Internet: A Technical Primer

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EDITOR'S NOTE:
In its continuing coverage of the Internet, the IS Audit & Control Journal *has initiated this three-part article documenting the history of the Net and the control and security issues associated with it. Part One, published here, presents an overview of the Internet, including its development and inherent control and security risks. Part Two, which will be published in the next issue, will focus on Internet uses and services, while Part Three will cover in greater detail what threats the Internet poses to corporate computer facilities and recommendations for protecting information.*

The Internet is a superstructure interconnecting diverse computer networks worldwide and is rapidly becoming an essential communication infrastructure of modern civilization. The users of the Internet have access to a variety of services ranging from traditional electronic mail, remote login and file transfer, to the World Wide Web (WWW).

The WWW or "Web" is the most sophisticated modern information system distributed over the Internet and its development is mostly responsible for the recent explosive growth in Internet usage and popularity. One of the most important features of the Web is its friendly graphical user interface.

The growth of the Internet has been formidable. The number of Internet hosts (a computer site with its own Internet protocol number providing Internet function to other sites on the Net) has been increasing exponentially as shown in Figure 1[1]. It shows number of sites (in thousands) versus a time scale.

> *"The Internet is purposefully anarchic. Its only central organization deals with standards, protocols and the establishment of domain names."*

Background

The seed money for the development of what has become the Internet was provided by the US government for the purpose of creating an independent computer network capable of sustaining its function after a massive nuclear attack. Designed to connect many heterogeneous networks, this network of networks evolved into a self-managing global computer super-network.

For a long time the major Internet backbone in the US was supported by the National Science Foundation. This governmental support was phased out and, starting in May 1995, the US part of the Internet has been privately owned and operated. As a result, a new Internet structure has evolved in the US.

The base of this new architecture is anchored to four all-purpose Network Access Points (NAPs). These NAPs are located in the vicinity of San Francisco, Chicago, New York and Washington DC, and are operated respectively by Pacific Bell, Ameritech, Sprint and MFS Datanet.

The NAPs allow various computer networks within the Internet to interconnect and exchange traffic. At the top of the Internet service provider hierarchy are the Network Service Providers (NSPs). The NSPs (e.g. MCI, Sprint, ANS, Alternet, PSI) maintain their own large-scale wide-area networks, and, by the National Science Foundation rules, must connect to at least three of the NAPs. NSPs may also interconnect their networks directly (see Figure 2)[2]. Most of the NSPs implement their backbone networks using high-speed lines (i.e. T3 lines with the speed of about 45 MB per second).

Regional Network Providers (RNPs) comprise the second tier of Internet service. The RNPs usually connect to the Internet through NSPs, but may also have direct connections to NAPs. Larger organizations usually connect to the Internet through RNPs while individual customers or small organizations typically connect to the Internet through intermediaries, the so-called Internet Access Providers (IAPs),

