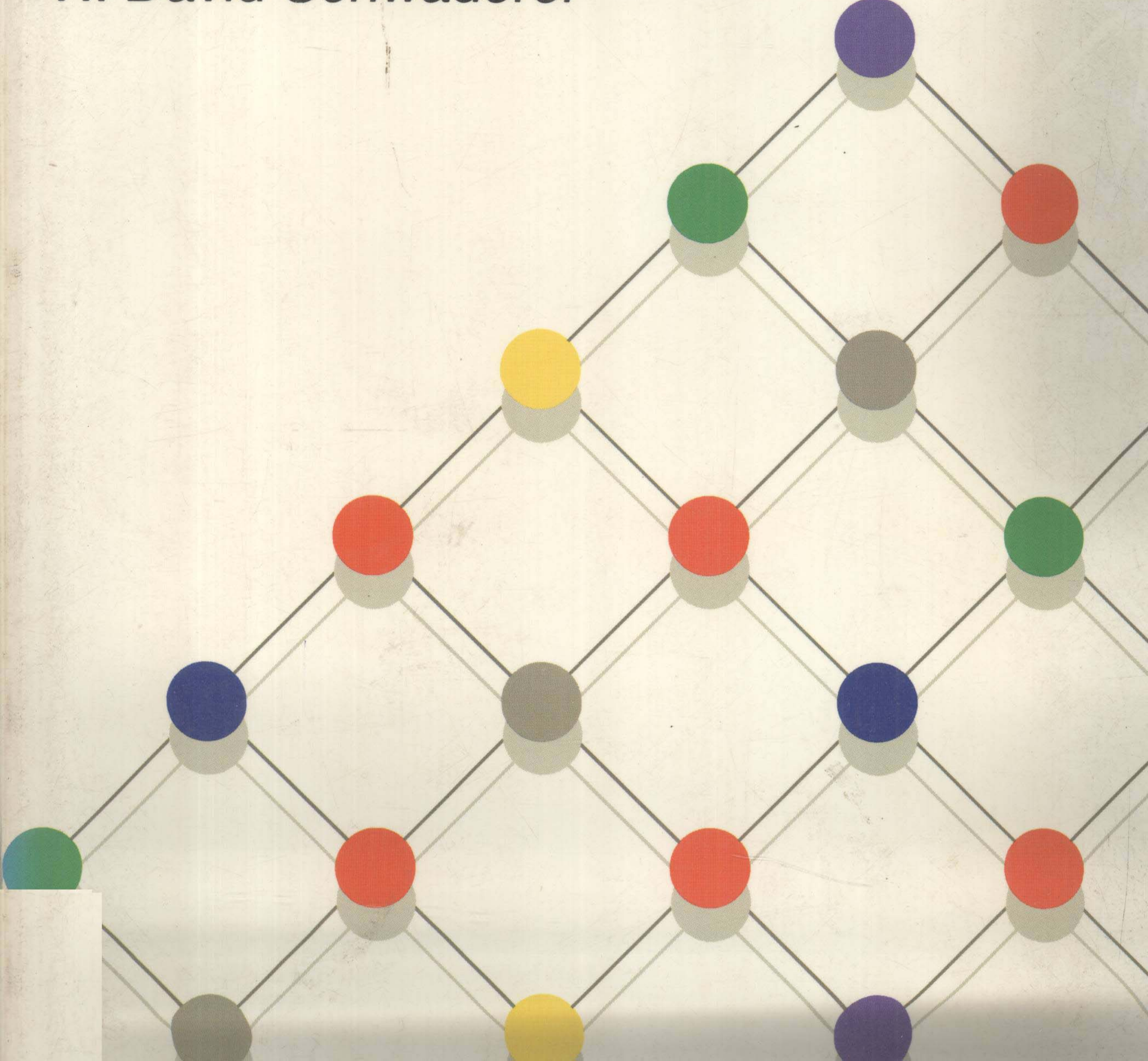
IBM's Local Area Networks: Power Networking and Systems Connectivity

W. David Schwaderer



Become Your Company's Local Area Network Expert With ...

