The Future Requires Change

New Technology, Techniques and Thinking

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Network managers everywhere are concerned about the performance of their networks. After all, it is their primary responsibility. When the network fails to perform properly, they ask a couple of key questions: What is going wrong, and what do I need to do to fix the problem? Fixing the problem is fine, but it is usually only temporary. Chances are good that the network will fail again with the same symptoms. Most network managers seem to forget the most important question of all: What can I do to prevent problems in the future?

Downtime directly relates to the company's bottom line. End users are getting paid to do nothing, the network staff gets to work overtime, and management is wondering what is being done about it, all the while counting the costs. Downtime can mean the demise of what could have been a promising IT career.

Concern for the health of the network, and thus the bottom line, is what separates successful network managers from unsuccessful ones. This concern manifests itself in the form of proactivity. Proactivity can be loosely described by the well-worn cliche: an ounce of prevention is worth a pound of cure. Proactive managers heed these words. They see into the future of their business, measure the up-and-coming technologies that are geared to handle this future, and look for ways to integrate these technologies into their networks.

Managers who are not proactive are considered to be reactive. They wait for problems to come to them, and by the time they do, it is already too late: the network is down. Now they have to spend valuable company resources to fix the problem to a point where the network is functional again. By this time, there may be no more money left in the budget for upgrades. As time goes on, repairs become a hodgepodge of solutions so entangled that it takes more time to figure out what and where the problem is than it does to actually fix the problem. Eventually, the organization will grow weary of this cycle and will replace the reactive manager with a proactive manager who actually cares about the future of the company and the health of the network.

The moral of the story is this: success for a network manager is measured by the amount of continuous smooth network operation and the contribution the network makes to the bottom line. Management is more likely to increase the network budget if they know the money is going to go toward improving the quality of work for its employees and increasing the bottom line.

Whether you are a network manager, or will be working with one, you need to know what the future holds for the network you are responsible for. The infrastructure needs to be able to support future applications by providing them with enough bandwidth, in addition to some overhead to compensate for future growth.

Keep in mind that the future referred to will always require increasing bandwidth needs, and that no technology will ever be sufficient forever, especially where data communications is concerned. All systems have a life cycle that needs to be accounted for when considering future needs. This life cycle should be determined and understood before undertaking any plans for future growth. With that said, let us move onto the first main focus of the article: applications.

High Bandwidth Applications

Why is there such a push for increasing bandwidth? A network that was sufficient just a year ago is inadequate now. New applications and new uses for old applications are continually being developed that are pushing the limit of the network cabling plant. Nowhere is this more evident than when we follow the evolution of Ethernet. Early networks had more than enough bandwidth for 10 megabits per second (Mbps) because all they were doing was sharing files and printers. Yet even then, proactive network managers were upgrading to Fast Ethernet, and now Gigabit Ethernet, because they intuitively understood the need to stay ahead of the game and maintain the overhead they were accustomed to.

GRAPHICS APPLICATIONS. The first application type concerns files that contain graphics, such as photographs, fonts and desktop publishing files. A prime example for this type of application is Adobe® Acrobat®. A vast majority of product documentation and promotional material found on the Internet is in portable document format (PDF), the basic format in which Acrobat files exist. PDF files by nature are graphical and thus much larger than their text only predecessors. Graphics increase the size of files that get transferred over the network and thus use an increased amount of bandwidth that could be used for other more mission-critical applications. Yet what would we do without the aesthetic and informational power that graphics bring? Sorting through mountains of text is very time-consuming, not to mention boring. Pictures describe more eloquently, in much less space, the fine points of a product, and when it comes through a network, it is much clearer to see details than if it came through a facsimile line. Critical business decisions are more quickly and easily made because of graphics. Therefore, the bandwidth taken up by PDFs is justified when considered into the bandwidth budget.

