Networks - It's a Jungle Out There
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I. Problem/Situation

This is not the definitive technical paper of the year on designing, implementing, and supporting a nationwide telecommunications network. My expertise lies not in the strange world of telecommunications, but in the field of business system's design. As part of the project team assembled to build an "information pipeline" to our satellite offices, I got involved in the building, care and feeding of a telecommunications network which was started in January of 1981.

Our company had a problem or opportunity, unlike most organizations that are not totally centrally located - the need to get information to their satellite offices in a timely manner. The method that our company used in the satellite offices to get information back and forth was a DEX machine.

This device allows the user to transmit paper images via telephone lines to another office that has a similar device. The fastest these devices can transmit is one page (8 1/2 x 11) in three minutes. The print quality and the reliability were poor. The device, as you can imagine, also has limited appplication. The device only transmits paper images. It does not provide permanent storage of the data nor does it have any ability to analyze it.

It was decided that we were to establish an "information pipeline" to our satellite offices - a good idea and obviously an idea that required MIS involvement and innovation. At the time of the request, our MIS department had a staff of eight people, none of whom were telecommunications experts. A staff of three people was assigned to the pilot effort of installing a computer, an "application's library", terminals (HP/2624), and printers (slave HP/2631B) out in three satellite offices. The pilot effort had a budget of $30,000 taken from keypunch funds of one of the systems that we had to replace. The $30,000 was to cover application development, three phone lines and telecommunications, lease of an HP3000/30, a MRJE line, 4 terminals, and 4 printers for six months. So you laugh....we were ambitious.

As we were not aware of what options were available to us as far as hardware, telecommnuications options, and software development tools, we contacted the three names in the minicomputer industry, IBM, DEC, and HP. I bet you can guess the ending. The IBM series 34 didn't meet a lot of our needs and was discarded almost immediately. DEC satisfied all of our hardware needs but made little or no attempt to assist us in finding application development tools. We finalized our decision on HP on April 30, 1981 and planned to install our first site on June 1, 1981.

II. Selection of Telecommunication Approach

For our telecommunications needs, being that we were only a pilot effort for six months, we contacted ATT long lines who advised us to use dial-in WATTS (two lines). These lines were to operate at 1200 Baud. The user would call an 800 number and when the high pitch tone was heard, would put the phone on hold and start the logon sequence.

Let me stray a little and tell you of inward bound WATTS. Inward-bound WATTS can be either geographically restricted or nationwide. For our purpose of a pilot to known sites, we selected geographically restricted, which is cheaper. This allows users in a certain geographical area to access our centralized computer via an 800 number.

This approach has some distinct disadvantages. For an example, if you have two phone lines (therefore two geographical areas) and one of the lines goes down, that means that the user is down until the line is repaired. They will not be able to dial-in using the other line. It also means you cannot use the line to dial-in to your computer say for HP remote support. There are ways around these problems, installation of additional lines, etc. but that was not my point. Regardless of these small problems, inward-bound WATTS has some distinct advantages, namely cost. It is especially cheap for low volume (less than two hours a day). It is easy to install as it can run with async protocol, HP's natural mode of operation, and can be connected via an ADCC. You can only go up to 1200 BAUD with ASYNC inward-bound WATTS, so speed can be a disadvantage.

For us, due to our financial constraints, this was the only telecommunicaitons option available to us. Remember that we were only to pilot this effort for six months and could later change our minds with little or no problems. Right? Well, we will get into that later.

III. Setup of the Network

In June, we installed three sites with minor problems. On the system were three applications, all marketing in nature. We had two data entry systems which were developed using V/3000, INSIGHT, and IMAGE. INSIGHT, for those of you who are not aware of it, is a productivity tool which allows you to develop applications with all file structures and V/3000 through an easy-to-use menu driven system. In addition to the data entry systems, we developed a reporting system which allowed the user to request one of three reports based on a limited selection criteria for reports which are resident on our IBM mainframe. I think a description of environment might be helpful at this point. Our company is a classic IBM shop. We have two IBM/3081 and two IBM/3033. Most of our typical applications are large IMS applications. These applications are the source of most of the information needed for our reporting applications.

