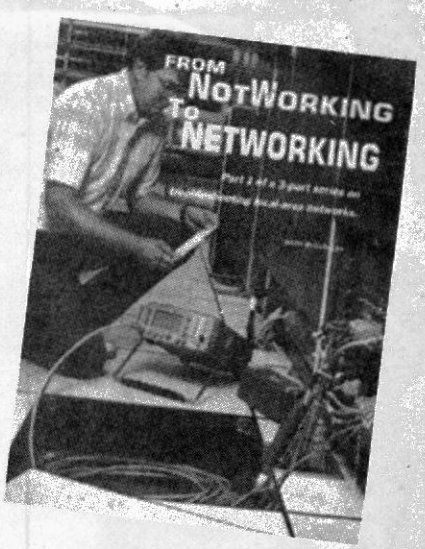
From NotWorking To Networking



Bring your knowledge to bear on several tough LAN case histories.

GARY McCLELLAN

PARTS 1 AND 2 OF THIS THREE-PART series on troubleshooting LAN's presented technical background on network technologies (in Part 1), and on tools and test equipment (in Part 2). This time we put our knowledge to work in diagnosing and solving network problems of varying difficulty.

In each case, we will describe the type of LAN, symptoms manifested, fault isolation techniques, use of test equipment, and repair methods. To follow the discussion, it is important to have at least a basic understanding of LAN technologies and test equipment as described in parts 1 and 2. So if you are unsure about anything discussed so far, reread those parts before continuing.

The computer ate my work!

This one happened at a local metal fabrication shop; the symptoms drove the company's finance people up the wall! That shop had five XT clones communicating with an IBM PC-AT file server via Ethernet. For a long time, the network had been reliable, but after several years of use, it began to run slower and slower whenever users ran order entry and accounting programs off the file server. Error messages began to appear, and sometimes users had to repeat the process. Troubleshooting began when several people in the order entry department complained of trashed data.

Several users were affected, so it seemed unlikely that their computers were at fault. That left the Ethernet backbone cable and the file server as suspects. The backbone cable could have been the problem, but it didn't seem likely. Then someone discovered that a seldom-used word-processing program ran fine, so we ruled out the possibility of cable fault. That left the file server and hard disk as a possible culprit.

That evening we shut down the network and ran a "disk doctor" program on the file server. Those programs are available from several sources, including Symantec (Norton Utilities), Central Point Software (PC Tools), and Gibson Research (SpinRite). What these programs do is perform a non-destructive low-level format of a disk drive. Typically, such programs work by reading a track of data from the drive, formatting that track, and rewriting the data. Any bad sectors detected along the way get mapped out, and the data gets moved elsewhere, if possible. Figure 1 shows a sample screen from the Calibrate utility included with versions 6.x of the Norton Utilities.

A related function often goes by the name of *disk defragmenting*, which attempts to group logically related segments of a file together physically in consecutive sectors of a disk. Doing so can dramatically increase the speed with which DOS reads files. A disk becomes fragmented because, when a file is erased, DOS subsequently adds the now-unused sectors to a pool of sectors that might subsequently be reused. A particular group of erased sectors might not contain enough space to hold an entire file, so DOS puts parts of the file in non-adjacent areas across the disk. The result is that when loading the program or data file, DOS sends the read/write head all over the surface of the disk, rather than lapping up sectors one by one. That jerky head motion can really slow things down. It is not unusual for overall operation to be speeded up by 10–20% or even more simply by "doctoring" the hard disk. Norton and Central Point both include disk defraggers as well.

Anyway, running a disk doctor program on the fabrication shop's server solved the problem. To avoid that type of problem, run a disk doctor program a minimum of every six months to catch bad cylinders and prevent data loss. If you encounter many bad cylinders, say 5% or more, you should replace that hard disk before a catastrophic failure occurs!

