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AS/400 in Multiprotocol Networks

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Abstract

This document is intended to address the growing trend of multiprotocol networks, from an AS/400 perspective. The AS/400 is found more and more in mixed protocol and system environments where interoperability is a major requirement. As networking moves to multiprotocol wide area backbones - supporting all the protocols required by today′s variety of applications and systems - the AS/400 is found communicating across these backbones.

The AS/400 networking person needs to understand the concepts of this new multiprotocol environment, in which their system sits. Networking people need to understand how easily the AS/400 fits in.

In an AS/400 dominated situation, understanding the concepts of multiprotocol networking helps you decide what direction the backbone should take, especially as the options available increase. This document should help to meet these different needs.

This document was written mainly for AS/400 networking people, however, it is also suitable for general networking specialists who find themselves working with AS/400s. It assumes basic knowledge of communications and networking.

(325 pages)

Contents

Figures

Tables

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Preface

This document is intended to give networking persons an introduction into the concepts of multiprotocol environments. The document addresses these aspects from an AS/400 perspective. It contains an introduction into protocol and networking technologies and various tested and documented networking scenarios.

This document is intended for AS/400 networking persons, however, it is also suitable for general networking specialists who find themselves working with AS/400 systems.

How This Document Is Organized

The document is organized as follows:

- Chapter 1, "Why Multiprotocol Networks"

  This introduction chapter discusses why customers are moving from pure SNA based networks to multiprotocol networks. The chapter then goes on to give a high-level overview of the two multiprotocol solutions considered in this book.

- Chapter 2, "Networking Technologies"

  In this chapter we give an overview of the common protocols in use today (those that we consider in this book). We also give an overview of bridging and routing.

- Chapter 3, "Router Technology"

  This chapter discusses router technology, both routing itself and the other forms of support provided by routers to allow them to handle nonroutable protocols.

- Chapter 4, "IBM Router Products"

  In this chapter we give an overview of the IBM router products currently available.

- Chapter 5, "Your SNA/APPN Network - A Multiprotocol Network"

  This chapter looks at how an APPN network can also carry non-SNA protocols and hence become a multiprotocol network.

- Chapter 6, "AS/400 Networking Capabilities"

  In this chapter we have a brief look at the networking capabilities of the AS/400. For the benefit of the non-AS/400 networking specialist, we also have a look at AS/400 communications configuration.

- Chapter 7, "IBM 6611 and IBM 2210 Router Configuration Tools"

  This chapter describes the router configuration tools we used during our residency.

- Chapter 8, "IBM 6611s in a Router Network"

  In this chapter we look at an IBM 6611 router scenario. For our multiprotocol network we consider TCP/IP, NetBIOS, IPX and SNA.

- Chapter 9, "IBM 2210s in a Router Network"

In this chapter we look at an IBM 2210 router scenario. For our multiprotocol network, we consider TCP/IP, IPX and SNA.

- Chapter 10, "IBM 6611 and IBM 2210s in a Router Network"

  In this chapter we look at a router scenario that uses both an IBM 6611 and IBM 2210s. For our multiprotocol network, we consider TCP/IP, IPX and SNA.

- Chapter 11, "IBM 6611s as APPN Network Nodes"

  This chapter looks at a scenario using the IBM 6611 APPN support.

- Chapter 12, "IBM 2210s and IBM 5X94 in a Router Network"

  In this chapter we consider the ability to attach IBM 5394/5494 remote workstation controllers via SDLC to an IBM 2210 router.

- Chapter 13, "IBM 2210s, IBM 5394 and SDLC Relay"

  This chapter looks at a scenario using the IBM 2210 SDLC relay support. The SDLC relay support is used to attach an IBM 5394 to an AS/400 where both are connected to the 2210s via SDLC lines.

- Chapter 14, "IBM 2210, Frame Relay and AS/400"

  In this chapter we show a scenario using the AS/400 frame relay support to communicate directly with an IBM 2210 router.

- Chapter 15, "IBM 2217 Configuration Tool"

  This chapter covers the IBM 2217 multiprotocol concentrator configuration tool.

- Chapter 16, "IBM 2217 as a LAN/WAN Gateway"

  In this chapter we look at an IBM 2217 MpC scenario where the 2217 also acts as the LAN/WAN gateway. For our multiprotocol network, we consider TCP/IP, NetBIOS, IPX and SNA.

- Chapter 17, "IBM 2217 as Multiprotocol Network Concentrator"

  In this chapter we look at an IBM 2217 MpC scenario where the 2217 is added to an existing APPN network. For our multiprotocol network, we consider TCP/IP, NetBIOS, IPX and SNA.

- Chapter 18, "IBM 2217 Operation"

  Here, we look at the operation/management of an IBM 2217 MpC.

- Chapter 19, "X.25 Support in Router Networks"

  This chapter looks at the X.25 support provided by routers.

- Chapter 20, "LAN Dial Access to AS/400"

  In this chapter we look at LAN dial-in access to an AS/400. The LAN dial-in access is via an IBM 8235.

- Chapter 21, "Providing Backup in Router Networks"

  In this chapter we look at how backup can be provided in router networks to give the networks greater resilience over, for example, communications link failure.

- Chapter 22, "Performance in Router Networks"

  Performance is another important consideration to be taken into account when designing a network. In this chapter we look at some of the factors affecting performance in router networks.

- Chapter 23, “Network Management in Router Networks”

  This chapter looks at network management in router networks. Some of the network management tasks included are: configuration, software maintenance and router operation.

- Chapter 24, “Multiprotocol Network Services from IBM Global Network”

  Multiprotocol network services are available from IBM. This chapter gives an overview of this offering.

- Chapter 25, “AS/400 and Printing in a Multiprotocol Network”

  In this chapter we consider printing in a multiprotocol network. We look at printer data streams, AS/400 printer support and the use of print servers.

- Appendix A, “MPTN Architecture and AnyNet Product Family”

  In this appendix we look at the MPTN (Multiprotocol Transport Networking) architecture and the AnyNet product family. We also consider how the AS/400 can use AnyNet.

Related Publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this document.

- *AS/400 TCP/IP Configuration and Reference,* SC41-3420
- *IBM 6611 Introduction and Planning Guide,* GK2T-0334
- *IBM 5394 Remote Control Unit, T2.1 Support RPQ 8Q0775,* SC30-3531
- *IBM Multiprotocol Network Program Configuration Guide,* SC31-6691
- *IBM Multiprotocol Network Program Operations and Problem Management,* SC31-6692
- *IBM 2210 Nways Multiprotocol Router Planning and Setup Guide,* GA27-4068
- *IBM 2210 Nways Multiprotocol Router Network Services Software User′s Guide,* SC30-3681
- *IBM 2210 Nways Multiprotocol Router Network Services Protocol Configuration and Monitoring Reference,* SC30-3680
- *IBM 2217 Nways Multiprotocol Concentrator User′s Guide*, GC30-3706

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- *AS/400 AnyNet Scenarios,* GG24-2531
- *IBM 2210 Nways Multiprotocol Router Description and Configuration Scenarios,* SG24-4446
- *The IBM 6611 Network Processor as an SNA/APPN Router,* GG24-4367
- *AS/400 APPN Problem Management,* GG24-4222
- *APPN Architecture and Product Implementation Tutorial,* GG24-3669
- *Performance and Router Networks,* GG24-4157
- *Introduction to Performance in Router Networks,* GG24-4223

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Part 1. Introduction

In Part 1 we introduce the world of multiprotocol networking. We start by explaining why networks have to support multiple protocols. We then give a brief introduction to the four most commonly found protocols and explain the functions provided by today's bridges and routers. Lastly, we provide some relevant product information on IBM router products, the IBM 2217 Multiprotocol Concentrator and the AS/400.

Chapter 1. Why Multiprotocol Networks

This chapter explains the move from a classic SNA-based AS/400-oriented network to a multiprotocol network. It is addressed to AS/400 and networking specialists.

Workstations communicating with an AS/400, locally or remotely, typically use the SNA protocol to exchange data. The remote workstations can be PCs or IBM 5494 Remote Workstation Controllers, which communicate, for example, via a token-ring LAN or a WAN connection with their host, the AS/400.

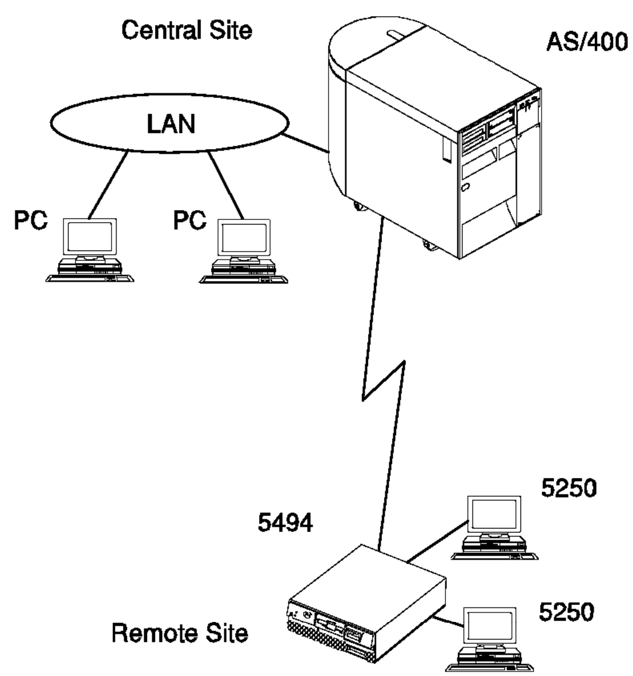


Figure 1. Classic AS/400 Networking Environment

New user requirements may need networking solutions which are not AS/400 based and require different network protocols to SNA.

This can be, for instance, a NetWare LAN server which uses primarily IPX as its protocol. TCP/IP is another often required protocol used to communicate with systems that do not use SNA, especially UNIX-based systems.

The application that meets user requirements *should* dictate the network protocol. Running a single protocol in a network has some advantages. However, today's popular network applications use different protocols.

These requirements lead us into a multiprotocol environment, and the question comes up as to how can we support different protocols via the same physical network.

1.1 How Multiple Protocols Arise

Traditionally, one site may have an AS/400-based application running and users at remote sites can access it by means of a remote IBM 5494 workstation controller over a wide area link. At the main site, another user requirement may have been satisfied by a NetWare LAN server solution. This means we have two protocols in use, SNA and IPX.

At the remote site there may also be a UNIX system running another application. UNIX systems mainly use TCP/IP-based network applications.

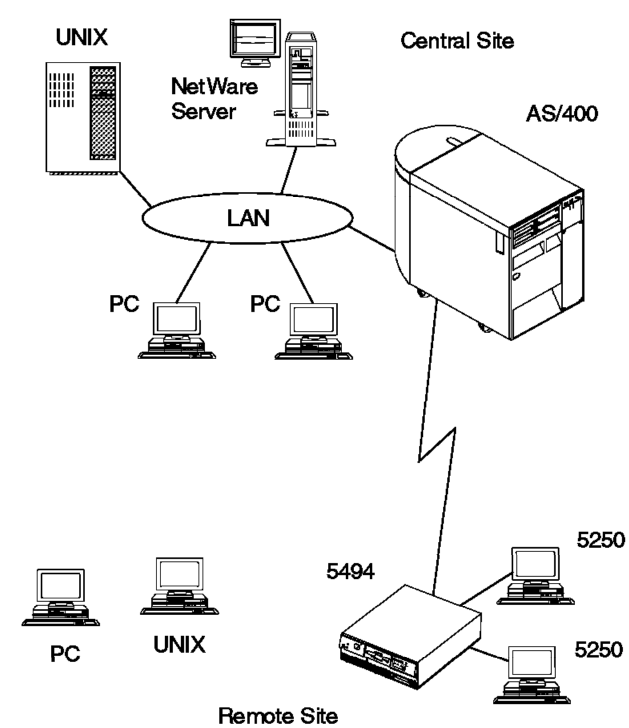


Figure 2. Different Applications Require Different Protocols

In this scenario, both the LAN-attached PCs at the main site and the PCs at the remote site now require access to both the AS/400 and the NetWare LAN server. The UNIX workstations will use TCP/IP to communicate with each other and with the AS/400. The network has to support SNA, TCP/IP and IPX protocols.

Nowadays, users need access to all systems and applications and do not want to be restricted by protocol and logistics. As the workplace changes, the evolving network must provide access to everything.

Multiple network protocols can coexist in a LAN environment. However, a WAN connection and the system or controller acting as gateway often only support a single protocol. In our scenario, the IBM 5494 is an SNA device. This means it is unable to forward TCP/IP or IPX.

In the next two sections, we look at two solutions for transporting all of these protocols over a wide area connection between the local and remote sites.

1.2 Multiprotocol Networks Using Routers

This is the point where a company's network has to become a multiprotocol network and where routers will take over the role of a gateway between the LAN and WAN environment. This means that the AS/400 and the user devices (like the IBM 5494) move one step back, and other devices (networking devices such as routers) take over the task of providing the backbone.

One solution to the situation in Figure 2 on page 4 is shown in Figure 3.

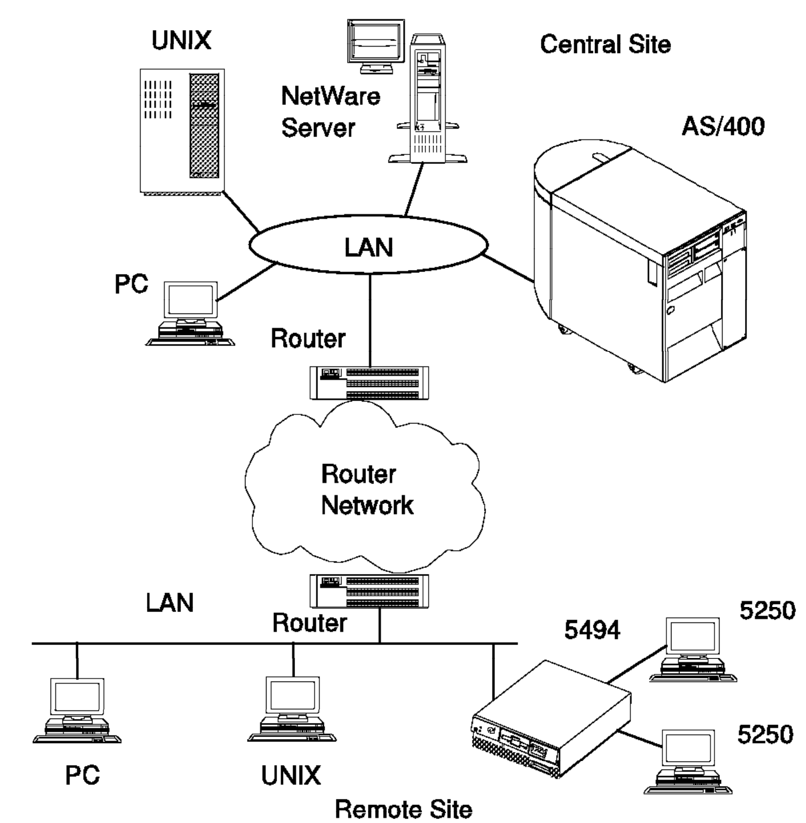


Figure 3. Multiprotocol Router Network with AS/400 and IBM 5494

1.2.1 What Are Routers?

Routers are networking devices usually equipped with a LAN and a WAN adapter. A pair of routers accomplish the interchange of data between two distributed LANs.

To this extent, bridges perform the same level of service. However, bridges are not protocol-sensitive and forward all traffic between LAN environments. To control and reduce this considerable amount of traffic, more sensitive networking devices called routers were introduced. Routers are configured to forward data for specified remote networks only. Routers make this decision for each piece of data sent based on the target address included in the header of the data.

The way the various protocols, like TCP/IP, SNA, and IPX, communicate differs. Only connectionless protocols, like TCP/IP, include the network addresses with each frame and piece of data sent allowing the router to selectively forward data. Connection-oriented protocols, like SNA, do not include the destination address with each frame exchanged. Consequently, SNA is not routable in the sense of the so-called multiprotocol routers. This means multiprotocol routers are only able to handle a limited set of network protocols, and different methods have to be used to forward nonroutable protocols, such as SNA and NetBIOS.

Remember that connectionless protocols route and connection-oriented protocols do not.

Today′s routers have function in addition to be being able to route routable protocols. For example, an IBM 6611 router offers the following four different categories of functions:

- Bridging token-ring and Ethernet traffic
- Routing protocols like TCP/IP and IPX
- Data link switching (DLSw) of SNA and NetBIOS
- Acting as an APPN network node

TCP/IP and IPX are typically routed natively over the multiprotocol router network. NetBIOS and SNA, however, must be encapsulated in TCP/IP frames and transmitted using TCP/IP protocols. This encapsulation and the additional control data (headers) represent an overhead. Hence, when changing from a pure SNA network to a multiprotocol router network, migration will not provide better performance.

Networking protocols and router technologies are discussed in Chapters 2 and 3.

1.2.2 Benefits of Routers

- Routers accomplish the sharing of various network protocols over the same physical link.
- Routers allow selective forwarding of protocol data based on network address information.
- The TCP/IP nature of multiprotocol networks allows nondisruptive connections and easy switching to alternate routes.

1.3 APPN-Based Multiprotocol Networks

It is a common solution to use routers to forward different network protocols via a WAN connection. Remember that, in most cases, a multiprotocol router network is basically a TCP/IP network via which other protocols are sent using TCP/IP techniques.

However, in most AS/400 environments an APPN network is the backbone of the company. It would be more desirable to transport non-SNA protocols via the APPN network than to encapsulate the major part of the traffic in TCP/IP datagrams.

The IBM 2217 Multiprotocol Concentrator (MpC) is an APPN network node. The IBM 2217 MpC accomplishes transport of other protocols, such as TCP/IP, NetBIOS and IPX, via an APPN network. Like any other APPN node, the IBM 2217 MpC uses independent LU 6.2 sessions. Consequently, you are able to interconnect IBM 2217 MpCs via any SNA network which supports independent LU 6.2 sessions such as an APPN network of AS/400 systems or an SNA subarea network.

This means that an alternate solution to the scenario depicted in Figure 2 on page 4 is Figure 4 where the NetWare server and requesters and the UNIX workstations talk via the IBM 2217 MpCs.

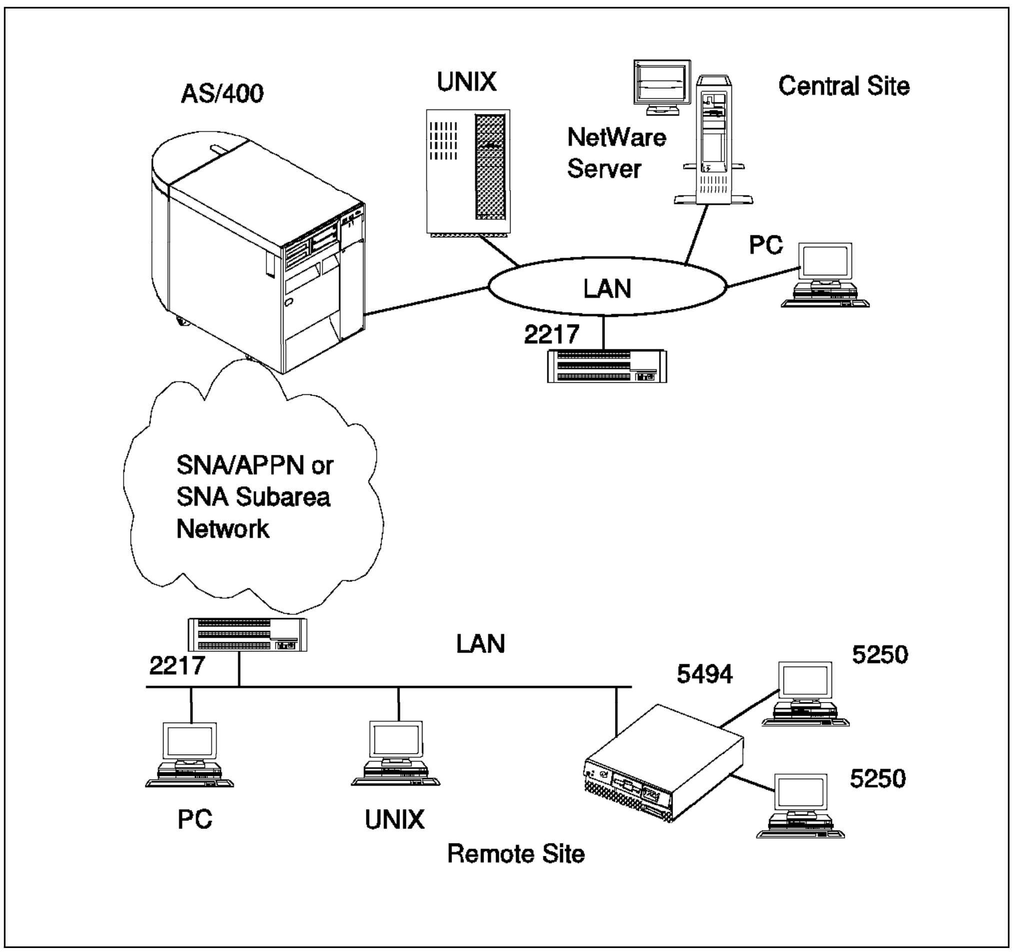


Figure 4. APPN-based Multiprotocol Network Using the IBM 2217 MpC

The following are advantages of using the IBM 2217 MpC instead of multiprotocol routers:

- The IBM 2217 MpC migrates easily into your current SNA network.
- You need not change your current SNA network.
- It isn′t necessary that you acquire multiprotocol router knowledge.
- You may continue to rely on the consistent response times provided by SNA class-of-service, adaptive pacing and compression.

See Chapter 5, “Your SNA/APPN Network - A Multiprotocol Network” on page 51 for more information.

Chapter 2. Networking Technologies

This chapter presents an overview of networking technologies by concentrating on the following areas:

- Protocols
- Bridging and routing
- Routable and nonroutable protocols

We will start by looking at four of the major protocols in existence today: SNA (including APPN), TCP/IP, IPX and NetBIOS. We will look in turn at each, describing the key points and summarizing their respective strengths and weaknesses.

We will then move on with a discussion on bridging and routing, summarizing each, and describing situations where one should be used in preference to the other. Finally, we close the chapter by looking again at our protocols and describing which can be routed and which cannot.

2.1 Why Different Protocols?

The first question is, why have support for *different* protocols. The answer to this question is that it all comes down to the choice of application and the protocol that it has been written to use. Certain applications use certain protocols. For example, IBM Client Access/400 uses SNA, TELNET uses TCP/IP and Novell NetWare uses IPX. If an environment has a mixture of applications, then the network must be able to support the mixture of protocols required by these applications.

The following table describes the protocols that are supported by many of the common application platforms available today:

Table 1. Common Applications and Protocols

Application	Protocol
Novell NetWare	IPX
IBM LAN Server	NetBIOS
Microsoft LAN Manager	NetBIOS
IBM Client Access/400	SNA
IBM Communications Manager/2	SNA
IBM PC/3270	SNA
TELNET	TCP/IP
FTP (File Transfer Protocol)	TCP/IP
SNMP (Network Management)	TCP/IP
SMTP (Mail Protocol)	TCP/IP
NFS (Network File System)	TCP/IP
Lotus Notes	TCP/IP, NetBIOS or SNA
Lotus CC: Mail	TCP/IP or SNA

2.2 SNA (Systems Network Architecture)

Systems Network Architecture (SNA) was developed by IBM in the early 1970s and rapidly gained acceptance as the way of networking IBM host systems and allowing access to them from terminal devices. More recently, SNA has evolved to provide support for client/server architectures with APPN playing a particularly prominent role.

SNA′s main selling points are the very strong support within the protocol for congestion control, flow control and traffic prioritization. This means that the SNA protocol can provide response time guarantees that other protocols will struggle to meet. SNA has also been proven capable of being able to provide stable support for very large and complex networks.

SNA is not capable of being routed natively across a router network, rather some encapsulation technique must be used. The best options for carrying SNA on router networks are bridging on local LANs and using Data link switching for transport over the wide area.

On the negative side, the configuration of SNA can be very time consuming and complex. Configuration of workstations to use SNA services does take far longer than for other comparable protocols. Also, SNA is owned by IBM. Some customers perceive this as a drawback as they move toward open systems. However, we should say that this is not a *technical* limitation of the architecture.

2.2.1 Subarea SNA

Subarea SNA was the original protocol used to build SNA networks and is still in use today. It relies on a hierarchical rigid structure with all of the network controlling function being handled by the *SNA rich* mainframes and Front-end processors (FEPs). The following diagram represents the hierarchical view of subarea SNA and summarizes the SNA PU types.

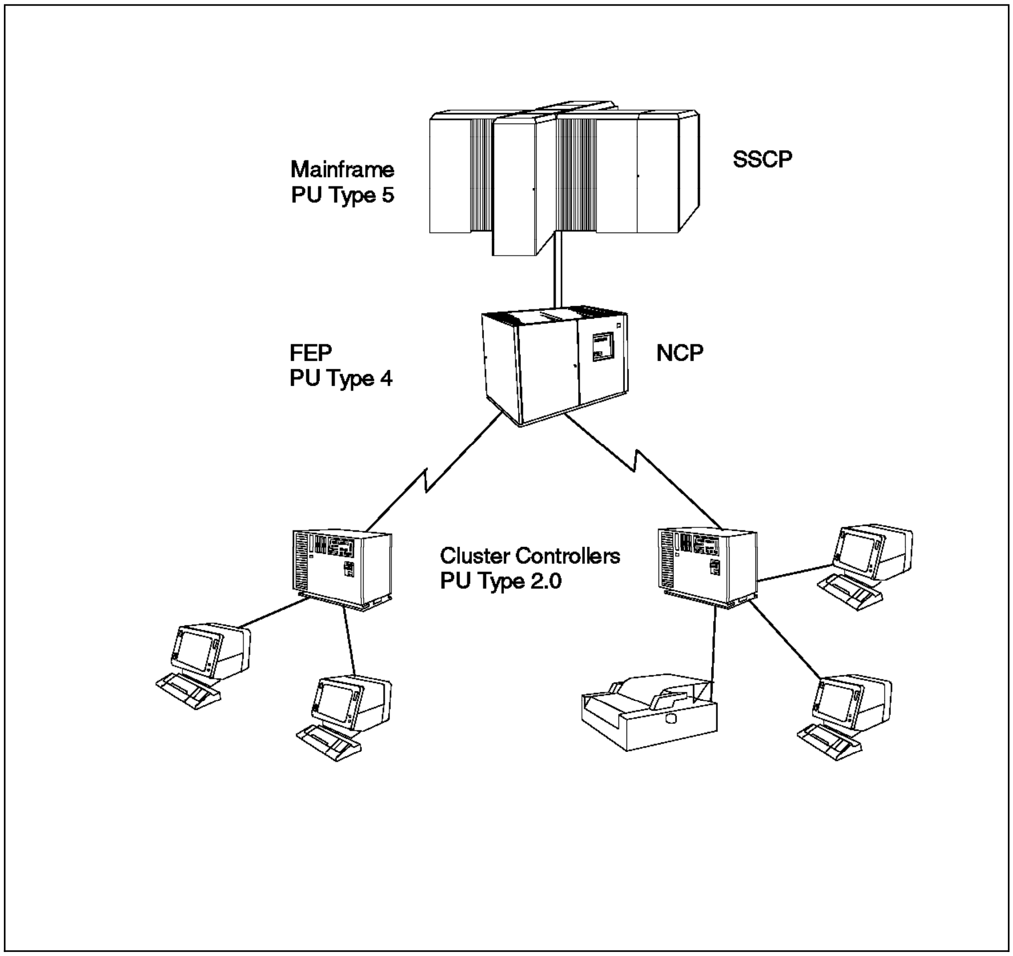


Figure 5. Subarea SNA Topology

All SNA sessions are set up and controlled by the SSCP, a special application that runs in the mainframe. Sessions cannot be established between devices without the SSCP being involved.

2.2.2 APPN (Advanced Peer-to-Peer Networking)

Advanced peer-to-peer networking (APPN) provides enhanced functions over SNA node type 2.1. It provides additional support in the SNA transport layers, which enable nonadjacent systems (nodes) to communicate over a single session and appear as if they are attached directly to each other. APPN changes the hierarchical nature of subarea SNA by using a peer-to-peer approach. APPN performs any-to-any routing, without requiring a session between any layers above the transport layers, known as intermediate routing. Control of the network is given to peer systems (nodes). This means that APPN sessions can be established between APPN nodes without the mainframe being involved.

The APPN architecture particularly lends itself to client/server applications running on distributed systems that do not need the mainframe in order to be able to communicate.

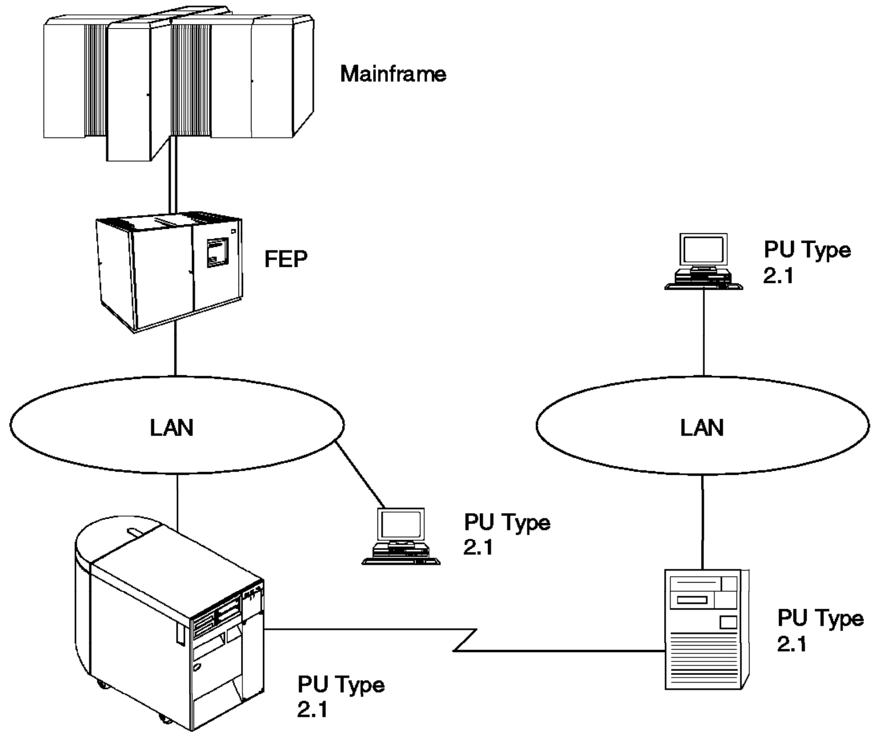


Figure 6. APPN Network Topology

APPN offers the following advantages over an SNA subarea network:

- Better performance during session initiation.
- Improved performance during network activation by eliminating the SSCP-PU and SSCP-LU control sessions.
- Reduced system definitions. APPN can dynamically learn about the network topology.
- Increased availability as the topology is learned dynamically. There is no need to shut down a part of the network to add a new node.

High Performance Routing (HPR) is an enhancement to APPN. HPR can be routed natively through router networks.

APPN defines the following three types of nodes within a network:

- APPN network nodes
- APPN end nodes
- Low entry networking (LEN) nodes

An APPN network node (NN) provides directory and routing services for all resources in its domain. A network node′s domain consists of the following:

- Local resources owned by the node
- A control point (CP) which manages the node′s resources
- Resources owned by APPN end nodes and LEN nodes that use the services of the network node

An APPN end node (EN) selects a network node to be its network node server and registers its local resources with it. This allows the network node to pass session requests for resources located on the end node.