IBM's LOCAL AREA NETWORKS: Power Networking and Systems Connectivity

W. David Schwaderer

Soon Local Area Networks (LANs) will be as all-pervasive as PCs and even telephones. Now, just one book can bring novices up to speed and promote experienced users to a state-of-the-art understanding of LANs, including IBM's.

With the clear information and techniques presented here, you'll be able to share workstation data and programs effectively, save fixed-disk storage efficiently, combine use of expensive hardware like CAD plotters and quality printers productively, and communicate between company micros, minis, and mainframes as never before. In fact, this superbly written book covers vital topics even IBM's own manuals don't clearly explain:

- *IBM Token Ring Hardware*—the new standard, used by over 90% of IBM's top 250 customers, now described and explained in detail.
- *PC Network Broadband/Baseband Hardware*—the first complete, easy-to-grasp coverage of these technologies—your essential key to understanding and, ultimately, simplifying your network.
- *LAN Software*—how to get maximum performance from your software, plus the complete lowdown on NET (the IBM PC LAN program), NETWARE /PCN, IBM 3270 emulators, IBM LAN Manager, Token-Ring Software, PC Network Protocol Driver, Advanced Program-to-Program Communication/PC, and much more.
- *Special tips*—how to extend IBM's PC Networks beyond normal configurations plus extensive appendices which present PC-DOS subdirectory concepts and IBM cabling system wire configurations.

All LAN considerations are here, providing the first end-to-end systems perspective accessible to all prospective and current LAN users. Moreover, the latest IBM developments, including OS/2 and PS/2, new protocols, and other systems just on the market, are featured with discussions of their far-reaching implications.

Thanks to this volume's uniquely qualified author, IBM's W. David Schwaderer, you can have both a no-nonsense guide to PC LAN implementation and a complete high-level reference to popular and leading-edge LAN hardware and software in one book.

Whether you need help with a buying decision or practical guidelines on customizing a broadband network, your only complete source is IBM's LOCAL AREA NETWORKS.

About the author

W. David Schwaderer is currently a Senior Programmer in IBM's Storage Systems Strategy and Architecture Development. He is an international authority on LAN and data communications and the author of three books, *C Programmer's Guide to NetBIOS, Modems and Communication on the IBM PC,* and *C Wizard's Programming Reference.* At IBM he has developed several IBM-marketed communications programs, including the ACS/VTAM Network Monitor, PC Network Remote Control, IBM PC 3101 Character Mode Emulator, and the S/370 IBM 3630/3600 Bulk Data Transfer Host Program, among others. At present he is spearheading the work on high-performance LAN connectivity products within IBM's Enterprise Systems Group.

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should be kept secure: personnel files, information relating to research and development, and the establishment's financial records are just three examples. But security should always remain a primary consideration for anyone designing, installing, or owning a LAN. Consider the following IBM statements:

IBM Statement 1

On page ii, the Token-Ring Network PC Adapter Technical Reference Manual states:

> Note: This product is intended for use within a single establishment and within a single, homogeneous user population. For sensitive applications requiring isolation from each other, management may wish to provide isolated cabling or to encrypt the sensitive data before putting it on the network.

User homogeneity may prove difficult to achieve on a departmental basis, much less on an establishment-wide basis. Even establishing user-homogeneity measurement criteria is likely to prove an interesting exercise.

IBM Statement 2

On page 1-4, the IBM NetBIOS Application Development Guide Introduction states:

> It is the responsibility of the operating system or application program to make sure that data or devices are secure on the network as network security is not built into the NetBIOS.

Private Nature

Because it is private rather than public, a LAN need not be regulated by governmental agencies (such as the the Federal Communications Commission in the United States). However, a LAN usually requires installation of wiring and may be subject to local building codes. Finally, a LAN's private nature prohibits it from gaining arbitrary right-of-way access over public thoroughfares and private land. Such right-of-way access may prove costly or difficult to secure.