So for our reporting requests, requests were batched together in some IBM JCL and sent to the IBM mainframe via MRJE, and a disc output file was generated. This output file from the request process was actually a pre-formatted IBM report with IBM carriage control. The COBOL program then read this file in, formatted escape sequences to match the IBM carriage control, and then sent escape sequences to the terminal for it to print the report on the slaved HP/2631B. This whole process is transparent to the user. This process is quite time-consuming and also ties up the terminal while they print their reports, thus restricting them to one function at a time.

We had all of the usual problems with a new installation; the equipment did not arrive until June 1. The HP/3000 was being installed simultaneously with our first training session in the field. Luckily, the installation went with only a few problems. We had developed our applications on MPE IV and were installed with MPE III. We had some initial problems configuring terminals and printers. HP is notorious for unusual cable configurations and cable problems. In our case, the required cables did not arrive with our HP/3000. All in all, the installation went great! We spent three days training the operators, who were secretaries and not familiar with computers at all. They felt comfortable by the time we left.

Our major problem came later in supporting and upgrading a network. Management felt that this was a pilot effort and that at any time one could drop the idea completely by pulling out the equipment or they could switch vendors, or expand the idea to install all our 30 - 50 satellite offices. We found that only looking at the next day or step causes problems when you are managing, installing or planning a nation-wide network.

III. Support and Expansion of the Network

There are three distinct parts to supporting and expanding a nationwide network:

1. The support of the system software and equipment that is installed both at the central site and the satellite offices

2. The support of the applications that are currently available to the users

3. The planning and execution of upgrades to the telecommunications network.

Even though each of these parts are heavily interdependent, I'd like to discuss them separately.

Support of Equipment and System Software

This is one of the tasks that we grossly underestimated. Despite what HP tells you about the ease of use, ease of care, and the wonderful system support that they provide, it is not entirely true. The computer does have certain physical requirements, including a real system manager, not just some Analyst with a System Manager's hat. The job of security, backup and recovery, and system performance and maintenance does not take a couple of hours a week. You need someone who can stay and work through a problem until it is finished and not have to worry about new applications development. When we began the "pilot" we did not have such a person on our staff. This made the problem of hardware/systems software support doublly difficult.

This and the fact that all of our support to the satellite offices was and is handled via phone calls makes the task almost impossible. As you can imagine the inability to see what is wrong is horribly frustrating. I hope that you will never have to experience this. In addition to this we had only inexperienced users. As you can imagine, this makes for some interesting conversations. To illustrate my point, let me give you a typical conversation. Most of our conversations started like this:

User says - My computer is broken.
Analyst thinks - What computer? You only have a terminal and a printer
Analyst says - Can you describe what is not working?
User says - I wanted to request a report and it wouldn't let me
Analyst thinks - Now the computer has supernatural powers. It willed the user's request away.

Analyst says - Start from the beginning and tell me everything you did and everything the computer said
Analyst thinks - Great now I have the computer talking|

Past our number one and number two problems:

1 - No full-time system manager
2 - All support for hardware and system software problems is done over the phone

we had another, which is inherent once you install phone lines into your computer - a two-vendor system. But, you say, they handle two different functions. What problems could ever arise with just installing two simple phone lines. Ah, ye of limited imagination, let me give a simple example that plagued our operation for two months.

Every once in awhile, not often enough to be easily solved, and not far enough apart to be able to be written off as a fluke, our phone lines would hang. We reported this problem to Ma Bell who said - software problem. HP said it was a hardware or phone line problem - noise on the line. We did not know how to troubleshoot line problems. We did not have any fancy line monitors. In fact, when the phone people would ask whether we were using one stop bit or two, we could not answer them. As we were rapidly finding out, to get any service from Ma Bell requires a general knowledge of the terminology, the equipment that you are using, and the configuration of every piece of equipment - computer ports, terminal configurations, and modem strappings. I could venture to say that first-time users like ourselves do not have that knowledge. We were lucky in that HP took pity on us and were able to walk us through that problem.

We now have steps and procedures in place to do troubleshooting of our phone lines. We now know the configuration of each piece of equipment and know the basic terminology. This still has not helped us with the more elusive problems. It would pay, if you plan to install a nationwide network, to send someone to class and then provide them with the appropriate equipment to solve the problems. If you are interested in these kinds of headaches and their answers, Ross Scrugg's TERMINAL TALK in last year's IUG proceedings is a good place to start.

