

# Developing A Social Science Microcomputer Local Area Network: Its Uses and Problems

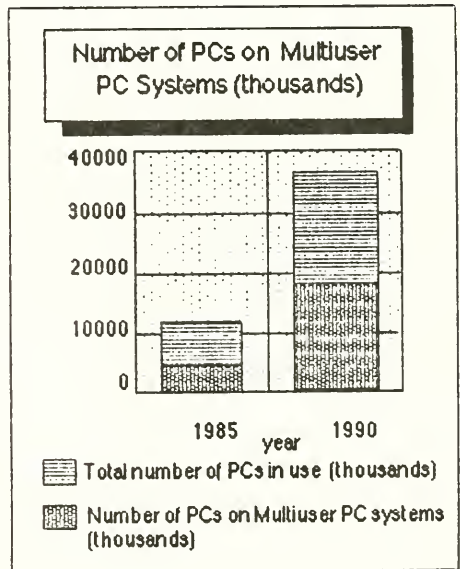
by Fred Nick  
 Center for Social Science Computation and Research  
 University of Washington

features. The microcomputer local area network is more than a technological fad, it is convenient and elegant way to add additional function to existing equipment for a moderate price. With proper planning and management, local area networks' uses far exceed their problems. This paper will briefly discuss the basic definition of a local area network and review some of the points to investigate when choosing one. It will then cover the problems and solutions one might encounter in constructing and running a social science local area network.

## Abstract

A local area network offers a social science microcomputer user many nice advantages but it can also create a host of problems for the individuals in charge of network administration. As social science microcomputer use continues to increase, local area networks will offer social scientists welcome communication, file storage and peripheral equipment sharing capabilities. For the network administrators problems arise in: initial funding for the additional equipment needed, the definition of which network to install, the added security problems in running a network, additional responsibilities for storage backup, the establishment of access policies, the day-to-day maintenance of the network and its software, and providing the additional help needed by the users of the system so that they can take advantage of the new network

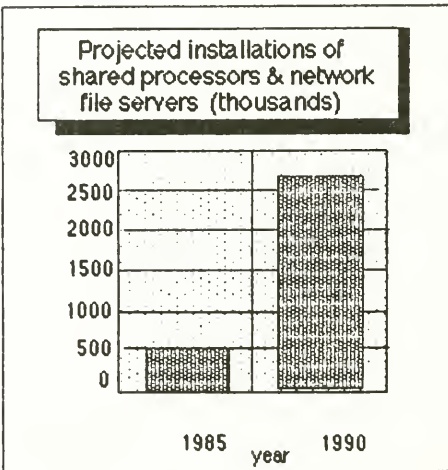
Figure # 1



**What is a Microcomputer Local Area Network?**

A brief definition of a microcomputer local area network (LAN) might be as follows: the equipment and software necessary to connect microcomputers to each other so that they can share files and peripheral equipment while establishing inter-microcomputer communication. Some LANs also enhance the operating characteristics of connected PCs (personal computers). A network usually includes a workstation which functions as a file or disk server, containing files stored by users and administrators of the network. This server is connected to the other network workstations by a cable. There may be more than one server on a LAN, and often there are many printers and other peripheral equipment attached to the network.

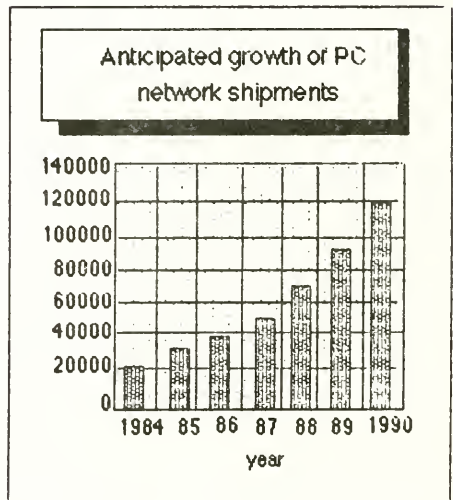
figure #2



Industry analysts predict that the number of microcomputer LANs will be 4 to 6 times greater in 1990 than in 1985 (see Figures 1-3)<sup>1</sup>

In 1985, 26,500 networks were purchased; it is projected that there will be 121,270 networks sold in 1990<sup>2</sup>

figure #3



<sup>1</sup>Lily, Susan *Vendors ready network versions of software*. PC WEEK 2(25):102, June 25, 1985. (Graphics included as figures 1-2 above)

