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TO: Working Committee on Terminals, Modems and Information Interchange for the Cambridge Project

FROM: Abhay K. Bhushan

SUBJECT: Data Communication Facilities for MIT Time-sharing System Users

This memorandum is concerned with the data communications requirements of the M.I.T. time-sharing system user, particularly for the medium (voice-grade 600 to 10,000 bits per second) and high-speed (over 10,000 bits per second) facilities. Some of the requirements for terminals, modems and computer interfaces are discussed by Al Vezza in a memorandum under progress. For reasons of flexibility and for maximum interaction between users of various facilities, it is of course desirable that uniform procedures be adopted. The Vezza memorandum recommends the use of Full duplex or Asymmetrical full duplex channels stressing the need for a reverse channel for at least control information. Also, it is suggested that the computer ports (or channels) be asynchronous (since this will permit both synchronous and asynchronous transmission) and that the port speed be under program-control. The standard port interface should of course be the EIA interface RS 232B, so widely used by the industry.

Such a computer port will permit the interconnection of most currently available data sets that are capable of operating over the voice network. In the low-speed range (300 bits/second or below), the services offered by the telephone company are competitive and most suitable. The Bell 103 data sets and the corresponding facilities can be safely recommended. For the medium-speed or voice-grade facilities, the answers are not as clear-cut. Many non-common carrier companies are coming out with "Bell compatible" modems which have an appreciably lower cost. For example, the Rixon FM-18 (up to 1800 bits per second) compatible with Western Electric 202 series is available at the basic purchase price of $500 which is about a year's rental of an equivalent 202. The Collins TMX 202 costs $850 and the Sangamo modem costs about $1300 which are compatible with the Bell data set. The Rixon modem is not as reliable as the Bell or Milgo modems (higher error rate) for long-distance

operation but may be satisfactory for short distances characteristic of the situation at M.I.T. Thus, a user could own a Rixon data set and still be able to dial the M.I.T. time-sharing system equipped with a Bell data set. One advantage of the Sangamo is that Sangamo is a Licensee of Western Electric and therefore the modem meets Bell System standards. This is particularly evident in the receiver sensitivity specification.

For achieving higher speeds over voice-grade lines and the voice-network, the telephone company and the non-common carriers provide more expensive data sets (these generally use special techniques) that cost between $2,500 and $10,000 depending on the manufacturer and the speed of operation. The Western Electric data sets appear to be competitive for this range. For the lower speed (800-1800 bps) voice-transmission, however, the non-common carrier modems coupled with the telephone company $2.00/mo. black box (Carter-fone Case) may be a better solution. Another alternative that may sometimes be attractive is the telephone coupler data set. Anderson Jacobson is manufacturing a telephone coupler data set to operate at 1200 bps.

In the high-speed range (over 10,000 bits per second), the facilities offered by the telephone company are very expensive ($450/mo. for the 303 data set). The non-common carrier companies do not offer any standard facilities. The high-speed facilities would normally be used for computer-to-computer communication such as in interactive graphic display or load-sharing applications. The Bell System is offering the 303 data set on the Dataphone-50, the 50,000 bits per second dial network. What is needed by M.I.T. users at this stage is probably an inexpensive hardwired modem capable of operating at high-speeds over cables. Brown University has a hardwired system operating (built to order by Tuck Electronics, New Cumberland, Pa.) at 40,800 bits per second for 3000 ft. distances. The total package including modems and cable only cost them $2,200. This may suggest the solution to our problem for high-speed data transmission.

As regards the current high-speed port situation, they are almost non-existent save for direct data channels. The high-speed ports would be rather specialized subject to computer-to-computer communications standards and requirements for custom-built systems such as in the case of the ARPA network. One way to obtain high-speed ports for the ARPA network and interactive graphics systems is by connecting a control computer as has been suggested. Such a computer will also be able to handle several medium-speed terminals. For 8 ARDS ports and 2 high-speed channels, the cost of system estimated by Vezza is $68,000 (for equipment only). This would mean an average cost per port to be $\frac{68,000}{10 \times 40}$ = $170/month. The average use per port (not per terminal) can be estimated to be 50 hours/week or 200 hrs/month, so the cost per port is less than $1.00/hour. The desirability of this course of action depends on the expected use of medium-speed lines and the ability of CTSS to support this load. The cost figures per port using a control computer are comparable to that of the adapter channels ($140/mo. for CAA channel in 645). The control computer is specially attractive considering that buffering as well as message handling can be performed there.

The possibility of an industry-wide computer-to-computer or even data communication control standard is quite remote at the present time. Therefore, it is my feeling that such procedures be implemented in software at present. A control computer would be able to handle this job adequately. For high-speed communication to the 645/Multics system, it seems that the Word Synchronous Adapter (WSA) is not going to be built by GE. The high performance channel seems the recourse left for connecting to ARPA network(the alternative is using the slower CAA channels - ARPA network greater at 50 kb/s). An alternative would be to obtain a custom-built adapter along the lines of the WSA (either in-house or GE) in accordance with the BBN specifications for Host to IMP interface connection.