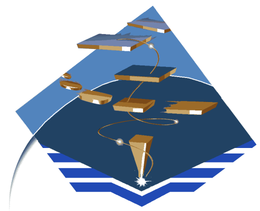
IBM eNetwork Communications Server



White Paper

"Energize your business network"

January 27, 1998

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Abstract

IBM eNetwork Communications Server is an integral part of the IBM eNetwork Software family. It provides host and Internet access, network integration, and end-to-end connectivity solutions. These interconnect people to the information they need with enterprise-class dependability and network computing support for e-business.

Communications Server is IBM's premier open solution for your networking needs, providing industrial strength SNA services on a workstation platform, over both SNA and TCP/IP networks. It is a high-performance multifunction multiprotocol gateway and networking application platform that enables workstations to communicate with other workstations and with host computers. It offers a robust set of communications and systems management features, to enable users to communicate through terminal emulation and client/server and distributed applications across local and wide area networks. It also offers a rich set of network management and client/server application programming interfaces (APIs). And Communications Server provides the widest range of connectivity across the industry.

Communications Server is the solution for companies who:

- run multiprotocol or multiple networks
- want to consolidate or change their backbone networks
- have SNA applications that they want to extend over TCP/IP networks
- have sockets applications that they want to extend over SNA networks
- have IPX applications that they want to extend over SNA networks
- have NetBIOS applications that they want to extend over SNA networks
- have IPX applications that they want to extend over TCP/IP networks
- have NetBIOS applications that they want to extend over TCP/IP networks
- want to provide SNA 3270 host access to TCP/IP users using TN3270E emulators
- want to provide IPX and TCP/IP attached clients access to SNA applications
- have users who want to get connected to a corporate intranet or to the Internet
- want to improve network availability
- want to ready themselves for high-speed networking such as ATM
- want to access data from anywhere using familiar interfaces and protocols
- need to support users in a variety of locations, in the office, at home or on the road

Communications Server provides an essential foundation for networked computing by providing industrial strength support for the most widely used networking technologies, enabling customers and business partners to build client/server applications that are independent of networking protocol or hardware, while preserving their investments in existing systems. Throughout this paper, the term "Communications Server" will be used to refer to IBM eNetwork Communications Server for OS/2, IBM eNetwork Communications Server for AIX, and IBM

eNetwork Communications Server for Windows NT. The full product names will be used where appropriate to highlight any differences between the products.

IBM eNetwork Software Family Overview

IBM eNetwork Software provides enterprise-class universal connectivity and information access for cost-effective network computing. By combining IBM's expertise in delivering industrial-strength solutions for the enterprise environment with the latest networking technologies, eNetwork Software provides the foundation you need to capitalize on the latest technologies and ways of doing business.

eNetwork Software offers a full range of networking software products:

The Communications Server product line connects people and applications, even when platforms and networks are diverse. This gives you the freedom to address business issues without being hindered by application dependencies or network design.

With a broad range of communication clients, eNetwork Software puts information within the reach of all users. From Personal Communications, the industry's premier solution for emulation and desktop communication, to Host On-Demand, a Web-based solution for accessing host applications, you can select the access method that's best suited to your needs. And with Communications Suite, the most powerful "universal client" available today, you have complete and easy access to your host applications, Lotus Notes, your intranet, and the Internet -- all in a single package.

eNetwork Mobile makes it possible to extend your applications and data even further through wireless communication to connect your mobile employees, wherever they are, to the enterprise.

It's more than just breadth of products that makes eNetwork Software unique in the industry. eNetwork Software products are designed and built on the essential elements required to address your networking needs:

Enterprise-class dependability
End-to-end universal access
Easy implementation and use
Effective network utilization

With eNetwork Software, you'll see your network as a competitive business advantage, not an IT constraint.

For more information about IBM eNetwork Software, visit our Web site at:
http://www.networking.ibm.com/eNetwork

Communications Server: Energize your business network

What is Communications Server?

IBM Communications Server is an integral part of the IBM eNetwork Software family. IBM has long been a leader in communication software. With the introduction of the Communications Servers IBM has implemented the broadest set of functions and connectivity, all based on industry-standard solutions and optimized for the platform of your choice. Fundamental to today's client/server and networked computing environments, Communications Server builds on the leading peer-to-peer networking protocols of Advanced Peer-to-Peer Networking (APPN) and TCP/IP. Communications Server has been built from tried, tested and award-winning components, to provide advanced function and performance as a standalone communications gateway or in support of other communications and application servers. However, it is much more than a repackaging of existing IBM technology: with the Communications Servers, IBM has implemented a fundamental change - from SNA-only gateway products to multiprotocol, multifunction gateways designed for interoperability.

Communications Server meets the requirements of customers who need reliable and powerful networking support, to enable workstations to communicate with other workstations and with host computers over today's leading networking technologies, and who need to maintain a competitive edge by being positioned to exploit the emerging high-speed networks of tomorrow.

Communications Server meets those requirements by providing:

- powerful multiprotocol gateway function to connect SNA and TCP/IP networks, enabling SNA and sockets applications on any platform and from any vendor to be transported across interconnected SNA and TCP/IP networks
- Communications Server for OS/2 Warp also includes a LAN gateway function to provide support for IPX or NetBIOS applications running over an SNA or TCP/IP network
- TN3270E server function to provide SNA 3270 access to host systems for TCP/IP users using TN3270 emulators
- Host On-Demand*, Web-based access to 3270 applications
- powerful SNA gateway function for any product using the industry standard 3270 display and printer protocols
- powerful multiprotocol access node function, which gives customers protocol independence, enabling them to run SNA and TCP/IP applications regardless of the transport network to which workstations and hosts are connected
- full support for APPN, providing state-of-the-art dynamic routing for SNA applications, such as client/server applications written using APPC or CPI-C, including 5250 and 3270 protocols, high performance routing (HPR), and dependent LU requester (DLUR) support
- a rich set of programming interfaces for client/server and network management applications
- the most extensive range of connectivity options in the industry for local area (LAN) and

wide area networking (WAN)
- Communications Server for Windows NT allows IPX and TCP/IP attached clients to access SNA APIs without SNA Protocol (split stack)

Today's networking challenge

In today's constantly changing environment, effective businesses depend for their prosperity, and even survival, on their ability to exchange information quickly and efficiently throughout the organization. The network that makes this possible should be and usually is invisible to its users - until it slows down or stops altogether. In any organization, the challenge for the network manager is to keep that network invisible, delivering data where it's needed, when it's needed, while at the same time ensuring that future requirements can be catered for with minimum disruption.

In the early days of computing networks, while this was not always easy, it was usually relatively straightforward. The number of key business applications to be supported was small. The work force was often centralized. The choice of networking standard was usually dictated by the choice of mainframe - for very many companies, of all sizes, this meant SNA. Today, the challenges of interconnecting people and applications in an invisible network are considerably greater. Corporate networks are required to support a constantly increasing number of diverse and complex networked applications. The work force is increasingly dispersed. The choice of networking technologies and protocols is no longer clear cut. Many organizations now have multiple networks, whether as the result of mergers or acquisitions or reorganization, or arising from a business strategy to incorporate the best technology for individual business requirements.

Given this diversity, the network manager is now expected to

- accommodate complex and constantly changing application requirements, while protecting the investment in existing applications
- maintain existing service level agreements for response time, availability and reliability, while maximizing the efficiency of the network and minimizing its costs
- position the organization to exploit new technologies, such as client/server applications, the Internet and high-speed networking such as ATM

Communications Server is designed to address these challenges by

- delivering protocol independence
- delivering advanced networking solutions
- delivering breadth of function and connectivity and capacity to support future needs

How it does this and the key technologies it uses are explained in the following sections.