<sup>2</sup> Lily, Susan *"IBM token ring opens doors for independent net vendors"* PC WEEK 2(51):113, December 24-31, 1985. (Graphics included as figure 3 above)

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## Initial Environment

The first stage in establishing a local area network is careful planning. Networks can be very expensive, and have a large number of differing capabilities; a bad choice could be costly. The first step in planning is to examine the environment in which the network will be placed. What equipment is presently being used? How much experience with microcomputers does the user community have? What functions are needed, and what capabilities are patrons likely to anticipate having available. A primary complaint about LANs is that they have not performed as the users had anticipated. Unfulfilled expectations can make a system appear to be a failure when it had merely not been designed to do what people requested of it.

As examples, I will draw on the installation of a LAN in my organization, a computer support group which helps social scientists to use computers. It has existed for 13 years, and has traditionally been mainframe oriented. It is located in a state-funded university, and derives its entire budget from state monies. It has no mechanism for recapturing expenditures through charges. All services are free to users of the facility. All users of the system were familiar with mainframe-style interactions and capabilities. We had purchased an Apple II+ five years earlier, but it had proven a failure. Not enough software was available at the time; the operating system was too simple, and the functions demanded by the mainframe users who experimented with the microcomputer were not available. That purchase was ahead of its time.

Three years ago we again became interested in introducing microcomputers to our patron community. A new generation of computers became available, major software packages were creating renewed interest, and microcomputer

word processing was becoming popular. Also, several major computer companies were starting to give equipment grants to universities. We therefore decided to try to develop a microcomputer LAN. The Apple II+ experience influenced the decision-making process when we began to plan for a microcomputer LAN. Our user would demand certain 'mainframe' characteristics. There must be 'personal storage'. Patrons were very uneasy about having files that any user could read, manipulate or destroy. They were accustomed to security precautions such as passwords and access modes. If our LAN was to include shared storage, on the same disk, then these features would be requested. Since the users had mainly mainframe experience, it was essential that we provide access to the mainframe so that files and programs could be moved freely to and from the LAN. We decided that since our organization had many diverse groups of potential users, we should choose one group and develop the LAN with those individuals in mind. Because we had little chance of developing a large LAN, we decided that a small LAN would have the most far-reaching exposure if it were dedicated to faculty education and instructional development. Faculty and teaching assistants interested in gaining skills on microcomputers or developing microcomputer courseware were allowed access to the LAN. Our staff developed free non-credit courses to educate novice users. Several other campus microcomputer facilities had developed severe management problems when word processing was allowed on them. The microcomputers had quickly become 24-hour-a-day word processing stations to the exclusion of all other uses. We therefore did not allow 'production' word processing. Development of word processing skills was allowed if not encouraged, however.

Having identified what you want, whom it will serve and a few of the operational details, how do you get started?

The first two tasks are obtaining financing and finding an appropriate space for the LAN. If you can charge for services, you should experiment with possible funding mechanisms to determine if the costs of developing and supporting the LAN can be recovered. LANs seldom have a convenient method of keeping track of useage. Charging by the hour, or a monthly fee, are possible alternatives. It is difficult to differentiate between "heavy" users and "light" users other than by the clock time they spend using the equipment. Even consumables, such as the paper used in printing, is difficult to monitor on some systems; other systems record the number of lines printed. Some granting agencies may be appropriate sources of funds to finance the LAN. Detailed advance planning will help organize and collect the information needed for grant applications.

At many institutions of higher learning, physical space may be more difficult to obtain than money. Each LAN microcomputer requires approximately 16 to 20 square feet of space, when placed on a table with a chair in front of it. Extra power outlets will be needed, and it is important to remember that microcomputers can generate lots of heat (as do their human users). Proper electrical connections, ventilation and heating must be considered. Also security must be considered when looking for space. Microcomputers are very popular booty for thieves. Consideration must be given to which floor of the building the room is on, where the windows are, how the room is locked, who has access to the room now, and if it can be rekeyed. Careful planning can prevent many management problems later.

In developing our LAN both space and funding were critical points. Our financial situation could not have been worse when we decided to pursue obtaining a LAN. Our budget came directly from the state legislature. The state was in a financial crisis. Our operating budget had just been cut by 20%. There were no capitol funds available for equipment purchases.