An APPN LEN node is a type 2.1 node without any APPN extensions. It can establish a connection to an end node or network node, but cannot register resources dynamically. All definitions must be predefined on the end node or network node.

2.2.3 High Performance Routing

High Performance Routing (HPR) is an extension to the APPN architecture designed to enhance APPN routing support. HPR provides a facility for non-disruptive path switching (NDPS) around failed HPR links without the disruption of sessions using the path.

HPR features a new transport protocol called Rapid Transport Protocol (RTP) which uses a new flow control mechanism called Adaptive Rate Based flow control or ARB. RTP is an end-to-end transport protocol which is active only at HPR connection endpoints. RTP uses APPN topology services to calculate routes. When RTP detects a failed route, it calculates a new route (if one exists) and reroutes data without disrupting end sessions. Also, since data flow between HPR nodes is connectionless, the processing required at HPR intermediate nodes is very small allowing very high throughput performance.

ARB is a new approach to flow control based on data rates rather than on traditional windowing schemes. ARB monitors the data rates at the RTP endpoints and is able to detect and respond to congestion much sooner than traditional windowing techniques.

HPR can be added into existing APPN networks with virtually no impact to end users.

2.3 TCP/IP (Transmission Control Protocol/Internet Protocol)

TCP/IP was designed and developed by a project sponsored by the US Department of Defense (DOD) during the early to mid 1970s. The protocol was built to support UNIX machines running on local area networks. It was probably the first example of a protocol designed to support client/server architectures.

TCP/IP has no concept of hierarchy. Unlike subarea SNA, all hosts are equal. TCP/IP can be carried natively through router networks by almost all router products.

The name TCP/IP came from two of its component parts. IP (Internet Protocol) is the name given to the network layer, while TCP (Transmission Control Protocol) is one of the transport layer protocols that can be used. The other common transport protocol that applications can use is the User Datagram Protocol (UDP). Please see Table 1 on page 9.

TCP/IP is the protocol that has been used to build the world′s largest network, the Internet. Other strengths of TCP/IP are its vendor independence and ease of configuration. TCP/IP is a defacto standard that has been published. Therefore, any vendor can write their own version based upon the published standard. Also, due to the fact that all implementations are written to the same standard, all versions should interoperate.

On the negative side, TCP/IP is let down by its poor congestion control, flow control and traffic prioritization. Some simple schemes do exist for each of these, however, they are not as efficient or effective as those employed by comparable protocols (in particular SNA). The lack of proper controls can make it very difficult to guarantee response times over wide area networks. This situation is made even worse by the presence of certain *character mode* applications (for example, character mode TELNET), which echo each character across the network as it is typed rather than transferring data in block format (like SNA). Finally, the current addressing structure for TCP/IP is under severe strain with a shortage of available addresses. This problem is being addressed by various groups by expanding the available addressing scheme.

TCP/IP addresses, or more accurately IP addresses, are 32-bit numbers usually written as four decimal numbers separated by dots (for example, 9.67.46.225). Each decimal number consists of 8 bits and hence can take any value between 0 and 255. The IP address is broken into two parts, the network portion and the host portion; the point in the address at which this break is made is governed by the *subnet mask*. Every IP address must be configured with an associated subnet mask. IP addresses must be unique within the IP network.

2.4 IPX (Internet Packet Exchange)

The IPX protocol was developed by Novell from an original specification of the XNS protocol designed by Xerox. IPX and XNS are in fact very similar protocols only differing in a few minor ways. However, the two protocols are not compatible.

IPX is the protocol used by Novell NetWare and thus has a very large installed base. IPX, like IP, was originally designed to run on local area networks with some later extensions being added to allow it to communicate over the wide area. As with IP, IPX is capable of being routed natively by almost all router products. Some products also provide the capability of encapsulating IPX within IP. Recent levels of the Novell code also allow servers and requesters to talk IP natively. This option may be used if, for example, you do not want to run native IPX on your routers.

As with IP, IPX describes the network layer of the protocol. Another commonly used term is SPX. SPX is actually one of the transport layer protocols and is similar in function to TCP.

The main strengths of IPX are its ease of configuration and the very large installed base. Typically, the installation of IPX on a Novell client requires three or four small modules and minimal configuration.

The principle drawback of IPX is its poor performance over the wide area. Even with the extensions provided to allow IPX to communicate over the wide area, the protocol does not perform very well. Some work has been done to improve the situation, in particular, with the implementation of IPX packet burst which is mandatory for any WAN connectivity. Even more recently some new IPX standards, namely LIP (Large Internet Packet) and NLSP (Novell Link Services Protocol), should improve performance once implemented.

IPX addresses, like IP addresses, consist of two parts: a network portion and a host portion. However, unlike IP addresses, the IPX address separates these addresses completely into a 32-bit network number and a 48-bit host address.

Normally, an IPX host will use its LAN adapter address (the MAC address) as its host address. Only IPX servers and routers are configured with the network number. IPX clients broadcast to find their own network number when they are brought up. IPX addresses (network number and host number) must be unique within the IPX network.

2.5 NetBIOS (Network Basic Input/Output System)

NetBIOS was designed jointly by IBM and Microsoft and originally implemented in the IBM LAN Server and Microsoft LAN Manager platforms. Like many other protocols, NetBIOS was only designed to run over local area networks and, as such, cannot be routed natively by any router products. The only ways of transporting NetBIOS over wide area connections are either by bridging or more recently, data link switching. The move in the industry at present appears to be away from NetBIOS as it cannot be carried natively by router products. See 2.8, "Routable versus Nonroutable Protocols" on page 25.

The positive aspects of NetBIOS are its ease of configuration and good performance over purely local networks. The negative aspects include its lack of routing support and the constant broadcasting which can flood wide area links. With DLSw there are limitations on the size of NetBIOS networks that can be connected together. Bridging is the only suitable solution for very large NetBIOS networks.

NetBIOS addressing is based on two concepts, *machine names* and *domain names*. The machine name is the name of the NetBIOS resource and is a free format eight character string. A domain name is a logical collection of NetBIOS resources and is also a free format eight character string. All NetBIOS names must be unique in the NetBIOS network. Note that a NetBIOS domain is a logical group of NetBIOS machines, that is, it does not specify where those machines should exist. It is not possible to route based upon a NetBIOS domain name.

2.6 Link Layer Protocols

Each of the protocols that we have looked at so far is defined at layer 3 and upwards in the OSI stack. They all make use of separate link layer protocols that govern how the data is transferred between stations. This section briefly covers some of the link layer protocols in common use today.

There are basically two groups of link layer protocols, those for transporting data over the wide area and those for transporting data over local area networks. We will look at each in turn.

2.6.1 Local Area Network Link Layer Protocols

We start this discussion by looking in detail at the lower three layers of the OSI seven-layer stack.

Table 2. Layers 1 - 3 of the OSI Stack - LANs

3	Network	IP, IPX, etc.
2	Data Link	LLC
		MAC
1	Physical	UTP, STP, etc.

At layer 1 of the OSI stack we have the different cabling (Media) options including unshielded twisted pair (UTP) and shielded twisted pair (STP).

Layer 2 of the OSI stack is responsible for two tasks: transmission of the data onto the physical media (Media Access Control - MAC), and the establishment of a logical connection between stations (Logical Link Control - LLC).

Media Access Control governs the way in which data is transmitted onto the physical medium. In the LAN world, there are many different standards, the most common being IEEE 802.5 (MAC standard for token-ring) and Carrier Sense Multiple Access/Collision Detect, otherwise known as CSMA/CD (the MAC for Ethernet). This layer of the stack contains the required logic to, for example, transmit data onto an Ethernet network.

Logical Link Control uses the Media Access Control to provide an end-to-end logical connection between stations. *LLC2* provides a connection orientated and reliable *session* between two endstations on the same LAN.

We should note that bridges operate at the MAC layer; that is, they have no knowledge or visibility of LLC sessions.

2.6.2 Wide Area Network Link Layer Protocols

Table 3. Layers 1 - 3 of the OSI Stack - WANs

3	Network	IP, IPX, etc.
2	Data Link	Frame Relay, PPP, SDLC
1	Physical	X.21, V.35, etc.

At layer 1 (the physical layer) we are again concerned with physical media. Common standards in this area include X.21, V.35 and V.24 (RS232).

At layer 2 (the link layer) we are concerned with one basic function: the establishment of a direct connection between two stations over the physical media selected. Again, as with LAN technologies, there are many standards but three common techniques are as follows:

- Frame relay
- Point-to-point Protocol (PPP)
- SDLC

Frame relay is very similar conceptually to X.25 and provides logical end-to-end connectivity between end devices across a frame relay backbone. This logical end-to-end connection is known as a Data Link Circuit Identifier (DLCI). Multiple DLCIs to different destinations can be configured on the same router port.

Point-to-point protocol (PPP) is a level two protocol that defines a direct point-to-point connection between routers. Only a single PPP connection can be configured on a single port. PPP supports most of the common layer three protocols (IP, IPX, Vines, XNS) directly.

SDLC is a standard protocol for the interconnection of SNA devices. SDLC only supports SNA.

2.7 Bridging versus Routing

We start this discussion with a presentation of the well known OSI seven-layer stack model of networking as follows:

Table 4. OSI Seven-Layer Model of Networking

7	Application	**Gateway**
6	Presentation	
5	Session	
4	Transport	
3	Network	**Routers**
2	Data Link	**Bridges**
1	Physical	**Repeaters**

2.7.1 Overview of Bridging

Bridges switch packets at layer 2 of the OSI model and allow *all* protocols connectivity by building one large flat LAN. Bridges do not see the details of the protocols that they are handling as the network layer addresses are not visible to them. Some protocols can only be bridged because they do not have network layer addresses that allow them to be routed.

On token-ring networks, Source Route Bridging is used. On Ethernet, it is known as Transparent Bridging. When bridging between token-ring and Ethernet networks, Translational Bridging is used.

The major advantages of bridging are the simplicity of the devices, the protocol independence and the fact that no complex management of the bridges is required. Protocol independence means that all protocols can be bridged across the same connection. In fact, in a purely local environment bridging works very well.

On the negative side, bridging does have some drawbacks particularly when network connectivity is required over the wide area. Primary amongst these are lack of congestion control and no prioritization of traffic. Because endstations themselves do not have visibility of bridges, the bridge cannot request that endstations slow down in the event of bridge congestion. Even more importantly, because bridges do not have visibility of the protocols they are bridging, they cannot prioritize protocols over one another. This can cause certain time-sensitive protocols such as SNA or NetBIOS to time out due to the delays on slow speed WANs.

2.7.2 Bridging Methods

The following are the two primary methods of bridging:

- Transparent bridging or spanning tree bridging (STB)
- Source route bridging (SRB) used in 802.5 LANs

Then, from these two primary methods of bridging, there are other methods as follows:

- Source route transparent bridging (SRT)
- Source route-translational bridging (SR-TB)

In the following sections we provide an overview of these bridging methods.

2.7.2.1 Transparent Bridging

A transparent bridge is also called spanning tree bridge (STB).

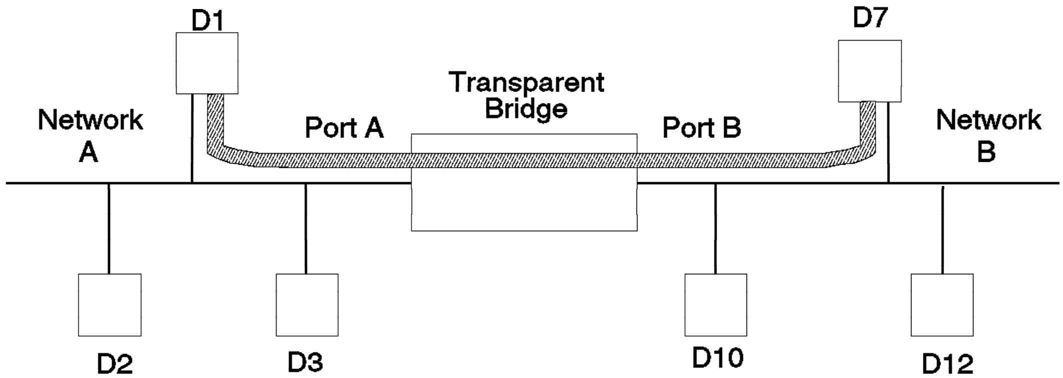
Transparent bridging is normally used to connect IEEE 802.3 segments. It is specified in the ISO 8802-1 standard.

Transparent bridging is based on the principle that a sending device can transmit a frame to a receiving device on a LAN network without having any knowledge of the location of, or the path to, that receiving device.

Within a network, transparent bridges are responsible for forwarding the frame to the correct destination. The decision on whether or not a frame should be forwarded is based on the MAC sublayer destination address.

Transparent bridges achieve this by building and maintaining a *filtering database* that acts as a *forwarding table* for received frames. They build their database by copying all frames from the LANs to which they are attached and learning the location of devices by inspecting the MAC sublayer *source address* in each received frame.

Figure 7 illustrates how a transparent bridge will build up its filtering database.



Filtering Database

Address	Port
D1	A
D2	A
D3	A
D7	B
D10	B
D12	B

Figure 7. Transparent Bridging

When the bridge receives a frame from device D1 on port A it learns that D1 can be reached via the LAN on port A. Similarly, if a frame arrives from device D7 on port B it learns that D7 can be reached via the LAN on port B.

For each new source address the bridge sees on the LANs, it adds an additional entry in its database. In time, a full picture is built up of all the devices on the two LANs and via which port they can be reached.

Transparent bridges support and use the spanning tree protocol which ensures a loop-free topology between all the transparent bridges within the network.

2.7.2.2 Source Route Bridging (SRB)

Source route bridging is implemented by IBM and compatible bridge products for use over token-ring LAN segments.

Source routing requires a sending device to specify the path that should be taken by a frame across an internetwork rather than allowing the decision to be made by individual bridges. To do this, a sending device must determine the best path to a destination and include it in all frames to that destination. The best path to a destination is found using a discovery process. One implementation of this process is described as follows:

A sending device sends a discovery frame to the intended destination device marked single-route broadcast. Bridges in a token-ring internetwork should be configured using the token-ring spanning tree algorithm to permit only one path for single-route broadcast frames between devices. The destination device should therefore receive only a single copy of the discovery frame.

The destination device responds to the discovery frame with a discovery response frame marked all-routes broadcast. This will contain the most significant bit (the route information indicator, also called RII) set in the source MAC address field and an entry in the routing information field (RIF). This will initially contain zero in the bridge number field, and the number of the network to which the destination device is attached in the segment number field.

The discovery response frame, because it is marked all-routes broadcast, will pass through all bridges on its way back to the original sending device. Each bridge that the frame passes through must insert its bridge number and LAN segment number. Hence, the frames that return to the original sending device contain the routes that they have taken through the bridged internetwork.

The routing information field can currently only hold data about seven bridges and eight LAN segments. If a frame is received by a bridge with this field full, it will be discarded. This limits the number of bridge *hops* in the network to seven, and is consequently the maximum size of source route bridged internetworks.

The original sending device, therefore, receives one or more discovery response frames. These frames contain routing control and bridge and LAN segment numbers in their routing information fields. The routing control field indicates the number of bridge/LAN segments in the routing information field and also the maximum frame size that can be supported by the route.

The sending device can now select the best route to use through the internetwork to reach the destination device. Current implementations select the route in the *first* received discovery response frame (the fastest path at the time of the discovery process) although the architecture allows route selection based on other criteria (for example, maximum frame size supported by the route).

Figure 8 shows how the routing information field in a source route bridge frame is used to define a route through an internetwork between the end nodes D1 and D7.

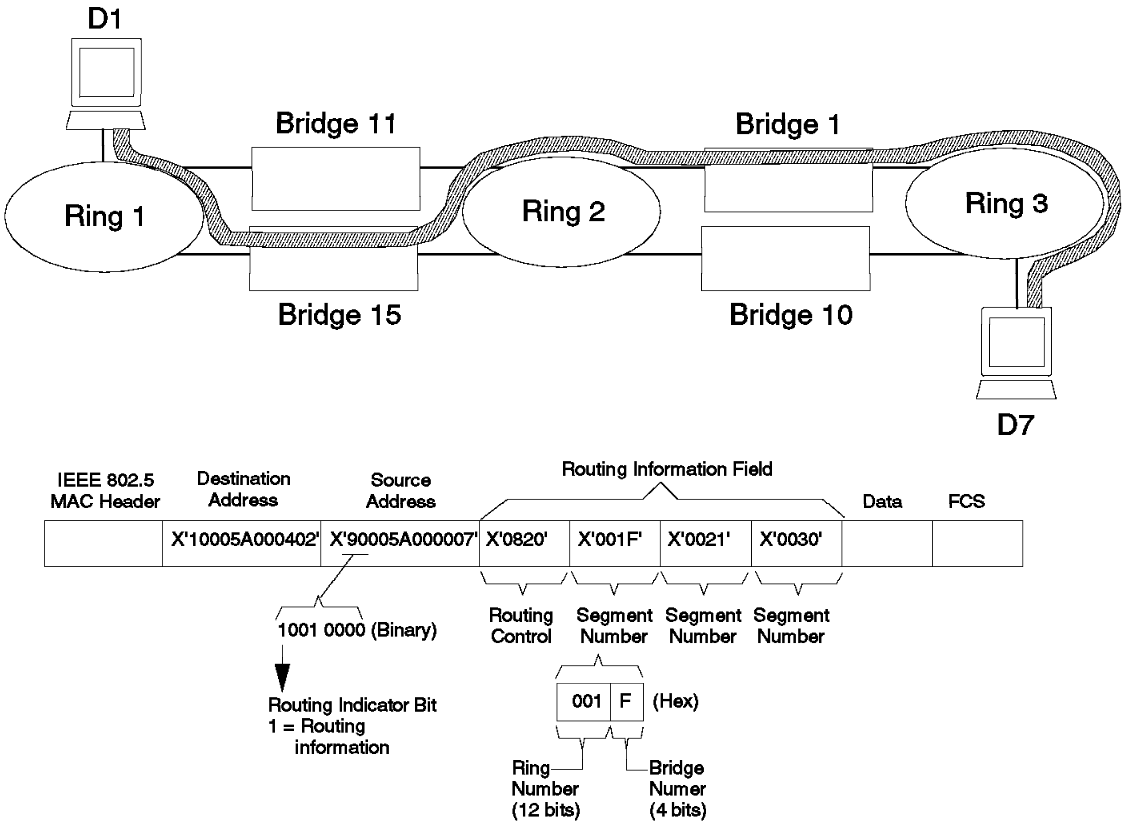


Figure 8. Source Route Bridging

2.7.3 Source Route Transparent Bridging (SRT)

The IEEE 802.1 committee identified the need for source route bridges to interoperate with transparent bridges in the same internetwork. A *source route transparent bridge (SRT)* standard has been defined to achieve this goal.

The principle behind SRT bridges is very simple. A SRT bridge inspects all received frames and looks for the presence of the routing information indicator (RII) and the routing information field (RIF). If these fields are present, the SRT bridge uses them and acts as a source route bridge. If not, the SRT bridge operates in transparent bridge mode and forwards frames based on their MAC sublayer destination address and its associated entry in the filtering database.

The source route transparent bridge *does not* allow source route bridge devices to communicate with transparent bridge devices. A SRT bridge has the capability to understand both source route bridging and transparent bridging devices. However, a SRT bridge will never translate source route bridge frames into transparent bridge frames and vice versa.

Figure 9 shows how a source route transparent bridge forwards token-ring frames as token-ring frames and Ethernet frames as Ethernet frames.

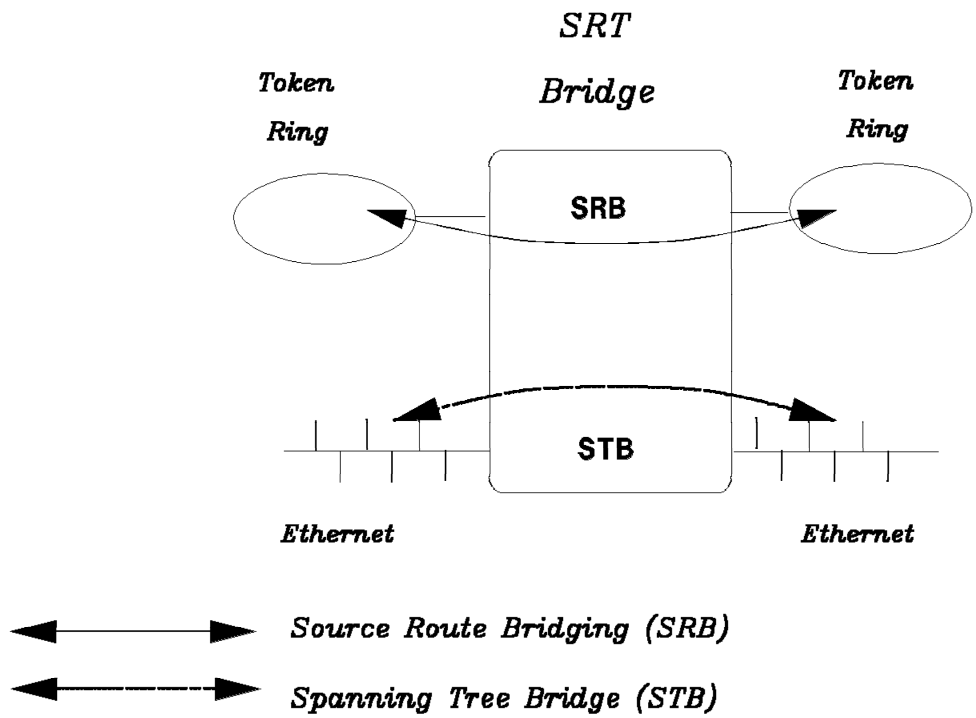


Figure 9. Source Route Transparent Bridge

2.7.4 Source Route - Translational Bridge (SR-TB)

The source route - translational bridge (SR-TB) is not an ISO standard definition. However, more and more bridges are implementing the SR-TB because of the need to interconnect source route bridge domains with transparent bridge domains.

The goal of the source route - translational bridge is to translate the source route bridge frame into a transparent bridge frame and vice versa.

The SR-TB bridges have to change the MAC layer protocol from (or to) Ethernet protocol to (or from) token-ring protocol. Actually, regarding the ISO bridge definition, this translation does not belong to a bridge. But it is implemented in a lot of bridges in order to be able to interconnect source route bridge domain and transparent bridge domain regardless of the protocol of the upper layer.

Figure 10 shows how the SR-TB allows a SRB device with RII=1, to communicate with a STB device (RII=0).

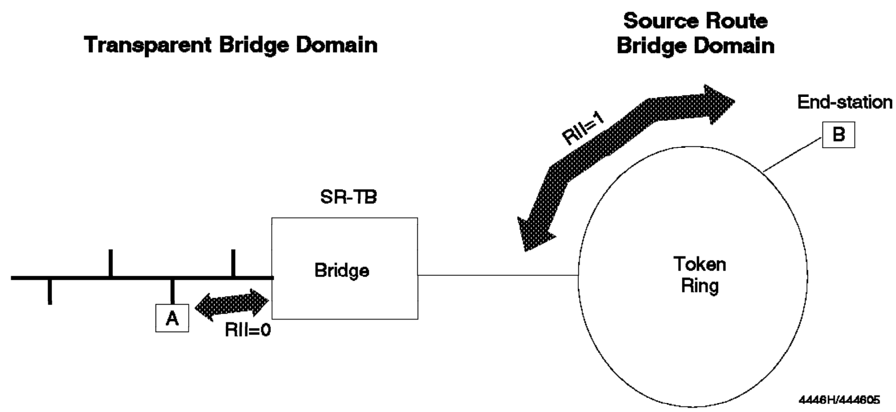


Figure 10. Source Route - Translational Bridging

See Figure 11 for a summary of bridging techniques.

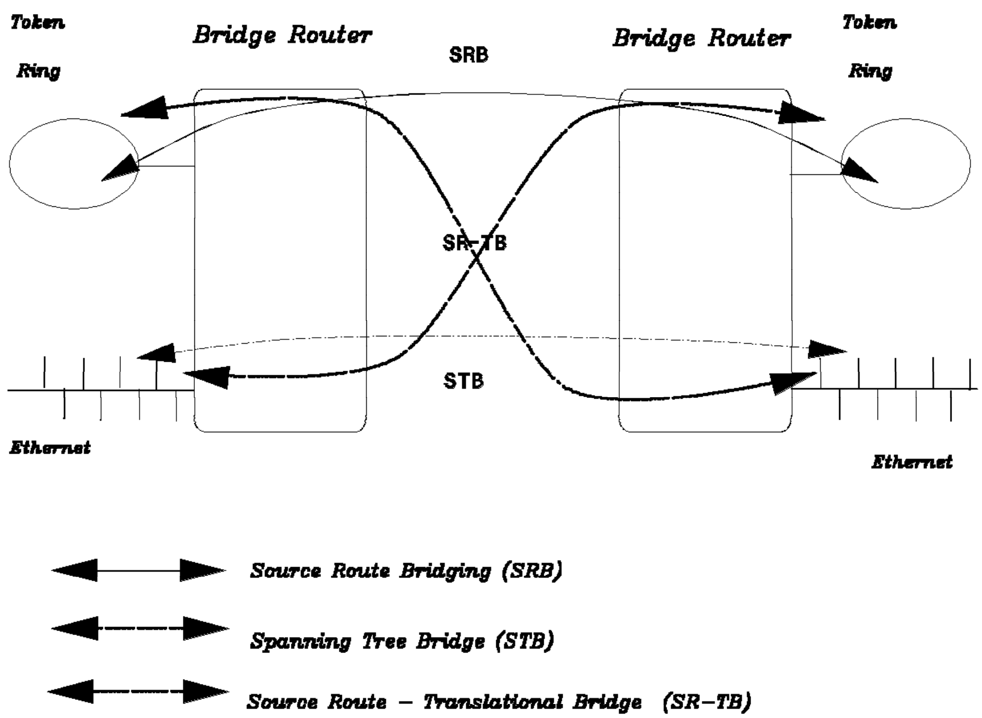


Figure 11. Summary of Bridging Techniques

- SRB means token-ring to token-ring.
- STB means Ethernet to Ethernet.
- A SRT (Source Route Transparent) bridge means the same box can do each of the above independently of the other. It can be used to interconnect either two Ethernet LANs together or two token-ring LANs together.

- SR-TB means token-ring frames are translated to Ethernet frames and vice versa. A SR-TB bridge allows you to connect an Ethernet LAN to a token-ring LAN.

2.7.5 Overview of Routing

While bridges switch at layer 2 of the OSI model, routers operate at layer 3 (the network layer). The network layer is protocol dependant which means that the router has to understand each of the protocols that it has to route. In order to perform this, the router must have a routing table for each protocol that tells it where to send a packet for a particular destination. Finally, a router can only route protocols which have an address at the network layer. Some protocols (for example, SNA, NetBIOS, DEC LAT) do not provide such a visible address and thus are not routable.

The main strengths of routing include protocol prioritization, isolation of network segments and extended network management.

Because routers have visibility of the protocols that they are routing, they also give us the ability to prioritize protocols against each other. Also, it is possible to define detailed filter schemes on each protocol to protect the network from unauthorized access.

Routers also, generally, provide much greater management capabilities over conventional bridges. This can allow network mangers greater operational control over their network (see Chapter 23, “Network Management in Router Networks” on page 277).

LAN broadcasts (for example, those issued by NetBIOS when searching for a resource) are not forwarded by routers. Therefore, a routed network provides some degree of isolation between network segments.

On the negative side, routers are by their very nature more complex than bridges. Each router has to be configured with the details of each protocol that it is routing. This information must be updated should any of this information change. Routers themselves require management.

Finally, routing is not a solution for all protocols. Some protocols cannot be routed.

2.8 Routable versus Nonroutable Protocols

Why are some protocols described as *nonroutable*? What does this mean? More importantly, what actually makes a protocol routable? This section covers these questions with answers that are surprisingly simple. To illustrate the answers, we will look at some common protocols: IP, SNA (subarea SNA and APPN) and NetBIOS.

What makes a protocol routable? Simply, it is the presence of a unique address at the network layer of the protocol (remember that routers switch at the network layer). Let us take a look at some of the common protocols to see which are routable and which are not.

2.8.1 TCP/IP

TCP/IP is a classic example of a routable protocol such as IPX and some others (see Table 7 on page 28). First, let us have a look at the structure of TCP/IP related to the 7 layer model.

Table 5. TCP/IP Relationship to OSI 7 Layer Model

7	Application	FTP, TELNET, SMTP ...
6	Presentation	
5	Session	
4	Transport	TCP/UDP
3	Network	IP
2	Data Link	LLC/MAC
1	Physical	

At the network layer of TCP/IP, IP provides a unique addressing structure based upon the IP address. Each IP address is basically split up into two parts: the *network number* and the *host address*. Because this addressing structure contains the concept of an IP network, routers can make routing decisions on that network to route traffic to the correct destination.

To illustrate this point, let us look at the following example in Figure 12 on page 26:

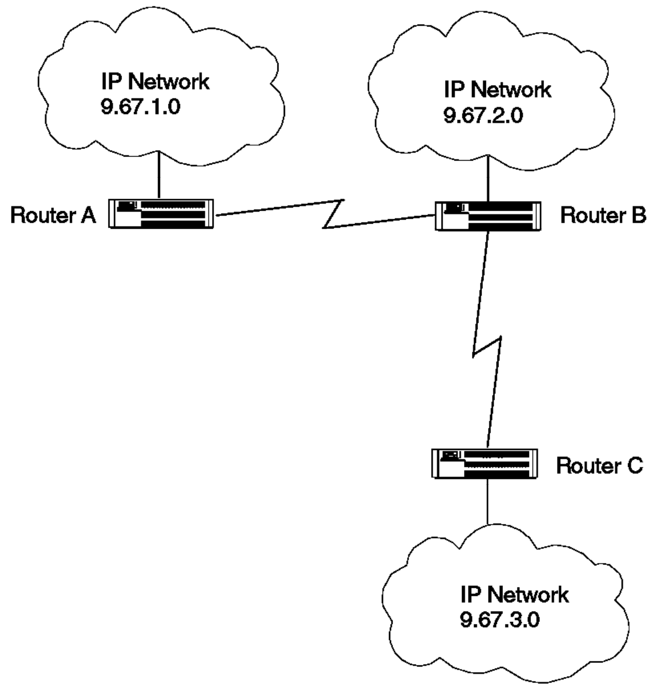


Figure 12. IP Routing - Sample IP Network Configuration

If router A receives a packet for IP network 9.67.3.0, it knows, either by static or dynamic routing (See 3.1.3, "Summary of OSPF versus RIP" on page 34) that router C is on this network and all packets should be forwarded towards it.

2.8.2 NetBIOS

While TCP/IP is a classical example of a routable protocol (it has a network address at layer 3), NetBIOS is a good example of a protocol that is nonroutable. Again, to see this, let us look at the NetBIOS protocol stack in Table 6:

Table 6. NetBIOS Relationship to OSI 7 Layer Model

7	Application	
6	Presentation	
5	Session	
4	Transport	NetBIOS
3	Network	*None*
2	Data Link	LLC/MAC
1	Physical	

Note that NetBIOS is a layer 4 (transport) protocol and, importantly, lacks a network layer and particularly a network layer address. Because NetBIOS does not provide a network address, routers (which operate at layer 3) cannot route the NetBIOS protocol.