In addition to the support of our telecommunications equipment, we found a great need for all sorts of system software. We have some large databases (80 mg - 100 mg) which, every once in awhile, require additional data items. After spending 16 hours unloading and reloading our data base, we rapidly saw the need for ADAGER.

Applications Support

As you might have been able to predict, most of our support problems were in this area. Not with true application problems, like programs abending or data missing or things just not working like you would expect them to, but with support of the 'how to' questions. You think to yourself, they did train the user. Right? Well yes, but we installed new applications and because of budgetary problems were not able to go back out to the offices to retrain them everytime a new application was developed.

Well, you think, did you send them a user's guide? Yes, we did, but it did not seem to be effective. That still puzzles me. Most times the user would not read the guide, nor would they read the error messages or directions on the screen. They seemed to need that human touch or should I say voice being we were supporting these applications by phone. In addition to the problems listed above, our personnel in the satellite offices changes with some frequency.

In application support we ended up with four major tasks:

1) How do you effectively solve applications related problems quickly and to the user's satisfaction over the phone?
2) How do you introduce and train the user to a new application?
3) How do you handle the problem of a changing user base?
4) How do you minimize the drain that application support has on your analysts' time, as they are still responsible for new application development?

These problems plagued us for a couple of years and in fact are still troubling us to some degree. The solutions that we have come up with fit our problems, but may not solve your situation. We have put the burden of support for applications on the users. We have trained two SUPER-USERS who handle all questions from the satellite offices. We are very lucky to have two users who are at our central site and are bright and energetic. They, like our users in the satellite offices are secretaries/clerks, so they are able to relate on a similar level. For existing applications, they are our first line of defense. They record the problem, answer it if they can (85% of the time they are able to), and then relay the problem to an analyst if they were unable to handle it. For new applications, our SUPER-USERS train an operator at each site over the phone. In addition to this, the user documentation is sent to each of the sites for additional reference. The SUPER-USERS try to train from the user documentation, as it accomplishes two tasks:

1) Makes the user familiar with the documentation
2) Provides an easy-to-follow training guide.

The problem of changing user base is handled one of two ways, either the user is brought to our central site and trained on all the applications by our SUPER-USERS, or is trained by the individual site's SUPER-USER, or if the change in the user base is significant, we send an analyst to their site for complete training of all of their staff.

These solutions have freed up our analyst to develop new applications to add to our "applications library". In addition to this, it has given our user base a consistent and steady contact for problems.

As you can imagine this solution's implementation was not without headaches. Our SUPER-USERS were not initially equipped to handle the 10 - 30 calls a day that we were receiving. Our satellite offices, because of some of the close ties that they had developed with some of our analysts, were not eager to "train" another problem solver. Our analysts, because of the close ties, found it difficult not to get involved. All of these problems took about six months to resolve or subside. I think you honestly need to expect those kinds of problems.

Expanding/Upgrading the network

The end of the first year came around and we were finding ourselves stuck with phones bills worse than the one received in the MCI commercials. Our "pipeline" was a success, too much so. The users were on and using the system an average of four hours a day. We felt this flurry of activity was due to the introduction of ad hoc reporting using QUIZ. This was costing us a great deal and was eating into our funds for application development. Dial-in lines become cost-ineffective when use exceeds two hours a day average. We were way past that point. Although the pilot phase had not officially been cancelled, we needed to explore some data communication options open to us quickly. We explored three:

1) X.25 Packet Switching using Telenet
2) Async/Sync Convertors (MICOM and ATT)
3) MTS/Leased Sync Phone Lines.

I'd like to talk about the technical merits of each and then compare at the end the financial data.

X.25

X.25 is an international standard for public valued added networks. Public data networks allow users of the network to access remote system without having the worry about data integrity. Typically one does not build your own packet switching network but instead buy time and packets from a packet switching network like Telenet. So to use such a service like Telenet you need a modem to access the network, a PAD (packetizer) and HP's X.25 interface. Your terminal logs into the packet switching network who connects you to your computer. Packets of data from your terminal are sent to the HP who de-packetizes it and processes the data. The major advantage of X.25 is that it is the cheapest alternative for medium to high volume sites.