Delivering protocol independence

Providing SNA 3270 application access to TCP/IP users

Communications Server provides TCP/IP and Internet users with easy access to IBM central computers through support of TN3270. This support provides Telnet 3270E server functions to TN3270E/TN3270 clients. It provides the functionality to convert Telnet client traffic to SNA format for communications to the host system and converts SNA traffic to Telnet format for communications to the clients. Supporting the new industry-standard TN3270E, Communications Server provides 3270 terminal and printer emulation to TCP/IP users enabling support of locally attached printers or printers in their TCP/IP network. TN3270E support also includes confirmation of print requests, positive and negative responses, handling the ATTN and SYSREQ keys, and support for LU classes (which simplifies user access, groups users by applications needs, and maximizes host resources). Telnet 3270E clients have the ability to request specific host LUs. In addition, an administrator can dedicate host LUs to specific Telnet 3270 and Telnet 3270E clients providing a higher level of security. Communications Server supports any industry-standard TN3270 or TN3270E client and is compliant with industry standard Request For Comment (RFC) 1576, 1646 and 1647. The TN3270E Server function enables you to configure your network as shown in Figure 1.

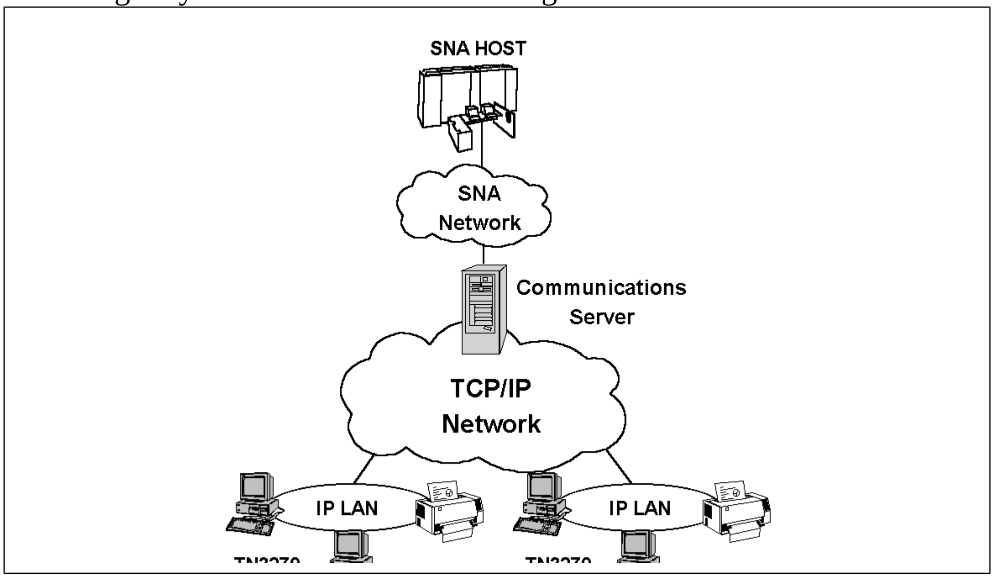

Figure 1. TN3270E Server with Wide Area TCP/IP Network

The TN3270E Server function supports:

- Terminal emulation
- Host print
- Response handling
- ATTN and SYSREQ key handling
- LU classes

TN3270E Server supports both standard and extended Telnet 3270. Typical client programs emulate a 3270 display. Clients that support the TN3270E protocol can emulate LU1 and LU3 printers.

SNA API client solution with Communications Server for Windows NT

The Communications Server SNA API client solution allows TCP/IP and IPX attached clients to access SNA APIs. This solution also gives you the ability to run SNA applications without installing an SNA stack on the client. Because almost all SNA configuration and processing is done on the server, you can reduce DASD, memory, and processor demands on your clients. And your System Administrator saves time by not having to configure SNA on every client.

The SNA API clients provide support for CPI-C, APPC, EHNAPPC, and LUA request unit interface (RUI) API interfaces and are packaged with the Communications Server for Windows NT. Supported clients include OS/2, Windows 3.1, Windows 95, and Windows NT as illustrated in Figure 2.

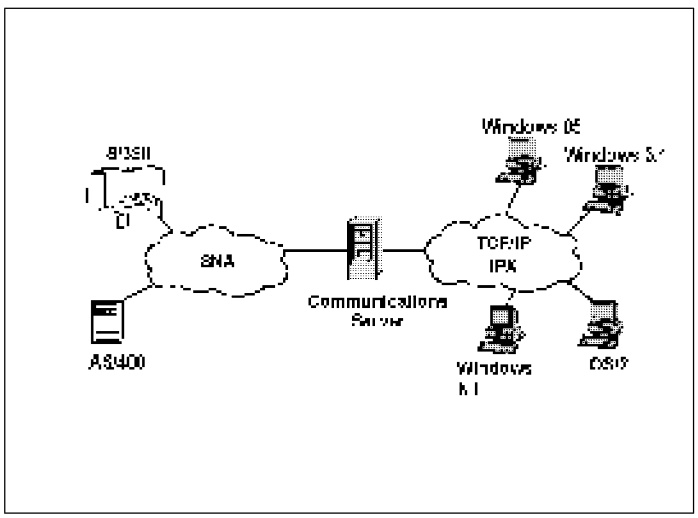

Figure 2. TCP/IP and IPX Attached SNA API Clients

Accessing SNA central computers directly from Web browsers

IBM’s new Host On-Demand reinforces IBM’s strategy to help customers integrate existing data into new, Web-based solutions.   IBM Host On-Demand is a high-performance cross-platform TN3270 (Telnet 3270) solution for intranet and World Wide Web users with an occasional need to access computer applications or databases in their company’s central computers. Access is as simple as pointing and clicking on an icon or menu list from within a Java**-enabled PC or workstation. No customer programming or additional hardware is required.

IBM Host On-Demand is an Internet-to-SNA interconnectivity solution that provides 3270 application discovery and access through the World Wide Web. Web users needing host applications, such as public catalogs, software applications, databases, or other resources, can use Host On-Demand from inside their Java-enabled Web browsers to access central computer data. For Web-oriented users with occasional need for central computer access, Host On-Demand provides an alternative to installing a terminal emulation program on the desktop. Host On-Demand brings network computing to the Web by enabling Web browsers to seamlessly access non-Internet-based content and services.

Host On-Demand uses the Java environment, the native TN3270 support provided by Communications Server, and Internet protocols to provide platform-independent host access from within a Web browser window. Host On-Demand integrates existing central computer data and resources with intranet, Internet, and Web capabilities. The result is dramatically increased availability of host-based information for Web-oriented users. Figure 3 below, shows how the Communications Server, with Host On-Demand installed, can provide SNA 3270 access to MVS, VSE, or VM systems for any Java-enabled web browser.

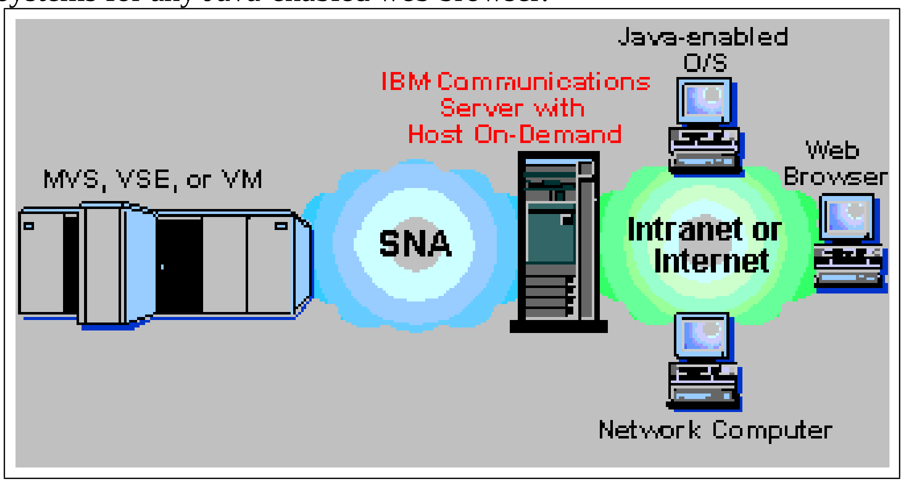

Figure 3. IBM eNetwork Communications Server with Host On-Demand

Multiprotocol Support

In addition to providing access to SNA 3270 applications to TCP/IP users, Communications Server delivers network protocol independence, allowing application design decisions to be made based on the characteristics of the application and not on those of the existing network. In this section we will explore why this is important and how this is achieved.