The dead PC

Many LAN problems go like this: A user cannot log onto the

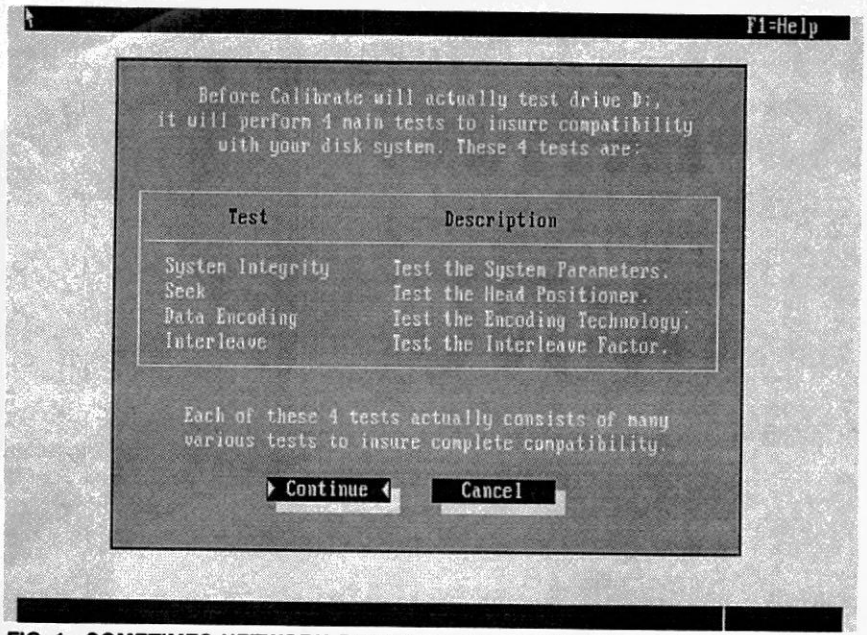


FIG. 1—SOMETIMES NETWORK FAULTS aren't network faults at all, but faults with hard-disk drives. In an MS-DOS environment, Norton's Calibrate utility can help to locate and lock out bad sectors.

network, or a PC suddenly drops offline—but other users remain unaffected. Following are two examples of this type of problem, along with corresponding solutions.

Example one occurred in a parts distributor's office. The LAN consisted of five clone PC's and a generic 80286 file server tied together via ARCnet. ARCnet operates over RG-58 thin coaxial cable that runs from computer to computer.

First, we tested the sick PC off-line and found it to be functional. That left the Network Interface Card (NIC) and LAN cabling as suspects. First we inspected the coax cables and they looked good. But a gentle tug on a loose BNC cable connector caused it to come off. Replacing the connector brought the computer back to life.

Generally speaking, connector faults are a major problem on LAN's. Most BNC connectors are crimp-on types, and if installed improperly, eventually they fail—but not before becoming intermittent and causing lots of grief! Connector problems usually develop several years after their initial installation; often they're caused by oxidation of contacts. For problem installations, we prefer soldered to crimp-on BNC connectors. They take 5 to 10 minutes longer to install, but are far more reliable.

Many connector problems are caused by users who accidentally damage cables by crushing them under chair legs, or dropping equipment on them. Our troubleshooting kit includes a collection of 10-foot cables which have coaxial BNC connectors, triple twisted-pair RJ-11 connectors, and quad twisted-pair RJ-45 connectors. The cables are for on-site substitution of questionable cables.

Example two in this category concerned a dead computer in a medical billing office. The company used five IBM PC's linked by telephone-type unshielded twisted pair (UTP) cabling into a Compaq 386 configured as a hub. The hub serves as both a file server and as a central point to which all cabling returns.

We tested the problem PC, and it appeared to be working. It just wouldn't log onto the network. We substituted a different drop cable between computer and wall outlet; the new cable worked for a while and then quit. Next we substituted a PC from the office of a vacationing user, but without success.

At that point the problem could have been anywhere, including the computer, its NIC, the cable plugged into the wall outlet, or even the wiring back to the hub.

First, we checked the old wall cable with the Paladin PatchCheck tester (discussed in the last article). PatchCheck checks cables in seconds, if you can access the modular plugs on both ends. Pin 2 showed a dim indication on the tester, suggesting high resistance. We didn't know which end was bad, so we replaced the connectors at both ends. The cable then tested good, so we reinstalled it and were able to log onto the network briefly. But then trouble developed again. On a hunch, we pushed and held the modular connector in the wall outlet. The user could log onto the network and work normally—until we let go of the connector. Then the PC crashed. Replacing the wall outlet solved the problem.