Figure 1

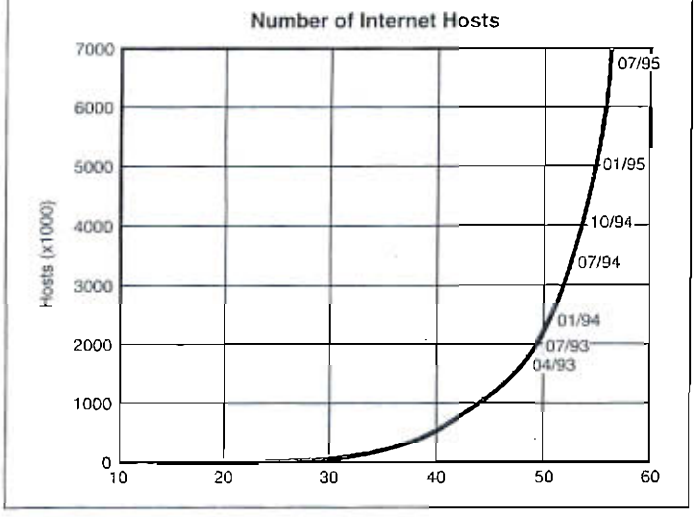
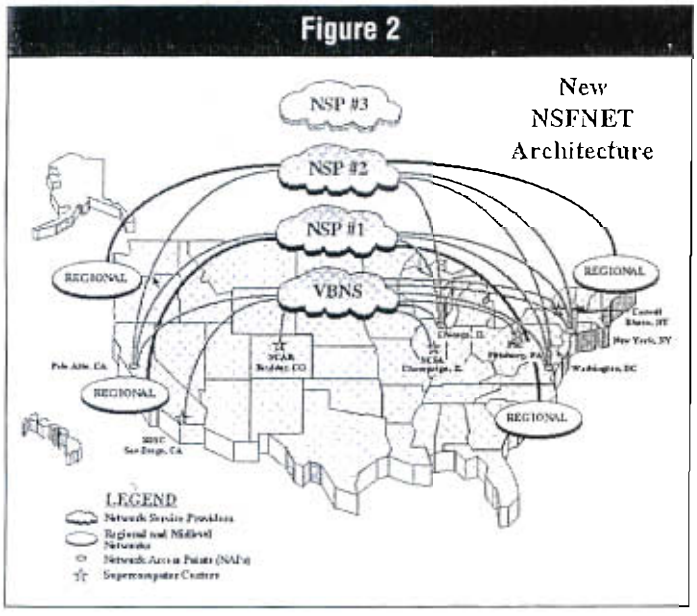


Figure 2



who resell Internet access over telephone dial-up connections. Boundaries between various types of Internet Service Providers are not well-defined.

Congestion on the Superhighway

Since it was developed as a research project, the Internet architecture has not been geared to support its function in a completely privatized free-market environment. The majority of the early Internet users were academics for whom Internet access was free. Universities and governmental organizations paid flat fees for Internet access with unlimited usage. Driven by technological developments, communication needs and media attention, the Internet usage is exploding exponentially. As a result, sporadic delays due to Internet traffic congestion occur with increasing frequency.

When Internet traffic congestion happens, end users start experiencing significant slowdowns in establishing connections with remote computers, in the speed of information flows (the number of bytes transferred per unit of time), and, in the most extreme cases, the unavailability of certain Internet services.

Figure 3

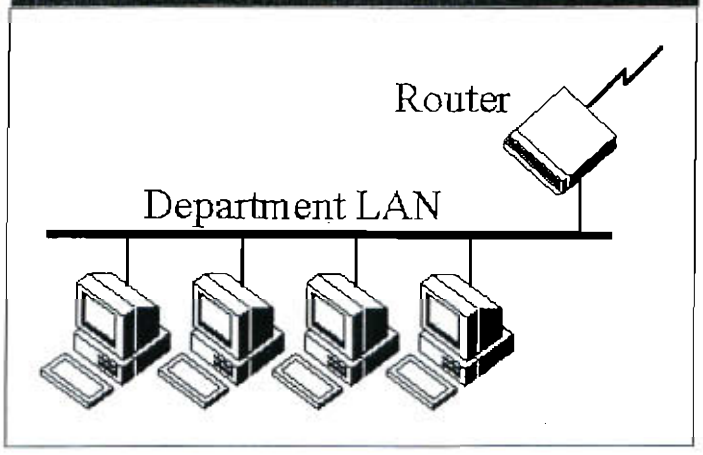
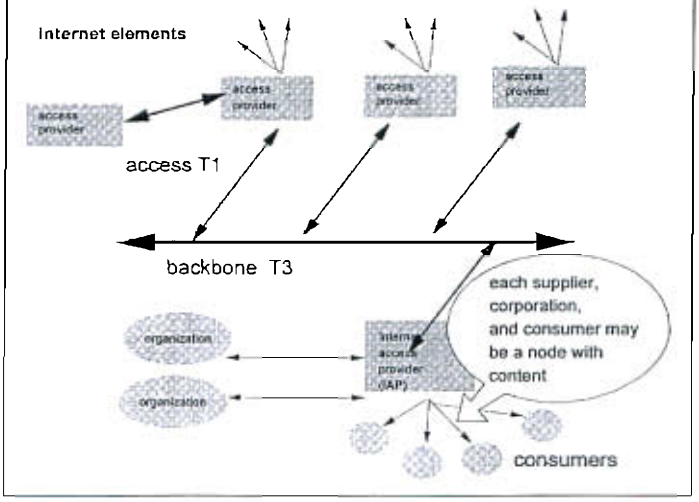