The Dean considered the project an experiment, and there was a considerable amount of prejudice against microcomputers to be overcome. Undaunted, we decided to proceed. We went directly to computer manufacturers, asking them for gifts or loans. To our delight and surprise, the IBM Corporation agreed to loan us 5 IBM XTs, 5 printers and some software to get things started. These were to be loaned to us for 6 months, but in the end we had kept them for one and one-half years. After 6 months of our having used the borrowed XTs, the budget situation had improved greatly. Use of the borrowed equipment had also quelled many criticisms voiced earlier. At that time we were given \$40,000 by the University to purchase a LAN. Many projects had been started on the borrowed equipment, which had laid a solid foundation for the request for a LAN.

Space was donated by another department, electrical outlets were numerous, and the power was not polluted by other equipment on the circuit. (Having other electrical equipment on the same circuit could cause voltage fluctuations which might affect the LAN equipment). The room had no windows, and the door was rekeyed so that even the janitors did not have access. We did not plan for ventilation, however. The room would become terribly warm with just a few individuals in it. Since there was no ventilation system, nor windows, users would open the door to allow the room to cool off, undermining our security and allowing access by unauthorized individuals. We eventually had to trade rooms to remedy the ventilation problem. We had no funds with which to have proper ventilation installed.

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## Which Network to Buy?

Choosing a network can be very confusing. There is a variety of technologies, hardware requirements and functional differences. Networking technology has its own set of "buzz words", or jargon, which is highly complex. There are many topologies or workstation layouts. Most of the literature is difficult to read without first having learned the definitions of the most commonly used phrases. The best approach in choosing a network is to avoid becoming too involved in comparing all the performance figures quoted in the literature. First, define how the network will be used, and then determine which network characteristics are important. If large files stored on a central disk are going to be used, transfer speed may be an important criterion. If users are to be able to converse from one station to another, check to see that the nodes on the network can address each other and send messages directly to the screen of another node. Electronic mail is an attractive method of communication which is not reliant upon the recipient being at his desk when you want to communicate with him. Electronic mail can store and organize correspondences, forward messages to others, and send replies along with the original message.

Cost is an important criterion. Networking hardware and software can be very expensive and is seldom inexpensive. If you are building a network of existing PCs, it may be possible to use some existing hardware to provide the communication connections. Low speed LANs can use standard serial cards as communication hardware. Networks can cost more than a \$1000.00 per station to install. Always try to balance cost and function. One network may cost a little more than another, but offer far superior performance or stability.

LAN technologies have length limitations between workstations, and usually have limitations on how far apart the first and last node can be. Limitations on distance on a low speed LAN will vary according to the speed at which the equipment is set. If the PCs are in different buildings, certain networks may not work at all. It is surprising how far apart two terminals can be if the wiring has to be run all over the building. Distances must be measured accurately before the hardware is bought. Since different networks use different hardware, the life of a network can be increased by choosing one which allows one to change from one brand of software to another without changing the hardware. Ethernet cards are used by several LANs as well as serial cards. The reputation of the company is another good indicator in making the choice of network. If nothing else, having a popular network insures that one may be able to obtain help from another local user.

What might you have to give up if you already have PCs and wish to install a network? Some networks alter the operating system. When the next version of the operating system is released, it may not be usable. PCs may behave differently, thereby causing present users some problems. The machine which becomes the server may no longer be usable as a regular PC.

What might you gain by installing a network? Enhanced PC capabilities are one possible benefit. Some networks make it appear as if the PC has more hard disks than it really has. You may gain electronic mail features. Access to printers not directly connected to the PC is a common benefit of LANs. Files stored on the server may be protected by security access and logins with passwords. The ability to isolate individuals' files and label printouts is another nice feature.

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### Choosing a Network: A Case Study