In 1982, our company was chosen to be a BETA test site for X.25. We were looking into these options for our long term telecommunication needs for our nationwide network. The BETA test went relatively well. The speed left a little bit to be desired, but then the access node could only be 1200 BAUD or less. This made the effective communication rate 1200 BAUD. HP did not support block mode in X.25. This means any full screen editors or V/3000 screens could not be used. Guess what? All of our systems were developed using V/3000.

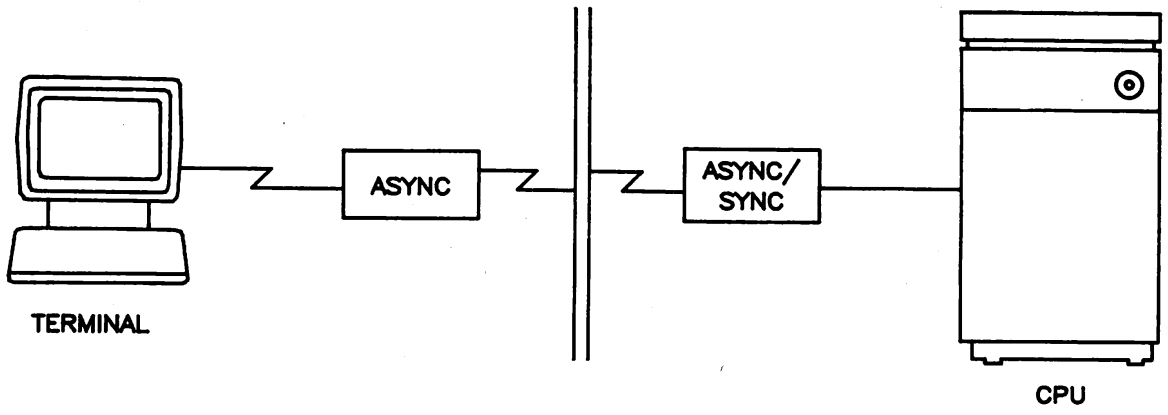
We decided not to use X.25 presently based on a number of items:

1) X.25 did not support block mode screens. Now you can use HP's PAD, the HP/2334 controller for block mode use
2) X.25 access was only at that time 1200 BAUD (Telenet said then that 2400 and 4800 BAUD would be available late 1983 and 9600 BAUD would be available in 1984.)
3) Telenet closed their St. Louis office, which being we are a centrally supported site, made us uneasy in the area of support.

Despite all the concerns sited, I still think that X.25 will be the alternative of choice in the future.

Async/Sync Convertors

An async/sync convertor is a hardware device which allows an asynchronous terminal to communicate to a computer via a synchronous phone line hookup. These devices are readily available from most of the modem vendors. The devices that we evaluated came from ATT and MICOM. The way these devices work is you attach the device between your terminal and the modem, and on the computer the device is attached between the computer and the modem. The device takes asynchronous protocol and converts it to synchronous protocol for transfer down the synchronous phone line. When the data arrives at its destination the data goes through the modem into the async/sync convertor where it is converted into asynchronous protocol. (Figure 1)



According to the vendors, this whole process should be transparent to the user. This means that you should notice no change in response time. When the vendors demonstrated these convertors to us, they hooked it up to my terminal which is hardwired to the computer and operates at 9600 BAUD. The vendors installed a "pseudo synchronous phone line" to the computer at 9600 BAUD and then hooked up my terminal to the async/sync convertor. Despite the claims of the vendors, I did notice an appreciable difference in the response time. This was a serious drawback to us because of the printing involved via a slaved printer, which I discussed earlier.

MTS/Synchronous Phone lines

MTS is the software that HP markets which allows HP terminals to communicate via synchronous phone lines. To use MTS you must have the following in place:

1) MTS software
2) An INP board for every physical line coming in (remembering that you can multidrop phone lines or have multiple users per phone line)
3) Install a POD or a 2333 controller at each site or terminal that you wish to be able to communicate via the MTS network.
4) Reconfigure your terminal

The INPs, PODs or HP/2333 controllers and MTS software is a one-time cost. A POD only allows one device per node to communicate to the computer. A HP/2333 controller, which is HP's version of a multiplexor, allows you to hook up multiple devices per node on your synchronous phone line. For an example, you could have a printer (non-spooled) and a terminal or a terminal, a printer, and an HP/150. The controller is expandable up to 16 devices.

