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by

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INTRODUCTION

Data communication has changed much in the last dozen years. Many factors have contributed to this change. The cost of computing has forced computer users to rely increasingly on communications systems to gain access to their required computing resources. Communication paths have become easier to use due to increased common carrier circuit quality and technological evolution allowing higher-speed, high-reliability modems. Now the minicomputer, in its various forms, is being utilized to greatly increase the potential of data communications.

It is difficult in any discourse, such as this one, to correctly state the future of anything as dynamic as the minicomputer and communication. At best I hope to point to some current trends and draw minimal conclusions as to where these trends may lead. I would also note that what many consider as minicomputers now are already becoming microcomputers. Thus the term mini is used here as a loose generic term referring to a small cheap computer (whatever small and cheap means!). Minicomputers are heavily infiltrating three major communications areas and several other loosely connected areas. Terminals, networks, and front ends are three major areas; the others will be discussed individually later.

TERMINALS

Terminals classically fall into the Remote Job Entry, Interactive, and special purpose categories. Remote Job Entry terminals generally handle card readers, line printers, magnetic tapes, card punches, etc. The original versions of these RJETs were "hard-wired" terminals with only a single protocol capability and minimal peripheral expandability. Now, with the use of minicomputers, protocol emulation and flexible I/O techniques are possible. This has allowed a single RJET to have maximum flexibility in which computer it connects to,

the speed with which it can communicate and what peripherals it can support. Increasing speeds of minis will allow cheaper peripheral controllers and faster communications speeds in the future. Also users will use their RJETs in offline uses as traditional computers even more than now.

Interactive terminals were once limited to the classical Teletype (TTY); now a host of newer hardcopy and CRT type terminals are available. Minis are already being added to these TTY-like terminals allowing more offline useability for editing of text. The addition of "floppy" disks and "cassettes" allows other small processing to be done. Once online, the mini will allow efficient line transmission and expanded editing and preprocessing capability.

Special purpose terminals have always existed, even if just for the online banking and airline reservation systems. These terminals will be greatly expanded in capability for the same reasons and in the same ways as RJETs and TTYs. However, many new special purpose "hybird" terminals will appear as the mini allows computer users to increasingly utilize their terminals in new and strange ways.

NETWORKS

"Network" is a greatly over worked term. I use it to define the communication medium itself, specifically NOT including the hosts and terminals that may be attached to it. I agree whole heartedly that this term can also be used to a higher level but I do not do so here.

Multiplexing is one of the classic first steps taken in networking beyond the "star" configuration. The "star" refers to a host with unique lines to several terminals (star-like). Multiplexing, as traditionally accomplished with hardware line multiplexers, attempts to allow many uses of one communication line.

This allows many terminals in one location to share one, more cost-effective, high-speed line to a common host computer. This function will be done more and more by software time division multiplexing as minis get faster and cheaper. This will not only cut multiplexing costs, but more importantly will allow dynamic bandwidth loading as opposed to static bandwidth allocation as hardware multiplexors now do.

Concentrators are devices that allow many communication lines to concentrate into one high speed line, typically for interfacing into a host. Admittedly the distinction between concentrator and multiplexer is fuzzy but I presume that a multiplexer is coupled with a symmetrical demultiplexer at the other end of the communication line. A concentrator (again, by my definition) is a non symmetrical device. A classical computer front end for communication could be considered a concentrator, however, I prefer to consider here only concentrators with communication lines incorporated in them. Minis will be very useful in the future to allow high level concentration by essentially moving the front end function to the remote site. This is more difficult to achieve than multiplexing as it will not always be transparent to the host; many software changes will be needed.

Distributed networks are becoming very popular; unfortunately often for political funding reasons. The terminology refers to a network of widely distributed hosts and terminals. Technically speaking any terminal should have access to any host. Distributed networks are only realizable with minis in them as they incorporate the most advanced forms of software multiplexing and concentrating as discussed above. To round out the confusion the term "packet switching" should be added to the fray as more advanced distributed networks use packet switching technology. This refers to the concept that the smallest piece of

information transmitted in the network, a "packet", is dynamically switched from line to line as network loading requires. Potentially this form of network has the greatest long term promise. The ARPA Network and the TYMNET are two good examples of distributed networks, though only the ARPANET is packet switched. The new Valve Added Network (VAN) tariffs will allow this technology to reach the marketplace to prove itself. However, it is most likely to be several (5-10) years before distributed networks will replace traditional networks for "star" like needs. Obviously the evolution of mini computers will play a key role in all of this but more importantly software techniques need to be developed to allow minimal impact to the hosts and terminals interfacing to these networks.

FRONT ENDS

Front ends are those "things" most typically added to a host computer as an afterthought. By this I mean that most hosts historically had hardware communication ports connected directly to I/O channels and the replacement of this port hardware with minis was done for economic reasons. Front ends include Remote Job Entry, Interactive and other special purpose communications handling equipment.

Remote Job Entry has become quite complex with the more sophisticated protocols, line speeds, additional terminal peripherals, multi-host configurations, etc. Minis allow simpler ways to adapt to new protocols. Note it still isn't easy to add them, just easier. The advantages of removing most of the CPU overhead from the host should be obvious. Performace monitoring and measurement are now possible via the mini front end. Typically these were not supplied by the host vendor and are increasingly in demand for procurement procedures of the government. Multihost interfacing is possible with the moving of the RJE protocols to the mini front end, also more sophisticated operator control,

monitoring and diagnostics.

Interactive mini front ends share most of the attributes of RJE front ends, and also allow more sophisticated text editing to be accomplished. Furthermore, CPU loading is removed from the host when line accumulation is done in the mini. This allows interrupts of the host on end of line only, and more responsive interaction for the terminal user as the host is not involved until end of line.

Other special front ends also share attributes of RJE front ends. The SACNET host is a good example of a special purpose front end.

OTHER USES

Many specialized mini and micro computers will be making their appearance in communications hardware, quite often in ways not readily identifiable as compu- ters. For example, a whole new class of communications multiplexers for mini- computers (Varian, Inderdata, Mod-Comp) are now appearing. These muxs use specially designed micro processors to minimize mini CPU overhead, so we have a front end for a front end beginning to appear.

Bolt, Beranek and Newman, the primary contractor on the ARPANET, is now devel- oping innovative multiple-mini-processor techniques for eventual use in the ARPA Network. These techniques actually constitute a distributed network of minicomputers to implement a distributed network.

So many of these special applications exist it is pointless to continue (be- sides I am running dry).

CONCLUSIONS

In the above gross generalizations I have tried to identify trends toward the future. Obviously this field is so dynamic that one can pick any part of communications and predict it will be evolving with minis and not be wrong.

As to cost benefits it should be obvious that all this is happening because costs do go down with most uses of the mini, but to show real cost comparisons is almost impossible. Variations in host computers, applications, and techniques cause greater variations in cost than does the use or non-use of a mini in a given application. This is mostly due to the totally dynamic rate of change. I would certainly make the general statement that in the last 5 years, I have seen RJE front end costs drop by 90%. That should be a good indication of the rate of change.

Two final things I would like to consider briefly are large host computer vendors and software costs. Most large computer vendors (IMB, CDC, NCR, UNIVAC, etc.) cannot begin to keep up with these rapid changes in mini (and other) technology. The most important changes of the future will still continue coming from the small computer company. However, not to allow the small vendor to get away with the last word, software will increasingly be the focal point and major cost factor in the use of minis in communication (so what else is new!). The small vendor will, in the long run, be hoisted on this same petard as the large computer vendor.