LOCAL AREA NETWORKING SIMPLIFIED WITH A DATA PABX

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Micom Systems is a rapidly growing manufacturer of data communications equipment for minicomputer users, and, as is typical of growing firms, our data processing systems have been expanding even faster than the company itself. In fact, in terms of the computers we use, the remote sites they support, and the communications links between them, we quickly became a very typical prospect for local networking.

Four years ago, when our company was less than a fifth of its present size, we met our processing requirements by using service bureaus. Today we have six in-house computer systems and three others at remote sites -- in Pennsylvania, Puerto Rico, and England. All are interlinked.

We fortuitously made some sound decisions in our very early stages of growth, and have since managed to avoid much of the pain that frequently accompanies major changes in installed networks. As a result, we believe we can set up some trail markers for others who might be progressing along the path we took: from dial-up lines, to data concentrators and dedicated in-house links, to data PABX-centered local networking, and finally to multiple interlinked nets.

Beginning with dial-up access

Starting in 1980, we used two major computing services, Xerox Computer Services and General Electric Information Services Company (GEISCO). Xerox supplied standard "canned" business applications, while GEISCO was used on a more ad hoc basis for engineering and management applications. Due to the different usage patterns of the two services, different communications techniques proved appropriate.

For the quick or intermittent problem-solving performed by a large user base accessing GEISCO, we used dial-up lines, allowing the engineer or manager to reach the system from a terminal in his (or her) office. Dial-up access is one of the simplest forms of data communications, requiring only a modem to supplement the user's terminal, and this is the way many organizations begin their dp. We were no different.

Concentrating on Leased Lines

We used the Xerox Service Bureau for the day-to-day commercial applications, which typically were accessed by a smaller group in the accounting and manufacturing departments. These users were on-line all day, or at least a great part of it. This meant that a leased, rather than dial-up, line would be most cost-effective.

To further keep telephone line costs under control, we installed 8-channel (later 16-channel) data concentrators at each end of the leased line. These concentrators (sometimes called statistical multiplexors) let us run up to 16 terminals while paying for only one telephone line.

In some ways, using concentrators and a leased line is at least as simple as dial-up access, since the amount of data communications hardware is reduced. Instead of 16 modems at our site and another 16 at the service bureau, plus 16 phone lines, our communications link had one concentrator with an integral modem at each end of the single telephone line. And the concentrators could pay for themselves in a matter of months in savings on telephone line charges).

Driving an In-House System

Then, about four years ago, when we were a $15 million company, our growing size and requirements finally sent us looking for our first in-house computer. Perhaps naively, we hoped for a single system that could handle all our dp needs: administrative, financial, engineering software support, customer service, and CAD/CAM. We installed a Prime 750, mainly due to software considerations.

However, by the time the Prime was up and running, we had already outgrown it. We proceeded to order our first HP 3000, a Model

44 (again chosen due to its software), along with another, smaller, Prime to handle CAD/CAM on a dedicated basis. We had decided to put financial, customer service, and manufacturing applications, including MRP and Bills of Material, on the HP, leaving the Primes for use by our engineering groups.

Fortunately for us, with the installation of our first computer, the Prime, we made a data communications policy decision which is with us today: unless the terminal is in the same room as the computer, we use line drivers to connect the terminals to their hosts. For those who are not familiar with them, line drivers are functionally analogous to modems but much less expensive. Capable of operating over distances of a few miles, they condition the signals going between computers and terminals in order to ensure reliable transmission beyond the EIA RS232C requirement of 50 feet.

While people routinely exceed the 50-foot limit without modems or line drivers, we didn't want to risk the problems of cross-talk or electrical interference when our walls and ceilings got more crowded with active datalinks. In fact, we even use line drivers to connect terminals to nearby data concentrators if there is any chance of a problem.

Accessing Multiple Computers

When our second computer, the HP 3000, arrived, we faced a new problem, one which would compound as we added more machines. While we had successfully managed to split applications between HP and Prime systems, many users needed access to both. So much for "best laid plans."

Faced with providing one user access to two computers, we had several choices. We could have added extra wires through walls and ceilings for each multi-machine user, and asked the user to plug his terminal to the appropriate set as needed, or we could have--even more magnanimously--installed a second terminal for each of these folks. Neither solution was economically viable, particularly when we envisioned the consequences of adding more people and more machines to cover our continuing growth.

