THE INTERNET - WHAT IS IT?

by Jack Rickard

Since our first Directory of Internet Service Providers, we have received a large number of calls virtually all seeking the same thing. The wording varies, but the question is the same: "How do I get the GOOD Connection to the Internet?" It is a question without answer. The Internet is a complicated matrix of connections in a constant state of upgrade with some 4,500 vendors making changes on a daily basis. But it is a legitimate question. Connections do vary, sometimes dramatically. All T-1 links are not created equal, all backbones are not created equal, and all Internet service providers are simply not created equal. Pricing and performance are near chaos, with little connection between the two.

And after talking with our readers at some length, we found that they are really struggling to form a mental picture or map of the Internet in an attempt to locate themselves on it. It's a bit of a geography exercise- "Where am I?" And the corollary, "Where do I want to be?"

It is helpful, in dealing with the Internet, to form some working mental image of what it is, how it works, and where the walls are. Since a great deal of its operation is logical rather than physical, this can be a bit of a challenge. Physically, it is a series of equipment rooms scattered across the globe with rack-mounted routers in them and few if any people nearby most of the time. They are connected with an array of "physical" leased telephone lines. That mental picture has little utility.

Picturing what is connected and where it is connected on the map is somewhat more useful. It is not perfectly accurate. All backbone maps are logical and symbolic simplifications of often extremely complex connections. But they can be useful.

FIRST-WHAT WAS THE INTERNET?

Historically, the Internet began with packet switching projects in the late 1960s, most notably the Advanced Research Project Agency's ARPANET. During the '70s this network grew to support many organizations in the US Department of Defense and other government agencies. It also began to support university and research organizations. The Transmission Control Protocol/ Internet Protocol (TCP/IP) was developed as a packet protocol that would allow connections across a variety of physical mediums including satellite connections, wireless packet radio, telephone links, and so on. It was included in a popular release of the Berkeley Standard UNIX, which was freely distributed through the university community. This was a rather loose development of technology, and in no clear sense a network of any kind.

In 1985, the National Science Foundation funded several national supercomputer centers. These included the Cornell Theory Center at Cornell University in Ithaca, New York; The National Center for Supercomputing Applications (NCSA) at the University of Illinois, Urbana, Champaign; The Pittsburgh Supercomputing Center in Pittsburgh; the San Diego Supercomputer Center at the University of California, San Diego; and the Jon von Neumann Center at Princeton University in New Jersey.

The NSF desired to make these supercomputer centers available to the research community in universities across the country. Many state and regional universities had already developed local and regional networks and some were even TCP/IP based. The National Science Foundation funded a 56 Kbps network linking these five original supercomputer centers, and offered to let any of the regional and university computer centers that could reach this network physically connect to it. This was the "seed" of the Internet network as we know it today and the original reason to connect to it was to access supercomputer facilities remotely.

A number of universities did link to the NSF network to gain access to the supercomputers. But beyond research, they found that the network was useful for other things such as electronic mail, file transfer, and newsgroups. The traffic on the network rose fairly dramatically. In November 1987, the National Science Foundation awarded a contract to Merit Network, Inc. in partnership with IBM, MCI and the State of Michigan, to upgrade and operate the NSFNET backbone using 1.544 Mbps T-1 leased lines connecting six regional networks, the National Center for
Atmospheric Research (NCAR) in Boulder, Colorado, the five existing supercomputer centers, and Merit at the Computer Center in the University of Michigan. No one had ever attempted a data networking project of this scale. Barely eight months after the award, the T-1 backbone was completed on July 1, 1988 linking thirteen sites. It carried 152 million data packets in its first month. Merit, IBM, and MCI also developed a state-of-the-art network operations center at the Merit site in Ann Arbor, Michigan, and staffed it 24 hours per day. The new NSFNet T-1 backbone started with a total of 170 local area networks from the supercomputer centers and regional networks served. On July 24, 1988, the old 56 Kbps NSF network was shut off.

The original thirteen sites include:

- **Merit - University of Michigan Computing Center** in Ann Arbor Michigan.
- **National Center for Atmospheric Research** in Boulder, Colorado
- **Cornell Theory Center at Cornell University** in Ithaca, New York
- **The National Center for Supercomputing Applications (NCSA)** at the University of Illinois, Urbana, Champaign
- **The Pittsburgh Supercomputing Center** in Pittsburgh
- **San Diego Supercomputer Center** at the University of California, San Diego
- **Jon von Neumann Center** at Princeton University, Princeton, NJ
- **BARRNet - Palo Alto, California**
- **MIDnet - Lincoln, Nebraska**
- **Westnet - Salt Lake City, Utah**
- **NorthWestNet - Seattle, Washington**
- **SESQUINET - Rice University, Houston, Texas**
- **SURANET - Georgia Tech, Atlanta Georgia**

It is worth noting that the NSFNet backbone was not the first, and indeed its purpose by this time was to LINK and interconnect the growing "regional” networks setup by various university systems.