As before, let us consider a sample network as follows:

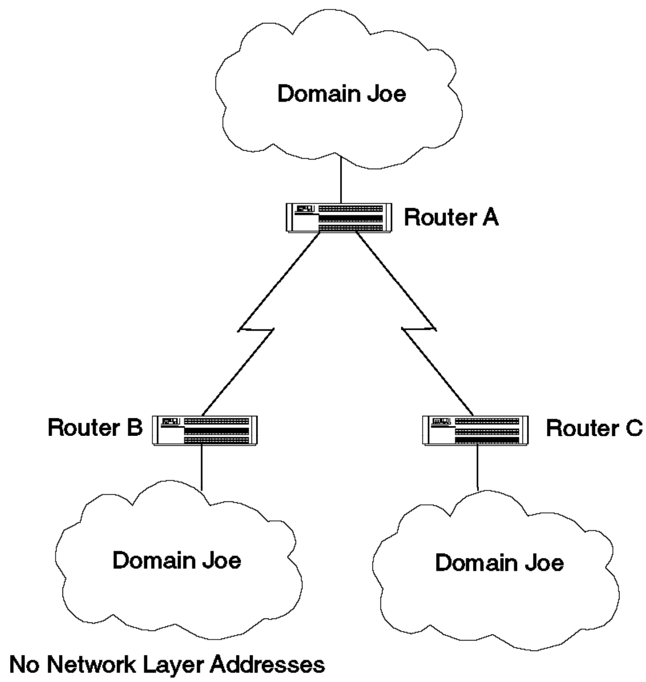


Figure 13. NetBIOS Routing - Sample NetBIOS Network Showing Domains

Consider the routers in this example. If they receive a packet for a NetBIOS machine, how do they know where to send it? There is no valid address at layer 3 for them to route upon. All addresses in the NetBIOS world are held at layer 4 (transport layer). Note that the NetBIOS concept of a domain does not equate to a network, that is, the domain *Joe* can exist in multiple locations as in the previous example.

If, for example, router A received a packet for a machine in domain Joe, how would it know where to send it? Each of the three routers has an interface in domain Joe.

2.8.3 Subarea SNA

A common statement that is made is that subarea SNA is not routable. This is a misconception. Front-end processors (37x5s) and the host VTAM have been routing subarea SNA ever since its original design. In fact, a 37x5 is an SNA router. The important point here is that the logic and addressing required to route subarea SNA is contained within the 37x5 and host VTAM and is not visible outside them. Thus, router products cannot themselves route subarea SNA as they cannot see the network layer addresses.

2.8.4 APPN

A special example of the SNA protocol is APPN. APPN is routable via High Performance Routing (HPR). Unlike a conventional SNA data packet, an HPR data packet contains all the information needed to route the packet to the destination node. It should be noted that while the AS/400 supports HPR, the current (V3R1) support is intermediate node only. Thus while an AS/400 can participate in an HPR connection, it cannot currently originate (be the endpoint of) an HPR connection.

2.8.5 Protocol Summary

The following table lists many of today's current protocols and states whether they are routable or not:

Table 7. Protocol Summary

Protocol	Routable	Comments
TCP/IP	Yes	
IPX	Yes	
Subarea SNA	No	Not routable by router products
APPN	Yes	Routable via HPR
NetBIOS	No	
DECnet	Yes	
Vines	Yes	
AppleTalk	Yes	
XNS	Yes	
DEC LAT	No	Use bridging or Cisco tunnel

Note: By *routable* in the above table we mean routable by a multiprotocol router such as a 2210 or 6611.

2.9 Summary

In this chapter we asked, why do we need support for different protocols? The answer to this question is that we are governed by the applications that we use. Certain applications have been written to use certain protocols.

We then briefly examined four of the more common protocols in existence today: SNA (including APPN), TCP/IP, IPX and NetBIOS summarizing the key points of each. SNA remains important for its strong quality of service, TCP/IP for its interoperability, IPX for its large installed base of Novell NetWare and similarly NetBIOS because of the IBM LAN Server installations.

We then moved on to examine bridging and routing, highlighting the key points of each and comparing the two techniques.

Finally, we looked at what makes a protocol routable. We have seen that this is the presence of a unique address at the OSI network layer (layer 3). We then described which common protocols are routable and which are not.

Chapter 3. Router Technology

This chapter describes the common techniques and technologies used in router products. It will cover the following areas:

- How routers work
- Data link switching (DLSw)
- Boundary Access Node (RFC 1490)
- SDLC Relay (Serial Tunnelling)
- Router APPN support

We start with a discussion of how routers work and in particular we describe how routers route packets to the correct destination. After this, we then move on to describe some techniques used within routers to transport nonroutable data across router networks. Data link switching (DLSw) is a mechanism for transporting SNA data across an IP network, Boundary Access Node is a mechanism for transporting SNA data across a frame relay network, and SDLC Relay is a method of encapsulating SDLC traffic in IP. We also look at the IBM router support of APPN.

3.1 How Do Routers Work?

More accurately, how do routers direct traffic so that it gets to the correct destination? Each router within the network maintains routing tables. These tables contain the rules that the router will use when it receives a packet that it has to forward. The format of these routing tables are generally very simple; usually they only contain three pieces of information as follows:

- Destination
- Interface
- Next Hop Router

The destination is the address of the received packet. The interface specifies which of the physical interfaces in the router the packet should be forwarded out on and the Next Hop Router specifies which router the packets should be directed to. Let us illustrate these points by means of an example that we have used once before.

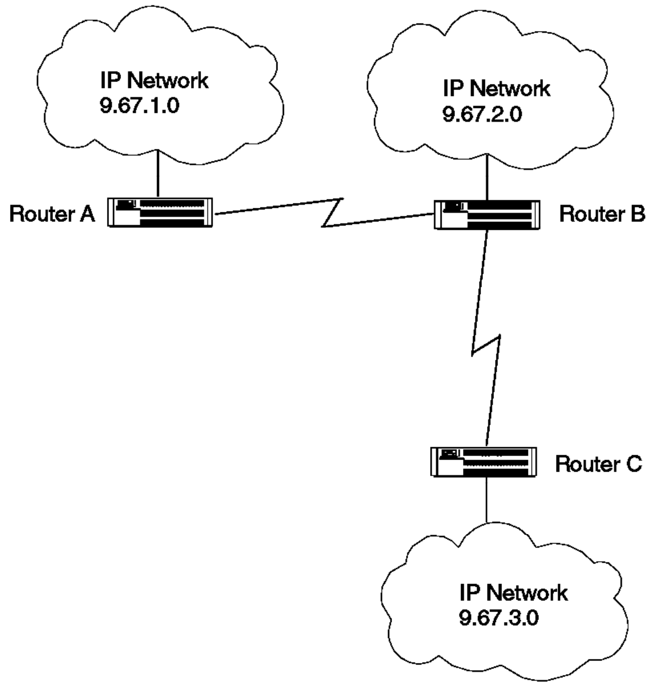


Figure 14. IP Routing

Let us now look at the routing tables that would be required for all three routers so that they could route between themselves.

Table 8. Network Routing Table for Router A

Destination	Interface	Next Hop
9.67.1.0	LAN	*None*
9.67.2.0	WANB	Router B
9.67.3.0	WANB	Router B

Table 9. Network Routing Table for Router B

Destination	Interface	Next Hop
9.67.1.0	WANA	Router A
9.67.2.0	LAN	*None*
9.67.3.0	WANC	Router C

Destination	Interface	Next Hop
9.67.1.0	WANB	Router B
9.67.2.0	WANB	Router B
9.67.3.0	LAN	*None*

Table 10. Network Routing Table for Router C

Note: WANx means the WAN link to Router X.

If router A receives a packet destined for network 9.67.2.0, it will forward it to router B over the WAN interface. Router B will then send this packet out over its LAN connection. If router A receives a packet for the 9.67.3.0 network, it will send it over the WAN to router B. Router B will then send it over its WAN connection to Router C who will then deliver it onto the LAN.

Each router needs a separate routing table for each protocol that it is required to route.

Finally, there comes the question of route table maintenance. It is possible to manually define all of these route entries; this technique is known as *static routing*. In small networks this may be possible, but in large networks the overheads of maintaining tables becomes too great. With *dynamic routing protocols*, each router swaps routing information with its neighbors and each builds up a complete topology of the network. In IPX, this dynamic protocol is known as RIP. With IP, two protocols are used: OSPF (Open Shortest Path First) and RIP (Route Information Protocol). Please note that IPX RIP and IP RIP are different protocols.

3.1.1 IP RIP

IP RIP is very similar to IPX RIP in that it works by each router periodically exchanging routing tables with each other (for IP every 30 seconds). Thus each router builds up a complete picture of the structure of the network. RIP is very straightforward and simple to configure; however, it can be inflexible and at Version 1 does not understand IP subnetting (RIP Version 2 does support variable subnetting). The 6611 supports RIP Version 2. Also, in large networks, the exchange of routing tables can cause large amounts of traffic to be transmitted across links every 60 seconds. IP RIP is hop-count based when it comes to calculating routes through the network. This means that IP RIP will chose a route based on the least number of hops from source to destination.

3.1.2 OSPF

OSPF is a more recent protocol than RIP and was designed to get around the limitations. The result is a complex protocol which provides much greater flexibility. Rather than being hop-count based like RIP, OSPF works by assigning a cost to each link within the network and picking the least cost route between destinations. This generally will result in a more optimum routing than RIP if the user-defined costs for each link are sensible. For example, consider the diagram in 21.2, "Second Telecommunications Circuit" on page 251 (Figure 215 on page 251). If the link between the two remote sites was a slow-speed link and should only be used in backup situations, OSPF could be tailored to support this by assigning this link a high cost. IP RIP would *always* route down this link as it is the least hop route.

Finally, OSPF has full support for IP subnetting.

3.1.3 Summary of OSPF versus RIP

Finally, let us close this discussion by summarizing the following advantages and disadvantages of RIP and OSPF:

RIP Advantages

- Simplicity

RIP Disadvantages

- Route table broadcast every 30 seconds
- No IP subnetting support
- Inflexible - hop-count based

OSPF Advantages

- No periodic broadcasting of the full routing table
- IP subnetting support
- More optimal routing and more flexibility

OSPF Disadvantages

- Complexity

3.2 Data Link Switching (DLSw) Overview

The IBM 6611 and IBM 2210 Multiprotocol Routers both implement data link switching as a mechanism for transporting non-routable protocols over a router backbone.

3.2.1 What Is DLSw?

- A way of routing SNA and NetBIOS over an IP router network
- An alternative to bridging for SNA and NetBIOS

Data link switching (DLSw) is an IBM-defined architecture that allows the transport of SNA and NetBIOS protocols across an IP-based router network. Both the IBM 6611 and IBM 2210 platforms support DLSw; although, the 2210 only supports SNA. The RFC for DLSw is not a standard but has been published with widespread acceptance as the way to transport SNA over an IP router network.

Various other vendors have produced versions of DLSw based upon the published RFC. In particular, Wellfleet, Cisco and Proteon have produced their own implementations. In addition, Cisco also supports Remote Source Route Bridging which offers a similar, although incompatible, function to DLSw. A sample Cisco RSRB configuration is given in an appendix at the end of this book.

DLSw is basically an encapsulation of SNA and NetBIOS inside TCP/IP. TCP is used to provide a reliable end-to-end delivery of the SNA and NetBIOS traffic across the router network. Because IP is used as the network layer protocol, DLSw does not supply the sophisticated Class of Service (COS) guarantees that conventional SNA networks do. As a result, it can be very difficult to provide consistent response times across an SNA over DLSw session.

Within router networks, DLSw is an excellent alternative to bridging. Additionally, DLSw can also be used to support SDLC-attached devices. DLSw supports SDLC devices by converting the SDLC frames into LLC2 frames (LAN frames) and using the DLSw TCP sessions to transport them over the wide area. Thus, to the destination SNA device, the SDLC device appears as if it too is LAN-attached. DLSw SDLC supports any PU Type 2.0 or PU Type 2.1 device including AS/400, 5494, 5394 and 3174. We should note that the DLSw SDLC support requires one of the two devices involved to be LAN-attached. It does not support SDLC to SDLC attachment.

3.2.2 DLSw Implementation

The following diagram shows a conceptual view of data link switching.

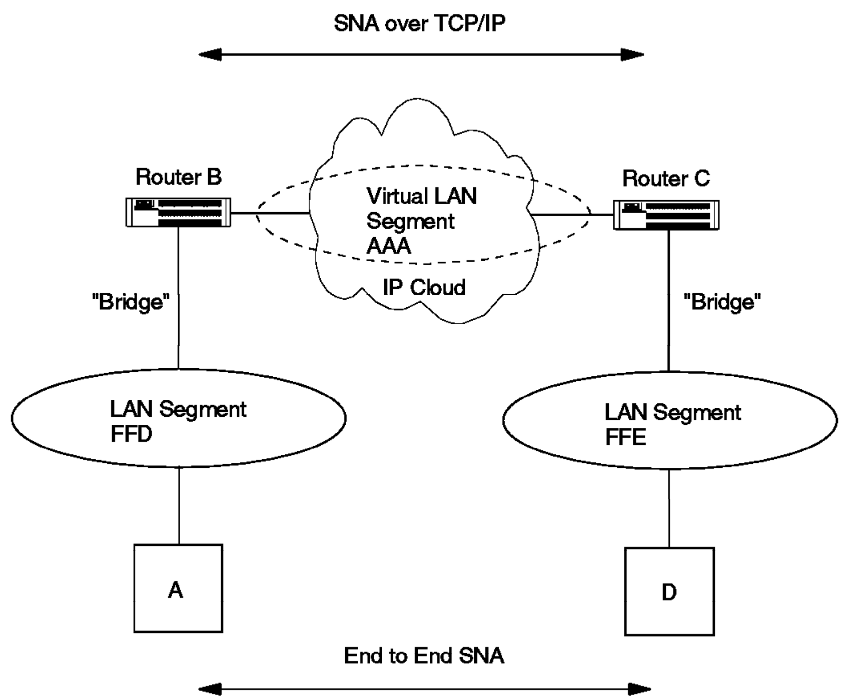


Figure 15. DLSw Overview: Overview of DLSw Showing IP Encapsulation

As mentioned previously, DLSw provides for the transport of SNA traffic across an IP network. To perform this, each router listens to SNA frames transmitted on the LAN. SNA frames are identified by the router by a special field contained within the frame called the Service Access Point (SAP). This SAP field contains a hexadecimal value that indicates which protocol the frame is carrying. SNA generally uses SAPs X′00′ and X′04′. In order to listen to SNA frames, the LAN adapter on each router must be configured to perform BRIDGING (Source Route for token-ring and transparent for Ethernet) and to forward bridged frames to the DLSw function within that router. Once DLSw has received an SNA frame, it then checks the destination address in its DLSw routing table (note that DLSw routing tables are similar to IP routing tables - 3.1, “How Do Routers Work?” on page 31). If the destination has not yet been discovered, then the router asks each of its DLSw partners if they know where the destination address is. If one of the partners sends back a positive response, then the SNA frame is sent to that router and an entry is placed in the DLSw routing table so that all future packets to that destination follow the same path without the need to ask the partners each time.

The end devices do not know that the SNA traffic is flowing across an IP network. What they think they see is the router acting as a bridge and the device that they are talking to existing on a segment one hop away on the virtual ring. Thus, to device A, device D appears as if it is on segment AAA. Also, device A appears to device D as if it is on segment AAA.

Please note, the bridging involved here is *not* real bridging. It is a technique used by DLSw to hide the fact that the SNA traffic is actually being transported across an IP network.

We have mentioned earlier that the use of IP in the backbone to carry SNA data can cause problems with the consistency of response times, etc. However, we should also say that the use of IP can also provide advantages. Because IP is a connectionless protocol, it is capable of routing around physical link failures inside the backbone without any loss of sessions. As long as IP reroutes (using a protocol like RIP or OSPF) within the TCP timeout value (the default is 120 seconds), then SNA sessions will not be lost.

Because the DLSw standard is open (RFC 1795), vendors can choose to implement their own value added features to DLSw and still be interoperable with other versions of DLSw that do not support these features. The features supported are exchanged when a TCP session is established and agreed upon between the two routers.

Finally, we describe a feature of DLSw that ensures that the SNA sessions are not lost due to wide area network congestion. In a conventional SNA network (such as a bridged network) there is an LLC2 (layer 2) session between the end devices. Over wide area network connections, this LLC2 session can be lost if the responses are delayed due to congestion. DLSw alleviates this problem by terminating the LLC2 connection between the devices at the routers and locally acknowledging the LLC2 frames (spoofing). This means that LLC2 timeouts will not occur due to network congestion, and moreover, the LLC2 frames are not actually transmitted over the wide area.

Figure 16 illustrates how in DLSw the LLC2 frames are acknowledged by the router.

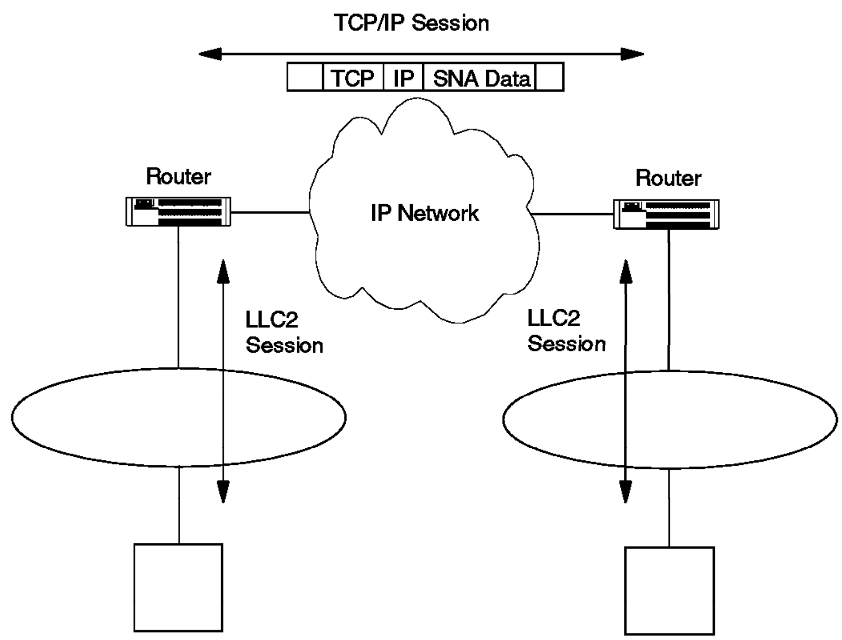


Figure 16. LLC2 Termination in DLSw

3.2.3 Problems with DLSw

DLSw provides the best means currently available to transport SNA traffic across an IP network. However, it does have some drawbacks and problems.

First, DLSw makes use of an underlying IP network. This means that the SNA data is running on top of a network protocol that does not provide sophisticated flow control or error control. Even though the end devices may be using SNA concepts such as Class of Service (COS), once inside the IP network these concepts can *not* be guaranteed. This means that providing consistent SNA response times may be very difficult over DLSw. Also, currently there is no recognition of SNA COS by the DLSw itself. This means that there is no prioritization by the router of interactive SNA traffic over batch.

Secondly, each SNA frame being handled by DLSw has to be encapsulated into TCP/IP on entry to the IP network and decapsulated into SNA on its exit. While the delays in performing this operation are small, they can be noticeable on heavily loaded routers.

An important consideration is that SNA over DLSw will *not* provide as good or as consistent response times as a pure SNA network based on 37x5, 3172, AS/400, etc.

3.2.4 DLSw versus Bridging

An often asked question is: ″When should I use bridging and when should I use data link switching″? As might be expected, the answer is not as simple as the question and will depend on many factors.

First, DLSw was designed to address some of the problems with bridging over the wide area. For a purely local environment (no wide area connections), bridging is the better option. In fact, DLSw should not be used on local LAN connections.

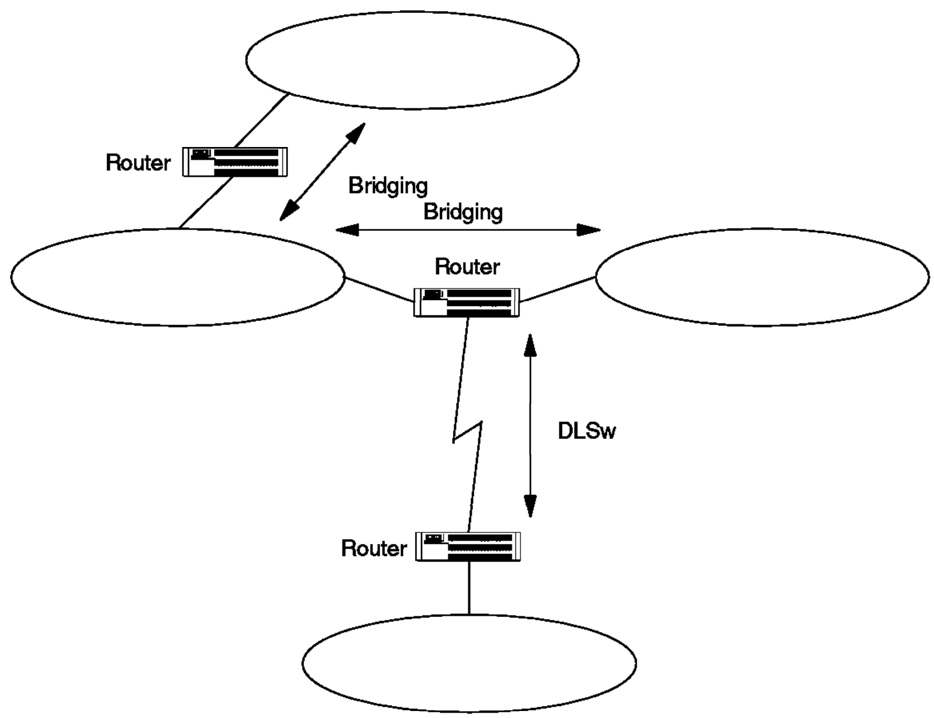


Figure 17. Diagram Showing Where to Bridge and Where to DLSw

The primary function of DLSw is to maintain the integrity of SNA sessions across low speed WANs. It accomplishes this by providing congestion control and minimizing the amount of data that has to flow across the WAN. DLSw terminates the layer 2 connection between the end devices by masquerading (spoofing) the destination endstation. This ensures a local response to all layer 2 frames. This prevents WAN timeouts and also allows us to perform congestion control on heavily used wide area links. Additionally, DLSw also supports SDLC devices by providing polling at the edge routers and conversion of SDLC into LLC2 (again reducing overhead traffic on the WAN). Finally, DLSw also buffers frames at the TCP layer to minimize the number of frames being transmitted across the wide area.

In summary, let us look at the following advantages and disadvantages of DLSw with respect to bridging:

DLSw Advantages

- Session Protection
  - Elimination of LLC2 timeouts and session termination
- Efficient WAN Utilization
  - Elimination of LLC2 traffic across the WAN
  - Reduction in broadcast traffic
  - TCP buffering - blocking of multiple DLSw frames into one TCP frame
- Congestion and flow control
  - Router to endstation (LLC2 busy - RNR)
  - DLSw to DLSw flow control
  - TCP flow control
  - Dynamic routing within the IP backbone (OSPF or RIP)
  - Reliable transport across the WAN by TCP
  - IP network rerouting without session failure
  - Prioritization of traffic over the wide area

DLSw Disadvantages

- Lower throughput
  - 700 - 800 Frames per second aggregate throughput
- Processor Utilization
  - DLSw frames are processed by the main processor on the routers; that is, they are not handled on the card. Processor utilization becomes the primary throughput limiting resource as traffic loads increase.
- Longer latency
  - The data flow and the TCP buffering increase the latency through the router.

3.3 Boundary Access Node Function

The Boundary Access Node function is a standard (documented in RFC 1490) that allows direct encapsulation of protocols in frame relay (layer 2) packets.

Support is now available in the IBM 6611 and IBM 2210 that allows the direct encapsulation of SNA data by RFC 1490 into frame relay packets for decapsulation by an SNA host such as a 37x5 or AS/400.

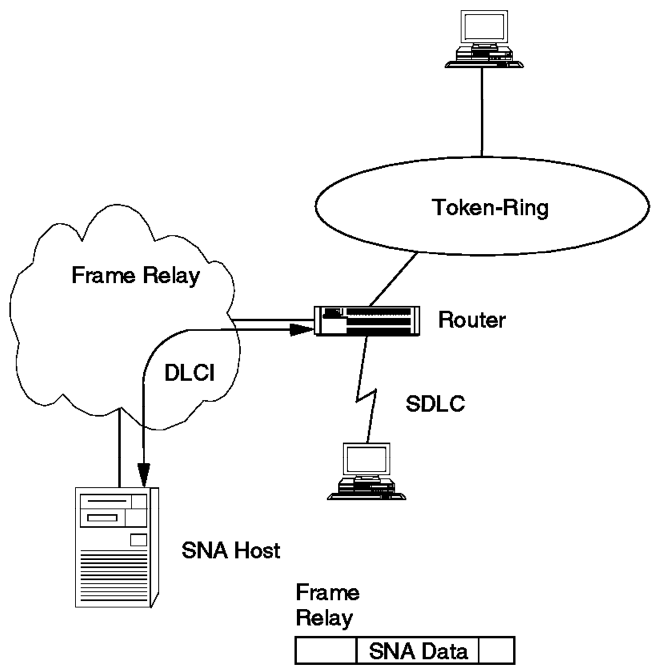


Figure 18. BAN Frame Relay Encapsulation

The IBM 6611 and IBM 2210 can also be configured to provide the local LLC2 termination to prevent wide area timeouts if the frame relay network becomes congested.

BAN support can also be used to route IP data from the router (2210 or 6611) to the SNA host (37x5 or AS/400).

BAN is, by its very nature, a more efficient technique than DLSw. Because DLSw uses TCP/IP to transmit SNA across the wide area, every DLSw packet that is sent has approximately 60 bytes of headers and trailers. With BAN, because we are using straight encapsulation in the frame relay packet (layer 2), the overhead is much less (on average about 16 bytes in total). This means that the BAN technique has a higher potential throughput than DLSw.

Second, is the issue of scalability. With DLSw we require TCP connections to each of our remote partners. There is a finite limit on the number of those TCP connections that we can maintain on both the 6611 and 2210. The 6611 has an upper limit of 100 TCP connections; the 2210 has a lower upper limit. With BAN, we are only limited to the number of DLCIs that we can configure. Both the 2210 and 6611 support over 200 DLCIs per router.

To balance these two points, however, BAN support is only available on frame relay networks.

3.4 SDLC Relay

SDLC Relay is a technique that allows the direct encapsulation of SDLC traffic inside IP to connect two SDLC-attached devices together. SDLC Relay is also known as *Serial Tunnelling*.

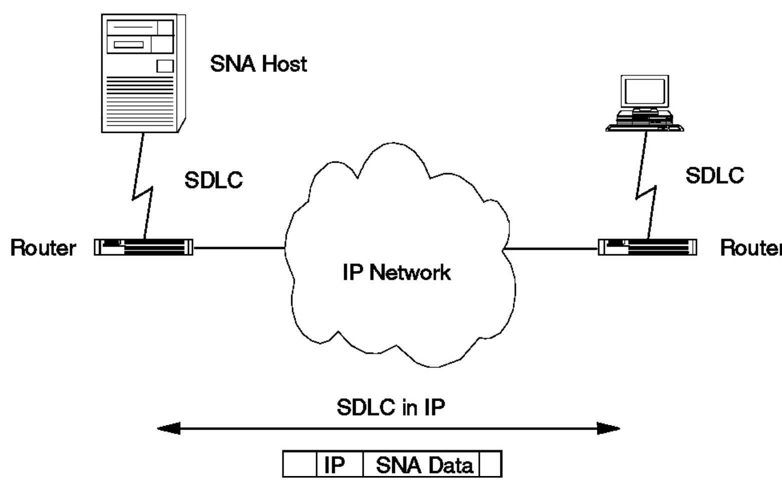


Figure 19. SDLC Relay

The router simply encapsulates all SDLC frames in IP and forwards the packet to a specified IP destination. The destination router removes the IP headers and forwards the SDLC frame onto its SDLC link. All of the SDLC frames (including link level Receive Ready frames) will cross the IP network as SDLC Relay does not perform local acknowledgement like DLSw. This means that SDLC Relay may suffer session timeouts due to IP network congestion.

The SDLC Relay implementation is not limited to a specific PU type, unlike DLSw SDLC support, which only supports PU Types 2.0 and 2.1. Also, unlike a 2210 DLSw SDLC connection, with SDLC relay the 2210 router does not need to be the primary link station.

SDLC Relay is the only way of connecting two SDLC-attached devices together using IBM router products.

3.5 IBM Router APPN Support

Currently, the only IBM router platform to support APPN is the 6611 which is capable of being an APPN network node.

APPN on the 6611 uses DLSw to provide a connection-oriented interface to APPN nodes and LEN nodes attached to token-ring or Ethernet LANs. DLSw uses bridging to transport SNA frames to and from the LAN environment.

Across a WAN, APPN in the 6611 uses either DLSw or a direct TCP/IP connection to communicate with another 6611 network node. The choice of how to do this is basically up to the user. The advantages of using a separate TCP/IP connection include being able to distinguish APPN traffic from *normal* SNA traffic carried by DLSw allowing different prioritization schemes to be used for each. However, maintaining additional TCP connections across the network can result in increased CPU load on the 6611 processor.

The following diagram illustrates these points:

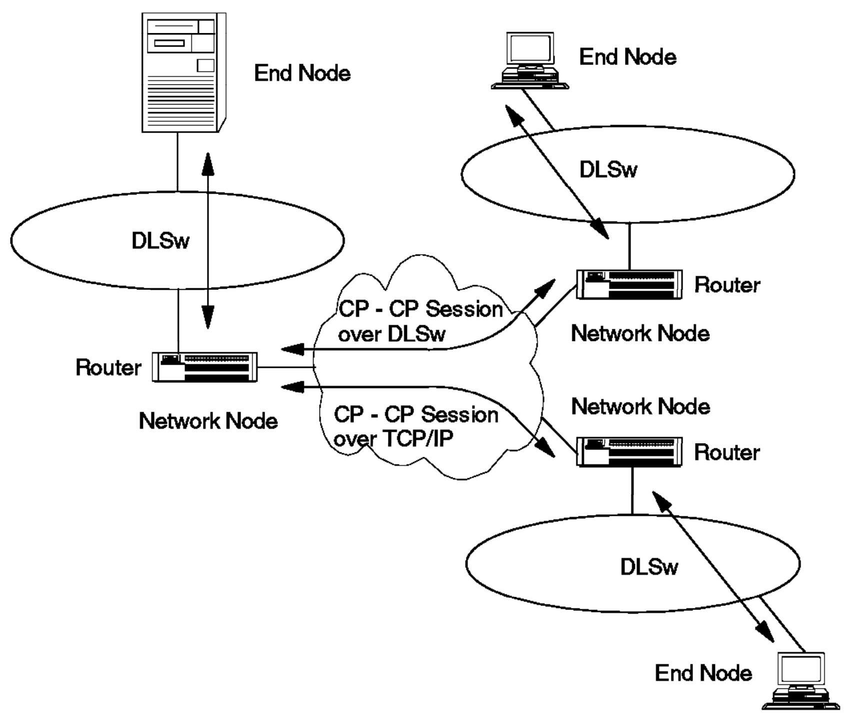


Figure 20. 6611 APPN Support

APPN support on the 6611 allows manipulation of the standard COS and MODE definitions with user-defined values. The standard MODEs and COSs defined in the 6611 are listed in the following table:

Table 11. 6611 Standard APPN COS and Mode Definitions		
COS	**Mode(s)**	**Transmission Priority**
#BATCH	• #BATCH	Low
#BATCHSC	• #BATCHSC	Low
#CONNECT	• #CONNECT • BLANK • QPCSUPP • IBMRDB	Medium
#INTER	• #INTER	High
#INTERSC	• #INTERSC	High
#CPSVCMG	• CPSVCMG	Network
#SNASVCMG	• SNASVCMG	Network

Scenarios where running native APPN on the 6611 provides distinct advantages are covered in 11.6.3, "Additional Information about 6611 APPN" on page 151.