Geographical Limitations

A LAN operates in a geographically limited area, such as a building, campus, or business complex. In practice, this limitation is useful both technically and economically because of the nature of establishment communication patterns. Studies have shown that 50 percent of all information remains within the group that generates it, 75 percent remains within a 600-foot radius, and 90 percent never leaves the establishment. Of course, some LANs are vastly smaller than others. And the "local" network that becomes "too large" (variously defined) is a "wide area network."

Speed of Data Transmission

A LAN's data transmission rate is related to its geographic range because of the characteristics of the medium of transmission. As a rule of thumb, the farther a LAN extends, the more expensive it becomes to maintain a high data rate. This is true whether you are starting with a large network or expanding a small one significantly.

In most cases, the LAN's data rate is constant across the network. This means that selecting a high data rate requires more expensive equipment, which can take advantage of it. Selecting equipment by price affects speed. As a result, large LANs may run more slowly than small ones because the large ones require more components, whose cost must be taken into account. Remember: Extending a network usually requires keeping the speed constant. So a small network that eventually will require major expansion should be built with the necessary network equipment the expanded network will need.

Interconnecting LANs

If a LAN's geographic scope proves too limited, it can be extended by creating a second local network and linking the two with what are called *network bridges*. Even two different types of networks can be connected by *gateways*.

Transmission Media

Establishments without networks frequently transmit data internally by means of modems and telephone lines or even hand-carried data disks. LANs use inexpensive transmission cables of various types, which are discussed in detail in Chapter 3. Transmitting data over a LAN can reduce the number of telephone lines and associated modems required while allowing a far higher-transmission rate.

Flexibility

LANs allow, but do not require, autonomy of workstation operation. This option is entirely consistent with current trends in computer operations toward what is called *distributed processing*—allowing the processing elsewhere of data from overworked central processing units. But it also increases the requirement for effective high-speed data communication.

Different Types of Computer Equipment

Finally, a LAN should support a variety of workstation types that, although not generally part of it, can be attached to it. Using common LAN hardware connectors allows flexibility in selecting equipment and preserves the benefits of a unified approach to wiring.

Chapter 2

Selecting a Network: What to Look for

A LAN is an establishment-wide communication catalyst that quickly becomes part of your establishment's day-to-day operations in subtle as well as obvious ways. Once acquired, the LAN is your establishment's resource for a long time—for better or worse. So its selection is a critical business decision the importance of which it is hard to overstate.

WHAT SIZE ORGANIZATIONS BENEFIT FROM LANS?

LAN connectivity offers a modular workstation-based alternative to the traditional approach of centralized computing. An organization's work can be spread across multiple independent workstations that coordinate their activities over a LAN. As parts of the work load increase, the power of the individual workstations handling the additional work can be increased selectively.

Thus, small organizations, such as a department, can use LAN-oriented computing approaches in lieu of centralized computers and their so-called "unintelligent terminals." On the other end of the scale, LANs can help large organizations to communicate with existing centralized computers and can interconnect independent departments' LANs to form establishment-wide communication networks. This helps solve the chronic headache of building wiring.

WHY IS BUILDING WIRING SUCH A BIG HEADACHE?

Consider the following historical perspective on the traditional practices of wiring a building for centralized computing environments. This casts light on the reason building wiring is such a chronic problem.

Wiring has historically been installed on an as-required, informal basis. As a result, wires were not marked with information that would allow later identification. Nor were general maps or wiring plans maintained.

If a terminal was moved, a new cable would casually be installed at its new location. The original cable was disconnected but usually not removed because of labor costs. However, because the original cable was not marked, its use and points of origin and termination were often forgotten. Thus, even if a terminal of the same type were later reinstalled, a new redundant cable would also be installed. On a global scale, the problem of wiring was repeatedly being solved on a case-by-case basis.