Instead, we left the wiring and terminal situation as it was, and made our move in the computer room, where we installed a Micro 600 Data PABX. With the data switch, as it is often called, we have in essence a private telephone system for data that can connect any authorized user to any available computer port. And, if a port isn't available--say all the HP ports are tied up with accounting business at the end of the quarter--then the user asking for an HP port is told (in effect) "They're all busy. Wanna wait? You'll be number three in line." (This is the data PABX equivalent of camp-on busy in a voice exchange.)

The Advantages of a data PABX

The primary advantage of a data PABX, although it has many, is its ability to connect any terminal to any requested resource (subject to security considerations programmed into the switch). This means we can hardwire a terminal to the data switch, and from the terminal keyboard a user can request a port on one of our HP systems, one of the Primes, a Zilog development system our engineers use, or whatever we may acquire in the future. We can add more computer systems and terminals as we grow. We can even let users call outside, through the switch, to reach one of the service bureaus.

We also benefit from a "statistics log" feature of the switch which provides detailed reports of all switch activity (a function which would require a dedicated processor in other proposed networking plans). And our network easily supports remote users and remote computers.

The switch also lets us save money by using leased lines, while still providing "dial-up like access" to several computers. And nothing keeps us from "remoting" CPU's, heightening that dial-up parallel.

An example may help to illustrate the degree of flexibility we realize by combining data concentrators, leased lines, and the switch. Say one user at Micom Caribe, our Puerto Rican facility, needs to use one of the HP systems. He simply turns his terminal on, and the switch, which is in Chatsworth, California, the central site, automatically asks him where he wants to be connected. He can answer with a symbolic name -- in our case with an "H" for one of the HPs or with an "M" for the HP running MANMAN, or whatever -- and the data PABX makes the connection.

A few minutes later, an engineer in Puerto Rico may turn on his terminal and ask for one of the Primes. Although both active terminals are on the same leased line, each user gets the same service he would on his own unshared line. For that matter, either of the two users can log off one machine and ask for another without affecting the transmission of the other user on the line.

Growing the Network

As might be expected, as our data processing capabilities have grown, so has the data PABX. Luckily, the switch is easy to expand with the addition of simple plug-in interface card modules. These provide four line or port interfaces per card slot, and each bay has up to 32 slots, which works out to 128 lines or ports (intermixed) per 19-inch bay.

As we fill a bay, we simply add another. Once we had our first HP 3000 and Prime pair connected to the switch, it took about 30 days before we added our second bay; 60 days later we put in bay number three. We've already installed our fourth, and we can continue to put them in until the raised floor collapses from the weight.

All of this can lead to a massive set of cables for local and remote terminals, we found. We have about 250 terminals in our Chatsworth facilities, and another 40 to 50 in the field. To simplify the wiring of the nearly 300 RS232C connections coming into the computer room, we have adopted a technique called "group termination." Incoming lines go to a wall-mounted telephone block; cables with 50-pin connectors attach the block to the switch. Each of the cables handles either six terminals (with EIA control signals) or 12 terminals (data only).

Of course this greatly reduces the snarled wiring behind our switch, and decreases the cabling under our flooring. It also makes connecting to the data PABX quicker, as we can attach as many as 12 terminals when we plug in a single 50-pin connector.

Growing New Networks

Another advantage of basing local networks on data PABXs comes from the transparency of the network and the flexibility for adding new network components. While our switch grew, we acquired a pair of used HP 3000 Series III systems. One has been traded up to a Model 64. The other is used for program development in Chatsworth.

The latter HP3000 was used to develop applications required at Micom Caribe. While our MIS department developed the programs, users in Puerto Rico could monitor our progress and offer feedback, as they, too, had access to the system through the data PABX. This arrangement allowed us to maintain centralized control over the development process, and we also avoided the problems of flying liason staff members back and forth between the two sites.

We originally thought this HP 3000 would be moved to Puerto Rico, and we planned to use the data PABX to smooth the cut-over: We would have put the Micom Caribe applications on one of our other HP 3000s, and have the switch automatically connect Caribe users to the new (temporary) host. We'd then ship the computer to Caribe, and fly the latest SYSDUMP of the Caribe applications to Puerto Rico once the hardware was installed and checked out. The actual cutover would take place on any convenient weekend.

However, since we found that we needed the computer for our own use, we wound up ordering another HP 3000 for delivery to Puerto Rico. Then, it was just a matter of sending the SYSDUMP tape and loading it over the weekend.

Even though Caribe now has its own computer system, we've retained our leased satellite link. We now use it to tie computer ports as well as terminals into our switch in California. This give users at each site access to each other's computer systems and data bases. And, when Caribe's workload warrants it, we can also install a data PABX there to attain still another degree of flexibility. An "interconnect facility" available for the data PABXs makes it possible to link switches, yet the resulting "network of networks" appears to the user as a single large data PABX.

