An Empirical Investigation of the Use of LOCAL AREA NETWORK in the Midwest

by

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ABSTRACT

The development of relatively inexpensive hardware has enabled an organization to install multiple computing elements at the same location (e.g. microcomputers). Local area networks provide a method to economically interconnect the computing elements and allow information sharing on a local basis as already popularly found in long-distance networks. This paper presents the results of a survey of several organizations in the midwest to determine the extent of their involvement with local area networks.

INTRODUCTION

Local area networks have received considerable attention over the last several years. New local area network products are continually being announced. However, defining local area networks and determining the extent of their use is quite difficult since features and technology are distributed across a wide spectrum.

The popularity of local area networks can be examined by reviewing the movement from central processing systems toward distributed processing systems. The development of relatively inexpensive hardware enabled an organization to install multiple computers in different geographical locations to serve the different departments of the organization. By interconnecting the previously independent computers the organization could efficiently exchange information between the different data centers.

Similarly, the development of relatively inexpensive hardware enabled an organization to install multiple computing elements at the same location (e.g. microcomputers). Local area networks provide a method to economically interconnect the computing elements and allow information sharing on a local basis as already popularly found in long-distance networks. In addition, the local area networks allow convenient sharing of scarce and/or expensive computing facilities such as printers, plotters, high-speed modems or concentrators, specialized terminals, and so on within a single organization [11].

This paper presents the results of a survey which was conducted to determine the extent and description of local area network use in different organizations. The paper also provides a background of the research on local area networks, which is followed by a summary and analysis of the survey results.

BACKGROUND

Local area networks have several aspects that vary among the different definitions of local area networks. These aspects include the distances involved, the devices used, the rate information is transmitted, the network topology used, and the physical medium used for transmitting the information. As a result of these variations Stallings [16] subdivides local area networks into local area networks, high-speed local networks, and computerized branch exchanges.

Stallings refers to local area networks as a general-purpose local network that can serve a wide variety of devices. Stallings defines high-speed local networks "to provide high end-to-end throughput between expensive high-speed devices, such as mainframes and mass storage devices [16]." Stallings then uses computerized branch exchange to refer to an on-site private branch exchange capable of handling voice and data communication.

One of the reasons local area networks contain so many varying aspects is the lack of definitive standards. Graube and Mulder [5] see the lack of standards as a primary reason for the wide variety of local area network products all of which are seemingly incompatible with the others. Shea [15] interprets the problem as a result of controversy concerning the suitability of Ethernet's baseband medium.

Ethernet is the result of a joint research project by Xerox, Intel, and Digital Equipment Company and is currently one of the more prominent local area network products [11]. Ethernet utilizes a baseband coaxial cable transmission medium which has undergone extensive development and testing and has been promoted by the companies as the standard for local area networks. In fact, many large and small computer and peripheral manufacturers have publicly announced their adoption of the Ethernet system and are busy designing and building products [12]. Critics of Ethernet contend that baseband's single channel transmission medium will be outmoded by broadband coaxial cable transmission medium which allows more than one signal to be transmitted simultaneously [15]. However, fiber optic transmission may provide a better alternative than baseband or broadband transmission.

Fiber optic transmission which transmits light or infrared rays instead of electrical signals presents significant potential for the realization of local area networks with powerful integrated services [3]. The advantages of fiber optics include very wide bandwidth capability, relative immunity from noise, security from unauthorized taps into the network, and the small, almost indestructible nature of the fibers [4]. However, there are problems with fiber optics such as the complexity of the medium--access mechanisms [3].

The problems appear to be the result of the relatively immature technology. However, a substantial amount of research [9] points to a rapid evolution of the technology. For example, Hara [6] in 1983 predicted the cost-effective use of fiber optics in high-rise office buildings by 1986 or 1987, yet announcements of this type were already being made in 1984 [14]. In addition,

the advantages of fiber optics have prompted Xerox to develop Fibernet II, which is a fiber optic network that is plug compatible with Ethernet [13].

A significant amount of local area network research deals with technical issues regarding standards formalization such as media access methods and performance analysis. Due to their technical nature these issues are beyond the scope of this paper.

METHODOLOGY

In order to better understand the extent and description of use of local area networks a questionnaire was mailed to 200 business organizations. The participants were selected from lists of the largest public and private corporations according to annual sales as determined by the St. Louis Business Journal [1].