In general, most twisted-pair cable problems are caused by bad crimps or by users pulling individual strands out of the connectors. In the present case, the initial installer used cheap connectors that probably were not crimped fully, which in turn caused resistance to increase over time. As for the wall outlet, close inspection showed that the pins were partly covered by a greenish film, probably caused by moisture in the wall corroding the faulty gold plating on the pins.

If you want to avoid a career in connector replacement you should always use quality cable and wall-socket connectors.

Warehouse madness

The problems described so far represent roughly 80% of the faults you will encounter on computer LAN's. But there are other kinds of problems that will tax your troubleshooting abilities, and that also require specialized test equipment. Our next case is a good example.

A firm relocated to a new headquarters 100 miles away, leaving behind a warehouse. The new system used an IBM midrange computer (at headquarters) and CRT terminals and printers (in the ware-

house), all connected via modems and a dedicated telephone line. The purpose of this arrangement was to generate customer shipping orders. One day all the terminals and printers in the warehouse stopped cold. The data processing manager (DPM) of the company found that his equipment was not working properly, and he blamed the telephone line. The local telephone company checked its line and pronounced it good! So where was the problem?

One possibility was that the fault was somewhere in the warehouse, between the modem and the outside line connections. With permission, we inspected the modem wiring in the telephone cable closet. It looked good, but then we measured the line voltage with a DMM. It read zero! We had expected 2 to 10 millivolts of AC noise, typical on a terminated line. A quick resistance check showed 7 ohms. There was a short in the wiring!

We then spent several hours walking between modem and cable closet, disconnecting wiring, and eliminating various suspects. One look at the huge bundles of wiring on the wall of the building was enough to discourage fault finding by visual inspection!

The solution was to use a time domain reflectometer (TDR), which can locate faults along the cable. After making sure the outside telephone line and modem cable were still disconnected, we attached a MicroTest Cable Scanner handheld TDR to the line in the closet. The TDR indicated some irregularity about 70 feet away, which put the fault near the modem. Then we made another measurement near the modem end, and the cable scanner indicated a dead short.

Then we traced the wiring into a storage closet where the red and white twisted-pair cable ran through a hole in a steel riser and up the wall. Close inspection of the wires running through the hole revealed that a sharp edge had cut through the insulation and shorted the cable. Insulating the wires with electrical tape brought the network back on-line.

The problem of different organizations blaming each other for faults neither can trace is common, because most LAN's consist of different products from different vendors, including computers, terminals, printers, modems, NIC's, cables, and more. The solution is to learn about your LAN equipment and service it yourself, or find a trustworthy service firm that can do it for you.

Cloak and dagger

We saved the most fascinating LAN servicing case for last. After this case was resolved, someone must have answered some interesting questions about his late-night activities.

Here's what happened: A software development firm became highly distressed when several of its workstations performed intermittently in the middle of a rush project. The firm promptly called its regular service company, which in turn concluded that there was a bad cable connecting those machines and the rest of the LAN. The service company recommended tearing the old cable out of the wall and replacing it. After considering the cost of a new cable installation, the firm asked that it be repaired instead.

At this point we were called in to provide a second opinion. Wisely, the service company had bypassed the bad cable with a temporary one; thus we could test the bad cable without shutting down the LAN. This network used a series of high-end workstations tied together via an ARCnet system into a minicomputer. A 60- to 100-foot length of coaxial cable connected the LAN with the last two workstations in the chain. We knew that the cable between them and the LAN was at fault.

We started troubleshooting by making continuity checks on the wiring. Instead of an open circuit, our DMM showed 10 ohms between the shell and center conductor of one of the BNC connectors extending from the wall.

There was definitely a short in the cable. But where was it located? Our initial response was to confirm the service compa-

NETWORK BACKGROUND

The following are reference materials, equipment suppliers, and network-related standards organizations.