On a small scale, the existence of redundant cable posed no problem or exorbitant expense. However, as the use of teleprocessing accelerated, the wires accumulated and establishments soon discovered their sheer physical weight and tendency to tangle prohibited their removal. In some situations, this made further expansion of teleprocessing applications difficult.

One major aircraft firm found that its only conduit under a public thoroughfare became clogged with cables, even though it was 2 feet in diameter. A nationally prominent research organization found that it had to reinforce its building's ceilings because of the crushing weight of accumulated cable. A development organization's roof support beam cracked, forcing an emergency building evacuation and causing the loss of many years of productivity before the beam was repaired. (See Figs. 2-1 through 2-4 for examples of how bad wiring problems can become.)

As the wiring problems compounded, they began delaying terminal installations. Because establishments depended on teleprocessing to assist them in daily operations, it was not uncommon to delay establishment reorganizations until adequate teleprocessing support could be provided for new organizational

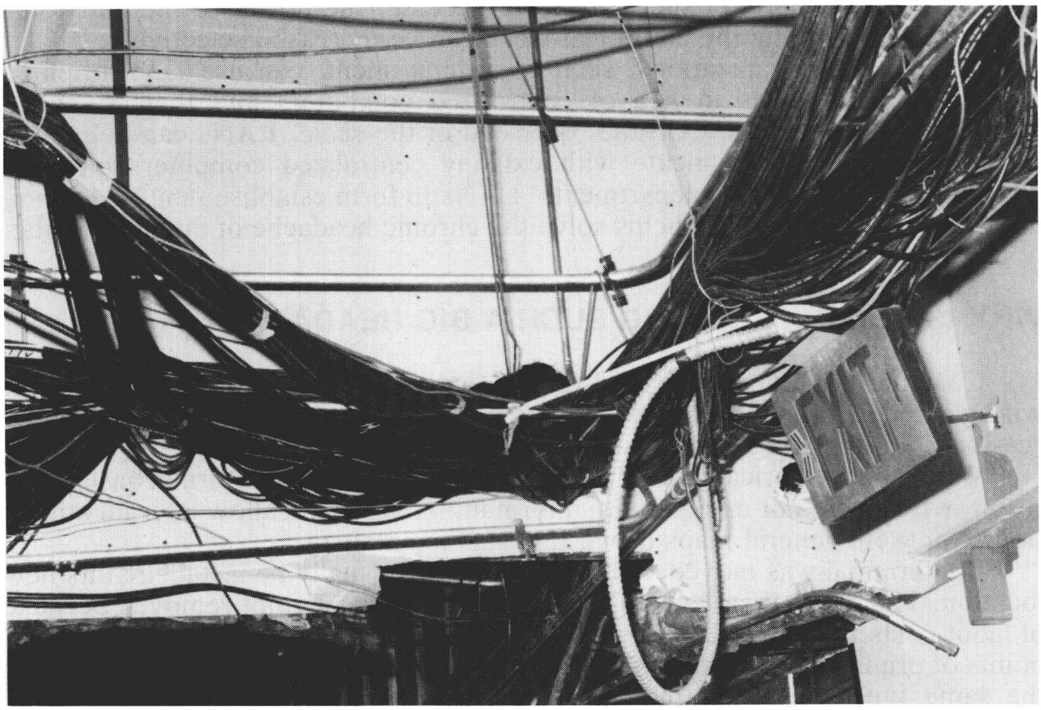

Figure 2-1 Wires extending through a ceiling fire wall. Generally, such wires should be plenum cable (flame-resistant) but aren't in this instance. Thus, if the wires ignite, they burn with a wick-effect through the fire wall, rapidly spreading the fire and generating dangerous smoke.