Note

Although not covered in this book, the 6611 now supports HPR as part of MPNP Version 1 Release 4.

This book covers 6611 MPNP Version 1 Release 3.

3.6 Summary

In this chapter, we have looked at some of the technologies used in router networks. We have started by covering details of how routers switch packets that they receive to the correct destination. We then looked at some key ways of transporting SNA data over router-based networks, the first of which was data link switching, which allows the transport of SNA traffic over an IP network. Then we looked at Boundary Access Node which allows SNA traffic to be transported directly over frame relay. We also looked at SDLC Relay which allows SDLC devices to communicate directly over an IP network. And finally we looked at APPN which gives APPN devices the ability to communicate using native APPN across a router network.

Chapter 4. IBM Router Products

This chapter looks at the IBM router products that exist in the market place today. It focuses on the function provided by each router and also describes how to position the products against each other. IBM has three entries in the router market currently: the IBM 6611 Network Processor, the IBM 2210 Nways Multiprotocol Router and the IBM RouteXpander/2.

4.1 The IBM 6611 Network Processor

The IBM 6611 was IBM′s first entry in the multiprotocol router market and was designed to be a flexible, cost effective backbone and remote office router.

The IBM 6611 is capable of handling the following protocols and bridging methods:

Table 12. 6611 Protocol Matrix

Interface vs. Protocol	PPP	FR	X.25	SDLC	ISDN		Token-Ring	E/net
					Demand	Backup		
IP	Yes	Yes	Yes	No	No	No	Yes	Yes
IPX	Yes	Yes	Yes	No	No	No	Yes	Yes
SNA	Yes	Yes	No	Yes	No	No	Yes	Yes
NetBIOS	Yes	Yes	No	No	No	No	Yes	Yes
BAN	No	Yes	No	Yes	No	No	Yes	Yes
DECnet	Yes	Yes	No	No	No	No	Yes	Yes
Vines	Yes	Yes	No	No	No	No	Yes	Yes
XNS	Yes	Yes	No	No	No	No	Yes	Yes
ATalk	Yes	Yes	No	No	No	No	Yes	Yes
SRB	Yes	Yes	No	No	No	No	Yes	N.A
TB	Yes	Yes	No	No	No	No	N.A	Yes
TRB	Yes	Yes	No	No	No	No	Yes	Yes

Legend:

BAN Boundary Access Node
ATalk Apple Talk
SRB Source Route Bridging
TB Transparent Bridging
TRB Translational Bridging
FR Frame relay
PPP Point-to-Point Protocol

The IBM 6611 natively routes many of the more common protocols in use today. It also offers the industry standard Data Link Switching (DLSw) support for NetBIOS and SNA devices attached to token-ring and Ethernet LANs. In addition, it supports DLSw from SDLC attached devices.

The 6611 is available in four different models: 120, 125, 145 and 175. It can be configured with a wide variety of communications cards. The communications cards available for the 6611 range are as follows:

- Token-ring (1 port card or 2 port card)
- Ethernet (1 port card or 2 port card)
- Serial card (V.35, X.21, V.24 or RS422, 2 port or 4 port)
- X.25 card
- SDLC card (4 ports X.21, V.35 or V.24).
- Ethernet combo (1 port Ethernet, 2 port Serial)
- Token-ring combo (1 port token-ring, 2 port serial)

The 6611-120 comes in 10 fixed configurations in combinations of the previously listed adapters.

The 6611-125 can house any two of the above adapters.

The 6611-145 can house any four of the above adapters.

The 6611-175 can house any seven of the above adapters.

The 6611 does *not* support any native dial functions such as *dial on demand* or *dial backup*.

Note

Although not covered in this book, the 6611 now supports HPR as part of MPNP Version 1 Release 4.

This book covers 6611 MPNP Version 1 Release 3.

Memory upgrades are available for the IBM 6611 depending upon the load being placed on the router. For CPU intensive operations such as DLSw and OSPF this may be advisable. Available from IBM is a program called 6611STOR which assists in making this decision. The program is held on the IBM internal marketing tools database. The IBM 6611 is field upgradeable with this extra memory which is available in 8 MB multiples.

4.2 The IBM 2210 Nways Multiprotocol Router

The IBM 2210 is a joint venture between IBM, who provided the router hardware, and Proteon who provided most of the software. The IBM 2210 is designed to be a low end, branch office or remote router; it is not designed to be a backbone router.

The IBM 2210 when using MRNS 1.2 is capable of handling the following protocols and bridging methods:

Table 13. 2210 Protocol Matrix

Interface vs. Protocol	PPP	FR	X.25	SDLC	ISDN Demand	ISDN Backup	Token-Ring	E/net
IP	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
IPX	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
SNA	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
NetBIOS	No	No	No	No	No	No	No	No
BAN	No	Yes	No	Yes	No	No	Yes	Yes
DECnet	No	No	No	No	No	No	No	No
Vines	No	Yes	Yes	No	No	No	No	No
XNS	No	No	No	No	No	No	No	No
ATalk	Yes	No	No	No	No	Yes	Yes	Yes
SRB	Yes	Yes	No	No	No	No	Yes	N.A
TB	Yes	Yes	No	No	No	No	N.A	Yes
TRB	Yes	Yes	No	No	No	No	Yes	Yes

Legend:

BAN Boundary Access Node

ATalk Apple Talk

SRB Source Route Bridging

TB Transparent Bridging

TRB Translational Bridging

FR Frame relay

PPP Point-to-Point Protocol

The IBM 2210 supports a subset of the protocols supported by the IBM 6611. Like the 6611, the 2210 supports DLSw which allows SNA interconnection of devices attached to token-ring, Ethernet and SDLC. Note that NetBIOS is not supported by DLSw on the 2210.

The 2210 comes in a small number of fixed configurations as shown in the following list:

- Model 12T - 1 port token-ring, 2 port serial
- Model 12E - 1 port Ethernet, 2 port serial
- Model 127 - 1 port token-ring, 2 port serial plus ISDN
- Model 128 - 1 port Ethernet, 2 port serial plus ISDN
- Model 14T - 1 port token-ring, 4 port serial
- Model 24T - 2 port token-ring, 4 port serial
- Model 24E - 2 port Ethernet, 4 port serial
- Model 24M - 1 port token-ring, 1 port Ethernet, 4 port serial

Note: Models 14T, 24T, 24E and 24M require MRNS V1R3.

Each of the 2210 models comes with 4 MB of DRAM as standard. For heavily loaded routers (for example, when running DLSw), it is recommended to upgrade the DRAM to 8 MB. Available from IBM is a program called 2210STOR which assists in making this decision. The program is held on the IBM internal marketing tools database. The 2210 is field upgradeable with this extra memory.

4.3 Choosing between the IBM 6611 and the IBM 2210

How do you chose between the IBM 6611 and IBM 2210? We try to help this decision by listing the advantages of each of the products. It should be possible to target the correct choice of router based upon the protocols supported in Table 12 on page 45 and Table 13 on page 47 and the following lists.

4.3.1 Advantages of the IBM 6611 over the IBM 2210

The IBM 6611 has the following advantages over the IBM 2210:

- The 6611 supports APPN networking (network node).
- The 6611 supports dual LAN ports or multiple serial ports.
- The 6611 supports XNS and DECnet.
- The 6611 has no real limits on the number of DLSw sessions.
- The 6611 supports NetBIOS over DLSw.
- The 6611 supports inverse ARP over frame relay.
- The 6611 is well suited to be a backbone router.

4.3.2 Advantages of the IBM 2210 over the IBM 6611

The IBM 2210 has the following advantages over the IBM 6611:

- The 2210 in its fixed configuration is approximately 30% cheaper than the 6611-125.
- The 2210 supports multiple IP addresses per LAN interface.
- The 2210 supports dial on demand and dial backup.
- The 2210 offers SDLC Relay (Serial Tunneling) for SNA PU types other than Type 2.0 and 2.1.
- The 2210 offers software clocking for V.35 and V.24 adapters.
- The 2210 supports FECN and BECN for frame relay.

4.4 RouteXpander/2

RouteXpander/2 is an OS/2 program combined with a special hardware adapter (the WAC card) that turns a normal PC running OS/2 into a router.

RouteXpander/2 is capable of handling the following protocols and bridging methods:

Table 14 (Page 1 of 2). RXR/2 Protocol Matrix

Interface vs Protocol	PPP	FR	X.25	SDLC	ISDN		Token-Ring	E/net
					Demand	Backup		
IP	No	Yes	No	No	No	No	Yes	Yes
IPX	No	Yes	No	No	No	No	Yes	Yes
SNA	No	No	No	No	No	No	No	No

Table 14 (Page 2 of 2). RXR/2 Protocol Matrix								
Interface vs Protocol	**PPP**	**FR**	**X.25**	**SDLC**	**ISDN**		**Token-Ring**	**E/net**
					Demand	**Backup**		
NetBIOS	No	No	No	No	No	No	No	No
BAN	No	No	No	No	No	No	No	No
DECnet	No	No	No	No	No	No	No	No
Vines	No	No	No	No	No	No	No	No
XNS	No	No	No	No	No	No	No	No
ATalk	No	No	No	No	No	No	No	No
SRB	No	Yes	No	No	No	No	Yes	N.A
TB	No	Yes	No	No	No	No	N.A	Yes
TRB	No	No	No	No	No	No	No	No

Legend:

BAN Boundary Access Node
ATalk Apple Talk
SRB Source Route Bridging
TB Transparent Bridging
TRB Translational Bridging
FR Frame relay
PPP Point-to-Point Protocol

We should note that RXR/2 is only capable of handling IP and IPX natively. All other protocols must be bridged. We should also be aware that since RXR/2 is not a dedicated router in the sense that IBM 6611 and IBM 2210 are, the performance achieved from the product will not be as good.

4.5 OEM Router Products

A wide variety of OEM products exists within the market place which we will not detail here. Router products from OEM suppliers do exist and can perform all of the functions listed in the previous tables.

4.6 Summary

IBM has three offerings in the router market place today. Starting at the low end we have the IBM RXR/2 which can be used where PCs are available that can be turned into routers by means of special hardware and software. The protocols supported (IP, IPX and bridging) are limited and performance may suffer on already loaded machines.

Moving up the scale we have the IBM 2210 which is designed to be a branch office or remote router. It offers small port density and is capable of routing many more protocols natively. It supports SNA over DLSw and native ISDN.

Finally, we have the IBM 6611 which offers a range of models from the small branch office to the larger backbone router. It offers support for more protocols than the 2210 and also offers NetBIOS over DLSw and APPN support.

Chapter 5. Your SNA/APPN Network - A Multiprotocol Network

In an earlier chapter we discussed how an APPN multiprotocol solution based on the IBM 2217 Multiprotocol Concentrator may offer a better solution in some cases. In this chapter we have taken a closer look at the IBM 2217 MpC.

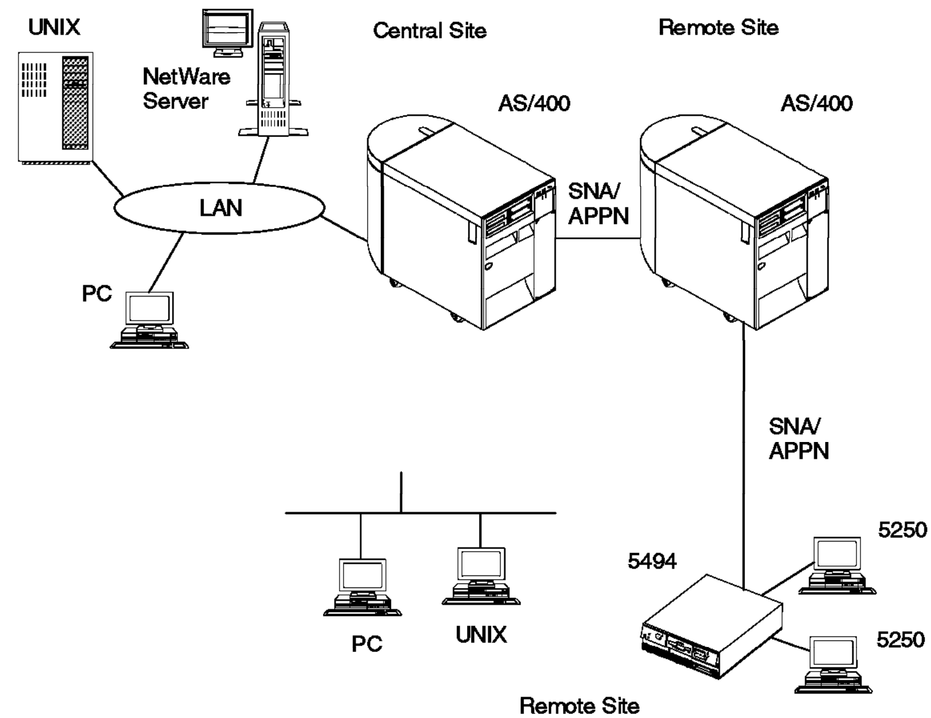


Figure 21. How to Route Various Protocols via an SNA/APPN Network

This scenario shows an SNA/APPN network. There are three different locations. The central office and one of the remote offices are equipped with AS/400 systems. The third location is equipped with an IBM 5494 Remote Workstation Controller. The central site includes a LAN with SNA, NetWare and TCP/IP applications. The company′s WAN network - the link between the AS/400 systems and the IBM 5494 - consists of SNA/APPN connections. These links are used by SNA/APPN applications, such as 5250 Passthrough, Client Access/400 and the IBM 5494 communicating with one of the AS/400 systems.

At the location with the IBM 5494 an Ethernet LAN also exists with NetWare and TCP/IP applications. The objective is to interconnect the networks and to support communications between all applications throughout the entire company.

You could consider isolated solutions for each type of applications:

- For instance, to interconnect the UNIX systems to run TCP/IP applications directly

- Or to use multiprotocol routers to attach the remote LAN to the central site LAN

In the long term, isolated solutions are often more expensive and less satisfactory because they can not easily be enhanced or merged with other solutions.

The classical approach is to build a multiprotocol network with routers which interconnect the LAN environment of each location. Routers allow the various protocols, SNA, IPX and TCP/IP, to flow between the different locations.

However, for most AS/400 environments, SNA/APPN is the major protocol. Most of your AS/400 applications use SNA/APPN as their network protocol. You built up a dedicated SNA/APPN network based on systems and controllers as routing network devices. Why not include the other network protocols into your existing SNA/APPN network? This would allow you to preserve your investments in equipment and skills.

The IBM 2217 Multiprotocol Concentrator (MpC) is an SNA/APPN router capable of routing other protocols such as TCP/IP, IPX and NetBIOS via an SNA/APPN network as well. The IBM 2217 MpC can be configured as SNA/APPN end or network node. IBM 2217 MpCs are interconnected using independent LU 6.2 sessions to transport TCP/IP, IPX and NetBIOS via an SNA/APPN network. TCP/IP, IPX and NetBIOS devices communicate via IBM 2217 MpCs and the SNA/APPN network to reach remote partners. Figure 22 uses two IBM 2217 MpCs to migrate the SNA/APPN network into a multiprotocol network.

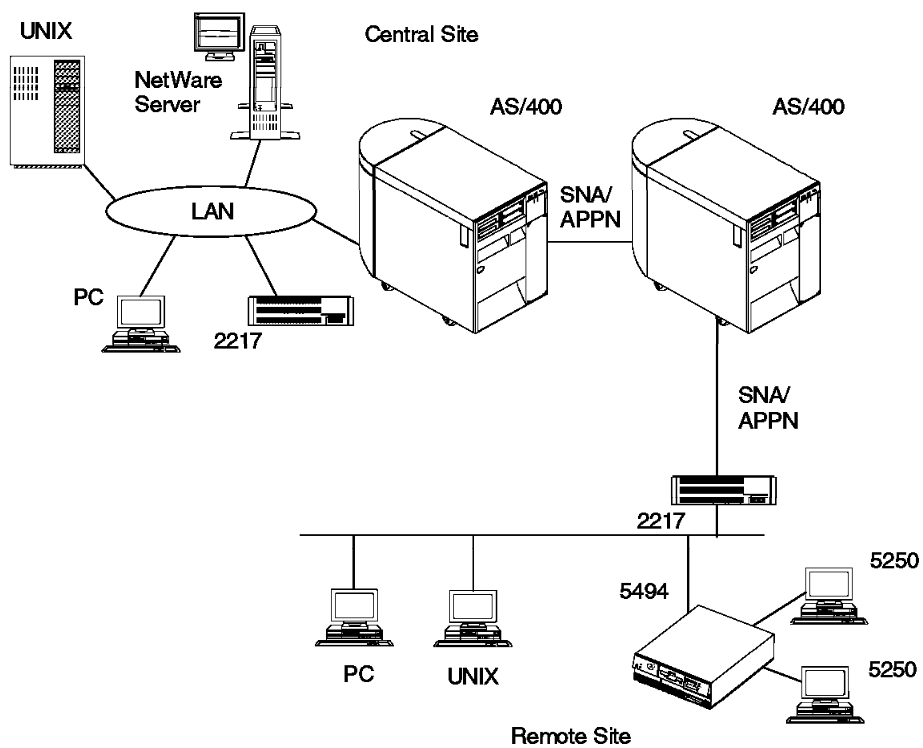


Figure 22. Using the IBM 2217 MpC to Route SNA/APPN and Other Protocols

The IBM 2217 MpC can either be an SNA/APPN network or end node. It implements AnyNet functions to accomplish multiprotocol transport. AnyNet is based on IBM′s Multiprotocol Transport Network Architecture (MPTN). See Appendix A, "MPTN Architecture and AnyNet Product Family" on page 309 for an overview of AnyNet and MPTN.

5.1 IBM Nways 2217 Multiprotocol Concentrator (MpC)

SNA networks involve a great deal of investment in the form of not only tools and equipment but more importantly skills. The IBM 2217 Multiprotocol Concentrator allows this investment to be maintained and extended to other protocols. The IBM 2217 MpC extends the advantages of SNA to other protocols. These advantages are: traffic prioritization, data compression, cost-effective bandwidth utilization and proven management.

5.1.1 Concentrating Multiple Protocols onto a Single Backbone

The MpC extends the scope of the SNA backbone to include multiprotocol transport. It preserves and leverages the investment in SNA networking skills, management processes, operating procedures and equipment.

The MpC is a multiprotocol solution that uses a single backbone protocol for interconnecting LANs. This solution works with current SNA/APPN or SNA subarea networks. In the near future, it will allow the use of high-performance routing (HPR) as the backbone protocol as well.

The WAN connectivity options include frame relay, X.25 and SDLC lines. By using the MpC, TCP/IP, IPX, NetBIOS, SNA and APPN, traffic is concentrated onto a single backbone and flows freely and efficiently among LANs located across the hall or around the world.

The 2217 MpC is an integrated hardware and microcode solution. The 2217 MpC can be configured and managed either locally or remotely via a configuration utility (the 2217 RCU) running an OS/2 workstation.

5.1.2 MpC as an Alternative to IP-Based Routers and Bridges

Multiprotocol concentration is different from traditional bridging and routing. Unlike bridges and routers that transfer data in its native protocol, the MpC transforms non-SNA protocols to SNA at the edge of the WAN and routes them across the WAN. At the other side, it converts the messages back into their native protocols. The only protocol routed across the WAN is SNA.

This efficient single-protocol transport method results in improved performance and reliability. The symmetrical conversion can produce a high-speed, fully meshed WAN backbone for supporting transparent, multiprotocol LAN-to-LAN communication. And this technique works with LAN applications without requiring modifications to the applications.

5.1.2.1 AnyNet Compatibility

The IBM AnyNet family of software products perform many of the same protocol conversions as the MpC. If you already have AnyNet software solutions installed, the MpC may be compatible with them. The 2217 manual (*IBM 2217 Nways Multiprotocol Concentrator User′s Guide*, GC30-3706) should be referenced to determine what is compatible with what.

5.1.2.2 MpC Configuration and Management

The MpC comes with a software configuration package that runs on an OS/2 workstation (the 2217 RCU). You can use this quick and easy-to-use tool to configure the MpC to reflect the network topology. You can configure all the MpCs throughout the network from one central workstation.

The MpC provides extensive support for SNMP managers like NetView for OS/2 and NetView for AIX. These management platforms can be used to view and log traps, turn on traces, and execute remote commands.

The MpC includes the management component that works with LAN Network Manager (LNM) Version 2. With LNM you can see and manage the LAN devices connected to MpC. LNM is supported when the MpC is using the frame relay protocol and is configured to operate as a bridge.

5.2 Usage of IBM 2217 MpC in AS/400 Scenarios

Basically there are two different ways to use the IBM 2217 MpC:

- IBM 2217 MpC as Multiprotocol Router and LAN Gateway
- IBM 2217 MpC as a LAN-based Multiprotocol Concentrator.

As long as LU 6.2 sessions can be established between the IBM 2217 MpCs, the two different ways of usage can be mixed.

Additionally, since the IBM 2217 MpC implements AnyNet functions, the IBM 2217 MpC can be combined with systems running AnyNet.

5.2.1 IBM 2217 MpC as a LAN Gateway

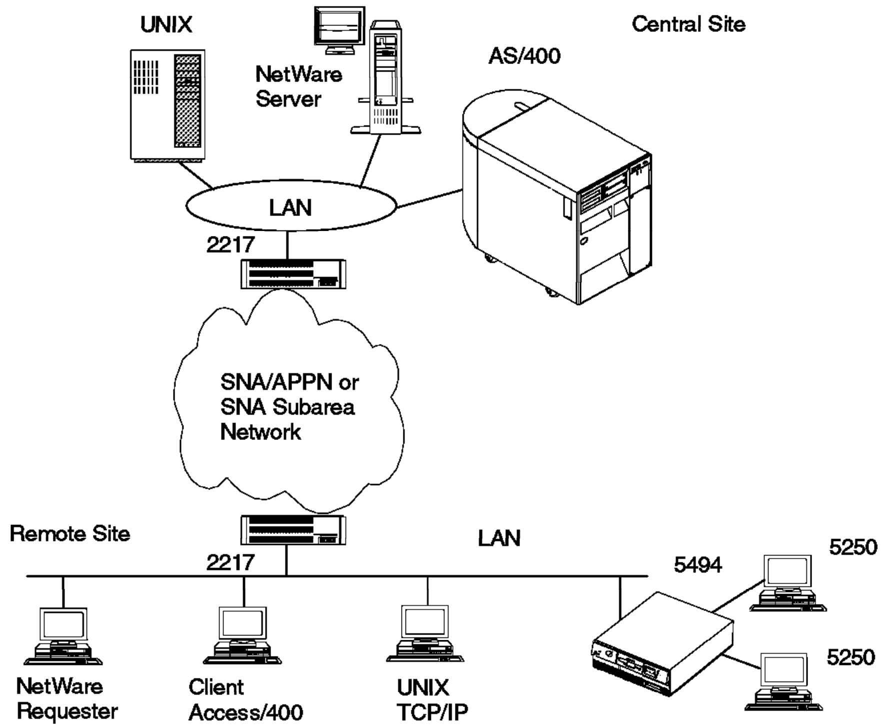


Figure 23. IBM 2217 as Multiprotocol Concentrator and LAN/WAN Gateway

In this scenario the IBM 2217 MpC acts not only as multiprotocol router but also as a gateway between the LAN and WAN environments.

5.2.2 IBM 2217 MpC as a LAN-Based Multiprotocol Concentrator

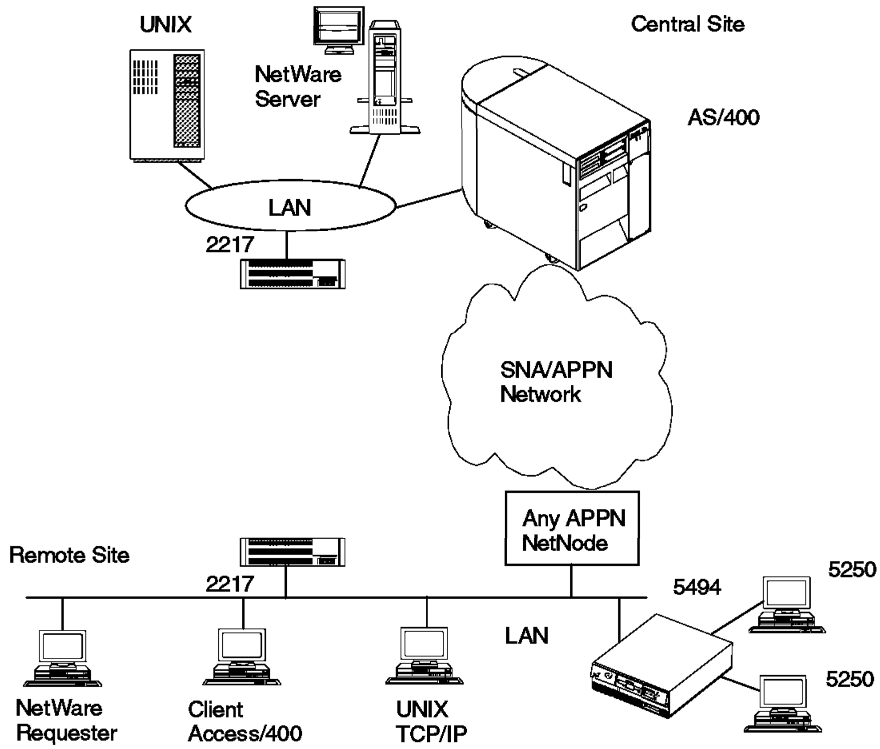


Figure 24. IBM 2217 as LAN-Based Multiprotocol Concentrator

The IBM 2217 MpC can also be integrated into an existing SNA network maintaining the current network topology. In this example, the IBM 2217 MpC is LAN-attached to the existing APPN network. The IBM 2217 MpC provides the multiprotocol routing function.

5.2.3 IBM 2217 MpC Directly Connected to AS/400

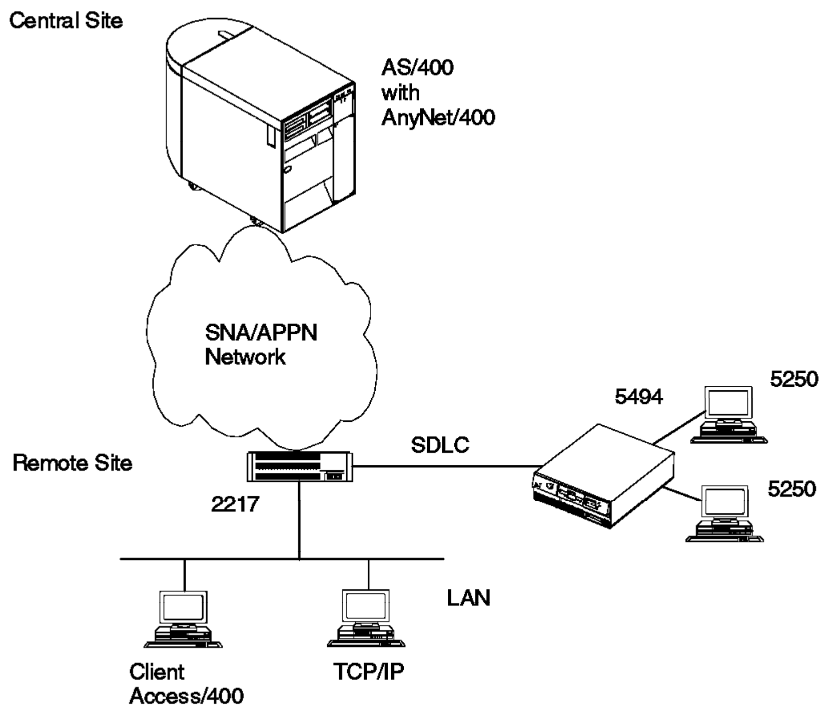


Figure 25. IBM 2217 MpC Directly Connected to AS/400

The IBM 2217 MpC can be directly attached to the AS/400 system. The IBM 2217 MpC is compatible with the AnyNet/400, this allows TCP/IP traffic to flow between the remote LAN and the AS/400 via the single IBM 2217.

This scenario may represent a first step in migrating from a SNA/SDLC network into a multiprotocol network.

Note that this scenario does not allow communications with a central site LAN via the AS/400.

The IBM 2217 MpC supports SNA T2.1 nodes via SDLC (for example, an IBM 5494 or the IBM 5394 with the SNA T2.1 node RPQ).

5.3 Using the IBM 2217 MpC or Multiprotocol Routers?

The IBM 2217 MpC is IBM′s answer for interconnecting LANs over an existing SNA/APPN network. It preserves the investment in SNA networking skills, management processes, operating procedures, and equipment.

The IBM 2217 MpC concentrates SNA, NetBIOS, IPX and TCP/IP traffic over SDLC, frame relay or X.25 wide area networks.

For networks which have predominantly SNA traffic, the IBM 2217 MpC will perform better because it is providing data compression and prioritization. In SNA networks, the IBM 2217 MpC provides data compression along the whole path over the SNA backbone between the IBM 2217 MpCs. Intermediate nodes do not need to support data compression.

For networks which have predominantly routable traffic (TCP/IP, IPX, etc.) a router network may offer the better solution.

In the near future the IBM 2217 MpC will support high-performance routing (HPR). HPR has evolved from today′s routing protocols and surpasses current LAN interconnection technologies in performance, dynamic rerouting, priority, congestion avoidance, scalability, and economy.

For networks with a majority of IP traffic the pure TCP/IP over frame relay should perform better.

When looking at which option to choose (a router solution or an APPN solution, for example), it is important to consider the future. For example, while the network may be predominantly SNA today, this may not always be the case.

Chapter 6. AS/400 Networking Capabilities

The aim of this chapter is to provide information for the networking and router specialist not familiar with the AS/400. We concentrate on the AS/400′s capabilities in terms of communications and networking. It is not a detailed presentation so for greater depth on any particular subject, the reader should refer to the AS/400 communications manuals and appropriate redbooks.

6.1 AS/400 Networking Support

The AS/400, although traditionally a node found in APPN networks and a T2.1 node in SNA subarea networks, also supports TCP/IP, IPX/SPX and OSI networking protocols. The AS/400 is increasingly found in mixed IBM and non-IBM network environments.

SNA and TCP/IP are part of the base support provided by OS/400. IPX/SPX is available via 5733-SA1. OSI is a separately licensed program product. NetBIOS is also supported as part of the LAN Server/400 licensed program product. The link protocol support is also provided by the base OS/400 code.

We look at an overview of the communications support, hardware and software, provided on the AS/400 in the following tables. The number of lines and adapters supported depends on the model of the AS/400, which goes from the low end model 200 (supporting up to 280 twinax attached devices) to the high end model 530 (supporting up to 7000 twinax devices), plus the server models, and the AS/400 entry level models which are portable.