References:

- *The Practical Guide to Local Area Networks,* Rowland Archer, Osborne-McGraw Hill. Good introduction to cable types, topologies, and access methods.
- *Networking IBM PC's,* Michael Durr, Que Corporation. Chapter 14 contains good overview of bridges, routers, and gateways.
- *LAN Magazine,* 600 Harrison Street, San Francisco, CA 94107 (415) 905-2200.

Suppliers:

- Black Box Corporation, P.O. Box 12800, Pittsburgh, PA 15241, (412) 746-5530.
- Cable Express Corporation, 500 East Brighton Avenue, Syracuse, NY 13210, (315) 476-3100.
- Contact East, 335 Willo Street South, North Andover, MD 01845, (508) 688-7829
- JDR Microdevices, 2233 Samaritan Drive, San Jose, CA 95124, (800) 538-5000.
- Jensen Tools, Inc., 7815 S. 46th Street, Phoenix, AZ 85044, (602) 968-6231.

Standards Organizations:

- American National Standards Institute, 1430 Broadway, New York, NY 10018, (212), 642-4900.
- IEEE Headquarters, 345 E. 47th Street, New York, NY 10017-2394, (212) 705-7900.

RESOURCES

The following are addresses of manufacturers whose products were discussed in this series of articles. Contact those companies for current pricing and more information.

- Paladin Corporation, 3543 Old Conejo Rd., Newbury Park, CA 92123, (800) 272-8665.
- MicroTest, Inc., 3519 E. Shea Blvd. Suite 134, Phoenix, AZ 85028, (800) 526-9675.
- *Radio Amateur's Handbook,* American Radio Relay League, Newington, CT 06111.
- Tektronix, Inc., Redmond Division, 625 S. E. Salmon Dr., Redmond, OR 97756, (800) 833-9200.
- AMP, Inc., P.O. Box 3608, Harrisburg, PA 17105, (717) 561-6168.
- Gibson Research, 22991 La Cadena Dr., Laguna Hills, CA 92653, (714) 830-2200
- Symantec Corp., Norton Utilities, 10201 Torre Ave., Cupertino, CA 95014-2132, (408) 253-9600.