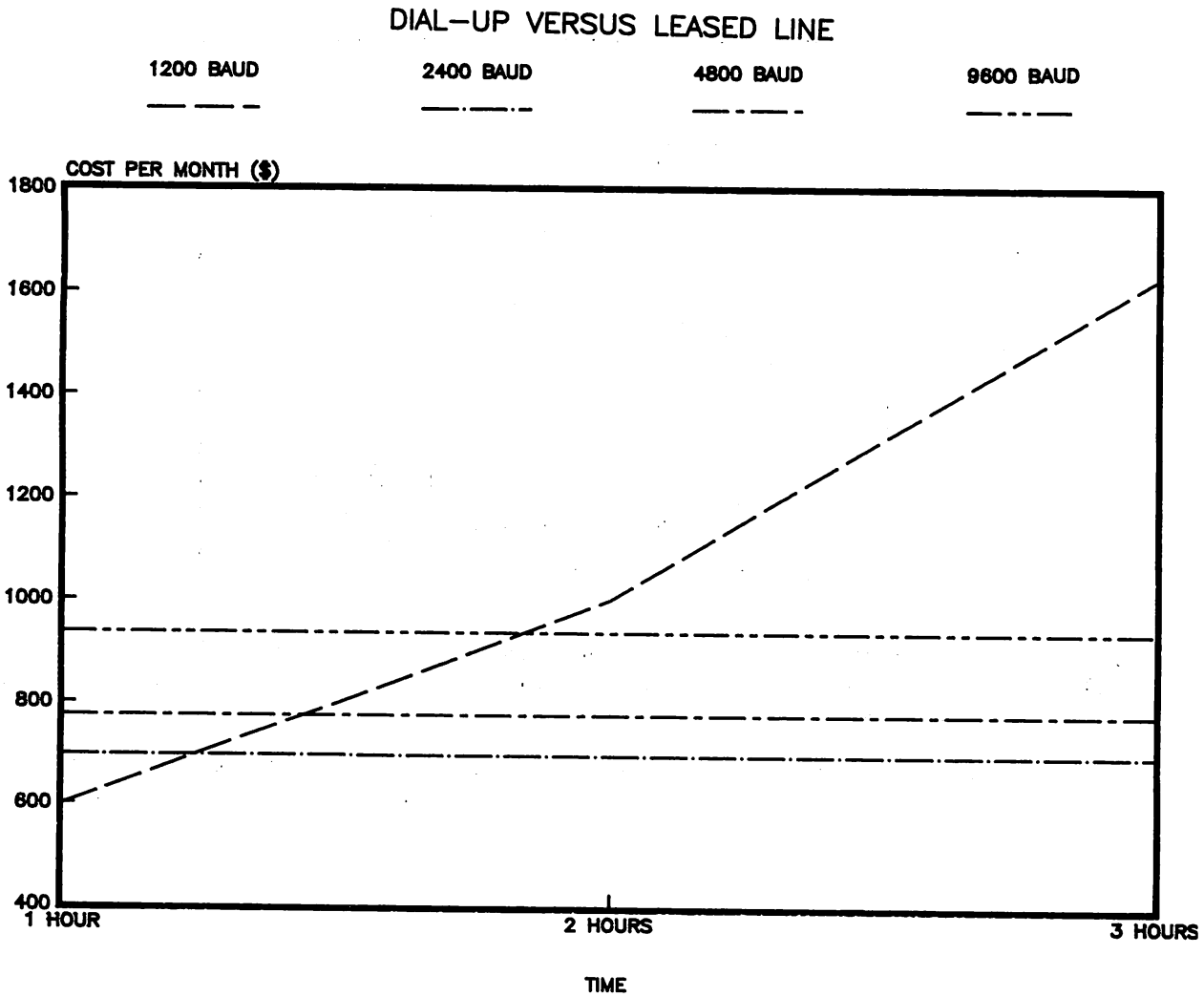
The MTS software is a proven piece of software which does not have any major bugs that I am aware of. It is HP which means that we still are only dealing with two vendors, ATT and HP. The operation of the MTS software is transparent to the user. When the POD was hooked up to my terminal, I could not tell that it was in place. The machine acted the same, except for displaying my password which can be fixed via a change to the command file. When and if we decided to expand our network, all that would be necessary would be to configure the devices into the MTS configuration and hook up the POD. With MTS, you can also assign a polling sequence, thus allowing you to give more time to your active users or devices.