And, there is more. We've brought our British subsidiary, Micom-Borer on-line with the installation of an HP 3000 model 40, our Black Box Catalog subsidiary in Pittsburgh, is coming on-line with a mini, and two other subsidiaries also link to Chatsworth for terminal access.

In Chatsworth, we plan to take the "interconnect facility" a step further: we're installing a data PABX in our customer service facility that will support local terminals there and also link To our data PABX in the headquarters building -- there will be no computer ports connected directly to this switch. Instead, the customer service data PABX will communicate with our central switch using data concentrators and leased telephone lines. Since communications between data PABXs is transparent, users still will have access to any needed resource just as if they were directly connected to the central switch, but this arrangement will allow us to use fewer telephone lines and data concentrators (compared to giving each terminal a channel on a concentrator). It also will mean that if a phone line fails, customer service's switch can automatically direct users' connect requests to a good line. In addition, we'll benefit from the statistics log of the customer service switch, which will readily tell us if we need more lines to accomodate demand, or if we have installed more lines than e really need.

Networks Within Networks

We're also expanding the scope of our networking in another way. With our third Chatsworth-based HP 3000 we began using HP's networking program, DS/3000. The new machine connects to our data PABX and (through a high speed link) to one of the other 3000s. Our reason for going to DS/3000 was one of response time for our many users in finance, manufacturing, and sales support who make inquiries against a large IMAGE data base originally residing on one of the 3000s.

We put MANMAN and Accounts Payable and General Ledger on one of the linked 3000s, Customer Service, Accounts Receivable, and Order Management applications on another. Files unique to each host became more readily available to our users, and common files are kept synchronized through the facilities of HP's networking program DS/ 3000.

Because of the transparency of the data PABX, we don't have any problems with the two networking systems (ours and DS/3000) operating together. Additionally, if someone needs to switch applications, say from A/R to A/P, it is more efficient to reconnect to the appropriate host through the switch, as opposed to using the high speed interprocessor link and stealing capacity from DS/3000. We also have DS/3000 capability on the Caribe HP 3000, so we can make bulk file transfers and synchronize data bases between California and Puerto Rico as well.

Conclusions

As we've grown our network, we've learned a few things, the most important of which is just how right we were to start with a data PABX. Unless your users stick to a single computer, or don't mind marching off to a centralized terminal room, it's difficult to see how to manage without one.

Perhaps it's inevitable that our version of local networking using a data PABX is continually compared to others which use more exotic technologies. We don't mind. We show up well in the comparisons. For example, the new proposed local networking techniques which use coaxial cable or fiber optics offer one very appealing feature in their ability to support many users on the same physical medium. But we can do the same by adding a few new twists to plain old telephone technology. For instance, in our corporate headquarters we've begun using a new type of line driver that can multiplex up to eight asynchronous terminals over the same two pairs of wire that might otherwise be used for a single telephone or terminal. This saves us time, money, and effort. We already have our offices wired for terminals, so now we can use the same wiring to connect several terminals in one room to the data PABX. In addition to saving us the time, cost, and disruption of stringing new wires, it also reduces the number of line drivers we need by as much as a factor of eight.

Should we wish to do so, a data/voice multiplexor is also available for use with the Micro600. (Called "Instalink", it allows a terminal and a telephone in the same office to share the existing single telephone line there without affecting each other's use.)

Granted, telephone technology is not as exotic or glamorous as working with coax or glass fibers, but it more than makes up for its lack of sexiness. Its technologies are proven, and relatively standardized in a de facto sense. Twisted-pair wiring or in-house telephone wiring is inexpensive, and in most offices, it's already in place. Likewise, using line drivers with RS232C interfaces provides a standard method of connecting to the network and avoids any special programming considerations.

In contrast, networks using coaxial cable or fiber optics run up increased costs due to the expense of the medium. In most buildings installing the broadcast medium also runs costs up very quickly, as well as disrupting everyone's work. Then too, the interfaces to the media are more expansive -- by an order of magnitude -- than line drivers, and are basically unstandarized, incompatible devices today.

A pioneering user who adopts one of these new and exotic networking technologies may well be casting his decision in concrete before the industry is ready for that. A mistake on his part is likely to become an expensive embarassment down the road. We're not going to have that problem. When those new technologies mature and users can install them with confidence, we won't be left behind; we can connect to them too.

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