In January of 1989, the Merit/IBM/MCI team presented a plan to upgrade the network to higher speed using T-3 lines to handle the rapidly increasing network traffic. IBM developed the first router capable of handling T-3 speeds using their RS/6000 workstations running a subset of UNIX. These were eventually capable of routing some 100,000 packets per second.

In September 1990, Merit, IBM and MCI spun off a new independent non-profit organization known as Advanced Network and Services, Inc. (ANS) to operate this NSFNET backbone and tackle the challenges of moving to 45 Mbps backbone speeds. IBM and MCI each contributed $4 million, and ANS acted as subcontractor to Merit. The backbone was expanded to 16 sites and the final T-3 router was installed in November of 1991. The new 45 Mbps T-3 backbone now connected some 3,500 networks.

This then was the National Science Foundation Network backbone. It reached such a critical mass of participation/population, that it became itself a thing to connect your private network to. The more small networks that connected to it, the more attractive it became. The term "Internet” was first used in 1983 to describe this concept of interconnecting networks. And ten years later, THE Internet was largely defined as having connectivity to the NSFNET national backbone.

There was a great deal of discussion regarding the commercialization and privatization of the NSFNET backbone. The issues centered around whether the government should fund and operate a communications structure that competed with private companies such as MCI, AT&T, Sprint, and others-particularly when a growing amount of NSFNET traffic was becoming largely commercial in nature. To address this issue, a number of private commercial backbone operators joined to establish a separate point for the exchange of Internet traffic. The Commercial Internet Exchange was formed and a router was set up in the Willtel equipment room in Santa Clara, California. In theory,
the private companies were "connected" through this CIX router. As a practical matter, most traffic still transited the NSFNET backbone. But it was a first step in addressing the issue.

National Science Foundation
NSFnet T-1 Backbone

THE NEW INTERNET

In May, 1993, the National Science Foundation issued a solicitation for bids [NSF 93-52] that would radically alter the architecture of the Internet. The NSF was getting out of the backbone business. In its place, the NSF designated a series of Network Access Points (NAPs), really quite similar to the CIX concept, where private commercial backbone operators could "interconnect" much as they had using the NSFNET backbone. But rather than connecting to different points on an intermediary backbone, they would directly connect at a series of single points. In this way, anyone could develop a national backbone for the connection of LANs, sell connectivity to it, and use the NAP as the physical point where they interconnected and exchanged traffic with all the other service providers. The NAPs would be based on a high-speed switch or LAN technology. No content or usage restrictions would be placed on traffic. The NAPs would serve to connect multiple providers, to allow the set of providers to suffice as a replacement for the current NSFNET service.

In February, 1994, NSF announced that four NAPs would be built. One would be located in San Francisco, under the operation of PacBell. The second was in Chicago, operated by Bellcore and Ameritech. The third would be in New York, operated by SprintLink. Sprint had already been coordinating international connections to the Internet for NSF. The New York NAP is actually located in Pennsauken, New Jersey, across the river from Philadelphia. Metropolitan Fiber Systems received the award for the fourth NAP, MAE-East in Washington, DC. Merit was awarded a contract as Routing Arbiter to maintain a database of information regarding the issues of interconnection. On April 30, 1995, the NSFNET backbone was essentially shut down, and the NAP architecture became the Internet.
NAPs ARE A GOOD IDEA

Currently, the heart of the Internet remains the four "official" network access points or NAPs in San Francisco, Chicago, Washington, DC, and Pennsauken. They establish the concept that interconnection is good, and that at least at these four points, anyone can in theory interconnect with the rest of the Internet. This is a key concept. Private backbone operators are not inherently inclined to "share" customers by connecting them with someone else's customers. But the demand to be connected to THE Internet quite outgrew the operators inclinations. If the NSF said that by connecting to what were essentially four "rings in the sand" you were connected to the Internet, then you were.

Unfortunately, the NSF declined to address the concept of "peering." While the NAPs provided a place of interconnection, anyone at a NAP can choose to interconnect with anyone else there, or for that matter, decline to. Today, you can rather easily get a connection to the NAP, but it is quite an "old boys club" as to who will peer with whom. The issue at the heart of "peering" is the concept that in peering with you, a vendor is basically agreeing to allow your traffic to transit his backbone. Most of the backbone operators therefore will only peer with other operators that likewise have a presence at ALL of the NAPs and they are becoming increasingly selective.

But once the resistance to interconnection was overcome via four official NAPs, the concept of interconnecting became increasingly attractive. Why should an e-mail message traveling from one office in Washington, DC, to another across the street have to transit through Chicago just because one of the correspondents uses SprintLink and the other uses internetMCI? The more interconnections you have across the country, if it is physically convenient to cross connect, the more you can shortcut or shunt traffic and avoid bottlenecks. It also decreases total traffic on your network. This concept is called "hot potato routing" in that as a backbone, you should offload packets destined for a site on another backbone at the nearest connection rather than hauling it across country and then delivering it. The destination site backbone should be responsible for cross-country transit.