6.1.1 AS/400 Communications Hardware

The Advanced Systems and Advanced Servers support the following communications controllers and adapters.

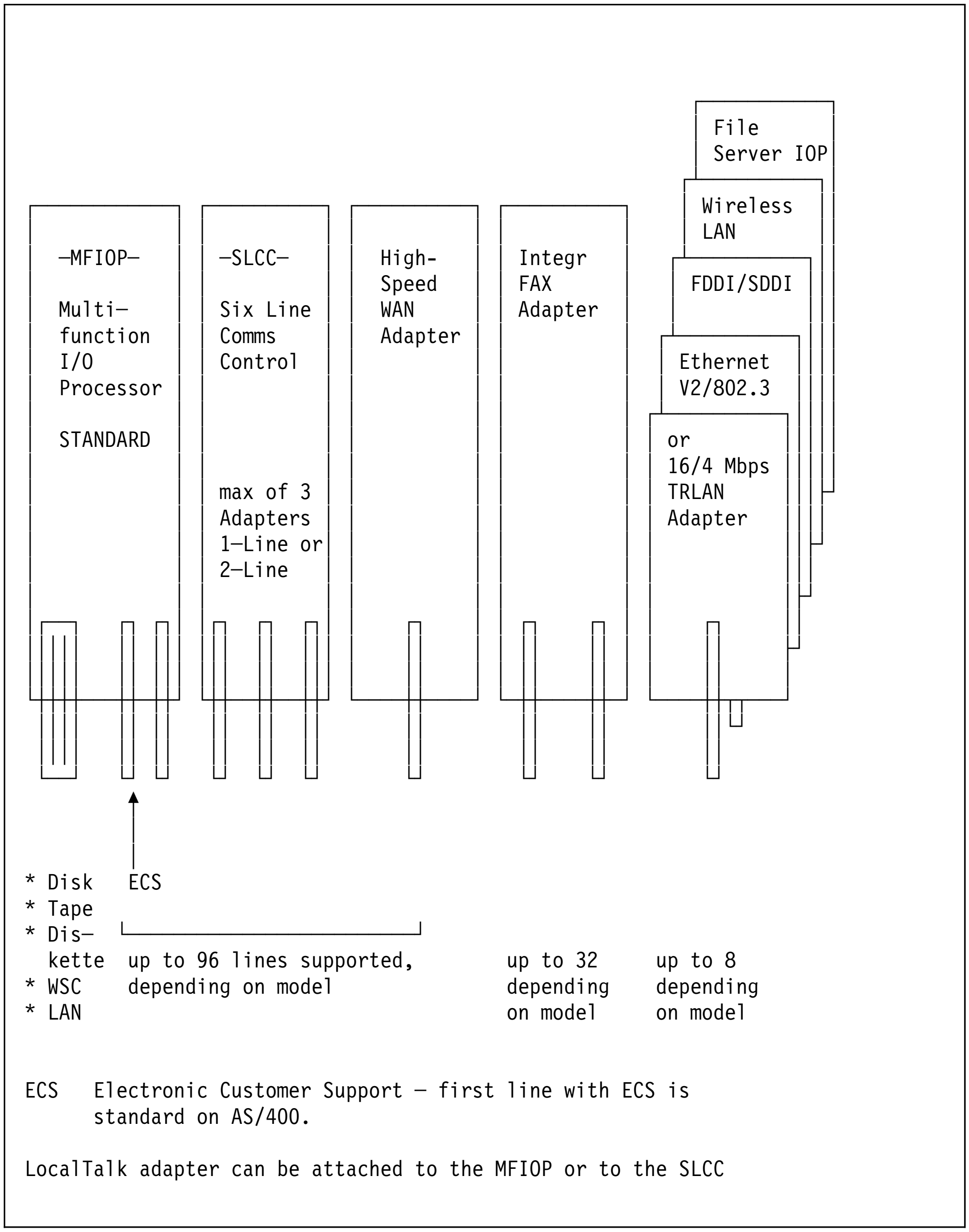


Figure 26. Adapters Supported on the AS/400

The MFIOP (Multi-Function I/O Processor) is a standard feature on the AS/400. It can be used to support either disk, tape, diskette or workstation controller attachments. It also supports two communications lines. The first communications line is supplied as standard via a V.24 supplied adapter. A second adapter can be ordered for the second line, which can be either V.24, V.35, X.21, or a LocalTalk workstation adapter. LAN adapters are also supported.

The SLCC (Six Line Communications Controller) is an optional feature that can support up to 6 communication lines via three adapter slots. These adapters can be a mixture of one and two line V.24 adapters, one and two line X.21 adapters, one line V.35 adapters, ISDN Basic Rate Interface adapter or a LocalTalk workstation adapter.

The FSIOP (File Server I/O Processor) is an optional feature which connects to the AS/400 to provide high performance file serving to PCs. The FSIOP can run Novell NetWare or IBM LAN Server. Integration Services for FSIOP (5733-SA2) is a feature of OS/400 that provides the OS/2 WARP operating system for the FSIOP. This feature allows the FSIOP to be used as a token-ring or Ethernet adapter. Network Extensions (5733-SA1), OS/400 Integration for Novell NetWare (5733-SA3) and Novell NetWare 4.1 can be used with 5733-SA2 to provide Novell NetWare support on the AS/400. The licensed program LAN Server/400 provides IBM LAN Server support for the FSIOP.

6.1.2 Adapters and Interfaces

Communication Controllers are integrated into the AS/400 System Unit.

Comms Ctrl	Adpt Intf	Link Protocols: ASYNC	BSC	SDLC	X.25	Frame Relay	Protocols running concurrently
MFIOP	V.24	19.2	19.2	19.2	19.2	–	SDLC, ASYNC, BSC,
	X.21	–	–	64	19.2	–	X.25 and X.21 SHM
	V.35	–	64	64	64	–	concurrently
SLCC	V.24	19.2	19.2	19.2	19.2	–	ASYNC, BSC, SDLC,
	X.21	–	–	64	64	–	X.25 and X.21 SHM
	V.35	–	64	640	64	–	concurrently
	ISDN	two 64 Kbps links (2B+D)					IDLC, X.25
High-Speed WAN	V.35	–	–	2 M	–	2 M	SDLC and
	V.36	–	–	2 M	–	2 M	frame relay
	X.21	–	–	2 M	–	2 M	not concurrently
TRLAN		Protocol is IEEE 802.2/.5 at 4 or 16 Mbps					SNA, TCP/IP, IPX
CSMA/CD		Protocol is IEEE 802.2/.3 and Ethernet V2, at 10 Mbps					SNA, TCP/IP, IPX
SDDI/FDDI		At 100 Mbps					SNA, TCP/IP
Local Talk		Allows attachment of Apple Macintoshs via the LocalTalk adapter					–
WLAN		Spread Spectrum radio, operating in the 2.4 to 2.4835 GHz band					SNA, TCP/IP
FSIOP		IEEE 802.2/.3 and Ethernet V2 or Token-Ring 802.2/.5					SNA, TCP/IP, IPX, NetBIOS
FAX		Group 3 fax					–

Figure 27. Link Protocols Supported on AS/400 Adapters

6.1.3 Network Architecture Support on Link Protocols

	SNA	TCP/IP	OSI
SDLC	X		
ASYNC			
BSC			
X25	X	X	X
IDLC (ISDN)	X		
FRAME RELAY	X	X	
SDDI/FDDI	X	X	
TOKEN-RING	X	X	
ETHERNET	X	X	
WIRELESS	X	X	

Figure 28. Network Protocols versus Link Protocols

6.2 5250 Device Support

The AS/400 workstation data stream is 5250. The AS/400 supports locally and remotely attached non-intelligent 5250 devices and also locally and remotely attached PCs running 5250 emulation, such as provided by the Client Access/400 PC product.

6.2.1 Remote 5X94 Controllers

Remote controllers are supported for the remote attachment of workstations and printers. This includes the 5394 remote workstation controller and the 5494 remote workstation controller. The 5394 provides a WAN (SDLC or X.25) link to the AS/400 and supports twinax-attached 5250 devices. The 5494 supports either a WAN (SDLC, X.25 or frame relay) or LAN link to the AS/400. The single 5494 LAN adapter (token-ring or Ethernet) can either be used for the AS/400 connection or for LAN attached 5250 devices. 5250 devices can also be twinax-attached to the 5494. The 5494 is an APPN LEN (low entry network) node.

6.3 AS/400 Communications Applications

The AS/400 provides applications for communicating in an APPN network, for communicating to a S/390 SNA host, for communicating in a TCP/IP network and an OSI network. We will describe some of these applications briefly in this section.

6.3.1 APPC Applications

The AS/400 is primarily an APPC host. APPC is the communications method of using the SNA LU Session Type 6.2 protocol. APPC stands for Advanced Program to Program Communications. APPN (Advanced Peer-to-Peer Networking) which the AS/400 also supports, allows data communications to route data between two or more APPC hosts in a network, that are not directly attached. The following are examples of APPC applications provided in the base AS/400 operating system (OS/400): Display Station Pass Through (5250 Passthrough), SNA Distribution Services (SNADS), Distributed Data Management (DDM) and Client Access/400.

5250 Passthrough is a communications function that allows a user to sign on to one system (AS/400 or S/36) from another system and use the remote system′s programs and data interactively.

SNADS (SNA Distribution Services) is a store and forward application that sends, receives and routes electronic mail, documents and files in APPN and SNA subarea networks.

DRDA (Distributed Relational Database Access) is an LU6.2 application which provides a set of advanced SQL protocols to provide access to distributed relational databases. DRDA can be used to issue remote units of work to access data on a remote database in the following environments - AS/400 DB2/400, OS/2 DB2, DB2 (MVS) and SQL/DS (VM).

DDM (Distributed Data Management) is a function which allows an application program or user on one system, to use data files stored on a remote system (that also supports DDM). To the user it appears as if the data is local.

Client Access/400 provides a method of connecting personal computers to the AS/400 system. The Client Access/400 server code sits on the AS/400 and provides Database Server, File Server, Print Server and Electronic Mail Server support to the PCs. Client Access/400 provides three types of client support: Original Clients, Windows 3.1 Native Client, and optimized Clients. Original Clients are 16-bit clients for OS/2 and DOS with extended memory. The Windows 3.1 client provides integration into the Windows environment and uses Windows memory management. The optimized clients are 32-bit clients, such as the OS/2 32-bit version that supports OS/2 2.1 and above. Four other optimized clients are announced. They are Windows NT optimized Client, Windows 32-bit optimized Client, Workplace OS optimized Client and UNIX optimized Client.

6.3.2 AS/400 to S/390 Applications

The following examples are of applications which allow the AS/400 to communicate with S/390 mainframe hosts: SNA 3270 emulation, SNA Primary LU Support (SPLS), VM/MVS Bridge, and RJE (Remote Job Entry).

SNA 3270 emulation allows the AS/400 user to remotely logon to a host system. The AS/400 appears as a PU Type 2 Control Unit to the host. 3270 display emulation converts the 3270 data stream, intended for a 3278 device, into 5250 data stream which can be recognized by a display station attached to the AS/400. 3270 printer emulation converts 3270 data stream, intended for a 328x printer, into data stream that can be recognized by an AS/400-attached printer. 3270 emulation is part of OS/400.

SPLS allows 3270 displays and printers, attached to a S/390 host, to communicate with the AS/400 as if they are 5250 devices directly attached to the AS/400. SPLS support is part of OS/400.

The VM/MVS bridge is a function provided by the AS/400 licensed program product Communications Utilities which provides distribution services between a SNADS network on the AS/400 and VM/RSCS, and between SNADS and MVS/JES. The AS/400 emulates an NJE node. This allows the AS/400 to send and receive electronic mail, documents, print output and files to and from the host.

RJE is also a function provided by the AS/400 licensed program product Communications Utilities. RJE allows the AS/400 to submit jobs/data that require processing, to a host, utilizing the processing power of the host. While maintaining the application and data locally. It does not provide a signon panel to the host and requires host/JCL knowledge.

6.3.3 TCP/IP Support

The AS/400 has native TCP/IP support. This support allows the AS/400 to communicate with a great variety of non-IBM systems which support TCP/IP rather than APPC. OS/400 V3R1 TCP/IP support is fully compliant with RFC1122 and RFC1123. The TCP/IP applications that the AS/400 supports include TELNET, FTP, LPD/LPR, electronic mail via SMTP, and network management via SNMP. TCP/IP support is part of OS/400 V3R1. The protocols are supported in the base OS/400 code. The program product TCP/IP Connectivity Utilities, which is shipped free, provides the applications. There is also a licensed program product called File Server Support/400.

The following is a brief overview of the TCP/IP applications supported:

TELNET - The AS/400 provides both client and server support to allow AS/400 users to login remotely to TELNET hosts and to allow remote users on TELNET clients to login to the AS/400.

FTP (File Transfer Protocol) - The AS/400 provides both client and server support for FTP. This allows files to be sent and received between the AS/400 and other FTP systems.

LPD/LPR (Line Print Requestor / Line Print Daemon) - The AS/400 provides LPR support to allow the AS/400 client to send spool files to a remote LPD server system. It also provides LPD support to allow it to receive print output from remote LPR systems.

SMTP (Simple Mail Transport Protocol) - The AS/400 allows users on the AS/400 to send and receive electronic mail and documents over a TCP/IP network via SMTP. The user interface to this protocol is through the Office Vision/400 licensed program product on the AS/400.

SNMP (Simple Network Management Protocol) - The AS/400 functions as an SNMP agent in an SNMP managed network. It provides, for example, MIB II and APPN MIB databases for interrogation by an SNMP manager.

FSS/400 (File Server Support/400) - This application is a server implementation of the SUN Network File System (NFS). It allows remote NFS clients to access data on the AS/400 as if it were local to the user.

6.3.4 OSI Support

The AS/400 supports the networking protocol OSI. OSI was developed as a standard by the International Standards Organization (ISO). This allows the AS/400 to interoperate with a variety of non-IBM systems, which support this open networking architecture. The AS/400 supports the following OSI standards: X.400, FTAM, X.500 and Network Management. The AS/400 implements OSI with three licensed programs: OSI Communications Subsystem, OSI Message Services/400 and OSI File Services/400.

OSI Communications Subsystem provides configuration functions, network management support and directory services (X.500). It also provides the lower layer support to allow the AS/400 to establish a connection via X.25 to another OSI host.

OSI Message Services/400 provides X.400 services for the sending and receiving of electronic mail and documents. It implements the 1984 level of X.400. The user interface to X.400 is via the licensed program product Office Vision/400 for electronic mail, and via the SNADS commands SNDNETF, SNDNETMSG and SNDNETSPLF to allow users to transfer files, messages and spool files.

OSI File Services/400 provides FTAM (File Transfer Access and Management) services. It allows file transfer and file management. A menu-driven user interface is supplied allowing you to interactively transfer and manage files.

6.3.5 NetBIOS Support

NetBIOS is supported on the AS/400 by the LAN Server/400 product. LAN Server/400 software supports the file server I/O processor (FSIOP) providing high performance file serving to a PC running LAN Requester.

6.3.6 IPX Support

Native IPX support is now available on the AS/400. This allows the AS/400 to transparently route IPX. IPX packets can be transported from one IPX network into another, either LAN to LAN or LAN to WAN, via the AS/400. The AS/400 implements RIP and NLSP for routing in an IPX network. Applications can be written to IPX sockets. IPX is also added to AnyNet/400, which will allow AS/400 users to transport native APPC application data over an IPX backbone.

NetWare application server support is available via the FSIOP (File Server IOP), that is, Novell NetWare 4.1 can be installed on the FSIOP.

6.4 AS/400 Communications Configuration

Before the AS/400 can communicate with a remote system or device, a communications configuration must be built. In many cases part of this configuration will be auto-configured when the system or device first contacts the AS/400. An auto-created configuration description is denoted by `CREATED BY AUTO-CONFIGURATION` or `AUTOMATICALLY CREATED BY QLUS` in the text field of the description. Configuration objects can either be created via a menu option or via a command. The main communications configuration menu can be reached by either taking option 6 from the main menu followed by option 4 or by entering the command `GO CFGCMN`. The following menu will be presented:

```
CFGCMN           Configure Communications and Remote Hardware
                                                             System:   RALYAS4B
Select one of the following:

     1. Work with lines
     2. Work with communications controllers
     3. Work with work station controllers
     4. Work with communications devices
     5. Work with printers
     6. Work with display stations
     7. Work with modes
     8. Work with classes-of-service
     9. Work with configuration lists
    10. Work with network interfaces
    11. Work with connection lists
    12. Work with network servers
    13. Work with NetBIOS descriptions
                                                                        More...
Selection or command
===>

F3=Exit   F4=Prompt   F9=Retrieve   F12=Cancel   F13=Information Assistant
F16=AS/400 main menu
```

Figure 29. AS/400 Communications Configuration Menu

An example of a communications configuration command is CRTLINSDLC (Create SDLC Line). If F4 is pressed after typing in the command, the system will prompt for input as shown in the following:

```
                     Create Line Desc (SDLC) (CRTLINSDLC)

Type choices, press Enter.

Line description . . . . . . . .                Name
Resource names . . . . . . . . .                Name
               + for more values
Online at IPL  . . . . . . . . .   *YES          *YES, *NO
Data link role . . . . . . . . .   *NEG          *NEG, *PRI, *SEC
Physical interface . . . . . . .   *RS232V24     *RS232V24, *V35, *X21,
Connection type  . . . . . . . .   *NONSWTPP     *NONSWTPP, *SWTPP, *MP, *SHM









                                                                      Bottom
F3=Exit   F4=Prompt   F5=Refresh   F10=Additional parameters   F12=Cancel
F13=How to use this display        F24=More keys
```

Figure 30. AS/400 Communications Configuration Command Example

When the information requested in the panel above has been entered, further information is prompted for.

The commonly used communications configuration objects are as follows:

- Network Interface
- Line
- Controller
- Device
- APPN local location list
- APPN remote location list
- Mode

In addition to the above, the system network attributes include system wide communications configuration information. Such as the system network ID.

A network interface describes an interface to a network. Currently, network interfaces are used with two types of networks; these are ISDN and frame relay. Where the network is ISDN or frame relay, the network interface is the first configuration object created. The network interface is used to define, for example, the network type and the interface type. The network interface also defines the communications port (resource name) to be used.

A line description describes the local system (the AS/400) and the communication type. It also describes the physical interface (V.24, etc.) between the local system and the network, whether the line is switched or nonswitched and the network address (for example, X.25 NUA) of the local system. With the exception of ISDN and frame relay, the line description is the first configuration object created. Where there is no network interface, the line description also defines the AS/400 communications port (resource name) to be used.

A controller description describes the characteristics of the remote system. It may describe a physical device (for example, a 3174/5494 remote workstation controller), or it may describe a logical connection to a remote system (for example, an APPC/APPN connection). If the remote system or device is reached via a switched connection, the controller description will also include the network address/telephone number/MAC address of the remote system. In the case of an APPN connection, the controller description will contain the network ID and CP name of the remote system/device. The controller description is normally created after the line description. In some cases (for example, a LAN connection) the controller descriptions can be auto-created provided that the parameter has been set in the associated line description to permit this. In SNA terminology, a controller description can be thought of as defining a PU.

A device description describes the characteristics of a physical or logical device. For example, in the case of a 3174, the device description could describe a display attached to the 3174, or in the case of an APPC connection, the device description would describe a communications session. The device description is normally created after the controller description. In the case of an APPN connection, the device descriptions would normally be left to auto-create. In SNA terminology, a device description can be thought of as defining an LU.

The APPN local location list is used to define the aliases for the local system. The default local location name (LU name) for the system is defined in the network attributes. If additional names are required, these are defined in the APPN local location list. The system will give a positive reply for APPN search requests received when the name is either: the CP name of the system, the default local location name of the system or the name is in the APPN local location list.

The APPN remote location list is used to define remote location names (LU names). In most cases a remote location list entry is not required. Some examples of where an entry is required are:

- Where the remote location (LU) cannot be located via an APPN search request. The most common example of this is where the location (LU) resides within a non-APPN VTAM host.
- Where the requirement is for passwords to be used when establishing a connection to a remote system.
- Where the remote location is via APPC over TCP/IP (AnyNet).

Mode descriptions describe session characteristics. Mode descriptions for the common modes (BLANK, #INTER, #BATCH, etc.) are system supplied. Before a session can be established using a mode other than one that is system supplied, a mode description must be created. Each mode description has an associated Class of Service (COS).

The system network attributes describe system wide values. These system wide values include communications definitions. The network attributes are accessed either by taking option 6 from the main menu followed by option 5 then option 1 or via the command DSPNETA. Some examples of the communications definitions defined in the network attributes are: System Network ID, System CP

Name, Default Local Location Name, APPN Node Type and the Default Mode used when establishing a session.

To summarize, the AS/400 communications objects are related to each other as shown in the following:

```
Network Interface (Frame relay and ISDN only)
  Line Description
    Controller Description
      Device Description
        Mode Description
```

Each of the above communications objects has a name associated with it. The objects are linked to each other via these names.

Once created, the communications configuration objects can be activated (Vary on) or de-activated (Vary off) again via either the system menus or a command. The object type and object name are used when accessing a specific object. For example, to show the current status of a line description and allow the status to be changed, you can either take option 6 from the main menu followed by option 1 then option 1 or enter the command WRKCFGSTS *LIN. By default, this menu option and command will show all line descriptions. As an example, if you wanted to determine the status of the line description L31TR, the command WRKCFGSTS *LIN L31TR would result in the following:

```
                        Work with Configuration Status                RALYAS4B
                                                             07/07/95  13:33:56
Position to  . . . . .               Starting characters

Type options, press Enter.
  1=Vary on   2=Vary off   5=Work with job   8=Work with description
  9=Display mode status ...

Opt  Description       Status               -------------Job--------------
     L31TR             ACTIVE
       WTR05130        ACTIVE
         WTR05130      ACTIVE
           QPCSUPP     ACTIVE/TARGET        WTR05130    MICK        003376
       L31TRNET        VARIED OFF
         L31TRTCP00    VARIED OFF



                                                                       Bottom
Parameters or command
===>
F3=Exit   F4=Prompt   F12=Cancel   F23=More options   F24=More keys
```

Figure 31. AS/400 Work with Configuration Status Command

Besides showing the status, this panel also allows the status to be changed. For example, activated via option 1 (Vary on).

In addition to showing the status of the line description (L31TR), the command also shows the status of communications objects associated with the line description. In this example it shows an APPC controller (WTR05130), a device description (WTR05130) and the mode being used for the active session (QPCSUPP). A TCP/IP interface is also associated with this token-ring line description. The system created configuration objects for this are also shown (L31TRNET and L31TRTCP00).

For further information on AS/400 communications configuration, see *AS/400 Communications Configuration*, SC41-3401.

The AS/400 TCP/IP configuration can also be carried out via either the system menus or commands. The main TCP/IP configuration menu is accessed via either option 6 followed by option 4 and then option 20 from the main menu or by entering the command CFGTCP. The following panel is presented:

```
CFGTCP                         Configure TCP/IP
                                                             System:   RALYAS4B
Select one of the following:

     1. Work with TCP/IP interfaces
     2. Work with TCP/IP routes
     3. Change TCP/IP attributes
     4. Work with TCP/IP port restrictions
     5. Work with TCP/IP remote system information

    10. Work with TCP/IP host table entries
    11. Merge TCP/IP host table
    12. Change local domain and host names
    13. Change remote name server

    20. Configure TCP/IP applications
    21. Configure related tables


Selection or command
===>

F3=Exit   F4=Prompt   F9=Retrieve   F12=Cancel
```

Figure 32. AS/400 TCP/IP Configuration Menu

If a command interface is preferred, the ADDTCPRTE command, for example, will create a route definition. As before, if F4 is pressed after typing in the command, the system will prompt for input.

For further information on AS/400 TCP/IP configuration, see *AS/400 TCP/IP Configuration and Reference*, SC41-3420.

Part 2. Router Scenarios

Part 2 contains various tested and documented AS/400 networking scenarios using multiprotocol routers. The aim is to configure a variety of multiprotocol router networks which include AS/400 systems, and to review any special requirements to allow communication with an AS/400 across the router backbone.

Each chapter has the following layout:

- An overview showing the entire network.
- A list of the hardware and software components involved.
- Sections that review the network based on a specific protocol. For example, we look at the layout of the TCP/IP network which is sitting within the multiprotocol network.

  In each of the above sections we include the configuration definitions of the AS/400 and any device communicating with it.
- Finally, a section which documents the complete router definitions used to support the complete multiprotocol network.

In each chapter we include a variety of components apart from the routers and AS/400 systems (for example, OS/2 LAN Requester and Client Access/400). The protocols included are SNA/APPN, NetBIOS, TCP/IP and IPX.

Chapter 7. IBM 6611 and IBM 2210 Router Configuration Tools

IBM routers can be configured using configuration tools running under OS/2, Windows or AIX, or the definitions can be entered directly using an ASCII panel.

The IBM 6611 router configuration tool is a very easy and helpful utility to prepare the router definitions. We used the OS/2 version.

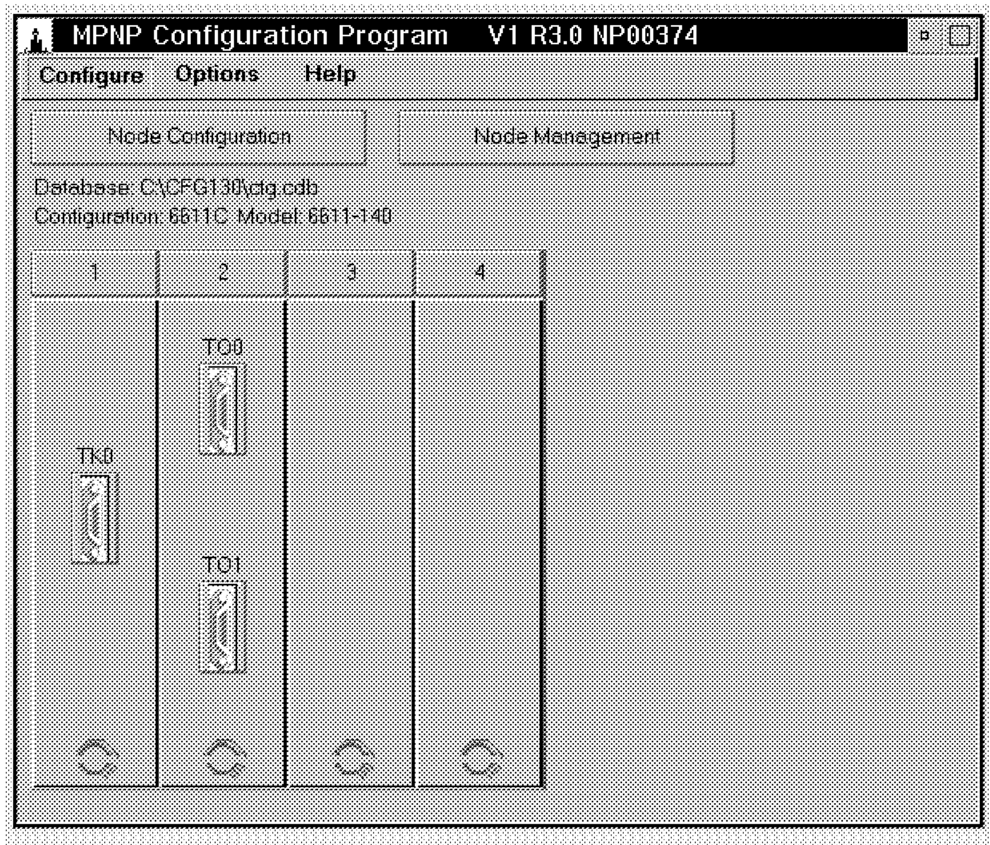


Figure 33. IBM 6611 Configuration Program, Main Menu

We found it easier to configure the IBM 2210 routers via an ASCII terminal directly attached to the IBM 2210 router. The ″Terminal″ provided with Windows 3.1 (in the Accessories group) provides a suitable terminal emulation program. A question and answer mode is driven by the router to enter the required definitions. We documented the IBM 2210 router definitions by writing down this configuration dialog.

Chapter 8. IBM 6611s in a Router Network

The objectives of this scenario are as follows:

- To interconnect two token-ring LAN segments via IBM 6611 routers
- To connect the IBM 6611 routers using a WAN link
- To configure DLSw in order to support SNA and NetBIOS
- To allow TCP/IP and IPX routing

The following figure provides an overview of the IBM 6611 multiprotocol router network we established. Further on, there are three chapters describing, from a user′s point-of-view, the networks we run via the routers. These are as follows:

- TCP/IP network
- DLWs network to support SNA and NetBIOS connections
- IPX network to allow NetWare requester to NetWare server traffic

The last chapter includes all router definitions required.

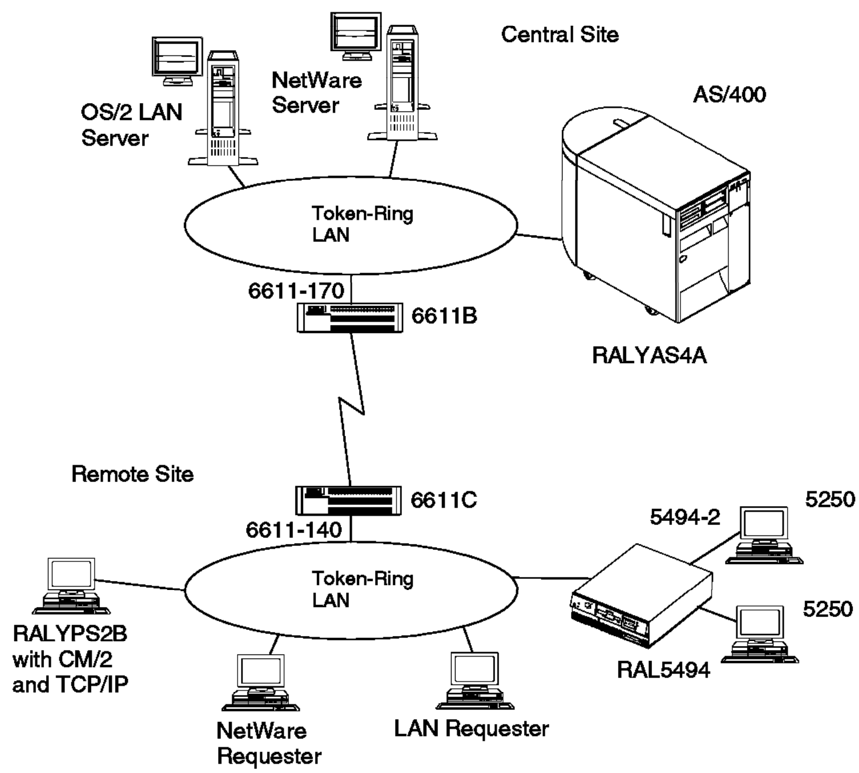


Figure 34. IBM 6611 Router Network, Overview

8.1 Hardware/Software Involved

- Routers
  - IBM 6611, Model 170, with MPNP V1R3
  - IBM 6611, Model 140, with MPNP V1R3
- WAN Link between routers

  The speed of the connection is 64 Kbps. We used IBM 5822-10 modems with V.35 interfaces.
- LAN Multi-Access Units
  - IBM 8228s to build token-ring LAN segments
- PS/2 Model 80
  - OS/2 V2.11
  - Communications Manager/2 V1.11
  - OS/2 TCP/IP V2.1
- NetWare requester and server
- OS/2 LAN requester and server
- IBM 5494 Remote Workstation Controller

  With Release 3.0 microcode

  Configured for token-ring upstream and twinax devices attached
- AS/400 System

  With OS/400 V3R1, OS/400 includes SNA and TCP/IP support

The routers involved in this scenario are certainly over-sized. However, the router configuration is not dependant on the model. This means a more appropriate model, like the IBM 6611-120, would be configured with the same values.