My organization had 6 months experience using IBM XT's when we made our decisions as to what equipment to buy and which network to install. The day the IBM XT's had arrived no one but myself was suppose to know of their arrival. The equipment was delivered in large cases stamped "IBM" all over the sides. By the end of the first day, I had received 20 requests for keys to the room where the XT's were placed. These 20 people were all interested in doing free word processing: a clear hint that word processing would a problem. Other management problems quickly emerged. Floppy disks were being stolen. Faculty accidently reformatted the hard disks on a weekly basis. Bootlegged software appeared on the hard disks even though we had instituted strict rules against its use. Many policies had to be hurriedly created in order to solve these problems. We decided to buy IBM microcomputers and connect them with a 3COM LAN. The LAN was viewed as a potential solution to many of the problems mentioned earlier. We had several users interested in using social survey data on the network, and therefore decided to try to obtain as high a transfer speed as possible. Because of "ownership" problems experienced with more than one person using the hard disks, we needed a network which would have access passwords for each user, and provide exclusive control over certain administrative functions. We also wanted to enhance the functions of the network PCs, since we were buying expensive network hardware, rather than extra disk drives and printers. We purchased IBM single drive PCs with 512k of memory, color monitors, 8087 math coprocessors, and a multifunction card which supplied each machine with a serial port, parallel port, and clock. The peripherals included a 6 pen table plotter, an ink jet plotter, a digitizer, and a dot matrix printer.

We decided to buy a 3COM network because it satisfied most of our criteria. It included a \$1000 ethernet board and software for each PC (these now cost about \$600). In addition, we had to buy thin ethernet cable and three pieces of software: file server software (\$750), mail software (\$750), and print server software (\$500). 3COM met our criteria in the following ways:

- a. It is very fast. It transfers information at 10 million bits per second. This was much faster than most other networks.
- b. It offers excellent security. Each user has an account and a password. Files belonging to one user can only be access or altered by another user if the owner gives permission. The administrative software and system library are protected from accidental erasure and the administrative menus are available only after a control password is repeated.
- c. The network dramatically enhances the performance of each PC. Each individual machine has only one disk drive, but when logged into the network, performs as if it had 4 additional hard disks. Each hard disk is emulated by the network and contains only information stored there by the owner. (Each user creates his own "virtual" disks.)
- d. The network commands are separate from the operating system, not patches to it. They are easy to use and there is a good help feature.
- e. The network automatically captures all print requests, including screen dumps, and directs them to the system printer where they are printed with a banner page on the front displaying the owners id.
- f. The electronic mail facility is elegant and

has many features.

- g. Users cannot control or contact another user's terminal except through electronic mail. We viewed this capability as a problem and were relieved that it was not available on the 3COM network.
- h. At the time that we made our decision, 3COM had the largest number of working networks in service, and after talking to several satisfied owners we felt that the network was reliable and that there were many possible sources of information and assistance.
- i. The installation of the network was straight forward and the installation instructions were very clear.

What were the negative aspects of 3Com? The following:

- a. It is very expensive. We spent twice as much on 3Com as we would have spent on other networks.
- b. 3COM allows any user to generate another account for himself. Only two individuals have discovered this feature, which is apparently an oversight in the networking administrative software.
- c. 3COM allows any user to delete another user's account but only if the account has no stored files. In practice, this is not as much of a problem as it may seem. Every user on our system has a mailbox file, and therefore every user has at least one file.

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### The Uses of a Social Science Microcomputer LAN

The social scientist can take advantage of a LAN for both instructional and research applications. On the research side, a LAN provides the user with a larger, embellished machine on which to perform analyses. Access to 4 virtual hard disks allows versatility in the organization and storage of text and data. The speed of these virtual disks can increase performance when using software that accesses multiple files simultaneously. (There is no need for one of these files to be on a floppy disk.) In addition, software can be stored on the system disk and many users can use these libraries simultaneously. The LAN workstation functions like a slow minicomputer rather than a single microcomputer. Many of the frustrations involved in using a microcomputer are alleviated upon installation of the LAN. The communication capability is a hidden blessing. Leaving messages for other members of a research team becomes an addictive, useful tool. On the instructional side, the LAN allows a single copy of assignments and data to be stored, instead of one on each machine. Again, mail allows faculty and student interaction outside classroom or office hours. The software available for microcomputers is often easier and more fun to use than mini- or mainframe software. LAN software is almost as elegant as mainframe software. It is also important to remember that microcomputers are now firmly entrenched in the business community. The microcomputer exposure that the students receive pays off not only in the classroom but also later when they are in the job market.

Many interesting applications and programs were developed on our instructional LAN. The Departments of Political Science, Public Affairs, Geography, Demography, Computer Cartography, Economics, Sociology, Social Work and Psychology all took advantage of the LAN.

