting technical information shortly after DARPA started the ARPANET project in 1969. The RFC "process" begins when an individual or a party (including an external organization) makes a document publicly available for comment; such documents are called *internet drafts*. Internet drafts can be new ideas or



(Source: Internet Society)

FIGURE 2.6 Internet Standards and Research Infrastructure

existing RFCs that may require revision. They are made available to the public electronically as well as on paper. The technical or informational merit of internet drafts is discussed openly through regular IETF meetings and electronically through mailing lists. An internet draft that is expected to become an internet standard proceeds through a standards "maturity track" that is similar to the ISO standards track: loosely speaking, a "proposed standard (RFC)" corresponds to an ISO CD; a "draft standard (RFC)" corresponds to an ISO DIS; and a "standard (RFC)" corresponds to an ISO IS.

Strictly speaking, there is a significant difference in the process. As a rule, an internet draft may advance to a *proposed standard* once the

Internet community has reviewed and commented on the need for and stability of its contents. (In cases where a proposed standard may affect a core aspect of TCP/IP, implementation experience may well be required before an internet draft is advanced to a proposed standard.) Once an internet draft has been submitted to the IETF, recommended by the IESG, and approved for advancement by the IAB, it is forwarded to the Internet Assigned Numbers Authority (IANA), where it receives an RFC number.[4] A proposed standard must remain so for six months; during this time, experience must be acquired from at least two independent and interoperable implementations, and any results suggesting modifications must be addressed. If the proposed standard is demonstrated to be "mature and useful," it is advanced to a *draft standard*. A draft standard remains so for at least four months. Only after significant implementation and operational experience is acquired may a draft standard be advanced to a *standard* (STD). The process is illustrated in Figure 2.7.

Applicability Statements, Requirements RFCs

The IAB offers guidance to those who wish to produce interoperable implementations through *applicability statements*. There are three main classifications: if a technical specification is essential to achieving minimal conformance—for example, without IP, your implementation is pretty useless, and therefore IP is essential—the applicability statement that is applied is "required"; if the technical specification has been demonstrated to be truly useful and desirable, but not essential, the applicability statement that is applied is "recommended"; and if the technical specification is an enhancement, bell or whistle, the applicability statement reads "elective." The requirements levels for all technical specifications are listed in the *IAB Official Protocol Standards* document, which is periodically issued as an RFC (e.g., RFC 1360).

Even in Internet standards, there are options and implementation considerations that are documented over a series of RFCs. Application of these RFCs contributes to the overall efficiency and performance of TCP/IP implementations. However, since RFCs, like ISO standards, are assigned numbers sequentially (chronologically), it is often difficult to know which RFCs are useful and which are not. To this end, a set of implementation requirements for host computers is documented (RFC 1122; RFC 1123). These serve as a form of implementers' agreements for the Internet community. A similar set of requirements is to be developed for routers.

4. Documents that are not expected to become or remain standards—those that are informational only, experimental, or have become obsolete and are hence "historical"—may have RFC numbers as well.

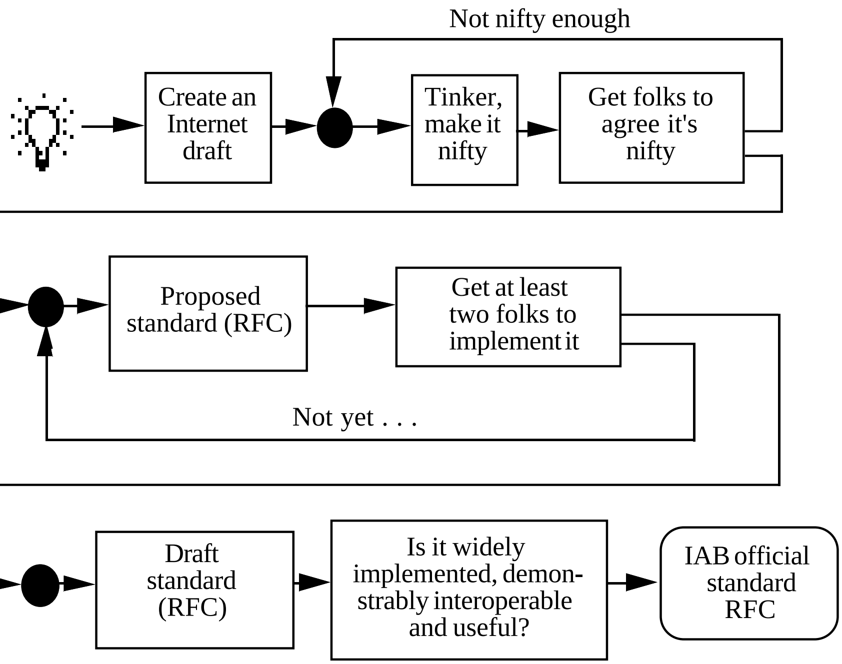


FIGURE 2.7 Internet Standards Process

Parting Comments on Open Systems Standards Processes

There is a perception (all too often accurate) that the OSI standards process is more apt to converge on a solution that is politically correct than one that is technically so. Within the OSI standards community, there also appears to be a tendency to compromise by embracing multiple solutions to a single problem as well as a tendency to create and tinker with new technology within committees often without the implementation and experimentation that is necessary (essential) to determining whether the technology is useful. These tendencies are inherently bad, and work progressed in this manner has a detrimental effect on the good work brought into OSI by organizations that went through the more rational process we associate with "R&D."