SUMMARY AND ANALYSIS OF SURVEY RESULTS

Extent of Local Area Network Use

Of the 200 questionnaires mailed 122 were returned resulting in an encouraging 61% response rate. The survey respondents represent a wide variety of organization types.

The 122 questionnaires returned revealed that 21% (26) of the organizations currently utilize a local area network. Of the remaining ninty-six responding organizations 21% (20) indicated that they plan to have a local area network installed within two years. An additional 15% (14) indicated that they too, plan to have a local area network installed, but not within two years. When the above are considered cumulatively, a surprisingly large 49% of the respondents indicated they have or plan to have a local area network.

The survey revealed that local area networks were found to be most popular in manufacturing organizations. Of the thirty-two manufacturing organizations which responded to the survey 39% reported use of a local area network, which is significantly above the overall percentage of respondents using local area networks.

Regarding the number of employees, it was expected that larger organizations with their generally more abundant resources would be more likely to have local area networks than smaller organizations. The survey showed that 50% of the responding firms with 10,000 or more employees have local area networks. Conversely, only 7% of the responding organizations with less than 500 employees have local area networks.

Design, Installation, and Maintenance

The decision to install a local area network can be analyzed in terms of the advantages an organization hopes to attain from its use. For those responding organizations which have local area networks, Table I reveals the factors which were influential in their decision. The column totals for Table I, as well as

succeeding tables, may indicate a response percentage greater than 100%. This results from respondents being allowed to select more than one response per question when applicable. As Table I indicates information sharing was the most popular factor given with 85% of the respondents indicating it was important to them.

Table I

Factors Considered Influential in Deciding to Install a Local Area Network

Response	%
Peripheral sharing	31%
Information sharing	85%
Reliability	15%
Efficiency	54%
Total	185%

This high response level was expected, since information sharing and peripheral sharing are generally considered the primary advantages of local area networks. Consequently, it is surprising that only 31% of the respondents indicated the importance of peripheral sharing. The capability to economically tie together a number of computing elements was expected to have been cited especially when considering how popular local area networks are in the office automation area.

Three of the survey questions deal with the delegation of responsibility for designing, installing, and maintaining the local area network. As shown in Table II a surprisingly large majority (77%) of the organizations charge their own employees with the responsibility of design and maintenance of the local area network.

Table II

Delegation of Responsibility For Local Area Networks

Response	Design	Installation	Maintenance
Consulting firm	-	-	-
Department of organization	77%	62%	77%
Total	100%	116%	108%

The fact that so many of the organizations used their own employees to design their local area networks may be attributed to the relatively immature market of local area networks. That is, despite the daily announcements of new local area network products, there are needs which are not being met. Consequently, this may result in organizations using their own employees to

design local area networks which satisfy their specific needs.

The responsibility for installing the local area network was found to be almost evenly divided between vendor and department of organization. For most organizations the installation was probably a combined effort between vendor and organization. Surprisingly, none of the respondents indicated that consulting firms were responsible for either design, installation, or maintenance. It was anticipated that at least for the design function some organizations would have selected consulting firms.

Characteristics of Local Area Networks

When describing a local area network it is necessary to specify the topology of the network. Table III highlights the most popular topologies as found in this survey. It is interesting that the completely connected topology was the most frequently chosen (39%) among the respondents. It is surprising since line and connection costs for the completely connected topology are the highest of the topologies listed, and can become quite expensive as the number of nodes in the network increases.

Table III

Topology Used in Local Area Networks

Response	%
Ring	8%
Star	23%
Bus	31%
Completely connected	39%
Total	100%

It was expected that the bus topology would be the most frequent choice due to its use with the popular Ethernet type local area networks. In addition to having lower line and connection costs than the completely connected topology, the bus topology is more reliable than the ring or star topologies since it allows nodes to be added or removed without impairing the network. This is made possible through the use of taps which were developed by the cable television industry.

Another aspect of describing a local area network is the communication medium used. The survey showed that coaxial cable and twisted pair are the dominant mediums of those responding organizations. The popularity of coaxial cable and twisted pair was expected due to their relative inexpensiveness and use with Ethernet.

The fact that the fiber optic and microwave mediums were not mentioned is not too surprising since fiber optic technology is still evolving and microwave is more common as a long distance medium. As previously discussed fiber optic mediums offer several advantages as a medium for data transmission. First, the

transmitted signal is practically immune from noise and distortion. Second, the signal can not be tapped without disturbing the medium itself, thereby ensuring security [10]. Consequently it is expected that as the technology develops in this area, fiber optic medium will become increasingly popular with local area network users.