With the growth of networking in general and local area networks in particular, many large customer networks have become collections of individual networks running different networking protocols. This situation occurs and will continue to occur for many reasons: as one company merges with another that already has a different kind of network; as a company decentralizes and increased autonomy encourages each department to make its own decisions relating to IT infrastructure; as customers become more concerned with choosing or developing the right business application than with the networking interface or protocol for which it was designed. In many cases, whether by accident or design, companies run duplicate physical networks. This considerably increases their IT infrastructure costs and requires them to invest in a multiplicity of increasingly scarce skills. It also makes network management more complex.

A number of solutions have arisen over the last few years to try to solve this problem. One of the most common techniques is encapsulation, or tunneling, in which one protocol is enveloped in another for transportation across the backbone network. This technique has been widely used, partly because it is relatively easy to implement, but it has its drawbacks. Getting the application data onto the network involves processing the data through layers of code all the way from the application, through the original network protocol to the point of producing a transport-level packet, complete with network headers; this packet is then presented to another protocol stack as application data, and processed a second time to add another set of headers. Traversing two protocol stacks adds to the computing time required to process the data. The additional headers - 10 bytes of SNA, for example, can get encapsulated into TCP/IP with 40 bytes of TCP and IP headers - add to the load on the network. And almost inevitably those applications using the encapsulated protocol receive inferior performance compared with those using the native protocol.

Another possible solution is to define a new programming interface, such as the X/Open Transport Interface (XTI), which can interface to any network transport protocol. This, however, does not take account of the wealth of existing applications, which would have to be rewritten for the new interface. Nor is there any guarantee that it would be widely adopted, given the popularity of the existing interfaces. Furthermore, in order to give true interoperability on any network this new interface could only support the lowest common subset of functions available on those networks, limiting the ability of the system designer to use the most effective techniques for the application.

IBM's solution, adopted as an open industry standard architecture by X/Open, is Multiprotocol Transport Networking (MPTN), implemented hitherto in the award-winning AnyNet products. MPTN adopts a more fundamental approach to protocol independence than previous solutions. It uses protocol conversion, whenever possible, rather than encapsulation. MPTN works at the API layer, converting, for example, the sockets interface to use SNA protocols instead of TCP/IP, or the APPC/CPI-C interface to use TCP/IP protocols instead of SNA. The application calls its preferred API, unaware of the true nature of the underlying network; MPTN then converts those calls to use the protocol of the installed transport network.

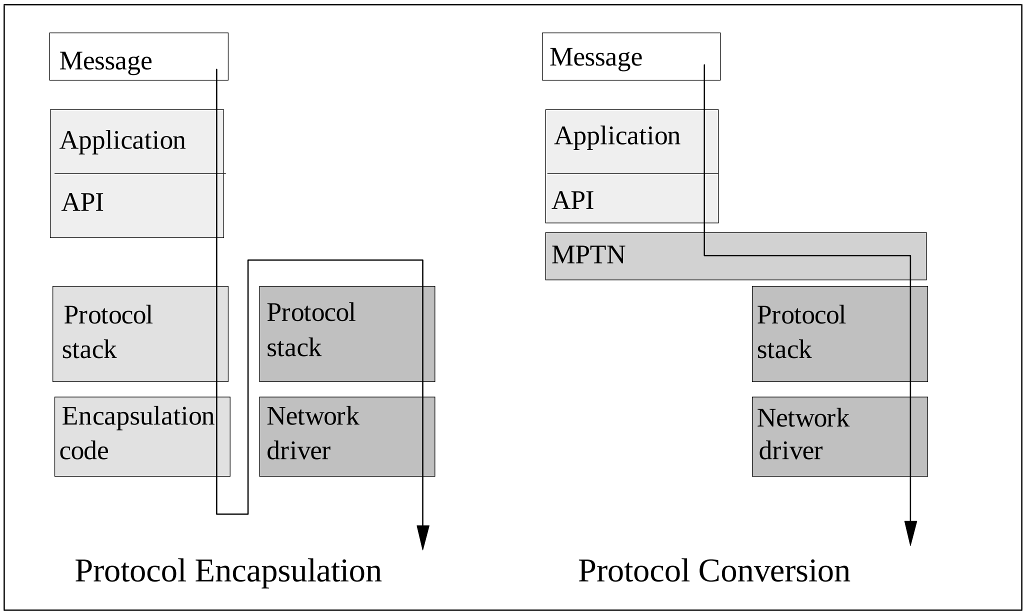

Figure 4. MPTN and Protocol Conversion

Of course, the different network protocols have essential differences which are reflected in their programming interfaces and in the way they are used by applications. SNA, for example, is record-oriented, where TCP/IP is stream-oriented; SNA supports expedited data, TCP/IP does not. MPTN incorporates compensation mechanisms to handle this and to ensure, therefore, that what began as TCP/IP traffic can still end up as TCP/IP traffic, even if it traverses an SNA backbone, but with the minimum of extra processing on the way.

MPTN thus delivers protocol independence without the need to change the applications and with the greatest efficiency of the techniques available today. Whether the transport network is SNA or TCP/IP, or a combination of the two, becomes totally transparent to applications and users. There is minimum encapsulation, no need to traverse two protocol stacks, and no need for additional networking headers. As a result, MPTN enables near-native performance for nonnative applications. Existing investment in applications and skills is preserved, and client/server system designers are free to choose the most appropriate programming techniques and interfaces for their applications.

Note that while the previous discussion has centered on TCP/IP and SNA protocols, MPTN is concerned with transporting any application over any protocol. All Communications Servers currently include SNA over TCP/IP and Sockets over SNA functions. In addition, Communications Server for OS/2 Warp provides IPX and NetBIOS over SNA and TCP/IP through the LAN gateway function.

Access nodes and gateways

Communications Server implements both MPTN access node and MPTN gateway functions.

An MPTN access node allows applications written for one protocol to run over another protocol within the same system. For example, existing, unmodified TCP/IP applications written to the sockets interface - such as Telnet, File Transfer Program (FTP) and Network File System (NFS), and including Internet web browsers - can run on workstations connected to an SNA network. Equally, APPC or CPI-C applications can run on workstations connected to a TCP/IP network.

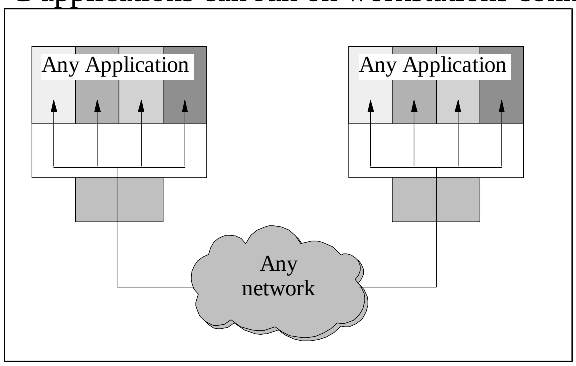

Figure 5. MPTN Access Node

An MPTN gateway concatenates networks running different protocols so that they function like a single network. Thus an SNA client/server application, such as DB2/2, for example, can be installed such that the clients are installed on workstations attached to a TCP/IP network and communicate with the server on an SNA network. Or a TCP/IP client application, such as an Internet web browser, can be installed on an SNA workstation and communicate with its server on an IP network; the IP network could be the Internet.