Committees are not laboratories for research, nor are they useful venues for field experimentation; all too often, ISO and CCITT standards committees hammer out compromises that have a significant impact on technology with regard only for the holy spirit of compromise (noteworthy examples here abound: the Ethernet type field versus the IEEE 802.3 length field, the selection of a 48-byte length for the ATM cell, multiple transport protocols for conformance). Committees should confine their activities to evaluating proposals of some demonstrated merit, with the aim of selecting those that are most likely to solve real networking problems. They should also contribute toward getting technology out of the laboratory and into the marketplace.

The TCP/IP standards community does a better job at this than the OSI community (although this, too, is changing: as the availability of OSI products grows, and OSI networks grow as well, a competence in OSI operations is slowly forming, and there is an increasing emphasis on interoperability). In the Internet, whether it is OSI or TCP/IP or hybrids thereof, the community attempts to perpetuate the rich tradition and image of "research and technology first." Quite often, even internet drafts have had some, albeit limited, field experience. And there is considerably less willingness to compromise in the TCP/IP community; here, there is more of a "winner-take-all" attitude, and those who have competing technologies often conduct what have become known as implementation "bake-offs" to test the mettle of the alternatives. The Internet has become a very good place for folks interested in acquiring OSI field experience.

The OSI standards community also suffers from an excessive concern for general applicability. Because of its international exposure, and partly because some of the participants don't know when to stop, OSI must support everything, and in a glorious and ultimate manner. In OSI, it often seems that solutions exhibit the properties of a gas, expanding to fill any container in which they are placed. In TCP/IP, solutions are often more modest and incremental; you'll never see the word *simple* or *trivial* as part of the name of an OSI protocol, but Internet standards developers covet those modifiers and are proud to include them, whenever possible, in the names of Internet standards.

Some of the differences between the two communities can also be attributed to *size.* In his defeat of the Spanish Armada in 1588, Sir Francis Drake demonstrated that small and maneuverable corsairs could defeat significantly larger warships. The TCP/IP community has a similar advantage over the OSI standards community. Although it is growing—and even today is facing some of the same difficulties that have faced the OSI standards community—the TCP/IP community has remained at a very manageable size, which allows standards makers considerable latitude in coming to closure on specific issues. OSI standards makers inherited the enormous bureaucracy that facilitated the construction of a global telephone service and established standards for mundane items such as wineglasses and prophylactics as well. A bake-off is a reasonable and eminently practical way to select a management or routing protocol partly because the community remains small enough that nearly everyone can understand and accept the results of a handful of implementations on technical merit alone. Bake-offs aren't as easy to conduct when countries that have either recently or forever been at war are involved, especially if they happen to be proponents of competing technologies.

Another difference lies in composition; participation in international standards making is expensive and time-consuming. Few members of the research community have the budget (or for that matter, the stomach) for standards work (even if more of them had, the politics of open systems would remain an exasperating and significant deterrent); hence, only the big guns from the commercial sector and public providers attend.

It is also true that the stakes in standardization are different. For the moment, TCP/IP is a cash cow. From an economic standpoint, the entire TCP/IP community—network providers, equipment manufacturers, and end users—stands to profit by rapid closure on issues. At an international level, however, what is profitable for one country may be unprofitable for another, and hence, a national delegation, or *community* of delegations, attending an ISO or a CCITT meeting may have a stronger incentive to thwart or impede progress as a protectionist act than any vendor attending the IETF could imagine. To accommodate the needs of a larger and considerably more diverse community, OSI standards makers often have little choice but to compromise in ways that in other circumstances might be considered incomprehensible.

There is also a difference in *process*. Here, the agility factor again plays in favor of the TCP/IP community. OSI is an international effort. The Internet community is largely a U.S. effort, and although the effort is becoming more international in nature, there remains a decidedly Caesarian attitude in the IETF—the governors of remote outposts are expected to come to Rome to visit Caesar and not vice versa (this, too, is changing, but slowly). Advancement of standards in OSI requires collaboration and consensus across a very wide variety and number of individual standards bodies. This translates into an overload of liaisons and meetings. ISO/CCITT standards goers and doers have to attend dozens of meetings a year to get something done, if only to see the advancement of a standard through the process without any damaging results. ISO standards preparation also involves translation among three languages (English, French, and Russian), which tends to slow things down—particularly near the end of the process.

Finally, there is a difference in document *distribution* and *availabilty*.

TCP/IP standards are free. They can be obtained electronically through the Internet itself, 24 hours a day, or requests can be made for postal delivery. There are on-line help facilities to get interested parties through the process. There are useful informational RFCs like the *Hitchhiker's Guide to the Internet* (RFC 1118), and helpful information services organizations such as the Internet network information center (InterNIC). Furthermore, members of the Internet can use the existing network infrastructure to conduct useful work between meetings through mailing lists, using the very technology they standardize. ISO and CCITT standards are difficult to identify, hard to acquire, challenging to read, and hideously expensive. Consider that the full set of CCITT Blue Books is "discount packaged" by resellers for approximately $3,000! Even the OSI MHS package alone costs $363. This simply doesn't make sense: if standards makers want open systems, then they should be doing everything possible to make standards freely available and easy to access. ISO and CCITT, and their associated national standards bodies (such as ANSI), are doing exactly the opposite. The Internet has the right idea. International standards organizations should wake up and smell the coffee brewing.