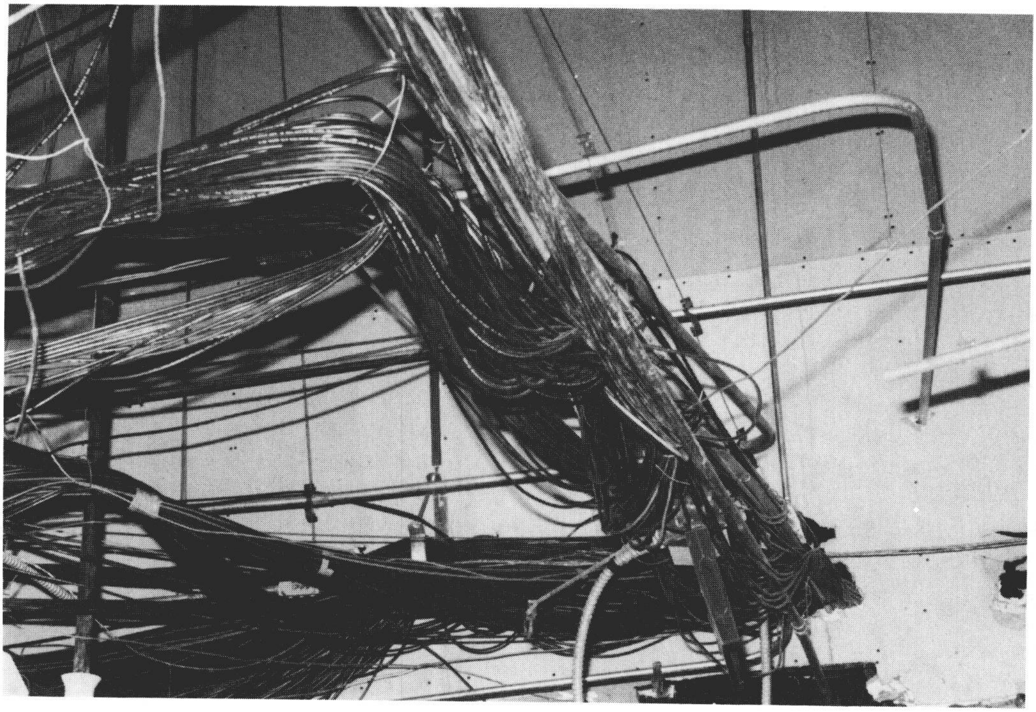

Figure 2-2 Typical ad-hoc wire routing in ceilings

structures. Ominously, the installation of terminal wiring began to inhibit an establishment's reorganization capabilities and, hence, its ability to compete on a flexible basis. What was previously a second-thought activity quietly became a potential major obstacle to business operation.

Exacerbating this situation was the increasing requirement for organizational flexibility. Staff reassignment and turnover volatility dictated that any establishment support system be rapidly and easily reconfigurable to the dynamic needs of the organization; existing wiring tended to be static.

It was not unusual to construct or remodel a building for a group, only to have the group be redirected in mission or location before the building was occupied, rendering the best-laid wiring plans useless. Thus, wiring had to be flexible in function and support varieties of devices in ways traditional wiring could not.

As the pace of business became increasingly competitive, it required greater synchronization between organizational functions, resulting in unprecedented requirements for information exchange and unified connectivity through establishment wiring. Business techniques such as "just before needed"