As it so happens, Metropolitan Fiber Systems, Inc. operates a series of Metropolitan Area Ethernet (MAE) systems in largish metropolitan areas across the country. This is basically a fiber-optic data ring around the city where companies and offices can inexpensively connect to a citywide network. MFS had been quite successful with this in Washington, DC, and MFS facilities made a natural point to interconnect private backbones. MAE-East, located in Washington DC, was actually doing interconnections on a fairly significant scale before the four official NAPs were really off the ground.

Today, MFS operates MAEs in San Jose (MAE-West), Los Angeles (MAE-LA), Dallas (MAE-Dallas), and Chicago (MAE-Chicago). And they actually have two in Washington, DC, the 10 Mbps Ethernet MAE-East, and a higher speed 100 Mbps Ethernet usually termed MAE-East+. The two MAE-East NAPs and MAE West are essentially defacto NAPs, with the other MAEs potentially serving as defacto NAPs. MFS has even gone so far as to redefine the MAE acronym as Metropolitan Area Exchanges rather than Metropolitan Area Ethernets.

Finally, there are two Federal Internet Exchange points: FIX-East at the University of Maryland in College Park, Maryland, and FIX-West at the NASA Ames Research Center at Moffet Field between Sunnyvale and Mountain View, California. These FIXs largely exist to interconnect MILNET, NASA Science Net and some other federal government networks. Since this represents a large population of federal workers, we don't really have an Internet with them totally disconnected. So there has been some interconnection through Metropolitan Fiber Systems largely to these FIX locations, and a largish volume of data traffic still goes through the FIX points. The current aim is to decrease this by moving more of the Interconnect to the official NAPs as they become more operational and, of course, the MAEs. The CIX router is still up in Santa Clara, but is somewhat salutary at this point. CIX also has a router in Herndon, Virginia, but with few actual interconnects there. The CIX and FIX NAPs can be thought of as historical legacy NAPs.
The Internet’s Major US Peer Interconnect Points

Eleven Major Interconnect Points
- 4 “Official” NAPs
- 3 Historical NAPs (CIX/FIX)
- 4 Defacto NAPs (MFS’s MAEs)

So we currently have approximately eleven major interconnection points - four official NAPs, three historical NAPs (CIX, FIX-East, FIX-West), and four defacto NAPs (MAE). Any national backbone operator that has a peer connection at one or more of these interconnects has some connectivity to the Internet. Most of the national service providers are connected to all four official NAPs and often to most of the MAEs as well. This series of NAPs could be considered the “top” of the Internet or the heart of the Internet. That said, at this point most backbone operators are cross connecting with other backbones at virtually any location of convenience where they both have equipment rooms. There are several hundred of these "private" exchanges in operation at this point, and the concept of NAPs has very much become the heart of Internet topology.

More information on NAPs is available through the World Wide Web site associated with each NAP:

FIX - Federal Internet Exchange - http://www.arc.nasa.gov
WHAT IS A BACKBONE?

A brief side trip might be in order to describe what we mean by a backbone. Basically, the entire Internet is a logical construct made up of packet routers that can be connected in almost any fashion, including wireless, satellite, landline, or conceivably smoke signals. These routers are connected in a matrix with each router typically connected to two or more others. The router examines packets and based on their "address" sends or "routes" them in various directions intended to get them closer to their ultimate destination.

As a practical matter, landlines of either copper or fiber provide the best performance and allow transmission of the highest data rates. And so most routers are connected using telephone lines from the existing telephone network. These lines can, and often are for small businesses and individuals, simply Plain Old Telephone Service (POTS) analog voice lines with a 28.8 Kbps V.34 modem on each end. For higher speeds, the routers are linked by leased permanent lines often with higher data rates. You can typically lease a Data Service - 0 (DS-0) 56 Kbps line from any telephone company linking any two points within its system. Similarly, you can lease, at somewhat higher cost, a 1.544 Mbps data line from any telephone company-usually referred to as Data Service -1 (DS-1) or T Carrier Level 1 (T-1). And for yet a bit more money, you can lease a 45 Mbps line Data Service-3 line variously referred to as "DS-3" or "T- 3".

With regards to fiberoptic lines, Optical Carrier level 3 (OC-3) provides a 155 Mbps capacity while OC- 12 provides a 622 Mbps capacity. These are just a few standard, off-the-shelf data line products typically offered by telcos. There are other products such as Frame Relay, etc.

So for any TCP/IP Internet, there is an underlying structure of physical connections-usually provided by an existing local or long-distance telephone company. Additionally, there is the "network" consisting of TCP/IP routers connected by this physical network. We usually refer to these as the physical layer and the logical layer of a backbone.