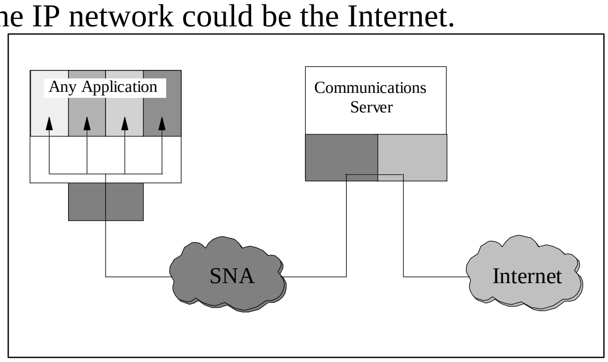

Figure 6. MPTN gateway connecting two unlike networks

A pair of MPTN gateways connects like networks through a backbone that uses a different protocol. Thus a TCP/IP client and server, each on an IP network, can communicate across an SNA backbone; equally, an SNA client/server application can communicate across a TCP/IP network.

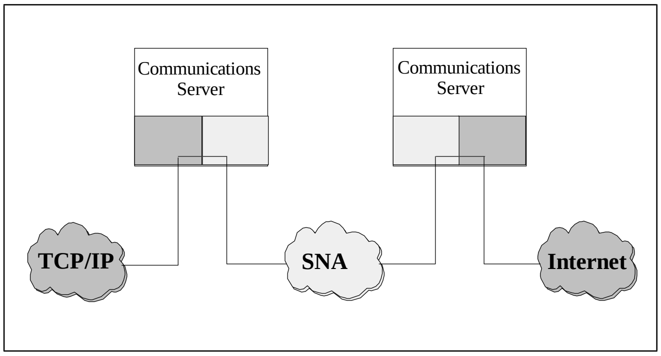

Figure 7. MPTN gateways connecting two like networks with unlike backbone

Protocol independence in action

The following examples illustrate how customers can use Communications Server to enable protocol independence.

Access the Internet from SNA workstations

The requirement: A company requires access to the Internet from SNA workstations on the corporate SNA backbone, in order to gain access to the Internet both for intercompany file transfer and electronic mail facilities and also to encourage its subsidiary businesses to establish a presence on the World-Wide Web. At the same time it does not wish to invest in the infrastructure necessary to add an IP-based network in parallel with the SNA one.

The solution: OS/2 Access Feature from Communications Server for OS/2, installed on the workstations, provides MPTN access node function and enables those workstations to run sockets applications such as FTP and any popular web browser. At the same time, they install the Communications Server on the corporate LAN in order to connect their SNA network to the Internet. Users on their SNA workstations can now access the Internet as if they were directly attached to an IP network.

Deploy SNA applications over an IP network

The requirement: A major supplier of news and entertainment products has an SNA central site network, with TCP/IP networks connecting its international locations. They wished to reduce costs by eliminating the parallel SNA lines to the remote sites while still giving end-users access to key SNA-based shipping and inventory applications.

The solution: Communications Server for OS/2 Warp connects the central SNA site to the TCP/IP network, with the OS/2 Access Feature on end-user workstations providing the function to access SNA applications over TCP/IP. As a result, line costs have been reduced and the network has become easier to manage - and with no changes to any application.

Connect IP networks over an SNA backbone

The requirement: A large bank with 400 branches has an SNA central site network and IP networks at remote branches. It wishes to manage the remote SNMP hubs using NetView/6000 and to provide branch to branch connectivity over the SNA backbone.

The solution: Communications Server for AIX on their RS/6000 at the central site gives them sockets over SNA access node function, with Communications Server for OS/2 at the branches to provide sockets over SNA gateway support. The result is that sockets applications can be deployed that communicate between the branches over the SNA backbone, and Tivoli* TME 10* at the central site can monitor and control the remote hubs, with no impact on the central site SNA network.

The requirement: A large corporation is rolling out Lotus Notes* throughout the organization, using TCP/IP for inter-server connectivity and for Notes* client-to-server communication within branch LANs. The remote branches are connected to the central site across an SNA X.25 backbone. The corporation wishes to exploit its investment in the existing network.

The solution: Communications Server for OS/2 provides the multiprotocol gateway facilities required to allow the branch and central site Notes Servers to be interconnected using TCP/IP as their protocol. At the same time, it allows the corporation to give higher priority to the existing mission-critical SNA applications than to the new and less critical TCP/IP applications.

This last example highlights one of the most significant benefits of protocol independence. If you can choose the best application for your business, without regard to the underlying network, you can also choose the best network for your business, secure in the knowledge that your investment in your existing applications can be preserved, and that those applications can continue to be used without change or disruption. In the next section of this paper we will look at some of the advanced networking features delivered by the Communications Servers.

Delivering advanced networking solutions

For some years, as TCP/IP has spread from its roots in the academic world into the business environment, there has been an occasionally strident debate comparing TCP/IP and SNA. Much has been said and published about both, not always entirely factual, and often colored by the authors' backgrounds and priorities. Each protocol has strengths and both architectures are evolving to support the strengths of the other.

IBM understands both SNA and TCP/IP, and indeed offers the most comprehensive set of world-class products for both protocols. However, IBM's support of TCP/IP and multiprotocol networking, embodied in IBM's Open Blueprint, does not mean that IBM places any less emphasis on SNA as the superior networking protocol for mission-critical business applications. IBM continues to evolve SNA to respond to the rigorous requirements of the professional corporate network. While the growth of TCP/IP networks will, of course, be phenomenal with the pervasive interest in the Internet, SNA will continue to grow at the rhythm of and to suit the needs of the business community. Users will continue to use SNA, even though TCP/IP is in many cases free. Why? Because SNA networks are known to be efficient, stable and predictable.

Communications Server supports both TCP/IP and SNA, and therefore makes it possible for you to ignore the debate and to deploy whichever protocol meets your business needs. However, it delivers its most advanced networking capabilities over SNA, and especially over the latest evolution of SNA - APPN and High Performance Routing (HPR).

In the rest of this section we will briefly compare SNA and TCP/IP, introduce APPN/HPR for those who may be familiar with traditional subarea SNA but not with this relatively new technology, and describe how Communications Server fully exploits the features of SNA to deliver advanced networking for business today and into the foreseeable future.

SNA - connection-oriented business communications

SNA was designed to meet the needs of business computing, delivering reliable and high-performance data transport, and enabling confidentiality of data throughout the network. SNA is based on a connection-oriented transport. Sender and receiver are connected in the same way as a telephone call: there is a defined network path for transmitting data, a virtual circuit which is secured for the duration of the call. This brings a number of significant benefits:

- Availability of network resources is known at the setup of the virtual circuit. This makes it possible to reserve bandwidth on a per session basis and thus to ensure a predictable transit time through the network - the basis for predictable response times for which SNA is noted.
- The path through the network can be determined based on the required class of service, making it possible to select the optimal routes for individual sessions and to route traffic according to desired priority or specific requirements such as the security of the links. Path information also facilitates tuning, problem determination, network control and network

management.

- Knowledge of the route enables congestion-avoidance mechanisms. It makes it possible to report the availability of network resources to the traffic-origination points at the boundary of the network, thus making it possible to decrease or increase the flow of data as it enters the network, and making it unnecessary for nodes simply to discard data as the network becomes more busy.

The downside of connection-oriented transports, however, is that they cannot easily adapt to changing traffic patterns or outages without resetting routes, with consequent loss of sessions.

TCP/IP - connectionless flexible connectivity

TCP/IP was designed to be an inexpensive and simple way of linking dissimilar computers for use by government and academic institutions. TCP/IP is based on connectionless transport, similar to the way mail is delivered, in which individual packets can travel over different paths. One significant benefit of this, of course, is that it makes it very simple to automatically and transparently route data traffic around network failures. However, since packets can travel over different distances or congested paths or even get discarded by congested nodes, arrival time is unpredictable. A connectionless transport cannot guarantee response times, and the absence of predetermined route information makes it much more difficult to deliver effective tuning, congestion avoidance and network management.