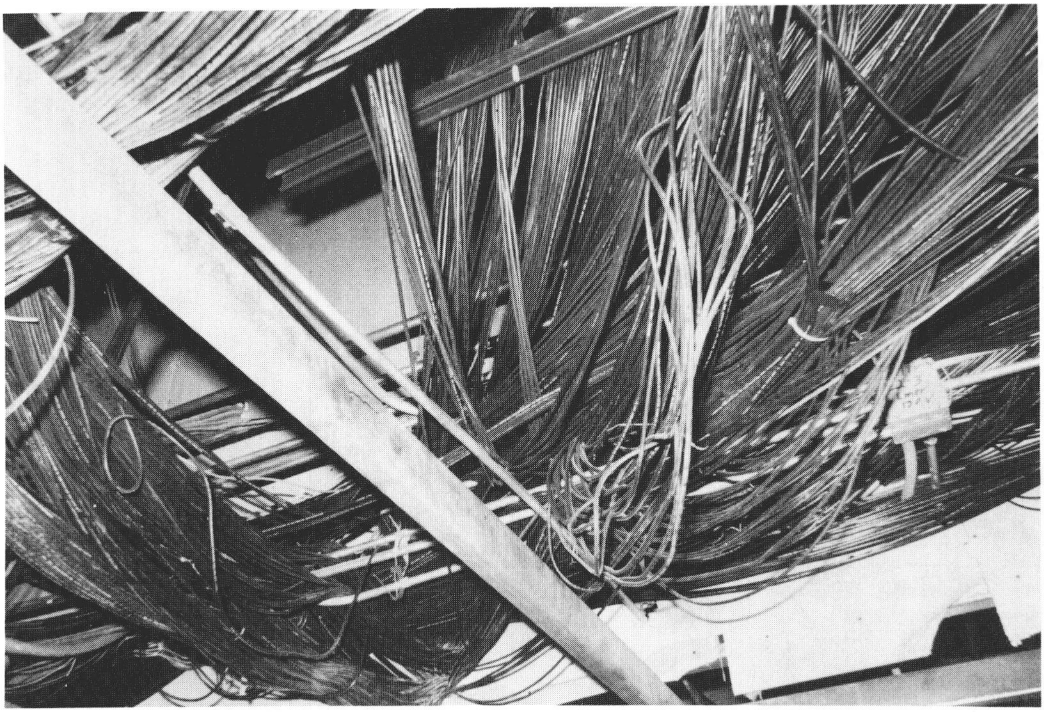

Figure 2-3 Ceiling wire accumulation near a wiring closet

manufacturing required accurate synchronization of activities from manufacturing to procurement to accounts payable.

In turn, this dictated that establishment members have a uniform perspective of the organization and its resources. However, since a specific type of wiring tended to be supported on a subsystem basis only, various departments could be using two different subsystems that had inconsistent data.

As technology extended the techniques and feasibility of distributed processing to the PC level, the potential for data inconsistency grew commensurately. Finally, something had to be done to address the widespread proliferation of PCs within establishments that would unify them into a cohesive network and allow them to communicate in a productive manner. Good network design was the answer.

"DO WE NEED A LAN?"

There is no specific way to determine whether your establishment will benefit from the installation of a local area network. But ask yourself these questions:

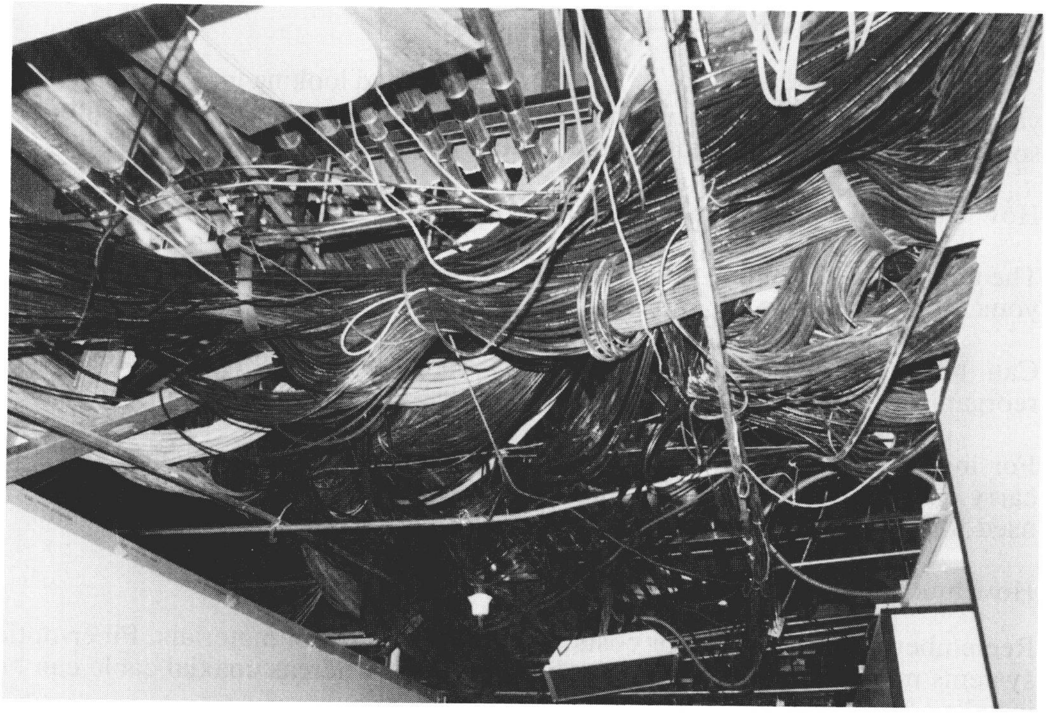

Figure 2-4 Ceiling wire converging into a wiring closet

- Does the physical distance between our personal computers interfere with information flow?

- Do we have computers that need to communicate with each other: PC to PC, PC to mainframe, or mainframe to mainframe?

- Will it be valuable for us to be able to share stored information, programs, and devices, such as hard disks and printers?

- Is our volume of computer processing increasing, so that it would improve the flow of information to have distributed processing (away from a central processing unit)?

If you have answered yes to one or more of these questions, you can probably make good use of a LAN. Virtually any establishment will find that a LAN is an expediter of organizational information, whether it has a few personal computers or uses a time-sharing system or any arrangement in between.

"WHAT QUESTIONS SHOULD WE ASK?"

If you are a newcomer to LANs but have started looking into acquiring one, you may feel uncertain discussing the subject with potential vendors. Here are some questions they should be able to answer to your satisfaction:

How easy is it to move and reattach devices on the LAN?

The answer should satisfy your need to move people and equipment throughout your establishment.

Can the LAN wiring support different services to facilitate establishment reorganization?

For instance, one LAN might use twisted-pair wiring (like telephone wire) to carry digital data only, while a different LAN might use coaxial cable (the type used for cable TV) that can carry sound and video pictures, as well as data.

How much does it cost to install a LAN?

Remember to ask about labor costs, as well as the cost of materials. Fiber-optic systems must be installed by high-priced experts, whereas coaxial cable can be installed by semiskilled laborers.

How fast can it transmit data?

Look for high transmission rates, with a wide bandwidth (frequency range), for high-speed, efficient operation. However, be aware that high transmission rates do not necessarily mean superior performance. To better understand this, think of transmission speed as travel speed. For example, you may be able to travel quickly on an expressway. But the speed may not make up for the time spent driving to and from the expressway, waiting at toll booths or metered entry points, and passing through detours or construction zones. You may do better on the surface streets, despite their lower speed limits and traffic signals.

Several key factors apart from transmission speed determine a network's efficiency. Analysis of operating LANs reveals a hierarchy of bottlenecks. In decreasing order of severity they are:

- applications software
- interface between the workstation and its network adapter
- network protocol
- medium transmission speed

Clearly, transmission speed must be balanced with many other factors. These include communication session setup delay, message transmission delay, error recovery efficiency, and message receipt acknowledgment procedures. Also, higher speed usually means reduced geographical coverage, higher equipment costs, or both.

In the final analysis, a LAN's transmission rate does not, in itself, play the major role in determining how fast a network application will execute. So, a network with a slower transmission rate may actually suit your needs better than a faster one.

How many different devices will this LAN support?

Again, it must meet your needs.

Is isolation one of its characteristics?

If one device on the network fails, it should not shut down the entire system. Conceptually, your system should work like Christmas tree lights: individual light bulbs are isolated from one another so if one burns out, the others can still function properly.

How available is maintenance for the LAN?