While leased lines are relatively inexpensive locally, they can be somewhat more expensive when they link distant cities. When we refer to a "national Internet backbone provider," we are describing a company that has physically located a high-speed TCP/IP router in a number of cities, and then leased high-speed data lines from long-distance exchange carriers to link the routers-thus forming a national "backbone" connecting those cities. By doing so, the provider can then sell access to many individuals and companies within each backbone city, and the traffic between cities moves over the leased lines of the backbone. The leased lines can actually be purchased from different long-distance companies for each city. In fact some backbone providers will lease several lines from different carriers to connect two cities so that if one carrier happens to have a problem and the link is lost, the provider still has a connection through the other carrier-maintaining the backbone at a perhaps reduced data rate. This is termed "redundancy."

Currently, backbones are generally formed from 45 Mbps DS-3 or faster leased lines. But this is a gross oversimplification of any backbone. In addition to a half dozen or a dozen major metropolitan areas that a backbone operator may link using DS-3 lines, they will likely extend dozens or even hundreds of less expensive 1.544 Mbps T-1 or DS-1 lines to surrounding communities from the major backbone cities. And they may further extend from THOSE points with yet less expensive 56 Kbps leased lines. The whole makes up a rather complex network often linking hundreds of cities large and small. Generally, we refer to all the nodes of the network owned by the national service provider as points of presence or POPs. Business customers then lease their own telephone lines from the telco to a POP and connect to the Internet. For the purposes of this publication, we will show national backbone providers at the very top high-speed T-3, DS-3 or faster logical backbone level, and then list all known POPs at the bottom level to show the "footprint" of the network. But note that there is often a very complex subnetwork extending this logical top level backbone to those POP locations.

And so generally, when shopping for a high-speed connection, you are looking for a provider with a POP near to you, and you might be interested in the nature of the POP-whether this is a T-3 node, a T-1 node, a 56 Kbps node, and so on. It would make little sense, for example, to lease a T-1 line to a POP that was connected to the backbone network with a 56 Kbps line, and in practice, no backbone operator would allow you to. But similarly, the costs of running a leased line 300 miles to connect to a T-3 connection when a barely used T-1 POP is down the street is a consideration.
LEVELS OF ACCESS

To form a rational image of the Internet, we can somewhat arbitrarily divide the topic into five categories or levels. Level 1 - Interconnect Level – NAPS; Level 2 - National Backbone Level; Level 3 - Regional Networks; Level 4 - Internet Service Providers; Level 5 - Consumer and Business Market

Internet Levels of Access

These are not absolute and indeed you will find many entities that operate in two or more of these levels, but they broadly hold true. We have already discussed the tip of the iceberg level, so to speak, with the network access points. This is where major backbone operators interconnect to establish the core concept of an Internet. Level two would be the national backbone operators, sometimes referred to as national service providers.

The third level of the Internet we think of as regional network operators. Most of these are remnants from the original NSF regional entities that connected universities. JvnCnet in New Jersey and Colorado Supernet in Colorado are examples of regional networks. Typically, they operate backbones within a state or among several adjoining states much like the national backbone operators. They typically connect to a national backbone operator, or increasingly to several national backbone operators to be on the Internet. Some do in fact have a presence at a NAP, but usually just a single NAP. But then they extend this network to smaller cities and towns in their areas with a combination of 1.544 Mbps T-1 lines, fractional T-1 lines, and 56 Kbps leased lines. They connect businesses to those points with direct access connections and usually maintain dial-up terminal banks to offer 28.8 Kbps dial-up SLIP/PPP connections to consumers. In many cases, regional networks are much more extensive than national backbones, just on a smaller geographic scale.
The fourth level of the Internet would be the individual Internet service provider. These vary from small two or three person operations up to actually quite large operations - we know of several with over 100,000 dial-up customers. But they don't generally operate a backbone or even regional network of their own. They lease connections to a national backbone provider, or a regional network operator. They might indeed offer service nationally, but using the POPs and backbone structure of their larger backbone operator associate. AT&T WorldNet actually operated at this fourth level - leasing a backbone connection from BBN Planet - while building a national backbone of its own, which it began operating this summer. Earthlink has a similar arrangement with UUNET as does Microsoft, Pacific Bell links to AGIS. And for that matter, so does George Peace with PAONLINE in Harrisburg, Pennsylvania. Generally, they operate an equipment room in a single area code, lease connections to a national backbone provider, and offer dial-up connections and leased connections to consumers and businesses in their area. They tend to focus on customer service, configuration, and training and often offer lower prices.

The fifth level of the Internet is the consumer and business market. Each time a small office leases a line from its office to an Internet service provider's point of presence, it has in fact extended the Internet by that number of linear feet. With a lot of this happening, we find today that most metropolitan areas of the United States have more linear feet of "Internet" constructed in this fashion than ever existed in the original NSFnet backbone. Further, many companies then setup dial-up ports at their offices for employees to make the connection from home or on the road. Within a few days of connecting to the Internet, most companies find out that internally they too have become an "Internet service provider."

