1. INTRODUCTION

Over forty representatives from computer vendors, common carriers, and sophisticated computer/communication users met under the auspices of the IEEE Computer Society in the Board Room at IEEE Headquarters in New York City on October 14, 1970, to hold a candid dialogue on technical aspects of computers and communication. The attendees brought to bear the views of a broad cross section of industry, the academic community, and the government. The discussions were constructive and objective. They opened the door for further discussions aimed at clarifying some of the engineering choices that have yet to be made and at resolving some of the uncertainties that characterize many of the requirements. The discussion also revealed the need for additional educational interactions among the parties interested in the area of computer communication to develop a better appreciation of the engineering tradeoffs involved.

Four major objectives were set down for the workshop. First, the workshop was to encourage an informal discussion on computer communication among representatives from the common carriers, computer manufacturers, and sophisticated computer/communication users. The second objective is a direct extension of the first one, namely, the workshop was to explore the desirability and the best possibility for the development of a regular computer communication dialog among the interested parties under the neutral auspices of a professional society. The next two objectives were aimed mainly at supporting the activities in progress with the Computer Communication System Subcommittee of the IEEE Computer Society. Thus, the third objective was to permit the 1970 FJCC Computer Communication Session participants to become exposed to a broad spectrum of considerations for use at the Session and to allow them to interact freely prior to the Session. And the fourth objective was to move along the preparation of an IEEE Handbook on Computer Communication of which a second draft has become available.

To permit a more free interchange of information, the ground rule was adopted whereby discussion items will not be attributed to individual participants or their affiliation. This summary reflects this ground rule.

2. DISCLAIMER

This is a report on the meeting and does not necessarily represent a consensus of opinion nor the views of IEEE.

3. DISCUSSION SUMMARY

3.1 Computer Communication — A Burgeoning Industry

3.1.1 Cornerstones of the Computer Communication Industry

The enticing promise of growth opportunities in computer communication is luring an unprecedented rush of business talent and investment. The speed of product and services innovations — a result of the revolutionary pace of electronic technology in the last two decades — tends to obscure the most important characteristic of both the data processing and telecommunications industries: They
are thoroughly established business domains, with roots that extend back to the 19th Century.

With the broadening of the acceptance of data processing it has been recognized that networks of computers can bring the computer power of large machines to work on a single problem and can provide reliable computer services to large populations. Other advantages of such networks include load sharing from one computer center to another center, and providing access to user files from any point in the network to any other point. This recognition has created the present thrust toward the strong contemporary effort of welding individual computer systems into total information systems. The forces behind this thrust are the communication suppliers, aggressive computer manufacturers, and the experienced users of computer and communication. These professional users want to apply their experience, some of which gained in the space programs, to expeditiously realize the potential of computer networks to the benefit of the unsophisticated data processing users who have a strong need for this type of resource-sharing computer networks.

**3.1.2 Market Characterization**

It was reported that several established companies today offer time-sharing computer services. Some of these companies have already developed their own computer controlled communication networks that interconnect the subscribers of the time-sharing service to a centralized computer center. Other companies are in the process of developing their own networks; some of these companies propose to make these computer controlled networks available as a public offering and have filed with the FCC accordingly. These networks are not confined to the continental U.S.; some of them extend to Canada, and plans for others include Europe. The computer controlled communication networks usually employ minicomputers that perform such functions as data multiplexing, error control, and network performance monitoring.

Today, about ½ of the users of time-sharing services are sophisticated and very knowledgeable in the information technologies. They do not require much support and the simple, general purpose TTY or CRT terminal devices services them well. In contrast, the remaining ½ of the users are only interested in business type of applications; they require much support since they are only interested in results. Interestingly enough, their applications programs are usually very sophisticated and the equipment supplied to them highly specialized. Thus, these business users require great system flexibility (proliferation in peripherals, codes, etc.) and demand that the time-sharing company becomes highly user oriented.

It has been estimated that in a few years the ratio of sophisticated users to business users will reverse (i.e., ½ scientific and ½ business).