Figure 4



Technically, congestion happens when the pipe is not wide enough, or more important, the routers are overwhelmed by the number of packets they get.

Routers, TCP/IP and Packet Switching

The basic building blocks in the Internet architecture are local-area networks (LANs) of computers located in relatively close proximity and physically connected. The LANs connect to the Internet through specialized computers, called routers, which direct information traffic (see Figure 3)[3]. The routers and the dedicated long-distance wires that connect them form the structure of wide-area networks (WANs). The most important "high speed/high bandwidth" long-distance wires are collectively called the Internet backbone.

All the computers talk to each other using a special Internet language known as the TCP/IP (transmission control protocol/Internet protocol) protocol suite. Computers send information to each other in packets.

"The upcoming advent of US$500 Internet computers and improved bandwidth access to the home will further...increase computer user populations."

Packets are basic information units consisting of a header and a body. The header contains source and destination information, while the body contains a portion of transmitted data. Typically, Internet packets range from a few bytes to more than a thousand bytes[4]. Whenever a message is transmitted over the Internet, it is first partitioned into packets of appropriate size. Packets of each message may traverse the Internet following different routes to be reassembled at their destination point. The paths of packets are determined by routers which read packet headers and direct them in accordance with certain algorithms.

Internet Access and Security

The Internet backbone links the NAPs which provide access to the retail Internet Access Providers (IAPs), which in turn give access to consumers through typically narrow channels (called PPP or SLIP and ranging in speed from 2.4 kbs to 28.8 kbs). IAPs provide wider channels to organizations generally ranging from 56 kbs lines to 1.5 mbs (T1) lines.

While the geographic description of the setup (Figure 4) gives a feeling for the basic structure of the Internet, it is important to emphasize several factors:

- Each node of the Net typically is responsible for three costs: 1) the cost of its computer facilities, 2) communications costs to the access provider, and 3) access fees paid to their IAP;
- Internet access is not free but is often paid by an organization (i.e. a university or a corporation) rather than by individual users;
- In the Internet world, any node can be either a user of the Net (i.e. client) or a content/service provider (i.e. server), to the world;
- Typically, any Internet site which has content will tend to be a constantly connected node with its own Internet address (IP address). These numbers are translated to what is called "domain names" for access and contact by other nodes; and
- Traditionally "online services" (e.g. America Online, Prodigy and Compuserve) were distinct service providers, with their own content structure and access communication lines. During 1994 and 1995, online services became a more integral part of the Internet by providing gateways and access to the Internet (consequently acting as IAPs). Many predict that in the future online services will become a nearly indistinguishable part of the Net.

Large organizations will use "firewalls" to monitor, manage and limit access to their facilities as well as to increase the security of their installations. Firewalls act as computer gateways which allow employee remote sign-on. They also permit the passage of legitimate messages and connections from the outside world (see Figure 5).

A PPP/SLIP access typically means that when a client (user) accesses its provider, it is assigned a temporary IP for the duration of that session. Each site will typically have a

definition of the type of services it provides ranging from basic e-mail to WWW services. Some sites can specialize in providing audio services, technical information through FTP, etc.

Audit and Control Issues

Figure 6 displays several concepts related to the Internet "hierarchy." The Internet is purposefully anarchic. Its only central organization deals with standards, protocols and the establishment of domain names. Much of the administration is delegated progressively to lower and lower levels of the hierarchy.