Our company elected to use this option with the HP/2333 controller so that we were able to unslave our printers and run them hot. This increased their print speed up to the capacity of the printer. It also allowed the user to operate two devices at one time, i.e. enter data in on their terminal and print a report. If we had elected to use any of the other options, we would have had to buy a separate device for each terminal we

would have wanted to operate. This would have gotten very expensive, very quickly.

Cost Comparisions

Most people, in addition to the relative functionality of each option, are also interested in the cost comparision of each option. The figures that I am providing are the costs at the time of comparision, namely late 1982. This is fine for my objective, which is to show the relative cost of each option, rather than the cost to install a network today. For all of the the non-dialup options the relative phone line costs are the same. So for your review, this chart shows you the cost of operating a dialup line at 1200 BAUD at a distance of 300 miles and the cost of operating dedicated lines or leased sync lines at 2400, 4800 and 9600 BAUD at the same distance.

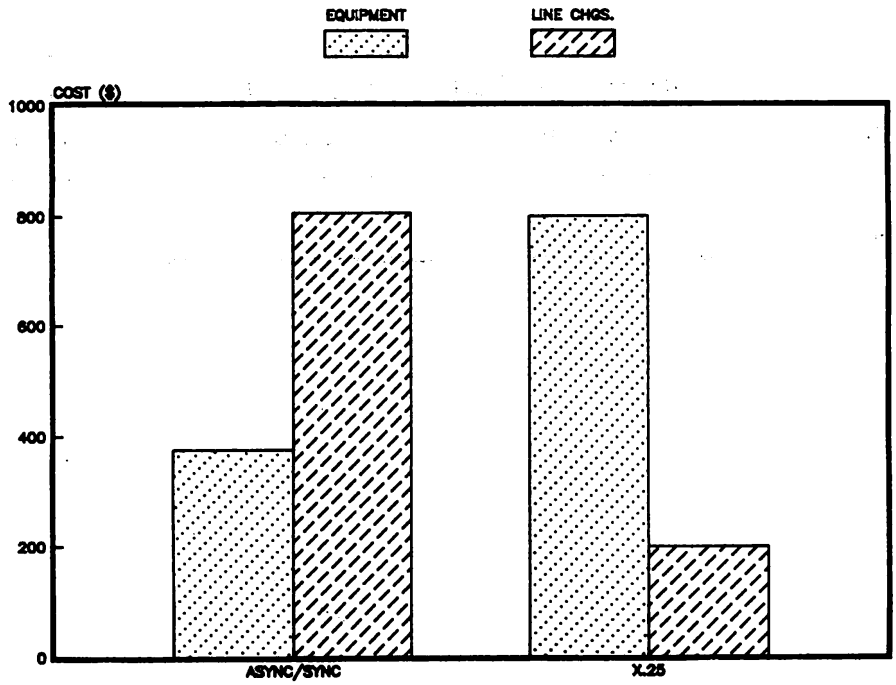


You can see from this diagram that the breakeven point for dial-in lines is about two hours of use per day. You can also see for 24 hour access on a leased line that you pay no more that five minute access. You can also see that there is a premimum for speed. The price of all data lines is calculated by adding up the cost for:

1) Data equipment - modems, async/sync convertors
2) Mileage
3) Type of service - leased line at a certain BAUD rate or dialup.

The comparison that follows for X.25 versus ASYNC/SYNC convertors and MTS assumes that the phones lines are in place at whatever BAUD rate that you elect. (Figure 3)

ASYNC/SYNC VERSUS X.25



You can see from this diagram that the least expensive alternative for volumes over two hours a day is X.25. This is not surprising because of the way it works. It is more efficient.

Each of you will have to evaluate which of the telecommunications options best suits your needs. I only hope that I have given you a look at what is available.