8.2 TCP/IP Network

The following figure shows the TCP/IP network layout as well as the IP network and host addresses involved.

The objective is for each TCP/IP host to reach any other host included in this network.

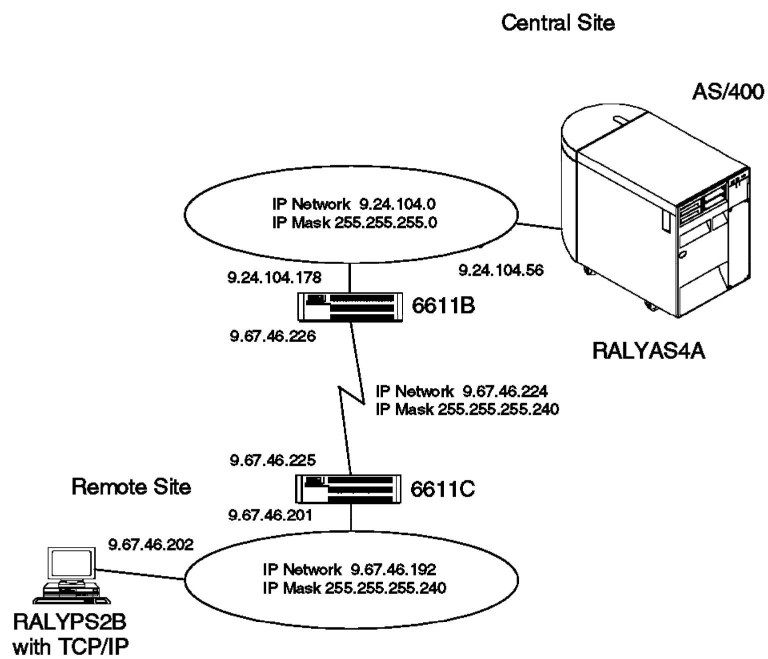


Figure 35. IBM 6611 Router Network, TCP/IP Part

8.2.1 OS/2 TCP/IP Definitions (RALYPS2B)

Select the **TCP/IP Configuration** icon to set the values for this OS/2 based TCP/IP host. The local interface IP address and a default route are the essential pieces of information to be entered.

```
Network
   Configure Network Interface Parameters
      Enable LAN Adapter:  0
      IP address:  9.67.46.202
      Subnet Mask:  255.255.255.240
      MTU:  1500

Routing
   Configure Routing Information
      Route Type:  DEFAULT
      Router:  9.67.46.201
```

Figure 36. OS/2 TCP/IP Definitions

8.2.2 AS/400 Definitions (RALYAS4A)

8.2.2.1 Token-Ring LAN Line Description

The following line description is used for SNA as well as for TCP/IP:

```
CRTLINTRN  LIND(L41TR) RSRCNAME(LIN041) LINESPEED(4M) MAXFRAME(1994) +
             ADPTADR(400010020001) TEXT('4M TR for RALYAS4A') +
             LINKSPEED(4M) AUTOCRTCTL(*YES)
```

8.2.2.2 TCP/IP Interface and Route Definitions

The TCP/IP Interface includes the IP address used by this AS/400 on a specified interface such as a token-ring LAN adapter. The *LOOPBACK entry is provided with the software. It is used to internally ping the AS/400.

```
                          Work with TCP/IP Interfaces
                                                          System:   RALYAS4A
 Type options, press Enter.
   1=Add   2=Change   4=Remove   5=Display   9=Start   10=End
      Internet         Subnet              Line      Line
 Opt  Address          Mask             Description  Type
      9.24.104.56      255.255.255.0    L41TR        *TRLAN
      127.0.0.1        255.0.0.0        *LOOPBACK    *NONE









                                                                      Bottom
 F3=Exit   F5=Refresh   F6=Print list   F10=Work with IP over SNA interfaces
 F11=Display interface status           F12=Cancel   F17=Top   F18=Bottom
```

Figure 37. AS/400 TCP/IP Interface

A TCP/IP Route entry helps to locate the next TCP/IP host (next hop) on the path to a target IP network. Looking from the system AS/400 RALYAS4A, the destination network 9.67.46.192 is found via the router 6611B.

```
                           Work with TCP/IP Routes
                                                            System:   RALYAS4A
 Type options, press Enter.
   1=Add   2=Change   4=Remove   5=Display
                                                 Type
         Route              Subnet               of              Next
 Opt     Destination        Mask                 Service         Hop
         9.67.46.192        255.255.255.240      *NORMAL         9.24.104.178

                                                                        Bottom
 F3=Exit      F5=Refresh   F6=Print list   F10=Work with IP over SNA routes
 F12=Cancel   F17=Top      F18=Bottom
```

Figure 38. AS/400 TCP/IP Route, 1 of 2

For problem determination you might also want to ping the WAN related IP addresses between the routers. This would require another TCP/IP Route entry as shown in the following figure:

```
                           Work with TCP/IP Routes
                                                            System:   RALYAS4A
 Type options, press Enter.
   1=Add   2=Change   4=Remove   5=Display
                                                 Type
         Route              Subnet               of              Next
 Opt     Destination        Mask                 Service         Hop
         9.67.46.192        255.255.255.240      *NORMAL         9.24.104.178
         9.67.46.224        255.255.255.240      *NORMAL         9.24.104.178

                                                                        Bottom
 F3=Exit      F5=Refresh   F6=Print list   F10=Work with IP over SNA routes
 F12=Cancel   F17=Top      F18=Bottom
```

Figure 39. AS/400 TCP/IP Route, 2 of 2

8.3 The Data Link Switching (DLSw) Network

In our multiprotocol router network we defined DLSw to support SNA and NetBIOS traffic. To the SNA devices, such as the AS/400 or the IBM 5494, the DLSw network is transparent as in a bridged LAN environment. This is true for NetBIOS devices as well.

The following are a few important configuration facts to remember:

- All routers representing a unique DLSw network share a common virtual LAN segment. In our case the segment number is AAA.
- The LAN interface of each router has to be enabled to allow bridging to take place.
- DLSw partners (the routers) communicate with each other using TCP/IP. Therefore, a specific IP address is required on each router for DLSw. In the case of the IBM 6611, it is suggested to use the IP adapter address of the LAN adapter.

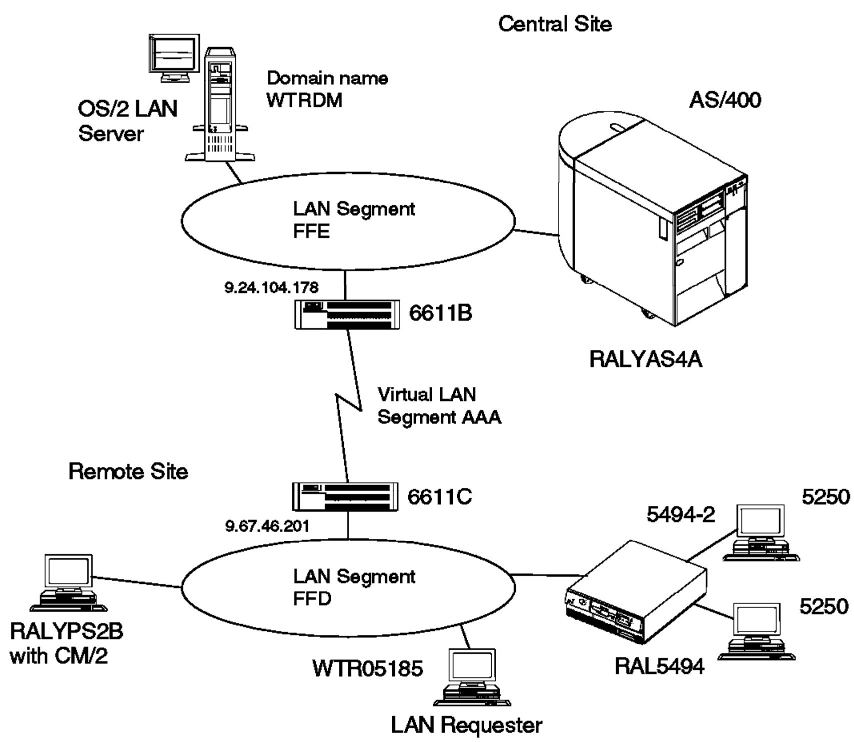


Figure 40. IBM 6611 Router Network, DLSw Part

We tested the following connections:

- IBM 5494 to AS/400 RALYAS4A
- OS/2 Communications Manager to AS/400 RALYAS4A
- OS/2 LAN Requester to OS/2 LAN Server

The definitions on the target AS/400 system (RALYAS4A) were created automatically. We include these definitions for reference purposes only.

In this section we are not going to describe the configuration of the NetBIOS requester and server. These were the standard configurations. Nothing extra had to be added for this network. The router network was transparent to the LAN requester/server users.

The token-ring line descriptions was created in 8.2.2.1, "Token-Ring LAN Line Description" on page 80.

8.3.1 AS/400 Network Attributes (RALYAS4A)

The network attributes of RALYAS4A are as shown in the following figure:

```
                           Display Network Attributes
                                                           System:   RALYAS4A
 Current system name  . . . . . . . . . . . . . . :   RALYAS4A
   Pending system name  . . . . . . . . . . . . . :
 Local network ID . . . . . . . . . . . . . . . . :   USIBMRA
 Local control point name . . . . . . . . . . . . :   RALYAS4A
 Default local location . . . . . . . . . . . . . :   RALYAS4A
 Default mode . . . . . . . . . . . . . . . . . . :   BLANK
 APPN node type . . . . . . . . . . . . . . . . . :   *NETNODE
 Data compression . . . . . . . . . . . . . . . . :   *NONE
 Intermediate data compression  . . . . . . . . . :   *NONE
 Maximum number of intermediate sessions  . . . . :   200
 Route addition resistance  . . . . . . . . . . . :   128
 Server network ID/control point name . . . . . . :   *LCLNETID   *ANY
                                                                  More...
 Press Enter to continue.
 F3=Exit   F12=Cancel
```

Figure 41. AS/400 Network Attributes

8.3.2 IBM 5494 Definitions

We defined the IBM 5494 Remote Workstation controller to communicate with AS/400 RALYAS4A.

```
        0        1        2        3        4        5        6
        ----------------------------------------------------------
  0/    00       00       00       00       00       00       00

  1/    00       00       00       00       00       00       00

  2/    00       00       00       00       00       00       00

  3/    00       00       00       00       00       00       00






AA-► 4
1-► 00 - -
F-► 04   G-► 01    H-► 30    I-► 030    J-► 08
                                                        P-► - -
```

Figure 42. IBM 5494, Setup Panel, 1 of 2

```
11-► USIBMRA   12-► RAL5494_  13-► RAL5494_  14-► QRMTWSC_
15-► 40005494E000___  16-► 010 06 1  17-► 00-00000  18-► ________


H1:1-► RALYAS4A  H1:2-► USIBMRA   H1:3-► USIBMRA   H1:4-► QRMTWSC
H1:5-► 400010020001________________________________________
                 H1:7-► 04  H1:8-► 2   H1:9-► 1

H2:1-► ________  H2:2-► ________  H2:3-► ________  H2:4-► ________
H2:5-► ____________________________________________________
                 H2:7-► __  H2:8-► _   H2:9-► _

H3:1-► ________  H3:2-► ________  H3:3-► ________  H3:4-► ________
H3:5-► ____________________________________________________
                 H3:7-► __  H3:8-► _   H3:9-► _

H4:1-► ________  H4:2-► ________  H4:3-► ________  H1:4-► _______
H4:5-► ____________________________________________________
                 H4:7-► __  H4:8-► _   H4:9-► _
```

Figure 43. IBM 5494 Setup Panel, 2 of 2 - Connecting to RALYAS4A

Table 15 shows the IBM 5494 configuration values selected and a description of those values.

Table 15 (Page 1 of 2). IBM 5494 Configuration Parameters

Field /Subfield	**Field Description**	**Value Selected**	**Value Description**
AA	Communication Mode	4	Token-Ring
1	Keyboard Code	00	US English
F	Token-Ring SAP	04	1
G	Response Timer	01	1
H	Inactivity Timer	30	1
I	Acknowledge Timer	030	1

Table 15 (Page 2 of 2). IBM 5494 Configuration Parameters			
Field /Subfield	**Field Description**	**Value Selected**	**Value Description**
J	Retry Count	08	1
P	Configuration Printer		
11	Network ID of 5494	USIBMRA	
12	LU Name of 5494	RAL5494	
13	CP Name of 5494	RAL5494	
14	Mode Name	QRMTWSC	
15	5494 MAC Address	40005494E000	
16	Retry Parameters	010 06	1
17	5494 Serial Number		
18	5494 ID Number		
H1:1	AS/400 LU Name	RALYAS4A	
H1:2	AS/400 Network ID	USIBMRA	
H1:3	5494 Network ID	USIBMRA	
H1:4	Mode Name	QRMTWSC	
H1:5	AS/400 MAC Address	400010020001	
H1:7	Token-Ring SAP	04	1
H1:8	TR Max Out	2	1
H1:9	TR Max In	1	1
Note: 1 Default values accepted			

8.3.3 OS/2 Communications Manager

The required Communications Manager/2 definitions can be generated by following these steps:

1. Select the **Communications Manager/2** icon.
2. Select **Communications Manager Setup**.
3. Select **Setup** to create or modify a configuration.
4. Open an existing configuration file or type the name of a new configuration file (RALYPS2B in our case).
5. Select **Commonly Used Definitions** and Communications Definitions for **5250 Emulation through Token-Ring**.

Go through all SNA profiles and enter the following configuration parameters:

```
DLC Profile
   (accept defaults)

SNA Local Node Characteristics
   Network ID         USIBMRA
   Local Node Name    RALYPS2B
   Node Type          End Node to Network Node Server
   Your Network Node  400010020001
   Local Node ID      default

SNA Connection
   LINK0001
       Adapter Type             Token-Ring
       Adapter Number           0
       LAN Destination Address  400010020001

SNA Features
       Partner LUs
         LU Name                USIBMRA.RALYAS4A
         Alias                  RALYAS4A

5250 Emulation
       Session Name             A
       Partner LU Name          RALYAS4A
```

Figure 44. CM/2 Definitions

8.3.4 Auto-Created AS/400 Definitions

AS/400 RALYAS4A serves as a target system for the IBM 5494 Remote Workstation Controller and the PS/2. As a target system on a LAN connection, APPC definitions are auto-created. We have documented these definitions for reference purposes only.

8.3.4.1 IBM 5494, Auto-Created Definitions on AS/400

The following are the auto-created APPC controller and device descriptions:

```
CRTCTLAPPC CTLD(RAL5494) LINKTYPE(*LAN) SWTLINLST(L41TR) +
             MAXFRAME(16393) RMTNETID(USIBMRA) RMTCPNAME(RAL5494) +
             ROLE(*NEG) ADPTADR(40005494E000) NODETYPE(*CALC) +
             AUTOCRTDEV(*ALL) SWTDSC(*YES)
CRTDEVAPPC DEVD(RAL5494) RMTLOCNAME(RAL5494) LCLLOCNAME(RALYAS4A) +
             RMTNETID(*NETATR) CTL(RAL5494)
```

With OS/400 V3R1 the RWS controller description, display and printer device descriptions are created automatically as well, as shown in the following:

```
CRTCTLRWS  CTLD(RAL54RMT) TYPE(5494) MODEL(2) LINKTYPE(*NONE) +
             RMTLOCNAME(RAL5494) LCLLOCNAME(RALYAS4A) +
             RMTNETID(USIBMRA) AUTOCRTDEV(*ALL)
CRTDEVDSP  DEVD(RAL5DSP00) DEVCLS(*RMT) TYPE(3487) MODEL(HC) +
             SHRSSNNBR(0) LOCADR(00) CTL(RAL54RMT) KBDTYPE(USB)
CRTDEVDSP  DEVD(RAL5DSP01) DEVCLS(*RMT) TYPE(3487) MODEL(HC) +
             SHRSSNNBR(0) LOCADR(01) CTL(RAL54RMT) KBDTYPE(USB)
CRTDEVDSP  DEVD(RAL5DSP02) DEVCLS(*RMT) TYPE(3487) MODEL(HC) +
             SHRSSNNBR(0) LOCADR(02) CTL(RAL54RMT) KBDTYPE(USB)
```

8.3.4.2 OS/2 Communications Manager Auto-Created Definitions on AS/400

```
CRTCTLAPPC CTLD(RALYPS2B) LINKTYPE(*LAN) SWTLINLST(L41TR) +
             MAXFRAME(16393) RMTNETID(USIBMRA) RMTCPNAME(RALYPS2B) +
             ROLE(*NEG) ADPTADR(400052005185)
CRTDEVAPPC DEVD(RALYPS2B) RMTLOCNAME(RALYPS2B) +
             LCLLOCNAME(RALYAS4A) CTL(RALYPS2B)
```

8.4 IPX Network

The router network is set up to route IPX via the following topology:

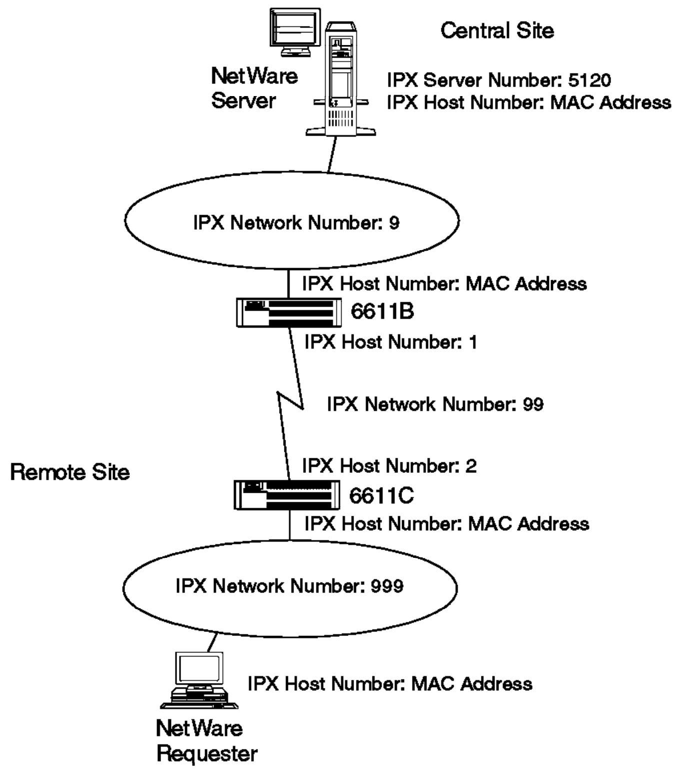


Figure 45. IBM 6611 Router Network, IPX Part

In this section we are not going to describe the configuration of the NetWare requester and server. These were the standard configurations. Nothing extra had to be added for this network. The router network was transparent to the NetWare users.

8.5 Router Definitions

The IBM 6611 configuration for 6611B and 6611C were created using the OS/2 MPNP Configuration Program V1R3.0. The definitions of 6611C and 6611B are shown below.

8.5.1 IBM 6611 Router Configuration - 6611C

The configuration of 6611C is as follows:

```
6611 Model 140

slot 1  2 port token-ring card
slot 2  single port serial card
```

```
Interface Definition

   Slot 1, Port 0 - Token-Ring
        Physical Interface
            - Universally Administered Address
            - Mac Address Format : Non Canonical
            - Token-Ring data rate : 4 Mbps
            - Broadcast type : non-local
        Source Route Bridging
            - Enable Source Route Bridging on this port
            - Spanning tree mode : automatic
            - Ring Number : FFD
        IP
            - Enable IP routing on this port
            - IP address : 9.67.46.201
            - Subnet mask : 255.255.255.240
            - MTU : 1492
        IPX
            - Enable IPX routing on this port
            - IPX network number 00000999
        DLSw for SNA
            - Enable SNA frame forwarding on this port
            - 00 & 04 are default SAPs
              08 & 0C can be added for further SNA applications if
              required
        DLSw for NetBIOS
            - NetBIOS frames           (click to enable)
            - NetBIOS Datagram and Datagram Broadcast Messages  (enable)
```

Figure 46. 6611 MPNP Token-Ring Interface Definition - 6611C

```
Interface Definition

   Slot 2, Port 0 - Serial Port
        PPP is the serial link protocol
        Physical Interface
            - Serial line speed : 64000 bps
            - NRZI
            - Locally Administered MAC address (IPX) : 000000000002
                                                        (IPX host number)
            - Queue priority : defaults
        IP
            - Enable IP routing on this port
            - IP address : 9.67.46.225
            - Subnet mask : 255.255.255.240
            - Destination IP address : 9.67.46.226
            - MTU : 1500
        IPX
            - Enable IPX routing on this port
            - IPX network number : 00000099
```

Figure 47. 6611 MPNP Serial Port Interface Definition - 6611C

```
Node Configuration

Bridging
     Source Route
         - Enable Source Route Bridging
         - Bridge number : 1
         - Designated ring number : FFD
DLSw
     Enable SNA DLSw
     Enable NetBIOS DLSw
         - Virtual ring segment number : AAA
         - Default DLSw IP address : 9.67.46.201
         - DLSw Partners : 9.24.104.178
IPX
     Enable IPX router
Routing
     IP Static Routes
          - Default
          - Next hop : 9.67.46.226
```

Figure 48. 6611 MPNP Node Definition - 6611C

```
Node Management

IBM 6611 host name : 6611C
```

Figure 49. 6611 MPNP Node Management Definition - 6611C

8.5.2 IBM 6611 Router Configuration - 6611B

The configuration of 6611B is as follows:

```
6611 Model 170

slot 1  Single port Token-Ring card
slot 2  2 port serial card
```

```
Interface Definition

   Slot 1, Port 0 - Token-Ring
        Physical Interface
            - Universally Administered Address
            - Mac Address Format : Non Canonical
            - Token-Ring data rate : 4 Mbps
            - Broadcast type : non-local
        Source Route Bridging
            - Enable Source Route Bridging on this port
            - Spanning tree mode : automatic
            - Ring Number : FFE
        IP
            - Enable IP routing on this port
            - IP address : 9.24.104.178
            - Subnet mask : 255.255.255.0
            - MTU : 1492
        IPX
            - Enable IPX routing on this port
            - IPX network number 00000009
        DLSw for SNA
            - Enable SNA frame forwarding on this port
            - 00 & 04 are default SAPs
              08 & 0C can be added for further SNA applications if
              required
        DLSw for NetBIOS
            - NetBIOS frames           (click to enable)
            - NetBIOS Datagram and Datagram Broadcast Messages  (enable)
```

Figure 50. 6611 MPNP Token-Ring Interface Definition - 6611B

```
Interface Definition

   Slot 2, Port 0 - Serial Port
        PPP is the serial link protocol
        Physical Interface
            - Serial line speed : 64000 bps
            - NRZI
            - Locally Administered MAC address (IPX) : 000000000001
                                                       (IPX host number)
            - Queue priority : defaults
        IP
            - Enable IP routing on this port
            - IP address : 9.67.46.226
            - Subnet mask : 255.255.255.240
            - Destination IP address : 9.67.46.225
            - MTU : 1500
        IPX
            - Enable IPX routing on this port
            - IPX network number : 00000099
```

Figure 51. 6611 MPNP Serial Port Interface Definition - 6611B

```
Node Configuration

Bridging
     Source Route
         - Enable Source Route Bridging
         - Bridge number : 15
         - Designated ring number : FFE
DLSw
     Enable SNA DLSw
     Enable NetBIOS DLSw
         - Virtual ring segment number : AAA
         - Default DLSw IP address : 9.24.104.178
         - DLSw Partners : 9.67.46.201
IPX
     Enable IPX router
Routing
     IP Static Routes
          - Default
          - Next hop : 9.67.46.225
```

Figure 52. 6611 MPNP Node Definition - 6611B

```
Node Management

IBM 6611 host name : 6611B
```

Figure 53. 6611 MPNP Node Management Definition - 6611B

To refresh the 6611 configuration via a diskette using the 6611 console do as follows:

```
login IBM6611C
password IBM6611C

main menu : select Configuration
Receive and apply configuration
Import method : DOS diskette
```

Chapter 9. IBM 2210s in a Router Network

The objectives of this scenario are as follows:

- To interconnect a token-ring and an Ethernet LAN segment via IBM 2210 routers
- To connect the two IBM 2210 routers using a WAN link
- To configure DLSw in order to support SNA
- To allow TCP/IP and IPX routing

In the first section of this chapter we look at an overview and the hardware and software involved. Following that we review the network from the different views of the three protocols running across it. The three views we look at are the following:

- TCP/IP network
- DLSw network to support SNA connections
- IPX network to allow NetWare requester to NetWare server traffic

The last section includes all the router definitions required.

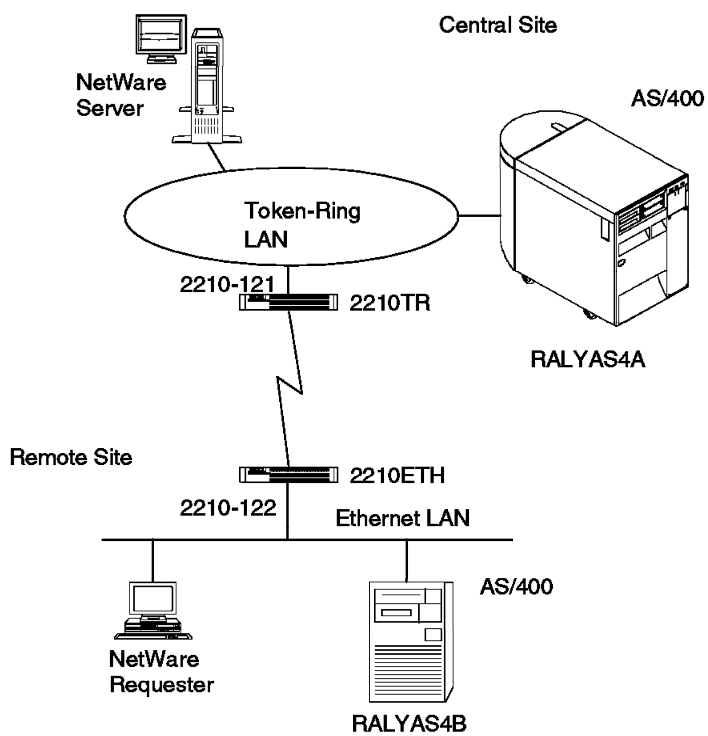


Figure 54. IBM 2210 Router Network, Overview

9.1 Hardware/Software Involved

- Routers
  - IBM 2210, Model 121, with MRNS V1R2
  - IBM 2210, Model 122, with MRNS V1R2
- WAN Link between routers

  The speed of the connection is 64 Kbps. We used IBM 5822-10 modems with V.35 interfaces.
- LAN Multi-Access Units
  - IBM 8228 to build the token-ring LAN segment
  - IBM 8224 to build the Ethernet LAN segment
- NetWare requester and server
- AS/400 Systems

  With OS/400 V3R1, OS/400 includes SNA and TCP/IP support.

9.2 TCP/IP Network

The following figure shows the TCP/IP network layout as well as the IP network and host addresses involved.

The objective is for each TCP/IP host to be able to reach any other host included in this network.

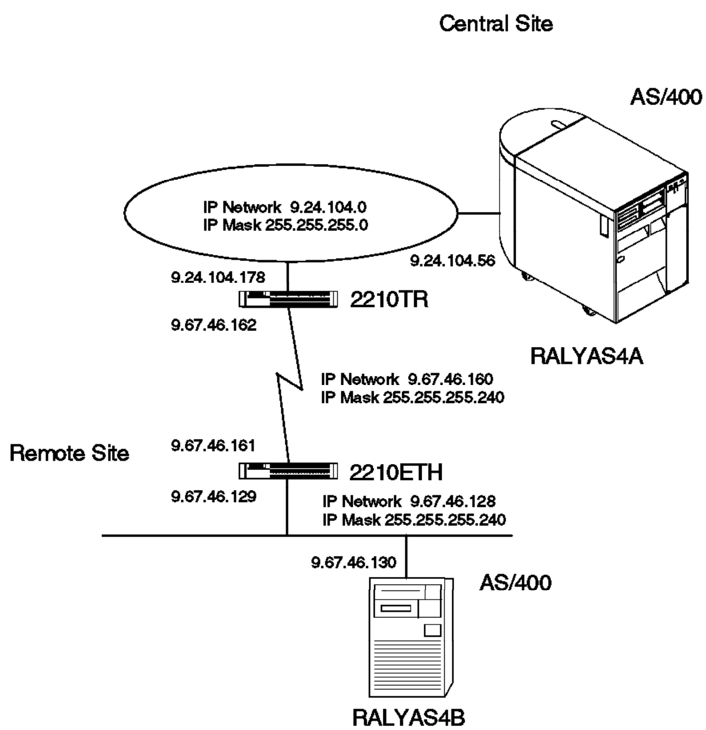


Figure 55. IBM 2210 Router Network, TCP/IP Part

9.2.1 AS/400 TCP/IP Definitions (RALYAS4A)

9.2.1.1 Token-Ring LAN Line Description

The following line description is used for SNA as well as for TCP/IP:

```
CRTLINTRN  LIND(L41TR) RSRCNAME(LIN041) ADPTADR(400010020001) AUTOCRTCTL(*YES)
```

9.2.1.2 TCP/IP Interface and Route Definitions

The TCP/IP Interface includes the IP address used by this AS/400 on a specified interface such as a token-ring LAN adapter. The *LOOPBACK entry is provided with the software. It is used to internally ping the AS/400.

```
                         Work with TCP/IP Interfaces
                                                         System:   RALYAS4A
Type options, press Enter.
  1=Add   2=Change   4=Remove   5=Display   9=Start   10=End
     Internet         Subnet              Line       Line
Opt  Address          Mask                Description  Type
     9.24.104.56      255.255.255.0       L41TR        *TRLAN
     127.0.0.1        255.0.0.0           *LOOPBACK    *NONE









                                                                     Bottom
F3=Exit   F5=Refresh   F6=Print list   F10=Work with IP over SNA interfaces
F11=Display interface status           F12=Cancel   F17=Top   F18=Bottom
```

Figure 56. AS/400 TCP/IP Interface - RALYAS4A

A TCP/IP Route entry helps to locate the next TCP/IP host (next hop) on the path to a target IP network. Looking from the system AS/400 RALYAS4A, the destination network 9.67.46.128 is found via the IBM 2210 router.

```
                           Work with TCP/IP Routes
                                                         System:   RALYAS4A
Type options, press Enter.
  1=Add   2=Change   4=Remove   5=Display
                                                  Type
        Route              Subnet                 of             Next
Opt     Destination        Mask                   Service        Hop
        9.67.46.128        255.255.255.240        *NORMAL        9.24.104.178











                                                                     Bottom
F3=Exit      F5=Refresh   F6=Print list   F10=Work with IP over SNA routes
F12=Cancel   F17=Top      F18=Bottom
```

Figure 57. AS/400 TCP/IP Route - RALYAS4A, 1 of 2

For problem determination you might also want to ping the WAN related IP addresses between the routers. This would require another TCP/IP Route entry as shown in the following figure:

```
                         Work with TCP/IP Routes
                                                        System:   RALYAS4A
Type options, press Enter.
  1=Add   2=Change   4=Remove   5=Display
                                               Type
        Route              Subnet              of            Next
Opt     Destination        Mask                Service       Hop
        9.67.46.128        255.255.255.240     *NORMAL       9.24.104.178
        9.67.46.160        255.255.255.240     *NORMAL       9.24.104.178

                                                                    Bottom
F3=Exit      F5=Refresh   F6=Print list   F10=Work with IP over SNA routes
F12=Cancel   F17=Top      F18=Bottom
```

Figure 58. AS/400 TCP/IP Route - RALYAS4A, 2 of 2

9.2.2 AS/400 TCP/IP Definitions (RALYAS4B)

9.2.2.1 Ethernet LAN Line Description

The following line description is used for SNA as well as for TCP/IP:

```
CRTLINETH  LIND(L71ETH) RSRCNAME(LIN071) ADPTADR(08005A1A60CD) AUTOCRTCTL(*YES)
```

9.2.2.2 TCP/IP Definitions

The IP address of the system AS/400 RALYAS4B is 9.67.46.130 on the Ethernet LAN adapter.

```
                         Work with TCP/IP Interfaces
                                                         System:   RALYAS4B
 Type options, press Enter.
   1=Add   2=Change   4=Remove   5=Display   9=Start   10=End
      Internet         Subnet            Line       Line
 Opt  Address          Mask              Description  Type
      9.67.46.130      255.255.255.240   L71ETH       *ELAN
      127.0.0.1        255.0.0.0         *LOOPBACK    *NONE











                                                                      Bottom
 F3=Exit   F5=Refresh   F6=Print list   F10=Work with IP over SNA interfaces
 F11=Display interface status           F12=Cancel   F17=Top   F18=Bottom
```

Figure 59. AS/400 TCP/IP Interface - RALYAS4B

Since all destination IP networks can be reached via the Ethernet-attached IBM 2210 router, a default TCP/IP Route entry is sufficient.

```
                           Work with TCP/IP Routes
                                                         System:   RALYAS4B
 Type options, press Enter.
   1=Add   2=Change   4=Remove   5=Display
                                                Type
         Route              Subnet              of              Next
 Opt     Destination        Mask                Service         Hop
         *DFTROUTE          *NONE               *NORMAL         9.67.46.129











                                                                      Bottom
 F3=Exit      F5=Refresh   F6=Print list   F10=Work with IP over SNA routes
 F12=Cancel   F17=Top      F18=Bottom
```

Figure 60. AS/400 TCP/IP Route - RALYAS4B

9.3 The Data Link Switching (DLSw) Network

In our multiprotocol router network we defined DLSw to support SNA traffic. To the SNA devices, such as the AS/400, the DLSw network is transparent as in a bridged LAN environment.