Repairs and servicing should be made quickly and inexpensively.

REQUIREMENTS FOR A LAN

The best way to approach selection of a local area network is to determine what you want it to do for you. Many establishments have found that the most useful LAN provides the following features.

Useful and Easy-to-Use Services

Once operational, your LAN must support a variety and varying number of devices economically and effectively. The individual workstations should be able to use the network equitably and efficiently, without encountering electronic "gridlock" (network paralysis due to blockages).

One of a LAN's most important services is its near instantaneous transmission of data. Under the best circumstances, this means a minimum of missed business opportunities due to the loss of the information's time value.

A LAN also provides quick and easy access to shared resources, such as printers, data storage devices, programs, and modems. You should keep in mind that it is often the expensive, one-of-a-kind resources that are shared and that this situation may be temporary. For instance, today an establishment might have one $20,000 laser printer in the graphics department; in 5 years, the price of laser printers may be low enough that every office can have its own. On the other hand, a $300 fixed disk may be shared, so everyone is using the same level of programs and data.

High Reliability

A LAN should be reliable, a characteristic that assumes many forms:

1. Ideally, it should be available for general use 100 percent of the time. Disruptions for maintenance or reconfiguration should be eliminated or at least minimized.
2. A LAN should have a very low rate of errors—usually less than one per 10 trillion characters transmitted—both in transmitting individual messages and in general operation.
3. It must be easily maintained. When failures do occur, the failing component must be easy to identify and isolate from the rest of the network. That implies that the network be robust under failure (versus failing robustly) and degrade "gracefully" in the event of failure. For this to happen, moderately trained individuals must be able to identify the failing component. Even better, the LAN itself should be able to predict when components are approaching failure, allowing removal or repair before failure occurs.

   For large and complex LANs, this may require a network support center with an administrator and staff to provide management services. For smaller networks, a contract with an outside consultant may serve the same purpose.

Uniformity

A LAN should provide a uniform interface to both users and equipment. An employee should be able to use any LAN workstation with a single set of procedures. Access to the LAN's services should be by an intuitively understandable menu or other consistent method.

The equipment should have uniformity of data transmission speed, data format, and transmission procedures (message protocols). A single type of attachment, known as a *multidrop direct cable* with a standard hardware adapter, should connect the workstations to the network.

Such uniformity allows higher transmission speeds with greater reliability. It also permits diverse types of equipment that provide a variety of functions to be integrated into the network.

Consistency in use and connections results in an establishment-wide image of uniform data and service systems. It does this while insulating users from any rearranging of LAN devices and services. It also provides an architecture for future enhancements. Finally, it preserves an establishment's investment in user training in two ways—it makes training easier for more people, and it extends the usefulness of the network's devices.

Ease and Economy of Installation

A LAN must be easy and economical to install. This implies the use of inexpensive cable, workstation connections, and low-skill labor, even for custom-designed networks.

Ease of Reconfiguration

It must be easy to add, remove, or move devices with little or no impact on the LAN's wiring. Initially, users do not generally know what they need or how they will eventually use the network. You may want to add more PCs, minicomputers, laser printers, or other devices as their costs come down. And relocation of offices or changes in layout usually include movement of network devices, as well.

Such changes should be insignificant to the operation of a LAN. For instance, a small LAN should even be connectable to another network, with little or no disruption of either one.

Price Performance

A LAN should be cost-effective. Many people's first impulse is to measure this in terms of the instantaneous transfer rate, such as 250,000 characters per second versus 1.25 million characters per second. But this figure is misleading, because it is not an adequate measure of performance. You must also include the processing requirements, message propagation and staging, error recovery, synchronization, and general network housekeeping. The cost-effectiveness of these functions is determined by the LAN's architecture and its software programming.

The LAN also should have a useful life, measured in decades, comparable to that of a cable TV network. While such a protection against obsolescence preserves an establishment's investment in the network, prudence should prevail. As Keynes once aptly quipped, "In the long run, we are all dead."