CAD/CAM (computer-aided drafting/computer-aided manufacturing) is another application that is graphical in nature. In businesses that use it, CAD/CAM is the mission-critical application. These files can grow to gigabytes in size, especially when they are three-dimensional models. Teams of engineers need access to the same files for collaboration on a project, which means that the file is constantly being transferred back and forth. Images like 3D modeling in a collaborative environment passing over a network can severely cripple a network if it does not have enough bandwidth. Overhead is an essential part of CAD/CAM networks because transferring large CAD files over it often exceeds maximum bandwidth and can bring operations to a halt. Ensuring that overhead is maintained should be the main focus of the network manager in this case.

SERVER-CENTRIC APPLICATIONS. These applications are installed and run from the server, or are large databases. Normally, the local PC has client software that establishes a session on the server or the appropriate database program. A database program can also be run within the client shell. One notable example of a server-centric application is data mining, which allows concentrated content searches through entire databases using keywords or topics. Once the query is complete, the server transfers the information via the network to the client. Many times these queries produce large answers and can tie up the network. Citrix® WinFrame® and Microsoft® Terminal Server are examples of server software packages that set up user sessions to take processing burdens off the client PC. However, video updates, keystrokes and mouse movements must still travel over the network. When coupled with normal network traffic, the cabling plant can quickly become overwhelmed with data.

REAL-TIME APPLICATIONS. Several applications exist that fall into this category, mostly consisting of video technologies. As large as still pictures get, one can only imagine how much bandwidth is taken up by videos. Broadcast quality video transmits up to 30 frames per second. That's like 30 picture files being transmitted every second. At this point in time, the bandwidth does not exist, except in high-speed networks like Gigabit Ethernet and ATM, to support the full capabilities of broadcast quality video. Throughput must be throttled either by scaling back on the frames per second count, or in the switching hardware with priority information contained in the packets. Either way, the video becomes choppy. Adding audio to the video streams further complicates the issue. This is one reason videoconferencing over the Internet hasn't been widely implemented. There is too much bandwidth contention. Streaming and downloaded videos are probably the highest bandwidth users in existence today.

TELEPHONY APPLICATIONS. The telephone is still the most powerful and widely used tool in business today, especially when considering doing business globally. Cutting back on long distance telephone charges is always a priority, so when new technology arrives that promises to wipe out long distance phone calls, management will definitely pay it some lip service. A new protocol for the TCP/IP stack, the protocol group that functions as the rules for Internet communication, called voice over IP (VoIP), is getting more attention as time passes. However, for most businesses, this is not an option unless they have implemented a private network. As with streaming video, placing a telephone call over the Internet causes unacceptable slowness, not because audio is so bandwidth heavy, but because of the sheer amount of telephone calls that are placed. Videoconferencing also falls into this category because of its roots in telephony. These applications and many more are the cholesterol of your network, clogging up the lines with their bandwidth needs, especially where network bottlenecks occur. However, the amount of traffic the network can carry isn't the only issue that must be considered. Sometimes it is the physical distance the data must travel in order to get from point A to point B.

Distance Limitations

Applications by themselves aren't the only reason for ensuring the network is future proof. Corporate workgroup LANs (local area networks) that previously did not need access to these applications suddenly need it. However, these LANs could be on a different floor at the other side of a large manufacturing plant, or even in another building, so connecting them together brings up another issue.

A common thread runs through the examples given above: the networks in question are all too far away from each other to be considered as part of the same network segment. The limiting factors in these cases are the performance characteristics of the cable connecting the networks together. One of the most important factors to be considered is attenuation. Attenuation is the loss of signal to internal and external forces as it travels through the cable. As the cable gets longer, it gets exposed to more forces. After a point, the signal will no longer be able to be interpreted by the receiver because it is either too weak or too distorted.

This hurdle can be overcome two different ways. The first is the use of repeaters, usually hubs or switches, strategically located to keep the cabling distance within the appropriate standard. Multiple telecommunications closets

(TC) may be required, one for each zone or area to be served. All of the station cabling terminates in these closets at a horizontal cross-connect. From there, the repeater sends the signal over backbone cable to a main or intermediate cross-connect. The signal travels this way until it reaches its destination.