The following are a few important configuration facts to remember:

- All routers representing a unique DLSw network share a common virtual LAN segment. In our case the segment number is AAA.
- The LAN interface of each router has to be enabled to allow bridging to take place.
- DLSw partners (the routers) communicate among each other using TCP/IP. Therefore, a specific IP address is required on each router for DLSw. In the case of the IBM 2210, it is necessary to define an additional internal IP address for DLSw.

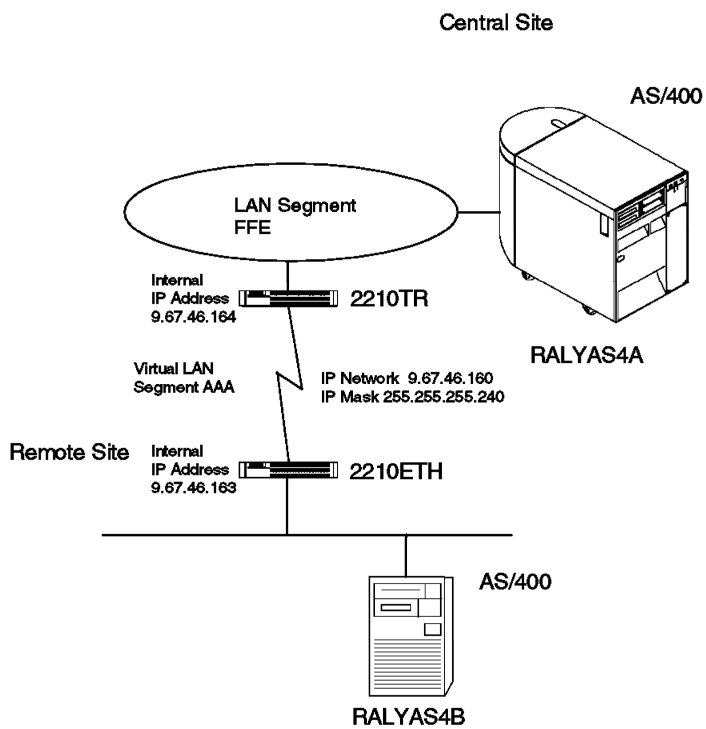


Figure 61. IBM 2210 Router Network, DLSw Part

To use the DLSw environment we established an AS/400 to AS/400 APPN connection.

The token-ring and Ethernet line descriptions were created in 9.2.1.1, "Token-Ring LAN Line Description" on page 97 and 9.2.2.1, "Ethernet LAN Line Description" on page 99.

The controller and device definitions on the target AS/400 system (RALYAS4A) were created automatically. We include the definitions for the source AS/400 system only (RALYAS4B). The CL command used to create the required APPC controller description is as follows:

```
CRTCTLAPPC CTLD(RALYAS4A) LINKTYPE(*LAN) SWTLINLST(L71ETH) +
    RMTCPNAME(RALYAS4A) ADPTADR(020008400080)
```

Please take note that we enter the MAC adapter address of the AS/400 system RALYAS4A in inverted form since we are communicating between token-ring and Ethernet LAN segments.

9.4 IPX Network

The router network is set up to route IPX via the following topology:

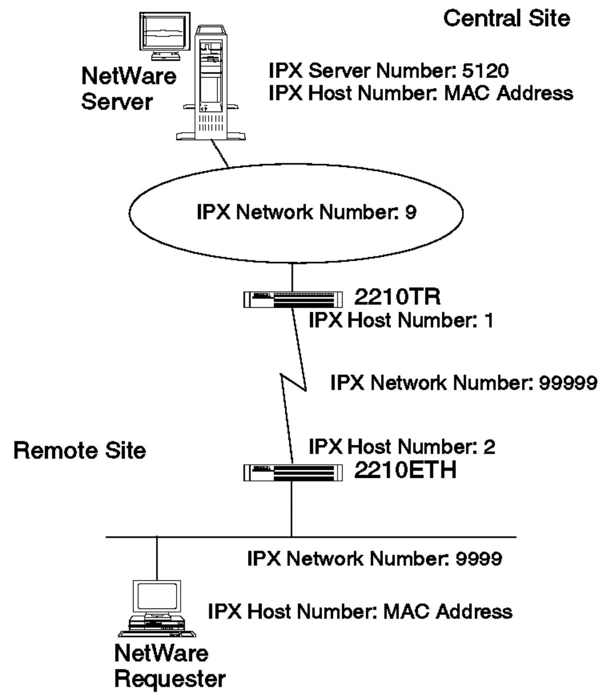


Figure 62. IBM 2210 Router Network, IPX Part

In this section we are not going to describe the configuration of the NetWare requester and server. These were the standard configurations. Nothing extra had to be added for this network. The router network was transparent to the NetWare users.

9.5 IBM 2210 Router Configuration

The following configurations of the 2210 routers were carried out using the ASCII console attached to the 2210. Many options are *prompted for* automatically by the router but not all are, so you need to be careful. For any command you can prompt for the options allowed using a ″?″ (question mark).

We used the Quick Configuration (QCONFIG) process to build the base 2210 configurations. These base configurations were then modified as necessary.

9.5.1 Token-Ring Attached IBM 2210 - 2210TR

The configuration of 2210TR is as follows:

The configuration task used is `6 Config`. The `Talk 6` command is used to access this task. This gives the `Config>` prompt. Refer to Figure 63 on page 105.

```
*Talk 6
Config> QCONFIG   Quick Configuration         1
Configure interfaces? > yes
Intf 0 is Token Ring
Speed in Mb/Sec (4,16) = [4] 4
Connector (STP, UTP) = [UTP] STP
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
This is all configured device information:
Intf 0 is Token Ring, Speed 4 Mb/sec, Connector STP
Intf 1 is WAN 1 with PPP Encapsulation, V.35 modem cable
Intf 2 is WAN 2 with PPP Encapsulation, V.35 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.24.104.178
Address mask : 255.255.255.0
Configuring Interface 1 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.162
Address mask : 255.255.255.240
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [no] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask
0             9.24.104.178    255.255.255.0
1             9.67.46.162     255.255.255.240
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Token-Ring encapsulation (frame) type? (TOKEN-RING MSB, TOKEN-RING LSB,
TOKEN-RING_SNAP MSB, TOKEN-RING_SNAP LSB) = [TOKEN-RING MSB] TOKEN-RING MSB
Network number (hex)  (0 - FFFFFFFF) [0] 9
Configuring Interface 1 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Network number (hex)  (0 - FFFFFFFF) [0] 99999
Enable IPXWAN (Yes, No) = [No] no
Configuring Interface 2 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] no
Configure IPXWAN NodeID? (Yes,No) = [Yes] no
This is the information you have entered:
Ifc  IPX Net (hex)  Encapsulation    IPXWAN
0    9              TOKEN-RING MSB   Not Configured
1    99999                           Not Configured
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 63. 2210 MRNS Quick Configuration - 2210TR

```
*Talk 6
Config> network 1
PPP config> set HDLC encoding NRZI
PPP config> list hdlc (to verify)
Maximum frame size in bytes = 2048
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: V.35 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
PPP config> exit
```

Figure 64. 2210 MRNS WAN Configuration - 2210TR

```
Config> prot ipx
IPX config> set host-number = 1
IPX config> enable interface 0
IPX config> enable interface 1
IPX config> exit
```

Figure 65. 2210 MRNS IPX Configuration - 2210TR

```
Config> prot ip
IP config> add route
IP destination (0.0.0.0)? (press enter to accept default)  3
Address mask (0.0.0.0)? (press enter to accept default)
Via gateway at (0.0.0.0)?  9.67.46.161
Cost (1)? (press enter to accept default)
IP config> list routes (to verify)
route to 0.0.0.0,0.0.0.0 via 9.67.46.161, cost 1
IP config> exit
```

Figure 66. 2210 MRNS IP Configuration - 2210TR

```
Config> prot ip
IP config> set internal-ip-address
Internal IP address [0.0.0.0] 9.67.46.164      4
IP config> exit

Config> prot asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config> enable bridge
ASRT config> enable source-routing
Port Number [1] (press enter to accept default)       5
Segment Number for the port in hex (1 - FFF) [1] FFE
ASRT config> enable fa-ga-mapping
ASRT config> enable dls
ASRT config> exit

Config> prot dls
DLSW config> enable dls
DLSW config> set srb
Enter segment number in hex (1-FFF) [0] AAA    6
DLSW config> add tcp
Enter the DLSw neighbor IP address [0.0.0.0] 9.67.46.163 (2210ETH internal
                                                                    IP address)
Transmit buffer size (decimal) [5120] (press enter to accept default)
Maximum segment size (decimal) [1024] (press enter to accept default)
Enable/disable keepalive (E/D) -(D)?  e         7
DLSW config> open-sap
Interface? [1] 0
Enter SAP in hex (range 0-FF) [0] 00
DLSW config> open-sap 0 04
DLSW config> open-sap 0 08
DLSW config> open-sap 0 0C
DLSW config> exit
```

Figure 67. 2210 MRNS DLSw Configuration - 2210TR

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No]): yes
```

For notes see page 110.

9.5.2 Ethernet-Attached IBM 2210 - 2210ETH

The configuration task used is 6 Config. The Talk 6 command is used to access this task. This gives the Config> prompt. Refer to Figure 68 on page 108.

```
*Talk 6
Config> QCONFIG   Quick Configuration        1
Configure interfaces? > yes
Intf 0 is Ethernet
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
This is all configured device information:
Intf 0 is Ethernet, Connector (10baseT, AUI) auto-configured
Intf 1 is WAN 1 with PPP Encapsulation, V.35 modem cable
Intf 2 is WAN 2 with PPP Encapsulation, V.35 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Ethernet)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.129
Address mask : 255.255.255.240
Configuring Interface 1 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.161
Address mask : 255.255.255.240
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask
0             9.67.46.129     255.255.255.240
1             9.67.46.161     255.255.255.240
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] yes
Configuring Interface 0 (Ethernet)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Ethernet encapsulation (frame) type? (ETHERNET_II, ETHERNET_SNAP,
ETHERNET_8022, ETHERNET_8023) = [ETHERNET_8023] ETHERNET_8023
Network number (hex)  (0 - FFFFFFFF) [0] 9999
Configuring Interface 1 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Network number (hex)  (0 - FFFFFFFF) [0] 99999
Enable IPXWAN (Yes, No) = [No] no
Configuring Interface 2 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] no
Configure IPXWAN NodeID? (Yes,No) = [Yes] no
This is the information you have entered:
Ifc  IPX Net (hex)  Encapsulation    IPXWAN
0    9999           ETHERNET_8023    Not Configured
1    99999                           Not Configured
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 68. 2210 MRNS Quick Configuration - 2210ETH

```
*Talk 6
Config> network 1
PPP config> set HDLC encoding NRZI
PPP config> list hdlc (to verify)
Maximum frame size in bytes = 2048
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: V.35 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
PPP config> exit
```

Figure 69. 2210 MRNS WAN Configuration - 2210ETH

```
Config> prot ipx
IPX config> set host-number = 2
IPX config> enable reply-to-get            2
Which interface (0)? 0
IPX config> enable interface 0
IPX config> enable interface 1
IPX config> exit
```

Figure 70. 2210 MRNS IPX Configuration - 2210ETH

```
Config> prot ip
IP config> add route
IP destination (0.0.0.0)? (press enter to accept default)  3
Address mask (0.0.0.0)? (press enter to accept default)
Via gateway at (0.0.0.0)?  9.67.46.162
Cost (1)? (press enter to accept default)
IP config> list routes (to verify)
route to 0.0.0.0,0.0.0.0 via 9.67.46.162, cost 1
IP config> exit
```

Figure 71. 2210 MRNS IP Configuration - 2210ETH

```
Config> prot ip
IP config> set internal-ip-address
Internal IP address [0.0.0.0] 9.67.46.163      4
IP config> exit

Config> prot asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config> enable bridge
ASRT config> enable transparent
Port Number [1] (press enter to accept default)
ASRT config> enable fa-ga-mapping
ASRT config> enable dls
ASRT config> exit

Config> prot dls
DLSW config> enable dls
DLSW config> set srb
Enter segment number in hex (1-FFF) [0] AAA    6
DLSW config> add tcp
Enter the DLSw neighbor IP address [0.0.0.0] 9.67.46.164 (2210TR internal
                                                                    IP address)
Transmit buffer size (decimal) [5120] (press enter to accept default)
Maximum segment size (decimal) [1024] (press enter to accept default)
Enable/disable keepalive (E/D) -(D)?  e          7
DLSW config> open-sap
Interface? [1] 0
Enter SAP in hex (range 0-FF) [0] 00
DLSW config> open-sap 0 04
DLSW config> open-sap 0 08
DLSW config> open-sap 0 0C
DLSW config> exit
```

Figure 72. 2210 MRNS DLSw Configuration - 2210ETH

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No]): yes
```

Notes:

1 When you power up a brand new IBM 2210 router, which has not been configured previously, you will automatically go into the QCONFIG program. This part of the configuration must always be done via the console.

2 *Enable reply-to-get* is done on the router in an IPX serverless LAN. This allows the router to respond to *get nearest server* requests, so the client can access servers in remote LANs.

3 A route with an IP destination and address mask of 0.0.0.0 defines a default route.

4 The 2210 uses a unique IP address for DLSw, not one of the addresses associated with its interfaces. We recommend that you choose an IP address that is valid for one of the subnets it belongs to. This is to avoid having to deal with routing for this address.

5 This is the port number/segment number. Port 1 is on interface 0 which is the token-ring interface. This segment number is the real segment number for the token-ring. The bridge number must be unique on the token-ring segment.

6 The segment number is the virtual segment number used by DLSw. Any two routers with a DLSw connection between them must use the same virtual segment number. It is easiest to use the same virtual segment number throughout the network for DLSw purposes.

7 We enabled *keep alive*, to force the router to poll the partner in the DLSw session every 10 seconds ensuring that the other end is still there. This can be useful for SNMP as a trap can be configured to report a partner dropping out of a session.

The following commands, which can be executed at the 2210 ASCII console, are very useful for checking the status of the configuration:

2210TR - Token-Ring Attached IBM 2210

```
*Talk 6
Config> prot dls
DLSw config> list tcp sessions
```

```
  Neighbor      Xmit Bufsize  Max Segsize  Keepalive
  9.67.46.163      5120         1024         ENABLED
```

```
DLSw config> exit
Ctrl P
* Talk 5
* prot dls
DLSw> list tcp sessions
```

```
Group  IP Address   Conn State   Pkts Sent  Pkts Rcvd  Bytes Sent  Bytes Rcvd
-----  ----------  ----------   ---------  ---------  ----------  ---------
1      9.67.46.163  ESTABLISHED  14984      12903       5429271    1450490
```

```
DLSw> list dls sessions all
```

```
 Source           Destination      State     Flags    Dest IP Addr   ID
 ------           -----------      -----     -----    ------------   --
400010020001 04   10005A5806B3 04  Connected          9.67.46.163    12
```

```
DLSw> exit
```

2210ETH - Ethernet Attached IBM 2210

```
*Talk 6
Config> prot dls
DLSw config> list tcp sessions
```

```
  Neighbor      Xmit Bufsize  Max Segsize  Keepalive
  9.67.46.164      5120          1024         ENABLED
```

```
DLSw config> exit
Ctrl P
* Talk 5
* prot dls
DLSw> list tcp sessions
```

```
Group  IP Address  Conn State   Pkts Sent  Pkts Rcvd  Bytes Sent  Bytes Rcvd
-----  ----------  ----------   ---------  ---------  ----------  ---------
1      9.67.46.164  ESTABLISHED  12584      15691       1441616    5618035
```

```
DLSw> list dls sessions all
```

```
 Source           Destination      State     Flags    Dest IP Addr    ID
 ------           -----------      -----     -----    ------------    --
10005A5806B3 04   400010020001 04  Connected          9.67.46.164     12
```

```
DLSw> exit
```

Note:

When using talk 5/talk 6, pressing Ctrl P will back you out of a task.

Chapter 10. IBM 6611 and IBM 2210s in a Router Network

The objectives of this scenario are as follows:

- To connect IBM 2210 routers to an IBM 6611 router
- To interconnect token-ring and Ethernet LANs
- To establish DLSw sessions between non-adjacent routers

This scenario reflects many real life situations where at remote sites a small router, like the IBM 2210, is installed and where at the central site a powerful router, like the IBM 6611, is located.

In the first section of this chapter, we look at an overview and the hardware and software involved. Following that, we review the network from the different views of the three protocols running across it. The three views we look at are as follows:

- TCP/IP network
- DLSw network to support SNA connections
- IPX network to allow NetWare requester to NetWare server traffic

The last section includes all the router definitions required.

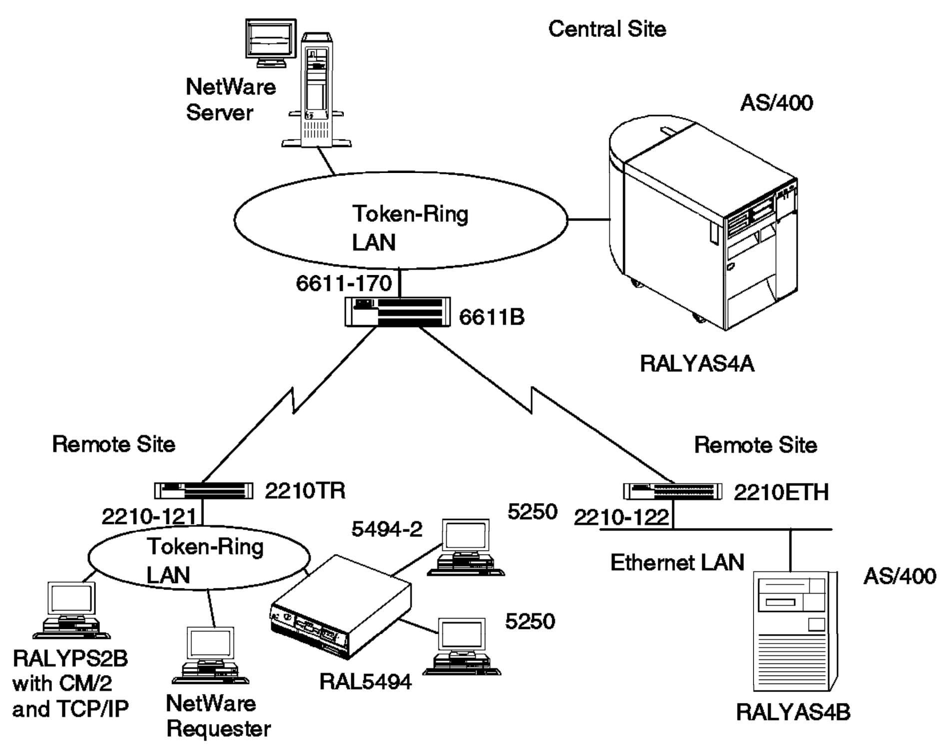


Figure 73. Mixed IBM 2210/6611 Environment, Overview

10.1 Hardware/Software Involved

- Routers
  - IBM 6611, Model 170, with MPNP V1R3
  - IBM 2210, Ethernet model, with MRNS V1R3
  - IBM 2210, token-ring model, with MRNS V1R3
- WAN Link between routers

  The speed of the two connections is 64 Kbps. We used IBM 5822-10 modems with V.35 interfaces.
- LAN Multi-Access Units
  - IBM 8228s to build the token-ring LAN segments
  - IBM 8224 to build the Ethernet LAN segment
- PS/2 Model 80
  - OS/2 V2.11
  - Communications Manager/2 V1.11
  - OS/2 TCP/IP V2.1
- NetWare requester and server
- IBM 5494 Remote Workstation Controller

  With microcode release 3.0

  Configured for token-ring upstream and twinax devices attached
- AS/400 Systems

  With OS/400 V3R1, OS/400 includes both SNA and TCP/IP support.

10.2 TCP/IP Network

The following figure shows the TCP/IP network layout as well as the IP network and host addresses involved.

The objective is for each TCP/IP host to be able to reach any other host included in this network.

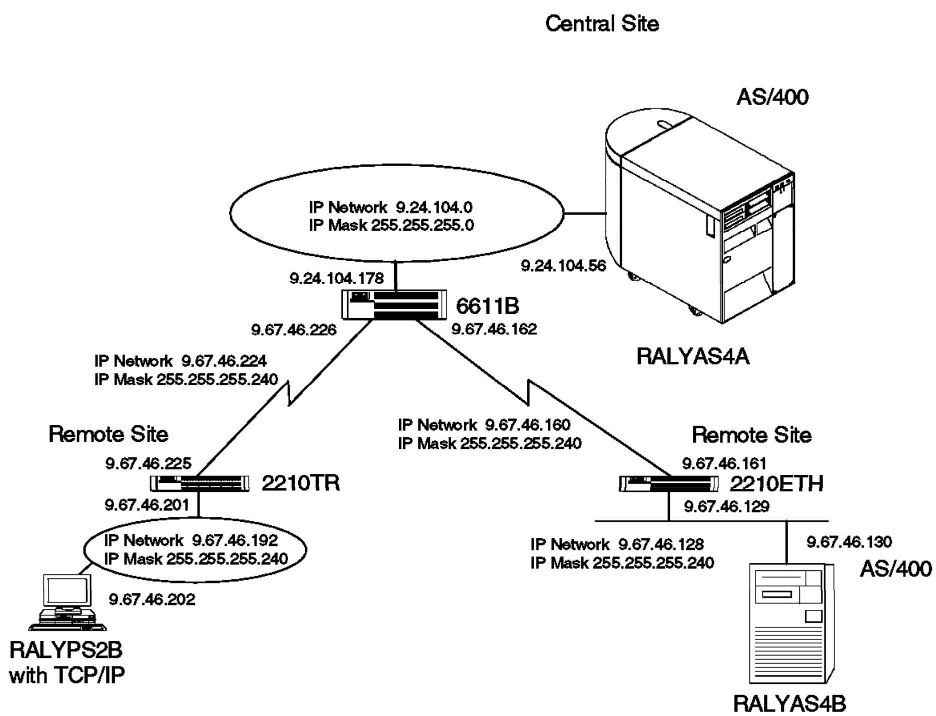


Figure 74. Mixed IBM 2210/6611 Environment, TCP/IP Part

10.2.1 OS/2 TCP/IP Definitions (RALYPS2B)

Select the **TCP/IP Configuration** icon to set the values for this OS/2-based TCP/IP host. The local interface IP address and a default route are the essential pieces of information to be entered.

```
Network
   Configure Network Interface Parameters
      Enable LAN Adapter:  0
      IP address:  9.67.46.202
      Subnet Mask:  255.255.255.240
      MTU:  1500

Routing
   Configure Routing Information
      Route Type:  DEFAULT
      Router:  9.67.46.201
```

Figure 75. OS/2 TCP/IP Definitions

10.2.2 AS/400 Definitions (RALYAS4A)

10.2.2.1 Token-Ring LAN Line Description

The following line description is used for SNA as well as for TCP/IP:

```
CRTLINTRN  LIND(L41TR) RSRCNAME(LIN041) LINESPEED(4M) MAXFRAME(1994) +
             ADPTADR(400010020001) TEXT('4M TR for RALYAS4A') +
             LINKSPEED(4M) AUTOCRTCTL(*YES)
```

10.2.2.2 TCP/IP Definitions

The TCP/IP Interface includes the IP address used by this AS/400 on a specified interface such as a token-ring LAN adapter. The *LOOPBACK entry is provided with the software. It is used to internally ping the AS/400.

```
                        Work with TCP/IP Interfaces
                                                           System:   RALYAS4A
 Type options, press Enter.
   1=Add   2=Change   4=Remove   5=Display   9=Start   10=End
      Internet         Subnet              Line      Line
 Opt  Address          Mask             Description  Type
      9.24.104.56      255.255.255.0    L41TR        *TRLAN
      127.0.0.1        255.0.0.0        *LOOPBACK    *NONE









                                                                       Bottom
 F3=Exit   F5=Refresh   F6=Print list   F10=Work with IP over SNA interfaces
 F11=Display interface status           F12=Cancel   F17=Top   F18=Bottom
```

Figure 76. AS/400 TCP/IP Interface - RALYAS4A

A TCP/IP Route entry helps to locate the next TCP/IP host (next hop) on the path to a target IP network. Looking from AS/400 RALYAS4A, all the destination IP networks are found via the IBM 6611-170 router, hence, a default route entry is sufficient.

For problem determination you might also want to ping the WAN-related IP addresses between the routers. In this example, the single default route entry will give access to this also.

```
                              Work with TCP/IP Routes
                                                                 System:   RALYAS4A
 Type options, press Enter.
   1=Add   2=Change   4=Remove   5=Display
                                                   Type
         Route               Subnet                of              Next
 Opt     Destination         Mask                  Service         Hop
         *DFTROUTE           *NONE                 *NORMAL         9.24.104.178

                                                                             Bottom
 F3=Exit      F5=Refresh   F6=Print list   F10=Work with IP over SNA routes
 F12=Cancel   F17=Top      F18=Bottom
```

Figure 77. AS/400 TCP/IP Route - RALYAS4A

10.2.3 AS/400 Definitions (RALYAS4B)

10.2.3.1 Ethernet LAN Line Description

The following line description is used for SNA as well as for TCP/IP:

```
CRTLINETH  LIND(L71ETH) RSRCNAME(LIN071) ADPTADR(08005A1A60CD) AUTOCRTCTL(*YES)
```

10.2.3.2 TCP/IP Definitions

The IP address of AS/400 RALYAS4B is 9.67.46.130 on the Ethernet LAN adapter.

```
                         Work with TCP/IP Interfaces
                                                          System:   RALYAS4B
Type options, press Enter.
  1=Add   2=Change   4=Remove   5=Display   9=Start   10=End
     Internet         Subnet             Line       Line
Opt  Address          Mask               Description  Type
     9.67.46.130      255.255.255.240  L71ETH       *ELAN
     127.0.0.1        255.0.0.0        *LOOPBACK    *NONE

                                                                      Bottom
F3=Exit   F5=Refresh   F6=Print list   F10=Work with IP over SNA interfaces
F11=Display interface status           F12=Cancel   F17=Top   F18=Bottom
```

Figure 78. AS/400 TCP/IP Interface - RALYAS4B

Since all destination IP networks can be reached via the Ethernet-attached IBM 2210 router, a default TCP/IP Route entry is sufficient.

```
                           Work with TCP/IP Routes
                                                          System:   RALYAS4B
Type options, press Enter.
  1=Add   2=Change   4=Remove   5=Display
                                                 Type
        Route               Subnet               of             Next
Opt     Destination         Mask                 Service        Hop
        *DFTROUTE           *NONE                *NORMAL        9.67.46.129

                                                                      Bottom
F3=Exit      F5=Refresh   F6=Print list   F10=Work with IP over SNA routes
F12=Cancel   F17=Top      F18=Bottom
```

Figure 79. AS/400 TCP/IP Route - RALYAS4B

10.3 The Data Link Switching (DLSw) Network

In our multiprotocol network we defined DLSw to support SNA traffic. To the SNA devices, like the AS/400 or the IBM 5494, the DLSw network is transparent as in a bridged LAN environment.

The following are a few important configuration facts to remember:

- All routers representing a unique DLSw network share a common virtual LAN segment. In our case the segment number AAA.
- The LAN interface of each router has to be enabled to allow bridging to take place.
- DLSw partners (the routers) communicate with each other using TCP/IP. Therefore, a specific IP address is required on each router for the purpose of DLSw. In the case of the IBM 6611, it is suggest to use the IP adapter address of the LAN adapter. On the IBM 2210 router, an internal IP address has to be assigned.

Canonical/non-canonical MAC addresses

When connecting SNA devices in a mixed LAN environment, meaning a token-ring to Ethernet LAN connection, the MAC addresses have to be inverted byte by byte.