Again, these levels are somewhat arbitrary, but broadly true. There is some cross-dressing. Sprint, for example, operates a NAP at level 1. The company is also one of the largest national backbone operators and, in fact, provide the connection for some 29 percent of level three and level four Internet service providers. In August 1996, Sprint also launched consumer access nationwide much like a level three or four operator.

AT&T on the other hand, with great fanfare and much public relations ado, announced the AT&T WorldNet service in spring 1996. In fact, the company leased all backbone operations from BBN Planet Corp., a national backbone provider. And in turn, BBN Planet operated a mixture of its own backbone, and backbone leased in turn from MCI. As a result, MCI was at least in part providing AT&T WorldNet's backbone. AT&T was in no detectable respect different than George Peace with PAONLINE, and we considered them a level four Internet service provider until AT&T built its own backbone. It is currently migrating its traffic on to it. Even this fall, AT&T continued to carry a substantial amount of traffic on the BBN Planet backbone. BBN Planet, however, became GTE Internetworking in September as part of a merger.

This is not an isolated situation. Deals are cut between operators at and across all levels of the Internet to the point of frenzied confusion. I suspect that some operators are agreeing to buy things from themselves through several third parties in some cases. And there is a fear that somewhere in the Internet there is a single router that all of this hangs on such that one power hiccup and the entire network takes a tumble. The point here is that there is an enormous amount of co-mingling of body fluids in the operation of an Internet. And there is a never ending quest to have the largest, best, and most munificent network, made up entirely of the work and investment of somebody else, and offer it for sale to the public.

Further, the Internet service business is growing rapidly. Many of these organizations have gone through an initial public stock offering, or are in the process of doing so. Enormous quantities of cash are being invested in these companies, and they are adding personnel in groups of hundreds and thousands at a time. The number of knowledgeable Internet technicians and engineers available doesn't approach the need. In attempting to assemble this data into some form of graspable information, we repeatedly encounter marketers and sales people who were enthusiastically and energetically ignorant and confused about their products, the network services they were selling, and just what an Internet is.

The point here is that you are likely to hear almost anything from an Internet connectivity sales representative. Some of it may be true. Some of it they may honestly believe to be true. In general, the signal to noise level is a little discouraging and you should take most assurances of quality, reliability, and service with a grain of salt.

That said, we did encounter other situations where the salesman at the field level was much more informed and competent than anyone at the management or public relations level.
A WORD ON THE QUEST FOR A CLEAR CHANNEL

The very heart of this publication, and particularly this section of it, is to provide networking professionals with some rational presentation of the Internet they are trying to connect to and a basis for comparing the services and connections they are attempting to purchase. It is a task at which we are inevitably doomed to fail, though we hope to fail in somewhat artful fashion. The core of the conundrum is that you want the GOOD connection to the Internet, and don't want to be saddled with the BAD connection to the Internet.

In an ideal world, the GOOD connection would be at the high price, the BAD connection would be at the low price, and you could pick the level of "goodness" based on your ability and willingness to pay. In the chaos of the current market, we have not found a persuasive coefficient of correlation between connectivity quality and price—all nearly hysterical assurances to the contrary notwithstanding.

Much of the feedback from our first directory seemed to be directed at cutting out all the middlemen and getting closest to the REAL Internet or the CENTER of the Internet, or the HEART of the Internet—any event, the GOOD connection. Since there is a geographic component to this, we assembled these maps and comparisons in an attempt to provide information you can use relative to your locale.

The second element of this is the concept of over-subscription of Internet services. Networking professionals accustomed to purchasing voice telephone service, leased data lines for networking, and so on are somewhat insistent on assurances from vendors that they will have 100 percent guaranteed bandwidth as advertised and purchased. "If I buy 1.544 Mbps T-1 pipes, I want the full 1.544 Mbps T-1 pipe available at all times."

This seems reasonable enough. But it is actually related to the quest for the heart of the Internet. There is no center to the network. And the entire concept of clear-channel capacity is alien to the packet-based TCP/IP networking philosophy and technical operation. In other words, it just doesn't work that way, and without total redesign from top to bottom, it cannot. There is no "clear channel" to the Internet because at its essence, the Internet is a packet switching technology and is not channel based.

In voice and dedicated data connections, a connection is SETUP for the duration of the need for a connection. It exists whether used to capacity or not, and is torn down at the end of the communication. In packet networks, there are no connections at all. All packets are individually addressed and aggregated inherent in the routing function. A single text file might be broken into a hundred individual packets, and each packet might take a different route through the Internet to its destination. The software at the two ends keep track of what was sent and received, and retransmits "lost" packets of which there are many.