Being in the service business, the time-sharing companies must be “now-companies.” They must respond rapidly to the fast-moving requirements. Standardization appears to be of paramount importance to permit rapid action. Uniqueness and innovation relative to the user requirements appears to be a must, it was pointed out.

The results of a market survey (which was financed by Datran, Inc.) within seven selected domestic segments was reported. These segments are: securities, insurance, manufacturing, retailing, banking, information services, and health care. These segments represent a substantial portion of the domestic, civilian economy, and probably an even greater portion of the nation’s data communication requirements. The results have been expressed in terms of (a) transaction volume, (b) call volume, (c) termination points, and (d) data terminals, and not in terms of dollar volume figures, since the latter figures are directly affected by the rates charged. It was emphasized that in a competitive environment, these rates could vary substantially and make dollar volume forecasts quickly meaningless.

The traffic forecasts reported were:

<table>
<thead>
<tr>
<th>Year</th>
<th>1970</th>
<th>1974</th>
<th>1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of transactions (billions)</td>
<td>14</td>
<td>50</td>
<td>250</td>
</tr>
<tr>
<td>number of calls (billions)</td>
<td>3.7</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td>number of termination points</td>
<td>84</td>
<td>310</td>
<td>1000</td>
</tr>
<tr>
<td>number of data terminals (thousands)</td>
<td>185</td>
<td>800</td>
<td>2500</td>
</tr>
</tbody>
</table>

The annual growth rates of these forecasts are in the 40% range during the first half of the decade and drop to about half that amount for the balance of the decade. The most prevalent applications in the industries surveyed were:

- securities - quotes/orders; insurance - claims/prem; manufacturing - inventory/sales; retailing - credit authorization/inventory/sales; banking and finance - credit authorization/internal operation; information services - facsimile/information retrieval/remote batch processing; health care - claims/lab tests/hospital operations.
- The fastest growth segments were said to be in retailing, banking and finance, information services, and health care.

It was pointed out, that the integrated combination of computers and communication can have an important effect upon the fundamental structure of tomorrow’s society. Long-range planners should therefore think in broad

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1 A termination is defined as the interface between a transmission facility and a data transmit/receive device. This device may be an individual data terminal or unit controlling several data terminals.
terms and not confine themselves to the present patterns of computer communication usage in our society, it was urged. With the great technological strides being made today, tomorrow's computer networks should be optimized for "people efficiency," not for efficiency of the system. For example, some practical systems may well be developed in which communications could be effectively substituted for transportation in our densely populated urban centers. Furthermore, computer controlled communication could greatly improve the process of dissemination and retrieval of information. One such improvement could be personalized publications which is already under consideration by some large professional societies.

3.1.3 International Scene

In Europe, communication is run by governments who often have not the same priorities as the users. The range of sophistication of computer communication uses among the European countries is very large. This makes respective negotiations quite difficult and sometimes leads to peculiar standards among those countries, it was pointed out. The emerging interest in the Common Market, however, demands better and more coordinated computer communication facilities to serve the Market.

In some areas of computer communication, Europe is lagging by three to four years, it was reported. In other areas, however, the gap is a few months at most. A high degree of standardization appears to have a highly beneficial effect in some countries (e.g., Germany). Some standards are being produced by CCITT.

To illustrate the range of data communication effort in Europe, the following numbers were quoted: Germany has 78,000 Telex terminals in operation, the UK provides data communication services (mostly for banks) by 272 private networks interconnecting 36,000 terminals, and Sweden is designing a system for the cashless society. Many countries, however, have little efforts going on in these areas.

The European communication community appears to be closely following the U.S. efforts; they have been requesting specifications of the proposed specialized common carrier systems, it was reported.

3.2 Communication Suppliers — providing communication support for a new frontier of human creativity

3.2.1 Communication Market Environment

Total information systems and their utilization have been referred to as one of the most important new frontiers of human creativity. The communication facilities have in turn been referred to as the life-blood of these systems. The existence and operation of these facilities are, based, in part, on the Communications Act which requires efficient and adequate communication service at reasonable charges.