In Political Science, a simulation was constructed to illustrate how community political pressure causes the development of a 911 response system. Economics constructed telecommunication software to enable the LAN microcomputers to act as elegant graphics terminals interacting with large economic time series databases stored on the mainframe. In Demography, population simulations were developed which graphically displayed population pyramids. Geography/Cartography developed a continous shading Choroplethic mapping program. We trained 5 Social Work faculty members to learn Basic so that they could program the IBMs they had at home. There are many other experiments and many faculty have increased their microcomputer skills.

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### **Problems in Using a Social Science Microcomputer LAN**

There are two major classes of problems with a LAN: problems for the users and problems for the administrators. Novice users are in need of extra support to help them begin. Purchasing good computer tutorials for the software is a wise investment, as is creating locally written documentation which highlights what options to learn first and how to use the help features of each program. The major problem we encountered was that the operating system for IBM PCs is terse and quite frightening to many novices. Our solution was to obtain a grant to hire a programmer, for a summer, to write a menu driven control program for the LAN. Each user merely inserts a disk and turns on the microcomputer. From that point on, a series of menus asks the user which programs he wishes to use. After he is finished using the selected program, the menu system again takes control, cleans everything up, and logs the user

off the network. It is an elegant piece of software which works not only on a 3COM LAN but also on any single IBM XT computer. The software also allows instructors to create class menus which providing their student with access to only that software necessary to complete their class assignments.

There were more administrative problems than user problems. The LAN demands a great deal more administrative attention than I had envisioned. There are constantly updates to software to be installed. To install software requires taking the time to become familiar with the program, its organization and its options. The installer is the first source for inquires about which version of the software is available, and is this or that option available. Backups must be made of the system disks on a regular basis. If the hard disk needs to be reformatted, it may be necessary to invest several days of work to rebuild it, and confirm that it is now working properly. Hard disk management is also time consuming. Reorganizing storage on the disk will be mandatory several times during the first few months of operation. Just to decide what software to buy can use days of time. There is no repair service that can be called in if the network stops working. If you are successful in developing a small LAN, you will probably immediately be asked to build a delivery LAN large enough to handle large classes. Everyone will demand use of the equipment for word processing. If the resources are available, there is little reason not to provide this service, but if resources are limited, one must beware of setting an unfortunate precedent. Everyone will want a key to the facility. But, one unlocked door can result in the loss of your entire LAN to thieves. Insurance on the equipment is a good investment, if the budget allows. We had not anticipated the legal problems of software licenses and software theft. It is the administrator of the LAN who is primarily responsible for upholding software contracts, as well as making sure that state, local and



university laws concerning software theft are upheld. When reading software contracts, beware of clauses prohibiting use of the software on a LAN. Several major software producers have such stipulations. If the license states that the software can only be used on one machine, indicate to the users which machine they must use to run that software. If possible, use of that software on more than one machine at a time should be hindered. When buying software that will be used by several simultaneous users, one should buy the legal number of copies or inquire about LAN versions of the software. The laws which concern software theft should be posted in the room containing the LAN. It is important to ensure that staff uphold these laws and that they project the right attitude about theft to the users of the system. Do not turn your back on illegal copying. If someone is caught, it is the administrator who will be indicated as legally responsible for the protection of the software license.

- c. Plan before you buy. Identify needs carefully.
- d. Plan to avoid obsolescence. Try to purchase from companies which will help the network evolve and expand, especially as national standards for network structures appear.
- e. Security should always be a primary consideration in developing budgets, buying equipment, and choosing space. Beware of setting bad precedents.
- f. Ask the network salesperson for a list of software and/or hardware that not work on their LAN.

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### Problems Versus Uses : Is a LAN Worth the Trouble?

Definitely! With proper planning, the problems can be reduced to a minimum and the value of the LAN to the users increased. Some steps which will streamline the installation of the LAN:

- a. Hire a LAN manager. If the funding is available, this will have a dramatic positive effect on the installation of your LAN.
- b. Take advantage of student employees. Especially in the beginning, the LAN will involve a number of small tasks which are time consuming. Student employees offer talented help at an affordable price.

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### Having Installed a Successful LAN, What Next?

A bigger LAN!! Because of the ease of use and friendliness of microcomputers and the added utility of the LAN, users will demand faster machines and more software. Also, if you do not have a closed community of users, your LAN converts will encourage others to use the system. Use in an instructional setting can grow exponentially with just a few moderately sized classes moving their work onto the LAN. My group is installing a 22 IBM AT LAN using the IBM ring network this summer. Again a grant from IBM purchased the equipment. The experiment starts over again, but on a larger scale!!

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