It is quite common for an Internet service provider to connect to a backbone with a single T-1 and yet sell T-1 connections to multiple customers. The packet aggregation function works quite as designed, and as a function of statistical multiplexing this actually works. Data traffic tends to be "bursty" where you need the 1.544 Mbps connection, but you only need it for seconds. Someone else can use it when you're not.

This actually all works. But the Internet is becoming profoundly congested on some days with relatively high packet losses. We think the problem is not that capacity is oversubscribed from the use end, but rather at the server end. If you put up a web site offering Rush Limbaugh neckties over the Internet and take over a million connections the first day, there isn't enough bandwidth in the world at your server end to handle the traffic—even if your server hardware could keep up. If it is connected with a T-1, you might have 300 or 400 users on THAT end of the pipe at one time. Most of the "congestion" you will see on the Internet centers on individual sites that just can't deal with it. If you access a different, less popular site, the "congestion" disappears. This appears inherent in a connectionless network where we could in response to some event or advertisement all land on the same server at the same time. This is analogous to a single McDonald's Restaurant that finds itself faced with 30,000 starving customers on the same noon hour. There are some traffic problems on the roads, but the roads are basically in good shape. And the McDonald's owner is thrilled. But a lot of people have to wait on hamburgers and in fact, the majority won't get their quarter-pounder at all that day. This reminds me of the T-shirt: "THE INTERNET IS FULL - GO HOME."

So if you could get a guaranteed clear T-1 channel directly to the Chicago NAP, you still don't have one. The routes to almost everywhere else FROM the NAP are aggregated in the same fashion. Larger vendors are no help. If they do have a T-3 connection in your city, they simply sell more T-1 connections off of it and the same dynamic works on a slightly larger scale. The bottom line is that the Internet works to about the same degree the worst part of it
works. And if you could gain a BETTER connection to it, you haven't accomplished a whole lot with regards to day-
to-day performance that your users within your company will be able to detect.

So if you demand a clear channel to the Internet, you are asking for something that isn't available. If someone sells
you a clear channel to the Internet, you've bought something they can't deliver. That is not to say that all vendors are
created equal. Any particular vendor will manage the load factor somewhat differently. But this is a fluid thing. A
vendor who manages this very conservatively in March simply attracts more customers in April, and the pressure to
hook them up and catch up on the load factor later is enormous. Largely, the performance and reliability you will
ACTUALLY experience with your connection to the Internet is ultimately a function of the technical expertise of
those in the equipment room at your service provider.

NATIONAL INTERNET BACKBONE OPERATORS

Since 1993, a number of serious players have entered the Internet service arena, including MCI, Sprint, IBM, ANS,
and others. They basically operate their own national backbones - often larger than that originally operated by the
National Science Foundation. As such any TCP/IP connection to a national backbone operator is inherently a
connection to the Internet.

Many smaller regional networks get their connection from a national backbone operator. Sprint IP Services, for
example, has been quite aggressive in signing up smaller Internet service providers for a connection to the Sprint
backbone. These smaller ISPs, in turn, offer connections to the public and businesses large and small - often at
attractive prices and usually focused on a particular type of Internet user.

Our first issue of the Boardwatch Directory of Internet Service Providers was intended to empower consumers with
information to select an Internet service provider in their area. The availability of Internet connections remains a
very regional or even local proposition. But we were somewhat stunned by the amount of response from LAN
managers in businesses across the country who were also a bit perplexed by where and how to get the "good"
connection to the Internet in their area.

In our Summer 1996 issue, we expanded the directory to include descriptions of the national backbone operators.
And we expanded coverage to include the lists of points of presence (POPs), telephone access numbers, backbone
maps, and product descriptions. We diagrammed 9 backbones in the summer issue, 14 in the fall issue and the
number continues to grow with 40 profiled in this issue.

This can be useful for LAN managers in a couple of ways. First, even at the backbone level, where you are makes a
difference. Generally, backbone providers have their BIG backbone, typically operating at DS-3 or greater speeds-
quite a few now introducing 155 Mbps service and talking about greater speeds. From each "node" on this
backbone, other cities are serviced with smaller DS-1 or often multiple DS-1 lines operating at 1.544 Mbps. If you
are in a specific city that is a MAJOR NODE at DS-3 speeds for one service provider, but a minor node with 1.544
Mbps service for another, you would probably be attracted to the larger node-particularly if you were looking for a
T-3 or fractional T-3 connection.

Unfortunately, selecting an ISP is not nearly as simple as finding the big nodes and calling for a connection.
Installation times, prices, and services all play a role. Over and over, we find much smaller ISPs offering better
services at a much better price. But even then, you may need to know whom THEY are connected to for THEIR
connection. It can make a difference. You may only need an ISDN connection from a small service provider, but if
they have multiple T-1 connections to a backbone provider with a T-3 in your city, you may have much better
performance than to a national service provider that has a T-1 connection to the entire city.

For larger companies, it may be a balancing act between several city locations where you have offices to find the
national service provider with the best average connection to all the cities you are trying to connect.

