Recommendations for the Global Information Highway: A Matter of Standards

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The Global Information Highway (GIH) is society's vision for the telecommunications systems that may one day provide nearly unbounded personal communications. To make this vision practical, telecom standards which define compatibility within the GIH and at the access points are necessary. These telecommunications standards become a form of laws, not governmental or physical, but related to both. These laws control the ways to access and implement the GIH, and a variety of standards organizations define these telecommunications standards.

The laws of the GIH are too important to society to be created only in the technical fora of standards organizations. Wider participation in the standards-making process is developing, and telecom standards organizations are expanding their focus to help implement society's new vision. But much more remains to be done to create a broad consensus that could further define and carry this early vision of the GIH forward to actuality.

What Is a Standard?

Today, standards are used for many purposes. Standards define a specific aspect of a device, such as its external color or the size of lead in a pencil or typefaces or computer operating systems. Device standards are very helpful in the manufacturing and distribution process, but they are not necessarily crucial for function: If every fire engine was a different color of red, the fire would still be extinguished. If every pencil had a different diameter of lead, the scribe could still take notes. If every computer had a different operating system and printed with a different type font, its applications would still be useful.

Standards that directly support telecommunications—the mechanical dimensions of a connector, the electrical properties of the signals that pass through the connector, or the protocols that maintain order in the data stream through the connector—are critical. For telecommunications to occur, standards must define aspects of two devices: the transmitter and the receiver. Without a transmitter and its compatible receiver, communications does not occur. Telecommunications standards define compatibility, not sameness. This makes telecommunications standards distinct from device standards.

History of Telecommunications Standards

The term standard was first used in 1138 A.D. in the description of the "Battle of the Standard" because "it was there that valor took its stand to conquer or die."[1] Thus, the earliest use of the term is as a flag or conspicuous object indicating a rallying point. Later, the term evolved to indicate a physical definition often called "the king's standard."

A telecommunications standard is derived from this concept of a defined rallying point. With less heraldic flair and far greater complexity, these standards define a point of connection in any public telecommunications system. But the concept of who defines the standard has changed completely since 1138.

In 1138, a king was the only creator of a standard. Following societal progression, kings gave way to governments. In communications, standards-creating evolved to the point that multiple governments needed to agree to create a standard. In 1865, the desire for compatible telegraph operation engendered the formation of the International Telegraph Union, the predecessor of the ITU (International Telecommunications Union) of today. In 1885, only 20 years after its creation, the ITU made the first formal provisions for international telephony. Thus, the ITU, an organization of many governments, created the world's first intergovernmental telecommunications standards: the laws that governed the interconnection of the telegraph and telephone systems. Today, standards are created nationally by governments and companies working together in national telecommunications standards authorities (e.g., ATIS, TIA, TTC, ETSI[2]). The work from these organizations is then brought to the ITU, which is still a government-based telecom standards authority. Through the auspices of the ITU, governments and companies together create international standards to make possible international radio and telecommunications.

The Rise of Membership-Based Standards Authorities

Companies such as IBM and later the newly-divested AT&T dominated North American telecommunications standards development in the 1980s with their significant technical expertise and capital for both meeting attendance and research work. To balance the power of these larger commercial organizations in the United States, various trade associations have sponsored formal standards-making authorities such as IEEE 802, TIA TR, and ATIS T1 committees to create national standards. Outside of North America, the Public Telephone and Telegraph (PTT) organizations of various governments have been able to balance the resources of the larger companies through TTC (Japan), ETSI (Europe), and other regional telecom authorities. These different regional telecom authorities have developed into a second tier of telecommunications standards authorities that also bring their standards to the ITU.

A standards authority may be distinguished from other standards organizations in two ways:

- Integration of its activities into the work of other existing standards authorities. In this manner, the area of work is agreed to have minimum overlap with other existing standards work.
- A set of rules are employed to maximize fair, unbiased operation of the standards authority, and the broadest possible consensus among the members, whether they be governments, companies, or both.

Standards authorities, then, create non-overlapping telecommunications standards ("Recommendations" in the ITU), based on industry or government consensus.

The Growth of Other Standards Fora

Telecom standards are being created by more and more varied standards organizations. Today, at least five different types of organizations are creating telecommunications standards (see Table 1).

Table 1
Telecom Standards Organizations

Organization	Type	Controlled By
ITU	Government standards authority	Governments
ATIS, TIA, ETSI, TTC	Membership standards authorities	Trade associations*
ATM Forum, Frame Relay Forum	Independent fora with ties to standards authorities	Members
Internet Engineering Task Force	Independent fora	Technical users
PCCA, DSVD†	Company fora	Companies

* ETSI and TTC also exhibit government direction.
† Portable Computer Communications Association and Digital Simultaneous Voice and Data Forum.