Since a local area network can be described as a communications network that covers a limited geographical area, it is not surprising that 62% of the respondents to this survey indicated their local area network covers an area of less than one mile. Networks that cover one to five miles are used by 31% of the respondents.

Another aspect to consider when describing local area networks is the components included in the network. As described earlier, device sharing is one of the primary advantages offered by local area networks. Table IV illustrates the most common components as found in this survey. As shown in Table IV intelligent terminals, minicomputers, and mainframes were the most popular components. However, given the growth in the popularity of microcomputers it is expected that in the future local area networks will increasingly include microcomputers.

Table IV

Components Used Within Local Area Networks

Response	%
Intelligent terminal(s)	62%
Microcomputer(s)	46%
Minicomputer(s)	54%
Mainframe(s)	62%
Other(s)	39%
Total	263%

The survey found that 38% of respondents reported that their local area network was connected to another network. Of those who were connected to another network 40% were connected to another local area network, while 60% were connected to a regional, national, or global network.

Comments of Local Area Network Users

In answering an open-ended question concerning problems encountered with local area networks the respondents indicated that cost was a major drawback of local area networks. As an example, AT&T Information Systems recently announced its local area network called "ISN" (Information System Network), which will cost users between $390 and $500 per port [7].

Survey respondents also cited vendor incompatibility and time required for installation as hindrances of local area networks. It is expected that over time, organizations will

develop acceptable standards for local area networks which will help alleviate the problem of vendor incompatibility. It is also expected that installation time will decrease as more vendors enter the market and as personnel become more knowledgeable and experienced with local area networks.

CONCLUSION

This paper has presented the results of a survey of 122 organizations to determine the extent and description of use of local area networks. The objective of the survey was to gain a better understanding of local area network use by requesting organizations to describe their local area network through use of a questionnaire.

As a result of the inherent constraints of this survey technical issues were de-emphasized. Future research should focus on these technical aspects such as the cost-feasibility of fiber optic local area networks. In addition, research is needed analyzing the effect local area networks have on productivity. With the current emphasis on local area networks in office automation, research on office worker productivity is especially relevant.

Currently local area networks are most commonly found in academic and manufacturing environments. However, it is anticipated that, as technology continues to develop and vendors provide more specialized products, local area networks will expand into a wider variety of business organizations. In addition, the office automation movement with industry leaders such as IBM and AT&T leading the way will help to increase the popularity of microcomputer use in local area networks in all types and sizes of businesses.

REFERENCES

1. Book of Business Lists. St. Louis Business Journal. St. Louis: 1984.

2. Dobran, Bill. Telephone interview. 23 July 1984.

3. Finley, Marion R. Jr., "Optical Fibers in Local Area Networks." IEEE Communications Magazine, Vol. 22 August 1984, 22-35.

4. Fitzgerald, Jerry. Business Data Communications. New York: John Wiley & Sons, 1984.

5. Graube, Maris and Mulder, Michael C. "Local Area Networks." Computer, October 1984, 242-247.

6. Hara, Elmer. "A Fiber-Optic Broadband LAN/OCS Using a PBX," IEEE Communications Magazine. Vol. 21 October 1983, 22-27.

7. "`ISN' LAN Steals Show." MIS Week. 4 July 1984, 1, 18.

8. "LAN Plans Told." MIS Week. 22 August 1984, 1, 8.

9. Li, Tingye. "Advances in Optical Fiber Communications: An Historical Perspective," Selected Areas in Communications, Vol. SAC-1 #3 April 1983, 356-372.

10. Loomis, Mary E.S. Data Communications. Englewood Cliffs: Prentice Hall, 1983.

11. Nilles, Jack M. " Micros and Modems" Telecommunicating with Personal Computers. Reston: Reston Publishing Company, 1983.

12. Saal, Dr. Harry J. "Local-Area Networks Possibilities for Personal Computers," Byte, Vol. 6 October 1981 92-112.

13. Schmidt, Ronald V. et al. "Fibernet II: A Fiber Optic Ethernet," IEEE Journal on Selected Areas in Communications. Vol. SAC-1 #5 November 1983, 702-711.

14. Scholes, William A. "High-Rise Gets Fiber Optics," MIS Week.vol 3 October 1984,

15. Shea, Ellen. "Surveying the LANscape," Office Administration and Automation, February 1983, 32-34, 106.

16. Stallings, William. "Local Networks." Computing Surveys, Vol. 16 March 1984.

QUESTIONNAIRE

Please circle the number of the most appropriate answer.