APPN/HPR - the best of both worlds

SNA and TCP/IP each have their strengths, and the latest evolution of SNA, HPR, an extension of APPN and known at one time as APPN+, has borrowed from TCP/IP and Frame Relay, combining their best features with the traditional strengths of SNA and APPN to deliver the best of both worlds. HPR has been described as "one of the most significant and dramatic metamorphoses undergone by SNA ... HPR has been designed from the ground up not only to be appreciably faster in terms of data routing than SNA, APPN, or TCP/IP, but also to have the 'weaving and darting' dynamic networking characteristics hitherto associated with TCP/IP". [1]

APPN was introduced by IBM in 1987 as a powerful, flexible and easy-to-use networking solution for SNA client/server applications. It provides peer networking between independent nodes, without the need for the traditional SNA reliance on a central host and without the need for static resource definitions.

APPN defines two types of node, end node and network node, classed as SNA type 2.1 nodes within the SNA architecture.

A network node acts as a server to end nodes, providing networking services such as directory and routing services. Directory services locates partners for the end node and frees the end node from requiring any definitions of where its partners are located. Route selection services finds the optimal path for the session through the network, based on user-specified class of service and

[1] Anura Gurugé, "APPN HPR: the future SNA?", Xephon, June 1994

transmission priority. A network node is also a router, acting as an intermediate node and forwarding traffic to other nodes.

End nodes register their network resources with their server, making it unnecessary to predefine the network. An APPN network is thus self-defining, and can expand or contract or change its shape without the need for constant changes to network resource definitions, nor for the network to be stopped and restarted with consequent disruption to its users.

APPN is an open standard. The end node architecture was published in 1991, the network node architecture in 1993. Also in 1993, IBM established the APPN Implementers' Workshop (AIW), to foster high-quality APPN implementations from a variety of vendors. Since then it has grown to include more than 50 companies. Recent APPN developments, including Dependent LU Requester/Server (DLUR/S) - which defines a technique for routing dependent LU traffic such as 3270 data stream natively across an APPN network - and HPR, have all been developed in consultation with and approved by the AIW. IBM continues to evolve SNA and APPN according to requirements identified not just by IBM but also by our customers and by most major networking vendors.

HPR adds the flexibility of TCP/IP and Frame Relay to APPN, at the same time streamlining the protocol to make significant performance improvements and to position APPN/HPR to address the key requirements of high-speed networking.

The two main components of HPR are Automatic Network Routing (ANR) and Rapid Transport Protocol (RTP).

ANR provides a low-overhead, connectionless routing mechanism for forwarding packets through the network along a predetermined path. Initial session setup follows traditional APPN partner-location and route-calculation mechanisms. However, instead of the intermediate nodes having to establish and maintain sessions with each other, incurring processing and memory overhead, the data packets are prefixed with a short header identifying to each node the link on which it should forward the packet. All the ANR node has to do is to strip this identifier off the packet and transfer the packet to the appropriate link: very little processing and no need for pre-allocated memory.

RTP operates at the endpoints of the HPR network. It is responsible for establishing a connection, often called a "transport pipe", with an RTP node at the other end of the network. This pipe traverses the ANR nodes described above. Having established the connection, RTP nodes are then responsible for all

- error detection and recovery - with emerging high-speed links with low bit-error rates it is counterproductive to perform error control at each intermediate node - including selective retransmission of only missing or corrupted packets, and not all packets after the last one successfully received
- end-to-end flow and congestion control, using an adaptive rate-based (ARB) technique that constantly monitors and adjusts the rate at which data flows through the RTP connection

- non-disruptive path and session switching, in which a new RTP connection is established if the original one fails for any reason, without the loss of the sessions using the connection; any data that may be lost in the network is automatically recovered using the RTP error recovery mechanisms.

HPR thus improves network availability through non-disruptive session (re-)routing, and improves network performance through reduced error checking, selective retransmission, its adaptive rate-based flow control, and reduced processing cycles and storage required in intermediate nodes. All of these position HPR as the ideal protocol for any high-speed network.

Exploiting SNA to deliver advanced networking

The IBM development laboratory for Communications Server works closely with that for host VTAM to take advantage of the latest host networking enhancements. Many of the benefits of SNA are realized from this synergy between workstation and host. Communications Server fully exploits these to deliver the most advanced networking available on a workstation platform.

Among the most important SNA features supported by Communications Server are:

APPN and **HPR**. The features and benefits of these have been described above. All three Communications Servers function as full APPN end nodes or network nodes and deliver full ANR and RTP HPR support.

HPR Multi-link Transmission Group (MLTG) will allow you to add additional capacity during peak periods. Links can be added and removed from a multi-link transmission group dynamically without affecting any network applications. This can provide lower costs by allowing you to add the extra capacity only when needed. In addition, MLTG support can lower the costs by allowing several circuits to be used together to achieve the capacity needed, a technique that lessens the impact of carrier pricing policies where very high speed links are significantly more expensive than the equivalent combination of lower speed links. This capability is provided by Communications Server for OS/2 Warp.

Branch Extender is a APPN border node subset that is designed to interconnect a remote branch office to an APPN WAN backbone network. Branch Extender optimizes the peer-to-peer communications environment for customers who want to connect LAN-based branches to one large WAN, primarily based on a switched network. This function is provided by Communications Server for OS/2 Warp.

Dependent LU Requester (DLUR) allows dependent LU traffic, including 3270 and LU type 0, to flow over an APPN network. 3270 and dependent SNA applications no longer need to reside on a node adjacent to their host, and can take full advantage of the enhanced performance and non-disruptive session capabilities of High Performance Routing.

In addition, DLUR makes it possible to support multiple PUs on a single physical link, thereby removing the limitation of 254 LUs (or dependent LU sessions) per logical host connection.

These multiple PUs can be mapped to PUs downstream of the Communications Server, and, coupled with the gateway's "PU passthrough" capability, this makes the downstream PUs visible to and accessible from the host for network management purposes.

SNA transmission priority has been referred to in the discussion on protocol independence. By using the SNA class of service mechanism, it makes it possible to assign different priorities through SNA nodes, and thus through the network, to different types of application.

SNA security. Communications Server provides architected SNA security for those applications that require it. It should be noted that with some proprietary non-IBM implementations of SNA gateway function this can only be effected between the gateway and the host, leaving the traffic between client and gateway potentially exposed; with the Communications Servers, this security is end-to-end, from client through to the final destination.

SNA data compression is a facility of SNA that allows data to be automatically compressed before it enters the network, using open industry-standard algorithms such as Lempel-Ziv (LZ9) and Run Length Encoding (RLE). Depending on the application this can significantly reduce the amount of data being transmitted, and is especially useful over relatively slow links where the computational cost of compression and decompression are outweighed by the reduced transit time of the data. SNA data compression is currently supported by Communications Server for OS/2 and Communications Server for Windows NT.

Self-defining dependent LU (SDDLU) - also known as dynamically-defined dependent LU (DDDLU) - is a VTAM enhancement that allows dependent logical units to be known by VTAM when they connect to the host, rather than having to be predefined. This means that new LUs can be added without interruption to other users in the network. It also helps to free up memory in the front-end communications processor, which now only has to allocate memory for LUs actually being used rather than for all LUs previously defined in the network.

Extending advanced networking to all applications

All of these make SNA the present and future advanced networking platform that almost all companies in the Fortune 500 rely on for their essential business communications needs.

With the multiprotocol support described earlier, Communications Server makes it possible to extend many of these benefits, especially high-performance routing and traffic prioritization, to TCP/IP applications as well as to SNA.

Advanced networking in action

These advanced networking functions are available now, as the following example illustrates.

The requirement: An international finance company uses IBM 6611 routers to connect its branch offices to the central data center, providing SNA access for 3270 applications and using AnyNet Sockets over SNA gateways to support sockets applications and to allow SNMP management of branch hubs. This solution provides the required function, but it is not possible to prioritize the different types of traffic on the bridged links and the gateways present a single point of potential outage since loss of one of them would disrupt all the TCP/IP sessions out of the branch.

The solution: The SNA backbone is upgraded to deploy the latest advanced SNA networking: the 6611s are upgraded to support HPR, Communications Server is installed in place of the gateways to provide both HPR support for the backbone and DLUR support for downstream 3270 sessions, and VTAM is upgraded to support HPR and DLUS. As a result, with no changes to applications and without the need for any additional networking hardware, the company now enjoys maximum availability of the network with the ability to prioritize traffic independent of application protocol: HPR enables APPN traffic to dynamically reroute in the event of link outage, DLUR/S enables 3270 applications to run over APPN/HPR, and carrying the TCP/IP traffic over APPN/HPR makes it possible to apply appropriate priorities to all the network traffic.