That said, it is our hope that by providing a map of the major interconnection points, and then maps and POP lists
for each of the national backbone operators, along with specifics on where they interconnect, we can provide a
picture of how the Internet is laid out, and how each national backbone operator or Internet service provider fits into
it. In this way, you can locate your own position on the Internet.
SHOPPING TIPS

Provisioning Internet service often entails a number of operations:

The Installation Charge
This is a onetime setup fee the provider charges to set you up with the service. It can vary widely, not only in price, but in what is included. Some operators actually provide all customer premise equipment as part of the setup charge. Others provide no customer premise equipment but use the setup charge to equip THEIR end of the connection to accommodate you.

Customer Premise Equipment
The basic customer premise equipment consists of a Channel Service Unit/ Digital Service Unit and a router. The CSU/DSU is the "modem" that connects to the telephone line. The provider will have a similar unit at his end. A variety of brands of CSU/DSU are available, and we've found features relatively unimportant. They work or they don't. But they do differ by speed. Generally you will use a different CSU/DSU for 56 Kbps connections than for T-1 connections.

The CSU/DSU connects to the router, typically using a V.35 cable. The router typically connects to the CSU/DSU on one end, and via Ethernet to your local area network on the other. Generally you are better off selecting a CSU/DSU and router that your provider is familiar with. It is rare to get these installed without some configuration issues. Often the provider will offer a package CSU/DSU and router for a price. In any event, if you want assistance from the service provider in setup and configuration, it would be helpful to provision equipment they recommend or are familiar with.

Port Charge.
The port charge is typically a monthly recurring charge you pay the service provider for the connection to his router, and thus to the Internet. It varies by bandwidth generally.

Local Loop Costs
In general, providers do NOT include local loop costs in their quoted monthly recurring charge. Typically, you contract with your local telephone company for the necessary line from your office to the provider point of presence. This is not an insignificant additional expense. It will typically be half again as much as the port charge. Since some providers DO include the local loop charges in the port charge, you do need to ascertain whether it is included when comparing prices. Broadly, a 10-mile local loop at T-1 speeds seems to run in the neighborhood of $500 to $600 monthly right now. Frame Relay connections tend to be less expensive, but can suffer in efficiency and additional congestion. Often, the ISP will manage the local loop ordering and installation process for you, but it almost always involves a custom quote on the additional cost.

Incidentals
There are a number of small but important items necessary to complete your connection. Domain name registration, for example, typically carries a one-time fee of $100 to register your company domain name (i.e. Boardwatch.com.) for the first two-years and a $50 annual renewal fee. The provider typically maintains a domain name server and forwards e-mail to you. You may want a number of POP e-mail boxes maintained on the server so that you do not have to run your own mail server, for example. If you want a Usenet news feed, this may or may not incur additional charges. Most providers are now hosting web pages for customers on provider equipment, usually for a fee and some even offer design services.

Installation Time
Incredibly, in a world of instant networked communication, it can take 3 to 8 weeks to set up a high-speed connection to the Internet. Check to see average installation time from date of signed contract.

Network Operations Center
Despite all assurances of reliability you may hear, we've never heard of anyone on the Internet who did not encounter periodic service outages. How you reach your provider and what they do in response in the event of outage is a critical element to consider. A 24-hour network operations center manned and capable of getting your link back up with a simple phone call from you is a huge plus. If you get voice mail and pager procedures when your network is down, you'll not likely be a happy Internet camper.
A WORD ABOUT IP ADDRESSES

The identity of your network and every computer on it depends on Internet Protocol addresses of the form 204.144.169.10. Typically, you will need a Class C IP address block for up to 255 machines (204.144.169.0 through 204.144.169.254, for example). You can use multiple Class Cs for more machines. In theory, these are your addresses, and until 1995 you would typically obtain them directly from the InterNIC, and they were yours for life.

The growth of the Net brought on some problems in the speed and design of packet routers. A router receives packets in one port, opens the packet, examines the header for address information, and sends the packet on its way via one of several routes depending on its ultimate destination and the connections the router has. To do this, it maintains a table of "routes."

As the network has grown, the size of this router table has grown correspondingly - and somewhat alarmingly. To alleviate this, the Internet community developed a concept referred to as Classless Inter Domain Routing or CIDR. In its most basic form, CIDR is a shorthand notation for routers that replaces thousands of addresses with a simple reference to another backbone provider that services those addresses. So all packets destined for any of these gazillion addresses can simply be routed to Sprint, for example, and the machine knows how to route from there.

The problem is that as the routing tables have grown, addresses that do NOT fall into a block of some size somewhere, have been eliminated from some routing tables. Sprint was the first to employ this obnoxious tactic beginning in June of 1995. Its version of the Internet simply didn't include some addresses in the 204.xxx.xxx.xxx and 206.xxx.xxx.xxx ranges. So if you were in one of those address ranges, anyone connected to the Sprint backbone couldn't reach you. This has the potential of fracturing the Internet into several networks based on addresses.