Source: K. Krechmer

New telecom standards fora are often formed to provide closer connection to user requirements, or to develop a specific technology or market segment. Rapidly-emerging technologies such as wireless, cable, and satellite require new standards. Development engineers engaged in the creation of these new communications technologies often lack an understanding of existing standards organizations, by type, function, or importance. There is currently no formal scholastic curriculum to teach the importance of standards. Development engineers are focused on development goals. Sometimes, the development engineers are of the opinion that standards authorities move too slowly. Because of this, development engineers often take the approach of standardizing a new telecommunications technology by forming a new, independent standards organization.

Independent standards fora, unlike standards authorities, are not controlled to minimize overlapping and incompatible efforts. The proliferation of independent standards organizations that are not connected to existing standards authorities has been cause for some concern as there is a tendency for multiple independent standards organizations to create overlapping and—worse—incompatible standards. The concern is that two different pieces of telecommunications equipment will not be able to communicate without supporting the exact same telecom standards. However, system and technology effects can make possible, or even desirable, support of certain incompatible telecommunications standards without impeding telecommunications.

Technology's Effect on Overlapping Standards

Telecom standards are a mix of definitions derived from physical laws and agreements reached by groups of people. Open System Interconnect (OSI) is a reference model defined in ITU-T Recommendation X.200 for the processes of a communications system. It comprises seven layers, ranging from the lowest layer (one) which is the physical (e.g., wire or fiber), to the highest layer (seven) which is the application. Applications may be user-related or associated with the information system.

At the lower layers of the OSI model, definitions based on physical laws dominate the standards. The lower layers of the OSI model deal with the dimensions of the connector, the electrical signals, and the organization of the data stream transmitted. This work is closely based on physical laws.

At the higher layers of the OSI model, the issues change. At higher layers, agreements reached by groups of people dominate the standards. Because of the inherent nature of the communications at each layer, formal (i.e., non-overlapping) telecommunications standards are less important at higher layers of the OSI model. OSI layers five and six deal with issues such as how the data is represented and procedures that support restart and/or data recovery in the event of a communications failure. These issues, while critical to some communications systems, are not critical to the operation of all communications systems. They are application-dependent. For this reason, it may be desirable to support multiple overlapping and incompatible higher-layer telecom standards for similar functions but differing applications.

The technology that makes practical the implementation of multiple overlapping telecommunications standards is the use of programmable processors. Fixed function telecom systems and equipment demand fixed standards, e.g., leased line modem communications over fixed facilities to a host computer. Currently, the lowest layers of the OSI model require fixed standards. These layers define the mechanical dimensions of connectors, the electrical characteristics of signals over wire, and start-up signals. But the protocols that define the data stream through the connector no longer must be fixed. Software-controlled telecom equipment can change the protocol as desired, decreasing the need for higher-layer fixed telecommunications standards. Examples of such operations include multiple protocol stack routers, V.42 error control procedures in modems,[3] and support for multiple voice digitization and compression algorithms in telephone network equipment.

The continuing expansion of the power of microprocessors and digital signal processors will soon make possible telecommunications equipment which is more completely software-controlled. In wireless standards, this effect will be even more pronounced once tunable radio frequency sections are controlled by microprocessors, and they are able to select operating ranges over a wide bandwidth. Wireless telecommunications equipment controlled completely by software is possible because there is no physical connector to standardize.

When the microprocessor and digital signal processor programs are loaded into telecom equipment under control of a user or managing system, the telecommunications equipment is described as having an open architecture. Open architecture telecommunications makes practical multiple overlapping standards. In open architecture systems, the lack of a common standard does not prevent telecommunications. With multiple standards for similar functions, the users can choose which standard to load into their equipment, and they may switch back and forth as needed. The equipment may be able to do such switching automatically, based on the signals received from the equipment at the remote end during start-up.

Some would argue that overlapping telecommunications standards are a waste of resources, even if they can be made to work. But overlapping standards can be a means to foster competition—between technology approaches and/or between companies. Overlapping telecom standards may also allow a consensus in the standards organization when it is not possible to achieve consensus within a technical debate. Finally, the declining cost of processors and memory within the equipment industry itself allows the support of similar but different telecommunications standards at very little additional cost.

GIH—Backbone of the Personal Communications Revolution

Until recently, worldwide telecommunications was offered with little choice of service or provider. Western Union provided telegraph service. AT&T, the regional Bell operating companies, or the Public Telephone & Telegraph in countries outside of North America provided telephone service. This lack of competition created a slowly-evolving communications system that lagged behind society's needs. For example, consider the difficulty in ordering ISDN service in North America, a PPP connection in Europe,[4] or a telephone in many other parts of the world. Where the public telecommunications service is well run and well funded, it is barely acceptable. And where it is poorly run and/or poorly funded, it can be a significant impediment to regional economic success.