One of the strong motivations for proposing the establishment of new specialized common carriers was said to be based on the critical attitudes of some communication users toward currently offered data communication services. It was reported that in a survey of communication users, most users contacted recognized the potential value of more advanced data communications applications but were discouraged by the communications services presently provided by the common carriers. The main criticisms advanced related to cost, range of services offered, performance specifications, facility performance, field service, and responsiveness. One determined user reported that he compensated himself for the communication service deficiencies by installing error control facilities (hardware or software) and fail-back systems. Still, this user keeps on looking to the common carriers for communication services that are less costly, more flexible, more reliable, and less a management problem.

3.2.2 Common Carrier Plans and Proposals

The following existing trends were forecast to continue strongly in the future for common carrier provided data communication services: (a) an increasing variety of service options and a broader range of interconnectability from which to choose, (b) an increase in transmission speeds and a reduction of connect times, (c) a reduction of transmission costs (in terms of bits/$, (d) an improvement in the interaction between computer people, communications people, and customers, (e) an improvement of installation and maintenance services, and (f) an acceleration of the pace of each of the foregoing.

These improvements will be forthcoming from the existing common carriers, it was asserted. Substantial improvements were promised by the common carrier candidates.

The current data communication offerings and recent announcements of future offerings were set in perspective by the following listing: (a) PL Telegraph - Key and Sounders replaced by I/D devices "talking" with computers, a widely used service for data; (b) TWX - 1930, first network in world where any "machine" could communicate with any other "machine," now fully automated; (c) PL Voice-Grade - SAGE, late 50's, a truly real-time data system - other in 1960, first 600 bps, then 1200, 2000, now 9600 over conditioned channels; (d) DATA-PHONE® - 1959 - very small market initially but rapid growth in mid and late 1960's; (e) PL Wideband - Early 60's - DATA-PHONE 50, 1968.
The announced plans for new services would seem to cover the gaps in the existing offerings, it was said: (a) Data on PICTUREPHONE® Network; (b) Also, DIVA (digital inquiry, video answer) with PICTUREPHONE Station; (c) PL Data Services Using Digital Facilities (an extension of present offering 1.344 mb/s); (d) High speed switching of above.

The computer controlled data communication network of one of the common carriers was outlined. The phase I network is controlled by 12 high-powered computers (Univac 418II) located in four major cities and uses 2400 bps transmission lines. The network provides three services: The first service provides computer switching of Telex inputted messages to Telex/TWX of the public message system, and the second one is a pseudo-private service. The third service is still experimental. It provides input by teletypewriters and the output of post offices. It was reported that a more powerful phase II network is under development.

Several specialized common carrier systems have been proposed. One of them is aimed at a national network of 16 regional microwave systems, which will offer a broad range of transmission channels not previously available for sending information between intercity plant and office locations. By this system, subscribers will have the flexibility and economy of microwave transmission on a common carrier basis instead of having to build their own private systems. Bandwidths will be tailored to meet exact individual needs in sending computer data, facsimile, radio and TV signals, voice, and teletype messages. This network will reach through 40 states. Along its routes it will be able to service almost 90 percent of the country’s computer time sharing companies, it is claimed. The network will provide 72 basic channel sizes ranging from 200 Hz to 1 MHz, instead of the three basic sizes of transmission channels now offered for private-line intercity communications by existing carriers: narrowband, voiceband, and broadband, it was said. Subscribers will have no restrictions on terminal connections, and will make their own arrangements for hooking into the system through local phone lines, direct microwave radio link, coaxial cable, or mobile radio. The estimated costs for the service has been claimed to be from 20 to 95 percent below those charged by existing carriers. This reduction is made possible in part by allowing subscribers to buy part-time use of channels and different transmission speeds in different directions; and to share channels with as many as four other subscribers.