In practice, it doesn't quite. It simply strands a few small companies. But it ends the concept of independent Internet addresses. In general, you will have to obtain an IP address from your Internet service provider and so exist as part of the provider's CIDR block to be assured of being reachable. The downside to this is that if you change Internet service providers- after being notified of a 400 percent price increase, for example- you will have to reconfigure every machine in your network, a tedious, expensive, and error prone process given the current software and operating systems. As a result, Internet service providers have a bit of a hold on you as a customer. This makes the initial selection of an Internet service provider perhaps more important than it might otherwise be.

A FEW NOTES ON THE NATIONAL BACKBONE PROVIDER SECTION

As noted, the Boardwatch Directory of Internet Service Providers was intended to provide a handy reference to locating an Internet service provider in your area. Internet connectivity is an almost totally unique commodity. The more of it you have, the more valuable it becomes. The more of it you sell, the more of it you have. Anyone you sell it to can likewise sell it. And the MORE middlemen you get in the game, the LESS expensive it becomes to the end user.

We received a tremendous response since the first issue of this directory. But much of it showed an intense curiosity to learn the structure of the Internet, and basically to map position on it. Many people were looking to cut out the middleman to cut costs. Some wanted to be closer to the "heart" or center of the Internet believing they would have better performance. No explanation of why these things weren't so would suffice. And most were just so overwhelmed by the misinformation and disinformation not only in the press, but from sales representatives of various services as well, that they welcomed any reliable information-even if they had no instruments to detect it when they were getting it.

In attempting to compile the information provided here, we encountered a number of difficulties. First, everyone we spoke with agreed that we were certifiably nuts trying to diagram the Internet on old-fashioned, two-dimensional paper. We were assured it could not be done, that we shouldn't try, and if we did anyway: Could they have a copy?

In fact, getting information from many of the backbone providers is often an arduous task. In many cases, they simply didn't know or more commonly they do not have it in a format that is readily communicable even to us. So it is in many cases a bit of a treasure hunt within these corporations to come up with the information we request. Our profound thanks to those within these companies who scramble under short deadlines to get what must seem like
terribly detailed information for relatively indecipherable purposes. This continues to be an arduous process for these constantly evolving companies.

From another point of view, this continues to be a terribly dynamic and exciting area. All national providers are expanding the number of points of presence and building or upgrading backbones at an incredible rate. It is worth noting that a publication such as this is inherently a "snapshot in time." In some cases we find that building is not quite as fast as public relations groups imagine. We have to omit a few providers simply because their backbones are not quite built yet. We will continue to expand the Directory each issue and will certainly include additional operators as they come online.

There is also a certain level of "Secret Internet" at play. Virtually all vendors have some information regarding POPs, backbone development, prices, or other elements that you would think would be very public information-that they consider very proprietary. This would be more persuasive if it was the SAME information across all providers, but it is essentially different with each one-lending a certain element of comedy to some of our conversations. We actually had one vendor tell us they would have to get clearance to release the SALES telephone number for their network. Again, there is a certain paranoia and confusion at work here that is comical to watch, but probably less comical if we were in their shoes.

Finally, we are frequently surprised to learn that a few providers simply don't want you comparing prices, services, and terms. We find this most surprising in its inherent hopeless naivete. If at this stage of the game, anyone is trying to build a business based on the "sucker born every minute" philosophy they won't be operating long in any event. One vendor took the profoundly arrogant position that they didn't WANT to be compared with those "other" networks - they are "unique." Unique in their own mind they may perhaps be, but for good or ill they will be compared-at least among those shopping for network connections-their current and potential customers.

But with a few disappointing exceptions, the national backbone operators are very cooperative in helping us assemble this information, and truly would welcome a more informed customer. For the most part, they are working night and day to get new customers up and in operation in a networked world, and provide the best possible service at the least cost and with the least headache. A few verged on the heroic in answering our endless and possibly mindless questions.

internet MCI, for example, has not released an updated backbone diagram since June 1996. Their claim that such information leaves them vulnerable to terrorist acts is not persuasive. But they have become terribly secretive with regards to their network topology and this sort of dark secrecy rather begs the question: What are they hiding?

Finally, many of them were correct in that casting a multidimensional Internet onto two dimensional paper stock just may be a fool's quest. And diagramming the very top-level backbones of the Internet, listing the POPs and prices and number of employees and so on may be somewhat akin to chipping a handful of paint flakes off the side of a battleship and taking them around to show people what a navy looks like. But we are persuaded by the screech in our phone that there is a need for a portable paper reference to use in comparing services and trying to visualize what it is we are all supposed to be connecting to and with. We will attempt to improve it over time in successive issues of this directory. Any clear suggestions of specific information you would find useful would be most welcome.