However, a signal can only be regenerated so many times before it is unreadable. Current standards state that a signal should travel through no more than three cross-connects if the starting point is set at the horizontal cross-connect the station is connected to (this cross-connect is not to be considered as one of the three cross-connects).

The second way is to use a media that has better transmission characteristics, i.e. one that may not be as susceptible to internal and external forces. Currently, network cabling is mostly made of metallic substances, usually copper. Copper cable is widely used because of its durability, which contributes to its ease of installation. The downside to copper cable is that it can be susceptible to electromagnetic forces that occur both internally and externally. As transmission rates increase, so does the sensitivity of the cable to unwanted signals. More care needs to be taken in placement and terminating to overcome electromagnetic interference/radio frequency interference (EMI/RFI).

Some premise networks that have EMI/RFI problems are turning to optical fiber cable. Optical fiber is made of either glass or plastic, which can be all dielectric, meaning that it has no metal in it. This makes it immune to EMI/RFI signals. Optical fiber has so few external forces acting upon it that they aren't considered in loss calculations Forces that cause attenuation almost always come from within. Briefly put, fiber optic signals lose power because the light from the transmitter is misdirected away from the optimal path.

However, the glass in fiber is delicate and can be broken easily if not handled and managed with the utmost of care. If fiber is installed properly, its benefits far outweigh its penalties. One we have already seen in distance. The other is the significantly higher bandwidth that can be realized with fiber optics.

New Technologies for Higher Bandwidth

Distance and speed are always concerns for the network manager. Advances in fiber optic technology allow for increasing bandwidth, speed and distance.

We have come a long way since 1958, when Arthur L. Schawlow and Charles H. Townes published their paper "Infrared and Optical Masers" while working at Bell Labs where they invented the laser. Numerous technical and technological advances have led us up to our current technology. Short wavelength lasers, vertical cavity surface emitting lasers (VCSEL), graded-index multimode, and singlemode fibers today are all fairly common telecommunications technologies. But what improvements lie ahead?

Scientists are constantly improving optical technology. The use of the soliton, or ultra short optical pulse, increases reliability by virtually eliminating problems caused by chromatic dispersion. Quantum cascade lasers are used to produce laser beams that are over a thousand times more powerful than conventional lasers, with less dispersion. Wave division multiplexing lasers allow numerous wavelengths of light to be transmitted simultaneously over a single fiber. All of these advancements either improve distance or bandwidth or both. Transmitters aren't the only component of a fiber optic system where improvements have been made; the cable itself is being enhanced as well.

One notable example of fiber improvement occurred in 1990, when a Bellcore researcher named Linn Mollenauer transmitted a 2.5gigabit signal over 7,500 kilometers of fiber optic cable. While this feat by itself is incredible, what makes it truly amazing is that he transmitted the signal the whole distance without the use of repeaters. Conventional fiber optic links require repeaters at regular intervals that rebuild the signal in order to transmit it as far as Mollenauer did. He accomplished his incredible feat by integrating soliton technology with erbium-doped fiber. During the manufacturing process, the fibers are combined with special materials, in the previous case, erbium. This process is called doping. A doped fiber regenerates the signal as it travels, thus eliminating the need for repeaters and amplifiers.

Many of these new advances are currently in use by long-distance carriers and some early adopters. It is only a matter of time before they emerge from the laboratory and into premise networks.

Conclusion

Staying abreast of these new technologies will allow you to better serve your company or your customers. Sharper practical knowledge will help to maintain a better business relationship with them. And above all else, keep an open mind to all opportunities available, and don't be intimidated by these new technologies, which are right around the corner. Study the options carefully and embrace understanding of them, thus avoiding costly mistakes. Following this advice will ensure that your company or your customers remain content with their network and will continue to employ you with further projects well into the new millennium.

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