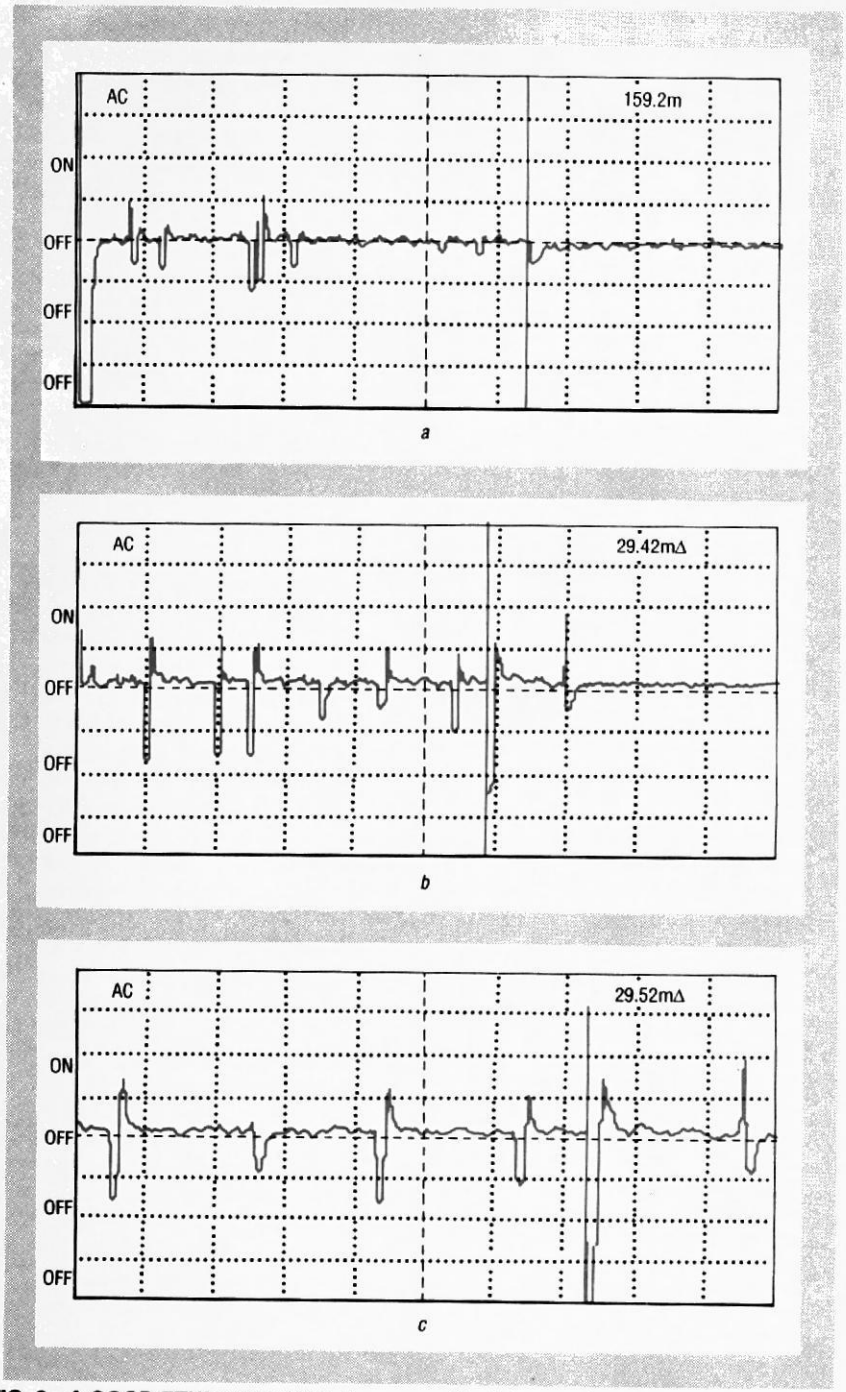


FIG. 2—A GOOD ETHERNET CABLE appears like this on a time domain reflectometer (TDR), which shows impedance vs. distance. The vertical line in *a* marks the end of the cable. In *b*, the vertical line represents a bad cable tap. The TDR can "zoom" into the display, and *c* shows an expanded view of the bad tap.

ny's assessment, and to recommend tearing out the old cable. However, we first decided to do some troubleshooting.

We rented a Tektronix model 1502C analog TDR from a local instrument rental company. (Rental is recommended anytime you need an expensive piece of equipment for just a few days.) We chose this premiere TDR because it displays minor faults that digital TDR's often miss. In the past we have located rusty connectors, loose connectors, and watersoaked cable sections with the 1502C, all of which were missed by a digital TDR. The down side of an analog TDR is that it requires more skill to use.

The 1502C displays distance vs. impedance on an LCD screen. The display shows, along the entire length of the cable, a continuous "snapshot" of impedance, which in our case was supposed to be about 50 ohms. Shorts cause the trace to drop to 0 ohms, and opens cause the trace to rise off the display. In operation, you look for suspect drops and rises, read the distance directly off the display, and start troubleshooting at the specified location. Figure 2 shows several examples of TDR displays.

After connecting the TDR to the cable, we checked the display, which showed the expected 50-ohms, but with a sharp drop about 29 feet away. A company manager, who had been looking over our shoulders, suggested that we check the ceiling. We lifted ceiling panels and located the cable. Since we had no idea of distance in the ceiling space, we guessed at the location and inspected cable for some distance each way from our access point. Above a service closet we found the culprit. Someone had sliced the cable open and crudely spliced another cable to it.

Upon closer inspection, we noticed that the added cable was pulled taut, causing strands from the uninsulated connections to touch. That, in turn, reduced signal levels to the workstations, causing intermittent problems. With excitement, we traced the second cable into a closet where we found a computer and a printer hidden behind a row of shelves.