Delivering breadth of function and connectivity

In addition to multiprotocol support and advanced SNA networking, Communications Server also provides comprehensive programming support, an extensive range of connectivity options, and support for almost any client on any platform.

Programming support

Communications Server supports the major distributed and client/server Application Programming Interfaces (APIs) in current use. It supports applications written to the sockets interface. In addition, it provides support and the libraries and headers for a comprehensive range of SNA-based client/server and general network programming requirements.

These include:

- Common Programming Interface for Communications (CPI-C) and Advanced Program-to-Program Communications (APPC), both of which enable client/server programming across SNA networks; CPI-C provides a set of high-level calls that are portable across multiple platforms, APPC provides lower level calls optimized for specific platforms
- Programming interfaces to secondary dependent SNA LUs, which make it possible to build a wide range of applications that use traditional SNA protocols, such as banking and finance terminal emulation, and including 3270 terminal and printer emulation
  - Communications Server for Windows NT and OS/2 Warp support the conventional LU Application Interface (LUA) RUI and SLI interfaces and Communications Server for AIX supports the LUA-RUI interface.
- Systems Management interfaces that provide support for applications to monitor and control the network and attached workstations and servers
- Programming interfaces and calls to start and stop communications services and to make use of other functions provided by the server, such as configuration and data conversion services

The widest range of connectivity in the industry

Communications Server uses an open link architecture: all types of link connectivity can be used regardless of the customer's network architecture. Thus LAN and WAN links can be used upstream or downstream of the gateway and Communications Server can be used equally as a network concentrator at the host or as a gateway at a remote site. You could, for example, install Communications Server for OS/2 on a LAN attached to the central computer, or Communications Server for AIX on a host channel, and connect downstream systems to them over an X.25 network. With multidrop SDLC links downstream, Communications Server can serve as a very effective single branch concentrator for many SNA SDLC devices, such as the 4702, 3174s, and

SNA Automated Teller Machines (ATMs). Communications Server is the only complete product available today that provides such extensive connectivity for the workstation platform.

General connectivity options include

- LAN: Token-Ring, Ethernet and FDDI
- ATM (LAN emulation)
- SDLC: switched or leased, point-to-point or multidrop
- X.25, X.32
- Frame Relay

Communications Server for OS/2 and Windows NT also support:

- Asynchronous
- AutoSync
- Twinax
- ISDN
- Intelligent adapters from OEMs (such as SDLC, X.25, Frame Relay and ISDN)

Communications Server for AIX and Windows NT also support:

- Direct attachment to host, via ESCON or Block Multiplexer channel
- Communications Server for AIX also supports Multiple Path Channel (MPC) over ESCON

•

•Powerful SNA gateway with comprehensive client support

Communications Server delivers industrial-strength SNA gateway function, supporting both SNA and TCP/IP-based 3270 and 5250 emulators, as well as SNA and TCP/IP client/server applications. Communications Server uses standard open interfaces and protocols between client and server, unlike some communications servers or gateways on the market today. It does not rely on proprietary interfaces and protocols, so it does not lock the customer into a restricted set of products and platforms, and can be used by any client on any platform that supports SNA or TCP/IP.

Supported clients include:

- SNA-based 3270 or 5250 emulators, such as the IBM Personal Communications family of products which run on OS/2, Windows 3.1, Windows 95 and Windows NT, as well as virtually any emulator product from other vendors
- TCP/IP-based 3270 emulators, conforming to the TN3270 and TN3270E standards, also available in the IBM Personal Communications products and from many other vendors
- SNA gateways, including any workstation gateway that uses SNA for its upstream connection, and including the IBM 3174 range and other SNA terminal controllers
- Any SNA client/server application, together with application servers such as the IBM Transaction and Database Servers

- TCP/IP client/server applications, including Telnet, File Transfer Program (FTP), Network File System (NFS), and many others

And the number of clients and applications that can be supported concurrently is equally impressive. Communications Server has proven itself in critical, bet-your-business environments in terms of reliability, performance and capacity. Communications Server is highly scalable, supporting from small branch environments to very large enterprise environments of tens of thousands of users. For example, in a test conducted by The Tolly Group, an independent testing firm, IBM Communications Server for OS/2 Warp Version 4.10 clearly outperformed Microsoft SNA Server in throughput and response time, while using lower hardware resources, in all tests conducted. The detailed report from The Tolly Group is available from the eNetwork Communications Server web site listed under further information at the end of this paper.

Integrating Server Administration using the Web

IBM eNetwork Communications Servers can now be administered over an intranet or the Internet. Either from a remote or local workstation, the administrator can manage Communications Server through a Web Browser. The Web Administration feature provides the Web administration function for eNetwork Communications Server. You can use this feature to manage Communications Server over an intranet or the Internet. Using a Web browser, an administrator can query node status, obtain information about resources, modify resources, display configuration files, display message logs, and perform other administrative tasks. This function is available on Communications Server for Windows NT and OS/2 Warp, and will be made available on AIX in the near future. Figures 8 and 9 below show sample screens of the Web-based Administration function of Communications Server for OS/2 Warp.