In the 1980s through the mid-1990s, the personal computer revolution has had major effects on society. In North America, the growth in small businesses and the flattening of the management structures of larger organizations was made possible by the increased use of PCs.

The personal communications revolution of the 1990s describes the external view of society's vision for the Global Information Highway. The personal communications revolution will also have a major impact on society. Personal communications will do much more than flatten the hierarchical telecommunications structures devised in the early 20th century. It will change the society we live in just as the telegraph (real-time point-to-point data) and the telephone (real-time point-to-point voice and data) did previously. Personal communications will support real-time or delayed communications, point-to-point and multipoint communications, for voice, images and/or data.

The Internet demonstrates that a worldwide telecom network based on lower OSI layer telecommunications standards can support as many applications as users can imagine.[5] And the higher-layer OSI standards need only be those accepted by the users of the Internet. This demonstrated capability of the Internet is one promise of the Global Information Highway—a network with applications limited only by the imagination. Once the lower-layer practicalities of required telecommunications standards are in place, each user should be free to create or choose the type of applications to use. Much like a modern highway, the Global Information Highway should allow the passage of an amazing number of different vehicles, with little or no change needed in any telecommunications standard.

Conclusions—New Directions for Standards Work

The world's telecommunications standards organizations are creating the standards that make possible the GIH. They are also taking part in a discourse to help direct the personal communications revolution. Two major areas must be considered:

(1) The changes required in the operation of the standards organizations themselves to prepare for further work on the GIH.
(2) How the GIH will exist in the societies it serves.

Some of the more vital issues regarding the changes needed in the operation of standards organizations are:

- Telecommunications standardization authorities need to adopt a more proactive stance toward emerging telecommunications standards fora, assisting with organizational issues, and working to avoid overlap in their respective work programs. In general, the existing telecom authorities should

provide active support, not competition, to emerging standards fora. Achieving the broadest support for the standard is far more important than where the standard is created.
- Telecommunications standardization authorities should focus even more on the lower layers of the OSI model. This is where new technologies (broadband ISDN, wideband wireless, PCS, satellite) will continue to create the need for new standards. These authorities should, at the same time, divide responsibilities for some areas of higher-layer work with standards organizations that have greater user membership and participation. Higher-layer work that might be considered for such division includes applications programming interfaces, security, and network management.
- Universities do not currently train engineers to understand the importance of standards in general or telecommunications standards in particular. The standards organizations need to help correct this omission.

Some of the key issues in the discussion on how the GIH will exist in the societies it serves are:

- Most highways are not toll roads. To allow the world's information the same freedom as the world's cars, the GIH should also not be a "toll road." But the issue of financing the GIH begs wider discussion.
- Many of the social issues of the GIH may be affected by technology as well as by laws (of the governmental kind). Consideration and public discussion of the technical possibilities to mitigate societal problems (pornography, undesired advertising, unsupervised or uncontrolled usage by minors, etc.) on the GIH is needed before less rational "solutions" are developed by factions that don't understand the GIH.

Finally, the most exciting, yet most disconcerting prospect of the personal communications revolution is that personal communications over the Global Information Highway will lead the societal structure. The attendant changes to the many structures in society—personal, business, and government—will not be well understood until after they have occurred. Personal communications over the GIH creates new possibilities for individual freedom and will require new awareness of individual responsibilities.

Wise guidance during this period of societal change will be very beneficial. Several hundred years ago, when new freedoms and responsibilities were also being discussed as the United States emerged as a new country, the leaders decided to create a charter to provide guidance. The ITU, as a U.N. organization chartered to support telecommunications, could be the logical organization to undertake the coordination of the work to write the "Declaration of Telecommunications Independence." Such a charter could go far to direct the vision of the Global Information Highway.

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[1] This was reported by a contemporary writer of the period, Richard of Hexham. The quote is from a Latin couplet written on the occasion.
[2] ATIS (Alliance for Telecommunications Industry Solutions) and TIA (Telecommunications Industry Association) are located in North America. TTC (Telecommunications Technology Council) is based in Japan, and ETSI is the European Telecommunications Standards Institute.
[3] V.42 supports two different error control procedures, LAPM (Link Access Protocol for Modems) and MNP (Microcom Networking Protocol), which was originally a proprietary solution.
[4] PPP (point-to-point protocol) is a popular mechanism used to access the Internet.
[5] The protocols of the Internet are associated with OSI layers three and four where end-to-end communications is supported.