While this architecture and relative absence of controls allows for nearly unlimited Internet growth, it can also cause problems associated with network congestion, lack of content control, limited standardization of nomenclature, security weaknesses, capacity planning, etc.

A Net server (that has content) will typically have a layer of software on top of its operating system for Net connectivity The typical PC connected to the Internet, as described in Figure 7, will use a communication layer to connect Windows to a transport line (say regular telephone twisted pair) and a browser/manager software (say Netscape) to interpret and present the data (files) obtained in the network. A more basic setup would be DOS-oriented using e-mail, telnet and lynx (a character mode browser).

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Along with the opportunities, the Internet also added a major layer of risk to corporate information systems. While firewalls and careful monitoring of Internet access may somewhat mitigate corporate risks, anonymous access to corporate computer facilities greatly increase corporate risk. These risks and the IS control professional's role will be discussed in a forthcoming article of this series to be published in the *IS Audit & Control Journal*.

Endnotes and Sources

[1] http://www.nw.com/zone/hosts-graph.gif
[2] http://pelt.cis.yale.edu/pcit/comm/ipdept.gif
[3] http://www.cerf.net/cerfnet/about/gif/nsfnetmap.gif
[4] A byte is a unit of information that consists of eight binary (0 or 1) digits.
[5] Siyan, K. and Hare, C. *Internet Firewalls and Network Security*. McMillian Publishing: New York. 1994
[6] Gessner, R. "Building a Hypertext System." *Dr. Dobb's Journal* (June 1990), pp. 22-33.

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Figure 5

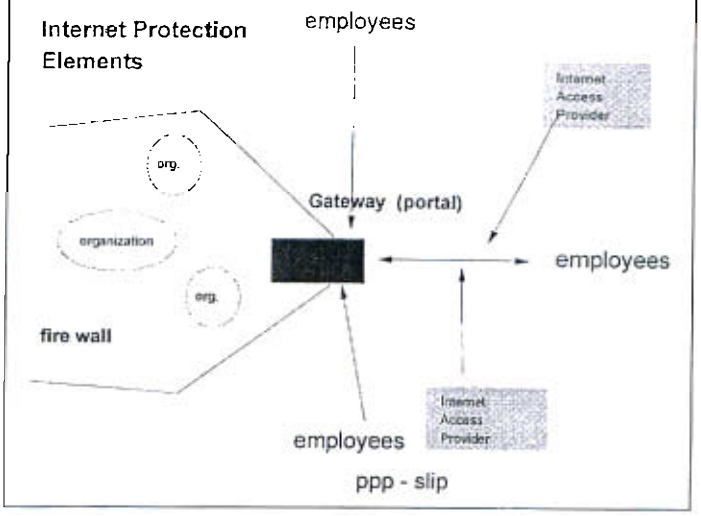

Figure 6

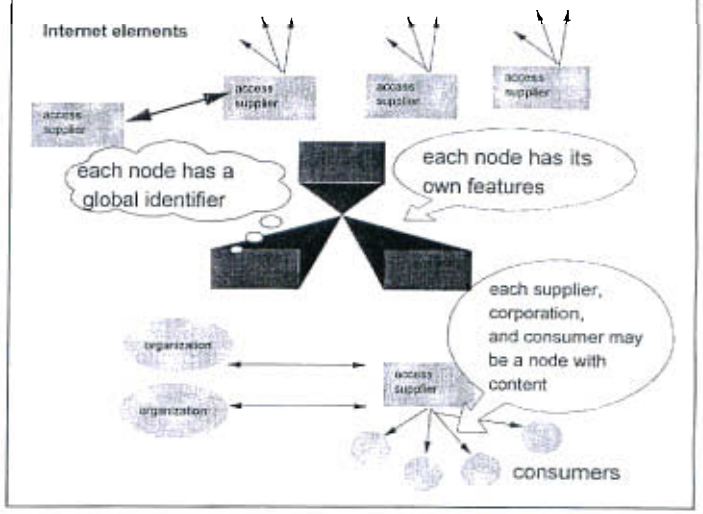

Figure 7