Another proposed specialized common carrier system will be strictly for digital service including switched service, (store and forward, and circuit switching) comprising 244 microwave radio stations serving 35 metropolitan areas. The proposed network is said to be capable of connecting subscribers in less than 3 seconds, compared to the 20 seconds normal in today’s DDD systems; and since the typical data transmission lasts only 15 to 20 seconds, the time saving is important. Messages could move over the network as fast as most customers’ communicating terminals could generate them — possibly as fast as 14,400 bits per second, whereas the practical limit on present-day switched voice facilities is between 2,000 and 4,800 bits per second, it is asserted. Since there will be no need to translate data from digital signals to voice-type signals and back again, the system will reduce system-induced transmission errors to no more than one in 10 million bits, according to the proposal. The customers would be billed only for the actual time used, instead of at a standard minimum rate for a three-minute call as on present facilities. The system would interface with computers and teletype machines and would also offer ready access to and from digital xerographic machines, so that facsimile and other types of graphic information could be transmitted at some six times the speed of conventional voice circuits. Low-cost graphic transmission is expected to be a boon for doctors, engineers, and numerous other people. Four basic speed categories will be offered: up to 150; 4,800; 9,600; and 14,400 bits per second, all of them switched.

A domestic satellite communication system has been proposed that will provide facilities which may be desirable for data communication, it was stated. Today, there are four satellites (of the Intelsat type) in use (two over the Atlantic Ocean, one over the Pacific Ocean, and one over the Indian Ocean). These satellites are accessed by some 50 antenna systems, providing 1900 telephone circuits. Intelsat I (Earlybird) was launched in 1965 and provided 240 circuits; 5000 two-way telephone circuits are provided on Intelsat IV which will be launched in 1971.

One of the domestic satellite systems proposed will be similar to Intelsat IV. Each of the two satellites will consist of 24 TWT repeaters; each repeater will have a capacity for 35-50 million bps corresponding to 900-1200 telephone channels, and thus provide a total satellite capacity of 840 million bps to 1 billion bps. The system will use five ground stations and may also be used in the context of a time division multiplexing scheme, similar to those
3.2.3 Experiences with a specialized Data Communication Network

It was reported that very reliable service has been realized to date with the Arpa network. Ten nodes are currently operational which are interconnected by 50 bps lines; the plans call for 14 operational nodes by November and 24 nodes by the fall of 1971. Some good resource sharing uses of the network are being made and a host-to-host communication protocol has been worked out. This protocol is expected to remain stable through the next year.

Data movements between the data bases of the computers connected to the network is not very high at present. Higher data communication traffic is expected since the communication cost associated with using the specialized computers, which are accessible through the network, appears to be significantly lower than other alternatives. This may result in better and less expensive uses of these computers, it was said.

The existence of the network has motivated some interesting developments in the area of making computer programs of different computers communicate with each other. The network is also stimulating a closer engineering cooperation among computer and communication people, it was pointed out. In addition, the network is providing a new dimension of automated maintenance testing.

3.3 The Computer Supplier’s Concern

It was pointed out that all processing computers require some sort of front-end equipment for communication, unless the CPU is directly used for I/O. The question appears to be the degree of flexibility required by the front-end equipment to meet the myriad communication requirements.

The use of programmable communication oriented front-end computers (efficient communication oriented instruction set, low-cost memory) offers the highest cost-effectiveness, except perhaps for the simplest of communication tasks, it was said. Furthermore, these computers provide insulation and reliabilities that greatly enhance the total system reliability (communication can be maintained by the more reliable front-end computer when the host computer fails). And equally important, the programmable front-end computers provide the complete flexibility needed to accommodate the terminals and communication requirement of the broadest of user base.

The variety of so-called standards against which hardware must be designed was said to be bewildering. Since most developments take about two years, it was pointed out that a product may be obsolete by the time it comes out. A high degree of modularization, both in terms of hardware as well as in terms of software, provides the flexibility needed to minimize this risk. A strong plea was made for increasing real and meaningful standardization which could result in desirable economics. It was recognized that standardization is inevitable in a growth environment.

Standards are voluntary, and governments can exert pressure for following standards only through their procurement specifications, it was said. Standards are no barrier (except if purposely designed to stop imports, e.g.) and are to the advantage of consumers as well as manufacturers. It was pointed out that meeting standards permits better quality control, provides for a broader range of alternate sources, and facilities subcontracting procedures.