V. Futures

In the next year, we are going to embark on a new phase of our network project. Currently, we are not in a pilot stage, but in a full production mode, with two part-time operators and a full-time system manager. The project now has four full time analysts working on the project and two SUPER-USERS providing day-to-day application support. Our overall staff has grown from eight to thirty-two professionals. Our hours of operation for the network are from 12:00 A.M. to 8:30 P.M. and then from 9:30 P.M. to 12:00 A.M.

Next year we plan to install another twenty-eight sites bringing us to thirty-two sites across the United States. In addition, we are thinking of installing sites in Canada. With the addition of these sites, we were faced with making some hardware decisions about the kind of terminals to install at the new sites. We could stay with the tried and true HP/2624, but this provides limited functionality. We could also install micros that can communicate to the HP/3000 for use of the applications library, plus allow the use of stand-alone applications like CONDOR (database), VISICALC, and WORDSTAR (word processing). The ability to use this terminal for the satellite office's unique uses well exceeds the extra cost of the micro computer. So, we have ordered 28 HP/150 to install next year in more satellite offices. I am sure that the challenges that face us in the area of training and support greatly surpass even my active imagination. Despite all the challenges that await the MIS staff in this endeavor, I see areas of opportunity arising, such as electronic mail. These are exciting and rewarding to both the MIS staff and our users.

VI. Conclusions

I guess I had two objectives that I wanted to accomplish in this paper. The first was to acquaint you with some of the telecommunications alternatives that are available to you. The second was I wanted to give you some hints on what not to do when setting up a network. I have learned a great deal in two years of working on this network project, and I would like to share some of the things that I have learned.

DO NOT EVER DO THIS

1. Install a system without proper environment controls, especially clean power. Telecommunications interpretes changes in fluxuation in power as data. Not a pretty sight. Bad power (i.e., not clean and grounded) can cause failure in the telecommunication equipment and the computer itself. Power problems are those types of elusive problems that you can live without.

2. Install a system without a person to take care of it. The user will only complain about the lack of such a person, when you lose two weeks of data due to a system failure and because no one has had time to do backup.

3. Install a pilot for a network without benchmarks and a definite end to the pilot phase. What happens when you do this is that your users have no way of evaluating success or failure and then want to extend the pilot period. This makes MIS planning for improvements and development difficult, if not impossible.

4. Install a network without easy access to a telecommunications person. It is a very, very, very hard job to pick up telecommunication's expertise on the fly. Telecommunications is weird magic anyhow. Get yourself a telecommunications magician; it will make solving those telecommunications problems a lot easier. If you think, what problems, you are kidding yourself. We have telecommunications problems at least three to four times a week.

5. Install a network without an expansion plan. The network will not remain static, despite what your user says. At the very least the technology will change, and you will want to take advantage of those changes.

6. Buy your telecommunications equipment. The technology is changing so fast in this area that you should not buy, but lease.

7. Lose your copy of Ross Scruggs TERMINAL TALK. It will save your soul on that wet and nasty night that you are there reconfiguring the system for the new telecommunications lines. Following his suggestion will keep smiles on your face and your user's face.

8. Take this paper as total fact. This paper is only my experience and is not meant to be the definitive paper on network design. I am not a telecommunications whiz. I am only a lowly analyst that happened through fate to get involved in installing a nationwide network.

TRY DOING THIS

1. Online documentation. We have found that most users will not use the hard copy documentation, but they will use online documentation. A style which we have found is the best is like the help facility in EZCHART.

2. Train the trainer. It is impossible for one or two people to train 150 users in the time period needed, so we have used our SUPER-USERS for such training.

3. Have the user assist in writing user documentation. We have found that the user writes the best user documentation, but we have also found that they won't write user documentation. So we are still writing user documentation, but getting the user to assist us in the editing of the document.

4. Accept obsolescence. No matter how good your plans are, technology and user needs change so rapidly that your best plans will be obsolete in 12 months.

5. Solict upper management support. Grass roots campaigns take a long time to get their message across. Try upper management instead. When upper management speaks, it is like E. F. Hutton, everyone listens.

I hope this paper was of some use to you.

P.S. I want to thank all those who helped me in putting this paper together. Thanks to:
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