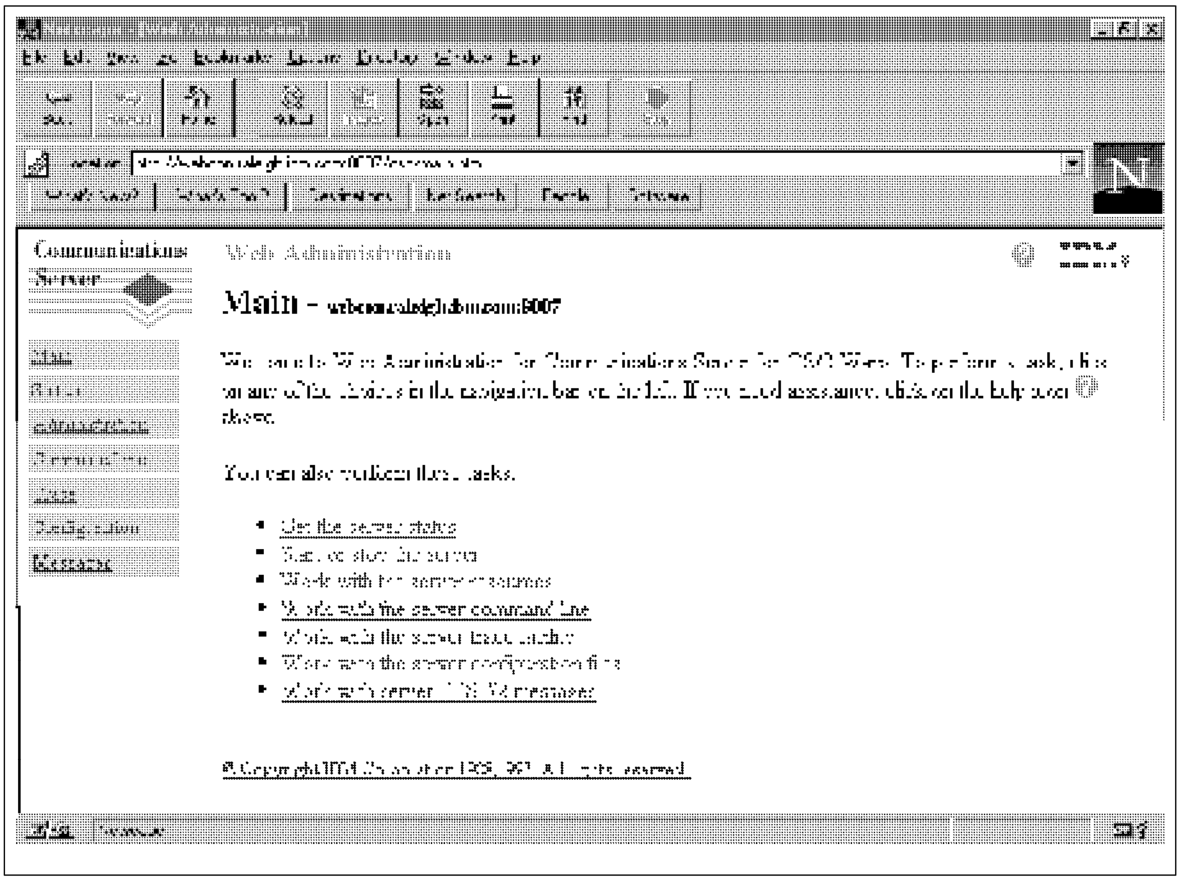

Figure 8. eNetwork Communications Server for OS/2 Warp Web-based Administration

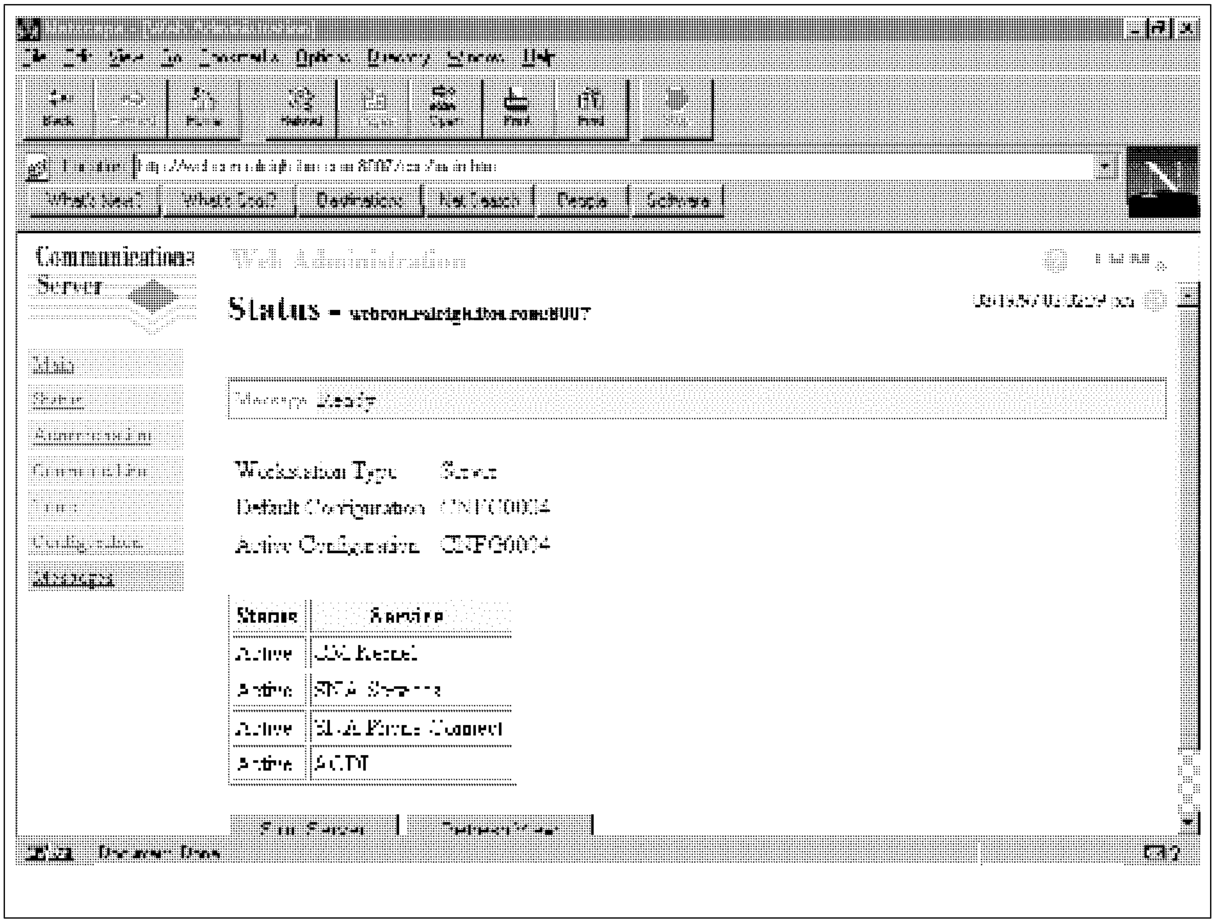

Figure 9. eNetwork Communications Server for OS/2 Warp Web-based Administration

The eNetwork Communications Server Family

The IBM Communications Servers currently include solutions for OS/2, AIX, and Windows NT, and are fully interoperable with OS/390, OS/400 and other SNA and TCP/IP platforms.

eNetwork Communications Server for OS/2

IBM eNetwork Communications Server for OS/2 Warp, Version 5, is a powerful OS/2-based multiprotocol gateway. It is the evolutionary successor to the industry-leading Communications Manager/2, Version 1.11, with added capacity, multiprotocol support, and enhancements designed to improve the availability and performance of the network. Enhancements include:

- integration of LAN gateway support enabling IPX and NetBIOS applications to communicate over TCP/IP and SNA WANs
- significant advanced SNA functions, including:
  - support for HPR as both an endpoint (with RTP) and an intermediate node (with ANR)
  - Dependent LU Requester (DLUR), enabling dependent LUs (including 3270 and 3270-based applications) to operate within an APPN network
  - SNA transmission priority, to take advantage of SNA's ability to maintain multiple transmission queues and to allow the administrator to ensure equitable distribution of valuable network resources depending on particular business needs
  - support for self-defining dependent LU (SDDLU), reducing the need for static definitions at the host
  - SNA backup link support
  - HPR over WAN
  - HPR Multi-link Transmission Group support
  - HPR Branch Extender
- 32-bit programming interfaces, and support for CPI-C 2.0 conformance classes that underpin effective and efficient SNA client/server programming: non-blocking calls, multiple conversation support for server programs, full-duplex and expedited data support
- expansion of the connectivity options, including support for 16 SDLC lines, up to 16 LAN adapters, SDLC connections at T1/E1 (1.544Mbps/2.0Mbps) speeds, multipoint downstream links, Asynchronous Transmission Mode (ATM) in LAN emulation mode, as well as a set of new open interfaces to enable other manufacturers to provide support for their own LAN or WAN adapters
- TN3270E Server support. TN3270E extends the definition of protocols for 3270 emulation over TCP/IP to include printer and graphics support. The TN3270E Server support in Communications Server runs as a Telnet server, supporting TCP/IP clients downstream, and providing SNA access upstream to the host.
- Remote Web-based administration
- Host On-Demand, Web-based access to 3270 applications

The new Communications Server for OS/2 packaging also provides client code, the OS/2, Windows, Windows 95, and Windows NT Access Features, which deliver multiprotocol application support on OS/2, Windows, Windows 95, and Windows NT workstations.

The OS/2 Access Feature is a subset of the Communications Server, including its multiprotocol access node functions for SNA over TCP/IP and Sockets over SNA, its APIs, and its connectivity support, but excluding specific gateway and APPN network node functions.

The Windows Access Feature is a combination of IBM APPC Networking Services for Windows, Version 1.0.1, and IBM AnyNet APPC over TCP/IP for Windows, Version 1.0. These provide support on Windows workstations for developing and running SNA applications over either SNA or IP networks.

The Windows 95 and Windows NT Access Features provide communications to host machines and other connections from Windows 95 and Windows NT client workstations. This feature includes support for Advanced-Peer-to-Peer Networks (APPN) as an end node and uses the advanced network features of high performance routing (HPR) and dependent LU requester (DLUR). This feature also includes AnyNet SNA over TCP/IP, which allows client/server SNA applications to communicate over a TCP/IP network.