3.4 Considerations of Systems Integration

3.4.1 Communication Service Reliability

It was proposed that the computer communication issue be broken down according to the services that are to be provided. Three distinct service categories were advanced: (a) communication service between two points, (data block = message), (b) switched service to permit interconnection of many points (data block = address and message), and (c) processing services (data block = address and order and message). The question was raised as to who should supply which of these services. A number of considerations must be applied to the first two services. These include data type (analog/digital), data rate (maximum, average), average connection time, permissible delay (allowing delays can make communication more economical but can cause problems for the user), reliability, privacy, number of connections, installation (start-up), and signalling and control (protocol). The processing services involve retrieval of stored information, addition and deletion of stored information, and data manipulation.

To provide adequate services, we need to concern ourselves with equipment, facilities, standards, and tariffs, it was said. The tariffs may eventually contain a grade-of-service guarantee, it was suggested.
The desirability for a guaranteed quality of communication service was expressed. It was reported that the Arpa network has a probability of making one error per year. Thus far, no errors were made. The system is protected by a 24 bit cyclic error detection code; during the existence of the network, the average probability of retransmission for correcting errors has been 1:10,000 it was said.

It was suggested that the customer should be able to receive a guaranteed level of service since it has been demonstrated that high quality service can be provided by proper systems design. The common carriers should assume the responsibility for guaranteed communication services, it was felt. One of the proposed new communication systems will carry a service reliability guarantee; failure of meeting this guarantee will result in a rebate. The question of who should arbitrate in case of disputed performance remained unanswered.

It was pointed out that customers want high-reliability communication service but do not seem to be willing to pay for specialized error control equipment, neither in the United States nor in Europe. Providing specialized error control as part of a specific application may result in an optimized error control capability, it was suggested. Still, there appears to have been an inclination toward looking to the common carriers for providing the necessary error control to guarantee a level of service. It was pointed out, however, that mixing of different error control schemes may cause problems because of the delays that are introduced by the various error control schemes. This is particularly serious with error control systems that rely on retransmissions since these systems are sensitive to delays, it was said. However, when the delays are known (e.g., in satellite systems), the systems can be designed for these delays, it was added.

The practicability of providing different grade services (viz. fast restoral and not so fast) by the common carrier was questioned on operational grounds. (How can you expect a maintenance man to pay particular attention to one set of circuits and deliberately neglect others? How can one do other than the best he knows how to do? i.e., provide graded poor performance?)

3.4.2 Interconnection Problems

There is an increasing trend toward being able to interconnect all types of computers, computer-controlled plants, and terminals, it was said. A great deal of standardization in terms of interfaces and protocol is required to permit such interconnections. It was pointed out that a group like the participants at the meeting could provide a highly beneficial thrust in that direction.

4. WHERE DO WE GO FROM HERE?

There seems to have been agreement that the meeting served a useful purpose in providing a forum for the exchange of information, and that a similar meeting should be scheduled in about six months. It was suggested that the group be subdivided into subcommittees. Each of these subcommittees should address itself to specific problems and report to the main group regularly. It was urged that the chairman establish a working arrangement with such bodies as the Office of Telecommunication through IEEE of Afips. Furthermore, it was suggested that the chairman establish contacts with European representatives, such as the Common Market Ambassador, to coordinate the IEEE effort on computer communication internationally.

There seems to have been further agreement that the Handbook in preparation by the IEEE Computer Communication Systems Subcommittee would serve a very useful purpose and that it would be reasonable to expect support for the project from industry (typically $2000 per corporation). The chairman was instructed to work out details for receiving such support, considering spreading the support request over one to two years. Furthermore, it was suggested that the handbook be issued in binder-form with updates supplied regularly and that it remain responsive to the user requirements by developing a suitable underlying organization structure.

The handbook is to meet the system design needs of industry, it was pointed out. Accordingly, it is planned to contain reference data for systems design and to inform about current developments. The technical expertise is to be furnished by members of the IEEE Computer Society.

Respectfully submitted,
REG A. KAENEL, Chairman
G-C Computer Communication System
Subcommittee

36/COMPUTER/MARCH/APRIL