1. Does your organization utilize a local area network?

   1 YES
   2 NO

For those organizations that do not utilize local area networks please complete the questionnaire beginning with question #17. Above all, please return the questionnaire so I know it was received and considered.

2. Which of the following were influential in deciding to install a local area network? (Circle each applicable number)

   1 PERIPHERAL SHARING
   2 INFORMATION SHARING
   3 RELIABILITY
   4 EFFICIENCY
   5 OTHER. . .(specify)

3. Which of the following best describes who was responsible for designing the local area network?

1 CONSULTING FIRM
2 VENDOR
3 DEPARTMENT OF ORGANIZATION. . . (specify)
4 OTHER. . .(specify)

4. Which of the following best describes who was responsible for installing the local area network?

1 CONSULTING FIRM
2 VENDOR
3 DEPARTMENT OF ORGANIZATION. . .(specify)
4 OTHER. . .(specify)

5. Which of the following are components of the local area network? (Circle each applicable number)

1 INTELLIGENT TERMINAL(S)
2 MICROCOMPUTER(S)
3 MINICOMPUTER(S)
4 MAINFRAME(S)
5 OTHERS. . .(specify)

6. Which of the following best describes the topology of the local area network?

1 RING (LOOP)
2 STAR
3 HIERARCHY
4 BUS
5 COMPLETELY CONNECTED
6 OTHER. . .(specify)

7. Which of the following best describes the type of communication medium used in the local area network?

1 COAXIAL CABLE
2 TWISTED PAIR
3 FIBER OPTIC
4 MICROWAVE
5 OTHER. . .(specify)

8. Which of the following best describes the local area network?

1 BASEBAND
2 BROADBAND

9. Which of the following best describes the geographical area covered by the local area network?

1 LESS THAN 1 MILE

2 1 to 5 MILES
3 6 to 10 MILES
4 MORE THAN 10 MILES

10. Is the local area network connected to any other network?

1 NO
2 YES

(If yes)
Is the local area network connected to:

1 ANOTHER LOCAL AREA NETWORK
2 MULTIPLE LOCAL AREA NETWORKS
3 REGIONAL, NATIONAL, OF GLOBAL NETWORK
4 OTHER. . .(specify)

11. Which of the following are used in conjunction with the local area network?

1 DATA BASE MANAGEMENT
2 WORD PROCESSING
3 STATISTICS
4 ELECTRONIC MAIL
5 OTHERS. . .(specify)

12. Which of the following forms of communication will the local area network support? (Circle each applicable number)

1 VOICE
2 DATA
3 IMAGE
4 TEXT
5 OTHER. . .(specify)

13. For which of the following departments does the local area network provide support? (Circle each applicable number)

1 MARKETING
2 FINANCE
3 PERSONNEL
4 ACCOUNTING
5 RESEARCH
6 OTHERS. . .(specify)

14. Which of the following best describes who is responsible for the maintenance of the local area network?

1 CONSULTING FIRM
2 VENDOR
3 DEPARTMENT OF ORGANIZATION. . .(specify)
4 OTHER. . .(specify)

15. What has been the major advantage of having a local area network?

16. What has been the major disadvantage of having a local area network?

Please skip to question 18.

For those organizations that do not have a local area network:

17. Which of the following best describes your organiztion's position regarding local area networks?

    1 HAVE NOT CONSIDERED LOCAL AREA NETWORKS
    2 HAVE CONSIDERED, BUT DECIDED AGAINST INSTALLING LOCAL AREA NETWORK
    3 PLAN TO HAVE LOCAL AREA NETWORK INSTALLED WITHIN 2 YEARS
    4 PLAN TO HAVE LOCAL AREA NETWORK INSTALLED, BUT NOT WITHIN 2 YEARS

Finally, I would like to ask a few questions about your organization for statistical purposes.

18. Which of the following best describes your organization's business activity?

    1 MANUFACTURING
    2 RETAIL SALES
    3 FINANCIAL SERVICES
    4 HEALTHCARE SERVICES
    5 OTHER. . .(specify)

19. Which of the following best describes your organization's size based on number of employees?

    1 LESS THAN 500
    2 500 to 2,499
    3 2,500 to 9,999
    4 10,000 OR MORE

20. OPTIONAL

    Name:
    Title:

    Organization: