

PROTOCOLS: KEY TO THE FUTURE OF COMPUTER COMMUNICATION

Lawrence Bernstein

Lawrence Bernstein is executive director of the Systems Software and Networking Division at AT&T Bell Laboratories in Summit, New Jersey. He is responsible for developing networked computing solutions for the AT&T Computer Systems Division. Mr. Bernstein received a B.S. in electrical engineering from Rensselaer Polytechnic Institute and has an M.S. in electrical engineering from New York University. He joined AT&T in 1961.

Minicomputers changed the corporate landscape during the 1970s, when individual computers could solve specific operational problems of department-sized organizations. Microprocessors followed in the 1980s, delivering computing power directly to individuals through their personal computers and workstations. When customers realized how powerful these discrete systems were, they began to look for ways to interconnect them. Interconnection would let their people distribute computing power and, at the same time, exchange data, share corporate databases, and communicate through electronic mail. It was clear, however, that applications operating in different environments would have to interact dynamically for the interconnections to work.

Recognizing this need, AT&T's Chairman and Chief Executive Officer, Robert E. Allen, made the following observation in his keynote address at the *Interface '89 Plus* conference and exposition in New York City:

“(Information systems) users at the leading edge don't want to standardize on a single vendor's proprietary systems any more. They want to mix, match and interconnect products from whatever vendors meet their needs. They want to take advantage of new technology without making their existing hardware and software obsolete. They want robust systems that seldom or never fail, but that recover quickly and transparently if they do. They may not want to operate their networks directly, but they do want to control them, especially those networks that are the corporate 'jewels.' They want the ability to manage such networks through software, and to reconfigure, expand and reduce capacity as needed.

“Standards are critical to meeting all these needs. And users are beginning to know it. Standards shift the focus of competition to where it belongs, away from the artificial restrictions created by proprietary systems and toward meeting specific user needs. It's been called 'free market' computing and communications, and with good reason.”

Computer communications are at a crossroad. Customers tell us they want to be able to solve complex global problems through networks of computers. Electronic mail, computer-generated facsimile and advanced network management are among the applications that will help solve customers' problems in the future. However, most of today's large data networks are still dedicated either to single applications, to multiple applications on a single host computer, or to multiple applications on several hosts manufactured by the same company. Ad hoc proprietary solutions have been developed. Implementation of the solutions has been error-prone; the path to success has been difficult.

Recently, computer communications networks have begun to make it possible both to share terminals among applications and to connect applications operating on different makes of host computers. This effort will continue in the '90s. Soon, it should be possible to link many brands of workstations, microcomputers, minicomputers, and mainframes. In addition, computers will be linked directly to one another as peers.

The Role of Protocols

Just as impedance matching made it possible to cascade electronic systems in unanticipated ways, properly designed and implemented protocols provide the means to interconnect disparate software systems. Protocols let separately developed systems work together with a minimum of intersystem testing, but only if these systems interpret and implement their protocols the same way.

Protocols now being implemented will permit migration from predominantly hierarchical (mainframe-centered) computer communications to nonhierarchical

(client/server-centered), peer-to-peer communications.

Rigorous testing of specifications and conformance is a key element in developing reliable protocols. A significant step forward in state-of-the-art protocol testing has been achieved by using the finite-state machine model, as well as algorithms that assure complete testing coverage. These techniques will make ISDN (Integrated Services Digital Network) and OSI (Open Systems Interconnection) practical on a large scale; they will foster the era of open systems that is so much a part of AT&T's commitment to the information movement and management industry.

Because networked computing holds such great promise, we need to build bridges between today's and tomorrow's networks. With considerations such as cost and response time, the future may well be dominated by intelligent workstations and peer-to-peer networked computing. These future networks must interconnect, as well, with the older, hierarchical networks to preserve customers' investments in those networks.

Interaction of equipment, made by numerous manufacturers and widely dispersed geographically and organizationally, calls for new computing solutions. AT&T's computer scientists and systems engineers are building the bridges — reliable protocols — that will let seemingly incompatible equipment coexist effectively on networks. The protocols will make possible a more graceful, predictable migration to tomorrow's world of communication.

(Manuscript received June 30, 1989)