Communications Server for AIX

IBM Communications Server for AIX, Version 5.0, is the latest product in the evolution of AIX SNA products, including AIX SNA Services/6000, AIX SNA Server/6000, SNA Server for AIX, and Communications Server for AIX, Version 4.2. Enhancements include:

An integrated TN3270E Server function supports both TN3270E and TN3270 protocols, providing access to 3270 sessions for clients using the telnet protocol over TCP/IP.
Multipath channel (MPC) support is provided for the ESCON adapter.
SNA over ATM (Asynchronous Transfer Mode) local area network emulation (LANE) is supported.
Supports frame relay over a token ring or Ethernet interface with the TPS**/SoftFRAD product.
The high-performance routing (HPR) feature of Advanced Peer-to-Peer Networking (APPN) now includes rapid transport protocol (RTP) in addition to automatic network routing (ANR). This feature provides end-to-end support for nondisruptive rerouting of session traffic around route failures or congestion. This function is supported over all link types.
DLUR support has been extended to sessions that use generic SNA, secondary LU 0, and the new LUA API.
DDDLU (Dynamic Definition of Dependent LUs) enables CS/AIX to dynamically define LUs to VTAM systems, reducing the need for host configuration. This function is sometimes known as SDDLU (Self-Defining Dependent LUs),
Provides easy 3270 SNA application access from any Java-enabled Web browser through Host On-Demand, Version 1.1 (included with CS/AIX)
Motif Administration program provides complete configuration and management facilities for CS/AIX in an easy-to-use interface for graphical X-terminals. This program simplifies CS/AIX administration and provides online help for configuration and management tasks. Configuration changes made using the Motif administration program, the command-line administration, and the NOF (Node Operator Facility) API are applied immediately to the node configuration file.

CS/AIX provides enhanced APIs that are more compatible with the APIs provided by members of the Communications Server family running on other operating systems. (Older API support is continued for existing applications; but you should write new applications using the new APIs.) CS/AIX now includes the following new or changed application programming interfaces (APIs):

The new LUA API enables application programmers to write applications that communicate with host applications at the request unit and response unit (RU) level, and to send and receive data on both the SSCP-LU session and the PLU-SLU session. This API can be used to support LU 0, 1, 2, or 3 communication with the host.

NOF API can be used to write applications that administer CS/AIX configuration and management resources.

The newCommon Programming Interface for Communications (CPI-C) provides CPI-C 2.0+ support and is backwards compatible with existing CPI-C applications written for CS/AIX.

The new advanced program-to-program communication (APPC) API supports LU 6.2 communication using either independent sessions for peer-to-peer communication or dependent sessions for host communication.

Common Service Verb (CSV) API provides utility verbs that enable an application program to perform functions such as character set conversion and trace file control.

The newMS (Management Services) API supports network messaging functions.

- Host On-Demand, Web-based access to 3270 applications

In addition to LAN and SDLC connections, Communications Server for AIX also supports direct channel attachment from a mainframe to a RS/6000 or SP2 system, over a Block Multiplexer or ESCON channel, allowing the RS/6000 or SP2 to be used as a high-capacity network controller.

Communications Server for Windows NT

IBM Communications Server for Windows NT, Version 5 takes advantage of IBM's experience with SNA and communications servers, and provides a high performance, high quality communications solution for the Windows NT environment. It contains similar capabilities as our other Communications Servers which have been described earlier. The key features include:

- integration of AnyNet SNA over TCP/IP access node and gateway
- integration of AnyNet Sockets over SNA access node and gateway
- TN3270E Server
- Host On-Demand, Web-based access to 3270 applications
- significant advanced SNA functions, including:
  - APPN network node and end node support
  - support for HPR as both an endpoint (with RTP) and an intermediate node (with ANR)
  - discovery of service providers
  - Dependent LU Requester (DLUR), enabling dependent LUs (including 3270 and 3270-based applications) to operate within an APPN network

- Powerful SNA gateway
- SNA API client services for TCP/IP and IPX/SPX
- SNA data compression
- Designed for Microsoft BackOffice**
- local and remote configuration and administration support
- Web-based server administration via easy-to-use graphical interface
- 32-bit application programming interfaces (APIs) including CPI-C, APPC, and LUA (RUI and SLI)
- data security
- local and wide area connectivity support
- entry-level emulator functions

Communications Server and the IBM Software Server Family

IBM Software Servers

The IBM Software Servers are a comprehensive family of modular application servers, which enable businesses to rapidly implement client/server applications, and to extend application capabilities to meet future business needs.

Seven IBM Software Servers are currently available:

- IBM Communications Server
- IBM DB2 Database Server
- IBM Directory and Security Server
- IBM Internet Connection Server
- Tivoli Management Servers
- IBM Transaction Server
- Lotus Domino* Server

These IBM Software Servers are designed to provide:

- the greatest depth and breadth of application services
  - unequaled depth of function in each application server
  - the widest breadth of application servers in the industry
- open solutions
  - on multiple operating systems, including OS/2 Warp, AIX and Windows NT
  - using industry-standard interfaces
- support for existing Investments
  - working with customers' existing IBM and non-IBM systems
  - tested together to ensure compatibility

- growth paths for future needs
  - easy to add new servers when needed
  - extending each server with new technologies such as networked and collaborative computing

- simplicity
  - easy to buy
  - easy to install
  - easy to operate

Each of the seven servers can provide a powerful solution by itself for IBM customers. However, they are designed to integrate with each other and to form a complete solution to enable existing and new business applications. Communications Server not only delivers powerful SNA and TCP/IP gateway support for client workstations and applications, it also provides the industrial strength networking support for other servers.

For example:

DB2 Database Server
Database Server is a relational database management system that enables companies to create, update and control relational databases using SQL. Communications Server integrates seamlessly with the Database Servers, enabling them to communicate with each other and with database servers on central mainframes, with predictable high performance and reliability. Database Server for OS/2 can also take advantage of the sync-point enablement feature of Communications Server for OS/2, making the combination of Database and Communications Server the only Intel product set which can deliver industrial-strength two-phase commit for critical business transactions.

Internet Connection Server
Internet Connection Server provides companies with the ability to build a presence on the Internet. When integrated with Communications Server it gives internet access to data stored within an SNA network and to SNA applications such as CICS or DB2. Internet Connection Server can also take advantage of the multiprotocol features of Communications Server to provide internet web access for SNA workstations and to deliver intranet facilities to the existing SNA network.

Transaction Server
Transaction Server, based on the most popular transaction processing product in the world, CICS, and including Transarc's Encina transaction-processing technology, enables customers to create and execute business-critical client/server applications. Communications Server delivers the corresponding industrial-strength networking technologies to support these applications.

Lotus Domino Server
Lotus Domino Server transforms Lotus Notes into an interactive Web application server, allowing any Web client to participate in Notes applications securely. Domino Server bridges the open networking environment of Internet standards and protocols with the powerful application development facilities of Notes. You get a solution that combines messaging, groupware, and the Internet, all built in.

For more information on the IBM Software Servers, please refer to the "IBM Software Servers - Overview White Paper", or visit our web site at **http://www.software.ibm.com/is/sw-servers**.

Summary

The IBM Communications Server provides the powerful and comprehensive networking support required to support the traditional line-of-business applications of today and the new client/server applications of tomorrow. It uses tried and tested components to provide reliable yet advanced function. It supports the most popular communications protocols in use today, while at the same time incorporating the latest in networking architectures and technology to support emerging high-speed networks. It can be used on its own to provide multifunction multiprotocol gateway support and also to work seamlessly to provide the underlying communications support for the whole family of Software Servers. As the inventor, architect and developer of SNA, IBM is uniquely positioned to provide the most efficient communication with host systems on all platforms; for workstation platforms, the networking software of choice is Communications Server.

Further information

For further information on the Communications Servers and other networking products from IBM, please visit our web sites, at:

http://www.networking.ibm.com/eNetwork - for IBM eNetwork Software
http://www.networking.ibm.com/cms/commserv.html - IBM eNetwork Communications Servers

Special Notices

This white paper is intended to provide an overview of the IBM Communications Server. This document is provided for general guidance only.

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