We showed our findings to the manager. He said he would watch the closet and determine the identity of the eavesdropper. A week later he called the service company and had them remove the splice and replace it with a crimp-on BNC connector and a barrel adapter. Later we heard that the computer had been removed from the closet, but the manager would not say whether he had caught the guilty person. If it hadn't been for the short, we might never have discovered that illegal tap! **R-E**

LETTERS

Write to Letters, Electronics Now, 500-B Bi-County Blvd., Farmingdale, NY 11735

AUDIO BUYING TIPS

I have enjoyed Larry Klein's *Audio Update* column very much over the years. He provides a breath of fresh air in a field often fogged by the strong odor of addled logic. Larry's coverage of the 1991 AES Convention was also enlighteninging because he drew attention to the significant psychophysical research concerning what we really can or cannot hear.

I'd like to add a few buying tips for consumers from my article "Can You Trust Your Ears?" *AES Preprint 3177.* Because humans have such a strong tendency to hear sounds that might never have occurred, audio equipment customers should be aware that even the best receivers, preamplifiers, CD players and amplifiers cannot be reliably evaluated under controlled conditions. (I am assuming that this equipment is being operated at its specified power limit and all cabling meets the manufacturers' requirements.)

Second, it is practically impossible to conduct a fair listening evaluation even in a studio-equipped retail store with all components matched and compensated. Finally, you are not stupid if you don't understand everything the salesman tells you. When you are tempted to buy a product but still unsure of yourself, wait until the next day to make a decision. There's a good chance that you'll decide you don't need whatever it was that was being pitched. *Caveat emptor.*

TOM NOUSAINE
Cary, IL

NETWORKING CORRECTION

As a long-time reader of **Radio-Electronics** and a data-communications professional, I was pleased to read the first part of Gary McClellan's series entitled "From Not Working to Networking."in your August issue. Unfortunately, the section entitled "Connecting networks" positions bridges, routers, and repeaters in the incorrect layers of the ISO/OSI model.

It is generally accepted in LAN networking that a repeater operates at layer one, a bridge operates at layer two, and a router operates at layer three of the ISO/OSI model.

I trust that statement clarifies Mr. McClellan's information, and I look forward to reading the remainder of the articles in his series.

SHELDON H. DEAN, CET
Calgary, Alberta, Canada

THE BOTTOM LINE

As panelists in a seminar entitled "Strategies to Guard Against Productivity Loss" during PC Expo on June 25, we were astonished to find that of the thousands of industry professionals at the show, only one decided that a session on productivity enhancement was important enough to attend.

The show's management found the topic compelling enough to sponsor the seminar, and experts on the subject were ready to talk. But it seems that the individuals in the industry—vendors, customers, and managers of corporate computing resources—did not find it important enough to learn more about the link between technology and productivity.

Members of the industry do seem to find glitz, power, and speed interesting. They seem to fixate on the question: "Can we make it bigger, faster, or better than our competitors?" The name of the game seems to be "hardware for the sake of hardware" and "software for the sake of software."

We forget that senior management, which controls the purse strings, cares about return on investment, productivity and profit. They don't care about chip speed or power. Who in our industry is thinking about vital productivity issues such as education, training, and support? Is anyone thinking about the need to re-engineer products to take advantage of developing technology? Is management afraid to find out if there really is a positive return on investment in computer technology?

Until the computer industry stops to takes stock of where it has been and where it is going—particularly the relationship between computer technology and the bottom line—the promise of technology will *not* happen. We should be concerned with how the technology can change the workplace, improve corporate competitiveness, and help us to meet our national economic goals.

None of this is glamorous stuff. Making technology deliver on its promise is tough, tedious work. It certainly does not offer the fun of playing with the latest and greatest graphics user interface. But it is where to find productivity increases. Productivity is the responsibility of people, not just machines. It seems that those attending PC Expo were looking for something other than strategies to prevent losses in productivity.

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SUSAN RASKIN
Rastec
RALPH E. GANGER
Sterling Resources

I'd like to respond to the letter by Stephen Schleick, "Seeing the Light,"(June **Radio-Electronics**.) In my opinion, as a technically trained person Mr. Schleik should have been better able to understand the point made by his "rocket scientist" friend. Mr. Schleik's anger at his friend is unwarranted, but he is correct in what