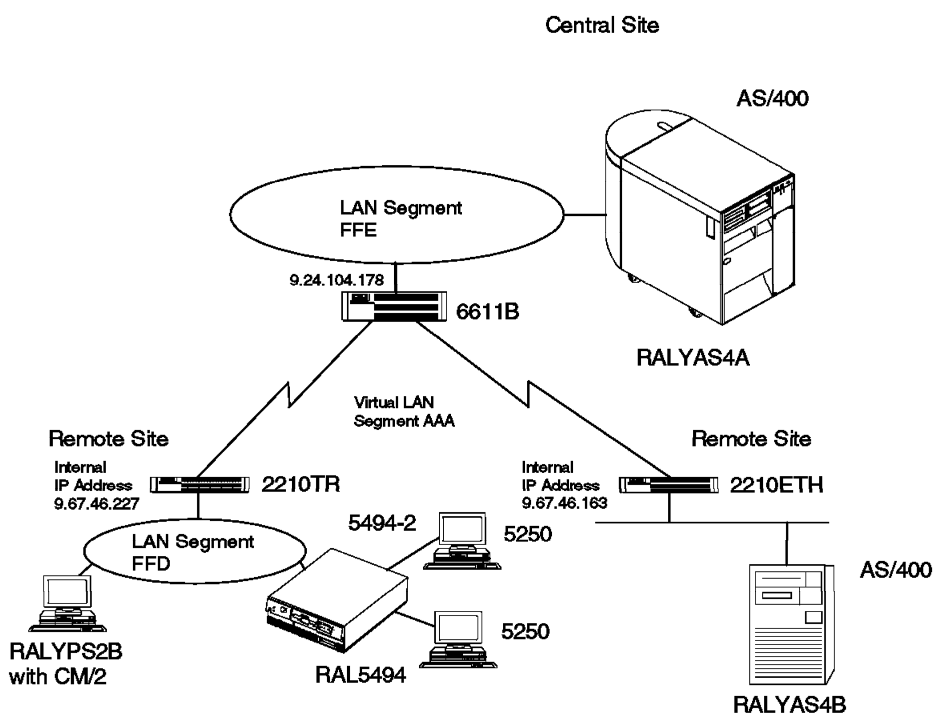


Figure 80. Mixed IBM 2210/6611 Environment, DLSw Part

We tested the following SNA connections:

- IBM 5494 to AS/400 RALYAS4A and RALYAS4B
- OS/2 Communications Manager to AS/400 RALYAS4A and RALYAS4B concurrently
- AS/400 RALYAS4A to AS/400 RALYAS4B

The definitions on the target AS/400 systems were created automatically. We do not include these definitions.

10.3.1 AS/400 Network Attributes and LAN MAC Addresses

To reach the two AS/400 systems, the following parameter values are needed to create the required definitions on the source devices:

	AS/400 RALYAS4A	AS/400 RALYAS4B
Local Network ID	USIBMRA	USIBMRA
Local Control Point Name	RALYAS4A	RALYAS4B
Default Local Location Name	RALYAS4A	RALYAS4B
APPN Node Type	NN	NN
LAN Adapter Type	Token-Ring	Ethernet
LAN Adapter MAC Address	400010020001	08005A1A60CD
LAN Adapter MAC Address, inverted	020008400080	10005A5806B3

10.3.2 IBM 5494 Definitions

We defined the IBM 5494 Remote Workstation controller to communicate with AS/400 RALYAS4A and then changed the IBM 5494 configuration to communicate with AS/400 RALYAS4B.

The base 5494 configuration shown in the following panel is used to communicate with both RALYAS4A and RALYAS4B.

```
          0       1       2       3       4       5       6
          --------------------------------------------------
    0/    00      00      00      00      00      00      00

    1/    00      00      00      00      00      00      00

    2/    00      00      00      00      00      00      00

    3/    00      00      00      00      00      00      00




  AA-► 4
  1-► 00 - -
  F-► 04   G-► 01    H-► 30    I-► 030    J-► 08
                                                        P-► - -
```

Figure 81. IBM 5494, Setup Panel, 1 of 2

These definitions are used to communicate with AS/400 RALYAS4A.

```
11-► USIBMRA   12-► RAL5494_  13-► RAL5494_  14-► QRMTWSC_
15-► 40005494E000___  16-► 010 06 1  17-► 00-00000  18-► ________


H1:1-► RALYAS4A  H1:2-► USIBMRA   H1:3-► USIBMRA   H1:4-► QRMTWSC
H1:5-► 400010020001________________________________________________
                 H1:7-► 04  H1:8-► 2   H1:9-► 1

H2:1-► ________  H2:2-► ________  H2:3-► ________  H2:4-► ________
H2:5-► ____________________________________________________________
                 H2:7-► __  H2:8-► _   H2:9-► _

H3:1-► ________  H3:2-► ________  H3:3-► ________  H3:4-► ________
H3:5-► ____________________________________________________________
                 H3:7-► __  H3:8-► _   H3:9-► _

H4:1-► ________  H4:2-► ________  H4:3-► ________  H1:4-► _______
H4:5-► ____________________________________________________________
                 H4:7-► __  H4:8-► _   H4:9-► _
```

Figure 82. IBM 5494 Setup Panel, 2 of 2 - Connecting to RALYAS4A

These definitions are used to communicate with AS/400 RALYAS4B which is Ethernet-attached. Please take note of the inverted MAC address.

```
11-► USIBMRA   12-► RAL5494_  13-► RAL5494_  14-► QRMTWSC_
15-► 40005494E000___  16-► 010 06 1  17-► 00-00000  18-► ________


H1:1-► RALYAS4B  H1:2-► USIBMRA   H1:3-► USIBMRA   H1:4-► QRMTWSC
H1:5-► 10005A5806B3________________________________________________
                 H1:7-► 04  H1:8-► 2   H1:9-► 1

H2:1-► ________  H2:2-► ________  H2:3-► ________  H2:4-► ________
H2:5-► ____________________________________________________________
                 H2:7-► __  H2:8-► _   H2:9-► _

H3:1-► ________  H3:2-► ________  H3:3-► ________  H3:4-► ________
H3:5-► ____________________________________________________________
                 H3:7-► __  H3:8-► _   H3:9-► _

H4:1-► ________  H4:2-► ________  H4:3-► ________  H1:4-► _______
H4:5-► ____________________________________________________________
                 H4:7-► __  H4:8-► _   H4:9-► _
```

Figure 83. IBM 5494 Setup Panel, 2 of 2 - Connecting to RALYAS4B

Table 16. IBM 5494 Configuration Parameters

Field /Subfield	Field Description	Value Selected	Value Description
AA	Communication Mode	4	Token-Ring
1	Keyboard Code	00	US English
F	Token-Ring SAP	04	1
G	Response Timer	01	1
H	Inactivity Timer	30	1
I	Acknowledge Timer	030	1
J	Retry Count	08	1
P	Configuration Printer		
11	Network ID of 5494	USIBMRA	
12	LU Name of 5494	RAL5494	
13	CP Name of 5494	RAL5494	
14	Mode Name	QRMTWSC	
15	5494 MAC Address	40005494E000	
16	Retry Parameters	010 06	1
17	5494 Serial Number		
18	5494 ID Number		
H1:1	AS/400 LU Name	RALYAS4A	
H1:2	AS/400 Network ID	USIBMRA	
H1:3	5494 Network ID	USIBMRA	
H1:4	Mode Name	QRMTWSC	
H1:5	AS/400 MAC Address	400010020001	
H1:7	Token-Ring SAP	04	1
H1:8	TR Max Out	2	1
H1:9	TR Max In	1	1

Note:

1 Default values accepted

10.3.3 OS/2 Communications Manager

To enter the required definitions proceed as follows:

1. Select the **Communications Manager/2** icon.
2. Select **Communications Manager Setup**.
3. Select **Setup** to create or modify the configuration.
4. Open an existing configuration file or type the name of a new configuration file (RALYPS2B in our case).
5. Select **Commonly Used Definitions**.
6. Select **5250 Emulation Through Token-Ring**.

```
DLC Profile
   (accept defaults)

SNA Local Node Characteristics
   Network ID         USIBMRA
   Local Node Name    RALYPS2B
   Node Type          End Node to Network Node Server
   Your Network Node  400010020001
   Local Node ID      default

SNA Connection
   LINK0001
       Adapter Type             Token-Ring
       Adapter Number           0
       LAN Destination Address  400010020001

   LINK0002
       Adapter Type             Token-Ring
       Adapter Number           0
       LAN Destination Address  10005A5806B3

SNA Features
       Partner LUs

         LU Name                USIBMRA.RALYAS4A
         Alias                  RALYAS4A

         LU Name                USIBMRA.RALYAS4B
         Alias                  RALYAS4B

5250 Emulation
       Session Name             A
       Partner LU Name          RALYAS4A

       Session Name             B
       Partner LU Name          RALYAS4B
```

Figure 84. CM/2 Definitions

10.3.4 AS/400 to AS/400

The objective was to build an APPN connection from the Ethernet LAN-attached AS/400 (RALYAS4B) to the token-ring LAN-attached AS/400 (RALYAS4A) via the multiprotocol router network.

The token-ring and Ethernet line descriptions were created in 10.2.2.1, "Token-Ring LAN Line Description" on page 116 and 10.2.3.1, "Ethernet LAN Line Description" on page 117.

It is sufficient to create an APPC controller description on the source AS/400 system. The CL command to create the required APPC controller description is as follows:

```
CRTCTLAPPC CTLD(RALYAS4A) LINKTYPE(*LAN) SWTLINLST(L71ETH) +
    RMTCPNAME(RALYAS4A) ADPTADR(020008400080)
```

10.3.5 Additional Considerations

The DLSw connection through the IBM 6611 is independent of the 6611 LAN connection. For example, if we unplugged the 6611 token-ring adapter cable, users attached to the IBM 5494 Remote Workstation Controller could still work with AS/400 RALYAS4B.

10.4 IPX Network

The router network is set up to route IPX via the following topology:

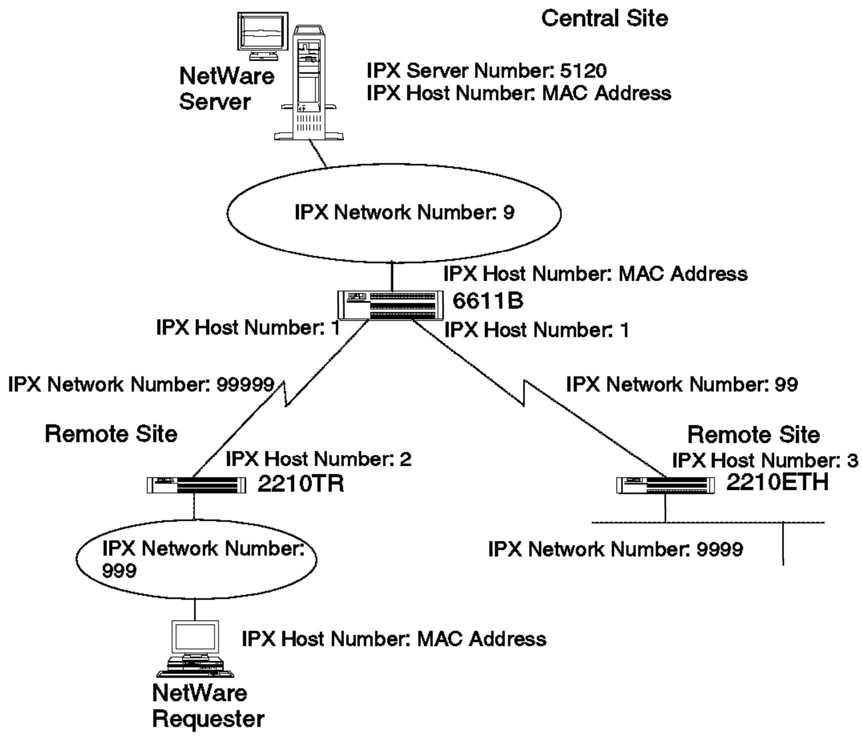


Figure 85. Mixed IBM 2210/6611 Environment, IPX Part

In this section we are not going to describe the configuration of the NetWare requester and server. These were the standard configurations. Nothing extra had to be added for this network. The router network was transparent to the NetWare users.

10.5 Router Definitions

It appears that configuring the IBM 2210 directly using an ASYNC terminal attached via V.24 port is easier than using the PC configuration utility.

In this chapter we document the 6611 parameters as well as showing step by step how we configured the 2210s.

10.5.1 IBM 6611 Router Configuration - 6611B

The 6611 was configured using OS/2 MPNP Configuration Program V1R3.0. We configured two WAN links to the 2210 routers and a token-ring LAN link as follows:

```
6611 Model 170

slot 1  Single port Token-Ring card
slot 2  2 port serial card
```

```
Interface Definition

   Slot 1, Port 0 - Token-Ring
        Physical Interface
            - Universally Administered Address
            - Mac Address Format : Non Canonical
            - Token-Ring data rate : 4 Mbps
            - Broadcast type : non-local
        Source Route Bridging
            - Enable Source Route Bridging on this port
            - Spanning tree mode : automatic
            - Ring Number : FFE
        IP
            - Enable IP routing on this port
            - IP address : 9.24.104.178
            - Subnet mask : 255.255.255.0
            - MTU : 1492
        IPX
            - Enable IPX routing on this port
            - IPX network number 00000009
        DLSw for SNA
            - Enable SNA frame forwarding on this port
            - 00 & 04 are default SAPs
              08 & 0C can be added for further SNA applications if
              required
```

Figure 86. 6611 MPNP Token-Ring Interface Definition - 6611B

```
Interface Definition

   Slot 2, Port 0 - Serial Port
        PPP is the serial link protocol
        Physical Interface
            - Serial line speed : 64000 bps
            - NRZI
            - Locally Administered MAC address (IPX) : 000000000001
                                                       (IPX host number)
            - Queue priority : defaults
        IP
            - Enable IP routing on this port
            - IP address : 9.67.46.226
            - Subnet mask : 255.255.255.240
            - Destination IP address : 9.67.46.225
            - MTU : 1500
        IPX
            - Enable IPX routing on this port
            - IPX network number : 00099999
```

Figure 87. 6611 MPNP Serial port 0 Interface Definition - 6611B

```
Interface Definition

   Slot 2, Port 1 - Serial Port
        PPP is the serial link protocol
        Physical Interface
            - serial line speed : 64000 bps
            - NRZI
            - Locally administered MAC address (IPX) : 000000000001
                                                       (IPX host number)
            - Queue priority : defaults
         IP
            - Enable IP routing on this port
            - IP address : 9.67.46.162
            - Subnet mask 255.255.255.240
            - Destination IP address : 9.67.46.161
            - MTU : 1500
         IPX
            - Enable IPX routing on this port
            - IPX network number : 00000099
```

Figure 88. 6611 MPNP Serial Port 1 Interface Definition - 6611B

```
Node Configuration

Bridging
     Source Route
         - Enable Source Route Bridging
         - Bridge number : 15
         - Designated ring number : FFE
DLSw
     Enable SNA DLSw
         - Virtual ring segment number : AAA
         - Default DLSw IP address : 9.24.104.178
         - DLSw Partners : 9.67.46.227 (2210TR internal IP address)
         -               : 9.67.46.163 (2210ETH internal IP address)
IPX
     Enable IPX router
Routing
     IP Static Routes
          - Specific
          - Destination address : 9.67.46.192 (the remote token-ring)
          - Destination mask : 255.255.255.240
          - Next hop : 9.67.46.225

          - Specific
          - Destination address : 9.67.46.128 (the remote Ethernet)
          - Destination mask : 255.255.255.240
          - Next hop : 9.67.46.161

          - Specific
          - Destination address : 9.67.46.160 (WAN network)    1
          - Destination mask : 255.255.255.240
          - Next hop : 9.67.46.161

          - Specific
          - Destination address : 9.67.46.224 (WAN network)    1
          - Destination mask : 255.255.255.240
          - Next hop : 9.67.46.225
```

Figure 89. 6611 MPNP Node Definition - 6611B

```
Node Management

IBM 6611 host name : 6611B
```

Figure 90. 6611 MPNP Node Management Definition - 6611B

To refresh the 6611 configuration via a diskette using the 6611 console do as follows:

```
login IBM6611C
password IBM6611C

main menu : select Configuration
Receive and apply configuration
Import method : DOS diskette
```

Note:

1 These static routes are for the 2210 internal IP addresses used for DLSw.

10.6 IBM 2210 Router Configuration

The following configurations of the 2210 routers were carried out using the ASCII console attached to the 2210. Many options are *prompted for* automatically by the router but not all are, so you need to be careful. For any command you can prompt for the options allowed using a "?" (question mark).

We used the Quick Configuration (QCONFIG) process to build the base 2210 configurations. These base configurations were then modified as necessary.

10.6.1 Token-Ring Attached IBM 2210 - 2210TR

The configuration of 2210TR is as follows:

The configuration task used is `6 Config`. The `Talk 6` command is used to access this task. This gives the `Config>` prompt. Refer to Figure 91 on page 130.

```
*Talk 6
Config> QCONFIG   Quick Configuration         1
Configure interfaces? > yes
Intf 0 is Token Ring
Speed in Mb/Sec (4,16) = [4] 4
Connector (STP, UTP) = [UTP] STP
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
This is all configured device information:
Intf 0 is Token Ring, Speed 4 Mb/sec, Connector STP
Intf 1 is WAN 1 with PPP Encapsulation, V.35 modem cable
Intf 2 is WAN 2 with PPP Encapsulation, V.35 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.201
Address mask : 255.255.255.240
Configuring Interface 1 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.225
Address mask : 255.255.255.240
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [no] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask
0             9.67.46.201     255.255.255.240
1             9.67.46.225     255.255.255.240
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Token-Ring encapsulation (frame) type? (TOKEN-RING MSB, TOKEN-RING LSB,
TOKEN-RING_SNAP MSB, TOKEN-RING_SNAP LSB) = [TOKEN-RING MSB] TOKEN-RING MSB
Network number (hex)  (0 - FFFFFFFF) [0] 999
Configuring Interface 1 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Network number (hex)  (0 - FFFFFFFF) [0] 99999
Enable IPXWAN (Yes, No) = [No] no
Configuring Interface 2 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] no
Configure IPXWAN NodeID? (Yes,No) = [Yes] no
This is the information you have entered:
Ifc  IPX Net (hex)  Encapsulation    IPXWAN
0    999            TOKEN-RING MSB   Not Configured
1    99999                           Not Configured
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 91. 2210 MRNS Quick Configuration - 2210TR

```
*Talk 6
Config> network 1
PPP config> set HDLC encoding NRZI
PPP config> list hdlc (to verify)
Maximum frame size in bytes = 2048
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: V.35 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
PPP config> exit
```

Figure 92. 2210 MRNS WAN Configuration - 2210TR

```
Config> prot ipx
IPX config> set host-number = 2
IPX config> enable reply-to-get           2
Which interface (0)? 0
IPX config> enable interface 0
IPX config> enable interface 1
IPX config> exit
```

Figure 93. 2210 MRNS IPX Configuration - 2210TR

```
Config> prot ip
IP config> add route
IP destination (0.0.0.0)? (press enter to accept default)  3
Address mask (0.0.0.0)? (press enter to accept default)
Via gateway at (0.0.0.0)?  9.67.46.226
Cost (1)? (press enter to accept default)
IP config> list routes (to verify)
route to 0.0.0.0,0.0.0.0 via 9.67.46.226, cost 1
IP config> exit
```

Figure 94. 2210 MRNS IP Configuration - 2210TR

```
Config> prot ip
IP config> set internal-ip-address
Internal IP address [0.0.0.0] 9.67.46.227      4
IP config> exit

Config> prot asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config> enable bridge
ASRT config> enable source-routing
Port Number [1] (press enter to accept default)       5
Segment Number for the port in hex (1 - FFF) [1] FFD
ASRT config> enable fa-ga-mapping
ASRT config> enable dls
ASRT config> exit

Config> prot dls
DLSW config> enable dls
DLSW config> set srb
Enter segment number in hex (1-FFF) [0] AAA    6
DLSW config> add tcp
Enter the DLSw neighbor IP address [0.0.0.0] 9.24.104.178 (6611 IP address)
Transmit buffer size (decimal) [5120] (press enter to accept default)
Maximum segment size (decimal) [1024] (press enter to accept default)
Enable/disable keepalive (E/D) -(D)?  e          7
DLSW config> add tcp
Enter the DLSw neighbor IP address [0.0.0.0] 9.67.46.163 (2210ETH internal
                                                                    IP address)
Transmit buffer size (decimal) [5120] (press enter to accept default)
Maximum segment size (decimal) [1024] (press enter to accept default)
Enable/disable keepalive (E/D) -(D)?  e          7
DLSW config> open-sap
Interface? [1] 0
Enter SAP in hex (range 0-FF) [0] 00
DLSW config> open-sap 0 04
DLSW config> open-sap 0 08
DLSW config> open-sap 0 0C
DLSW config> exit
```

Figure 95. 2210 MRNS DLSw Configuration - 2210TR

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No]): yes
```

For notes see page 135.

10.6.2 Ethernet-Attached IBM 2210 - 2210ETH

The configuration task used is 6 Config. The Talk 6 command is used to access this task. This gives the Config> prompt. Refer to Figure 96 on page 133.

```
*Talk 6
Config> QCONFIG   Quick Configuration         1
Configure interfaces? > yes
Intf 0 is Ethernet
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
This is all configured device information:
Intf 0 is Ethernet, Connector (10baseT, AUI) auto-configured
Intf 1 is WAN 1 with PPP Encapsulation, V.35 modem cable
Intf 2 is WAN 2 with PPP Encapsulation, V.35 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Ethernet)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.129
Address mask : 255.255.255.240
Configuring Interface 1 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.161
Address mask : 255.255.255.240
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask
0             9.67.46.129     255.255.255.240
1             9.67.46.161     255.255.255.240
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] yes
Configuring Interface 0 (Ethernet)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Ethernet encapsulation (frame) type? (ETHERNET_II, ETHERNET_SNAP,
ETHERNET_8022, ETHERNET_8023) = [ETHERNET_8023] ETHERNET_8023
Network number (hex)  (0 - FFFFFFFF) [0] 9999
Configuring Interface 1 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Network number (hex)  (0 - FFFFFFFF) [0] 99
Enable IPXWAN (Yes, No) = [No] no
Configuring Interface 2 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] no
Configure IPXWAN NodeID? (Yes,No) = [Yes] no
This is the information you have entered:
Ifc  IPX Net (hex)  Encapsulation    IPXWAN
0    9999           ETHERNET_8023    Not Configured
1    99                              Not Configured
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 96. 2210 MRNS Quick Configuration - 2210ETH

```
*Talk 6
Config> network 1
PPP config> set HDLC encoding NRZI
PPP config> list hdlc (to verify)
Maximum frame size in bytes = 2048
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: V.35 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
PPP config> exit
```

Figure 97. 2210 MRNS WAN Configuration - 2210ETH

```
Config> prot ipx
IPX config> set host-number = 3
IPX config> enable interface 0
IPX config> enable interface 1
IPX config> exit
```

Figure 98. 2210 MRNS IPX Configuration - 2210ETH

```
Config> prot ip
IP config> add route
IP destination (0.0.0.0)? (press enter to accept default)  3
Address mask (0.0.0.0)? (press enter to accept default)
Via gateway at (0.0.0.0)?  9.67.46.162
Cost (1)? (press enter to accept default)
IP config> list routes (to verify)
route to 0.0.0.0,0.0.0.0 via 9.67.46.162, cost 1
IP config> exit
```

Figure 99. 2210 MRNS IP Configuration - 2210ETH

```
Config> prot ip
IP config> set internal-ip-address
Internal IP address [0.0.0.0] 9.67.46.163      4
IP config> exit

Config> prot asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config> enable bridge
ASRT config> enable transparent
Port Number [1] (press enter to accept default)
ASRT config> enable fa-ga-mapping
ASRT config> enable dls
ASRT config> exit

Config> prot dls
DLSW config> enable dls
DLSW config> set srb
Enter segment number in hex (1-FFF) [0] AAA    6
DLSW config> add tcp
Enter the DLSw neighbor IP address [0.0.0.0] 9.24.104.178 (6611 IP address)
Transmit buffer size (decimal) [5120] (press enter to accept default)
Maximum segment size (decimal) [1024] (press enter to accept default)
Enable/disable keepalive (E/D) -(D)?  e         7
DLSW config> add tcp
Enter the DLSw neighbor IP address [0.0.0.0] 9.67.46.227 (2210TR internal
                                                                  IP address)
Transmit buffer size (decimal) [5120] (press enter to accept default)
Maximum segment size (decimal) [1024] (press enter to accept default)
Enable/disable keepalive (E/D) -(D)?  e         7
DLSW config> open-sap
Interface? [1] 0
Enter SAP in hex (range 0-FF) [0] 00
DLSW config> open-sap 0 04
DLSW config> open-sap 0 08
DLSW config> open-sap 0 0C
DLSW config> exit
```

Figure 100. 2210 MRNS DLSw Configuration - 2210ETH

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No]): yes
```

Notes:

1 When you power up a brand new IBM 2210 router, which has not been configured previously, you will automatically go into the QCONFIG program. This part of the configuration must always be done via the console.

2 *Enable reply-to-get* is done on the router in an IPX serverless LAN. This allows the router to respond to *get nearest server* requests, so the client can access servers in remote LANs.

3 A route with an IP destination and address mask of 0.0.0.0 defines a default route.

4 The 2210 uses a unique IP address for DLSw, not one of the addresses associated with its interfaces. We recommend that you choose an IP address that is valid for one of the subnets it belongs to. This is to avoid having to deal with routing for this address.

5 This is the port number/segment number. Port 1 is on interface 0 which is the token-ring interface. This segment number is the real segment number for the token-ring. The bridge number must be unique on the token-ring segment.

6 The segment number is the virtual segment number used by DLSw. Any two routers with a DLSw connection between them must use the same virtual segment number. It is easiest to use the same virtual segment number throughout the network for DLSw purposes.

7 We enabled *keep alive*, to force the router to poll the partner in the DLSw session every 10 seconds ensuring that the other end is still there. This can be useful for SNMP as a trap can be configured to report a partner dropping out of a session.

Chapter 11. IBM 6611s as APPN Network Nodes

The use of IBM 6611 routers as APPN network nodes can offer many advantages as follows:

- Distributed network nodes may improve performance.
- The end nodes′ control sessions need not cross the multiprotocol network.
- Using an IBM 6611 as an APPN network node ″concentrator″ can lead to a reduction in the number of AS/400 controller descriptions required.
- The path of SNA sessions via the multiprotocol network can be selected based on APPN mechanisms.
- IBM 6611 network nodes provide rerouting capabilities. See 11.6.4, “APPN Rerouting Scenario” on page 153 for an example.

Today the APPN traffic between the IBM 6611 routers uses either DLSw or TCP/IP connections. In the future, routers will use High Performance Routing (HPR) to transport APPN session data.

The objectives of this scenario are as follows:

- To interconnect two token-ring LAN segments via IBM 6611 routers
- To connect the two IBM 6611 routers using a WAN link
- To define the IBM 6611 routers as APPN network nodes
- To allow AS/400 and Client Access/400 to use this APPN network

Figure 101 on page 138 provides an overview of the IBM 6611 multiprotocol router network we established. We defined the two IBM 6611 routers as APPN network nodes. AS/400 RALYAS4A is an APPN network node and AS/400 RALYAS4B is an APPN end node. Client Access/400 for Windows is a LEN node.

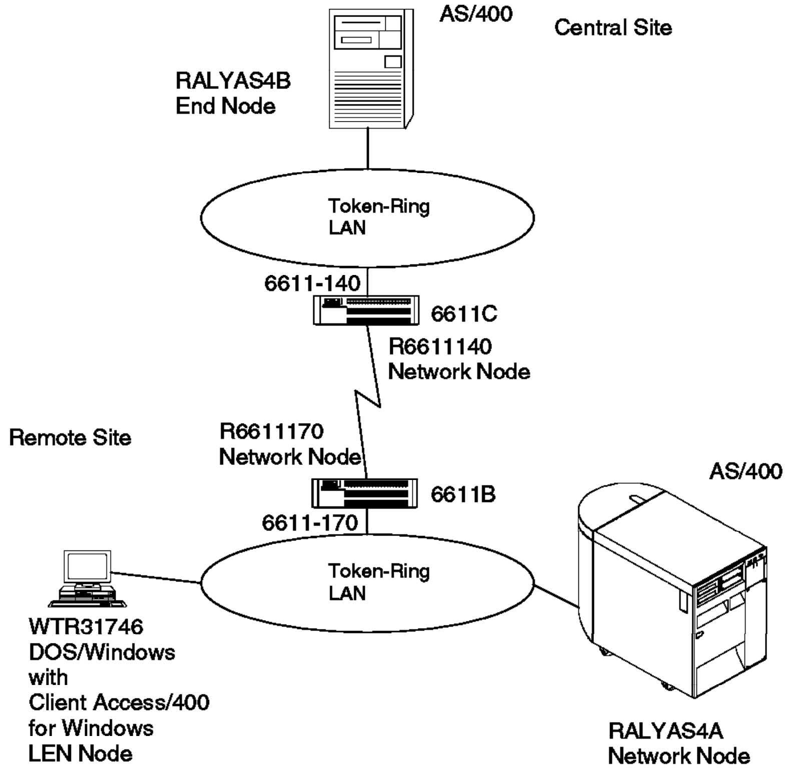


Figure 101. IBM 6611 Routers as APPN Network Nodes

This chapter includes the required definitions for the following involved devices:

- The AS/400 systems
- Client Access/400 for Windows
- IBM 6611 routers

11.1 Hardware/Software Involved

- Routers
  - IBM 6611, Model 170, with MPNP V1R3
  - IBM 6611, Model 140, with MPNP V1R3
- WAN Link between routers

  The speed of the connection is 64 Kbps. We used IBM 5822-10 modems with V.35 interfaces.
- LAN Multi-Access Units
  - IBM 8228s to build token-ring LAN segments
- PS/2 Model 80
  - IBM DOS 6.1

  - MS Windows 3.1
  - Client Access/400 V3R1
- AS/400 Systems
  - With OS/400 V3R1, OS/400 includes SNA/APPN support

11.2 AS/400 Definitions (RALYAS4A)

AS/400 system RALYAS4A is configured as an APPN network node. Its control point and its default local location (LU) name is RALYAS4A. Figure 102 shows the network attributes from this system.

```
                          Display Network Attributes
                                                           System:   RALYAS4A
 Current system name . . . . . . . . . . . . . . :   RALYAS4A
   Pending system name  . . . . . . . . . . . . . :
 Local network ID . . . . . . . . . . . . . . . . :   USIBMRA
 Local control point name . . . . . . . . . . . . :   RALYAS4A
 Default local location . . . . . . . . . . . . . :   RALYAS4A
 Default mode . . . . . . . . . . . . . . . . . . :   BLANK
 APPN node type . . . . . . . . . . . . . . . . . :   *NETNODE
 Data compression . . . . . . . . . . . . . . . . :   *NONE
 Intermediate data compression  . . . . . . . . . :   *NONE
 Maximum number of intermediate sessions  . . . . :   200
 Route addition resistance  . . . . . . . . . . . :   128
 Server network ID/control point name . . . . . . :   *LCLNETID   *ANY
                                                                   More...
 Press Enter to continue.
 F3=Exit   F12=Cancel
```

Figure 102. AS/400 RALYAS4A, Network Attributes

A token-ring LAN line description is needed to describe the AS/400 LAN adapter as follows:

```
CRTLINTRN  LIND(L41TR) RSRCNAME(LIN041) LINESPEED(4M) +
              ADPTADR(400010020001)
```

An APPC controller description describes the adjacent IBM 6611-170 router as an APPN network node as follows:

```
CRTCTLAPPC CTLD(R6611170) LINKTYPE(*LAN) SWTLINLST(L41TR) +
              RMTCPNAME(R6611170) ADPTADR(400006611170) +
              NODETYPE(*NETNODE)
```

11.3 AS/400 Definitions (RALYAS4B)

AS/400 system RALYAS4B is configured as an APPN end node. Its control point and its default local location (LU) name is RALYAS4B. Figure 103 on page 140 shows the network attributes from this system.

```
                        Display Network Attributes
                                                             System:   RALYAS4B
 Current system name  . . . . . . . . . . . . . . :   RALYAS4B
   Pending system name  . . . . . . . . . . . . . :
 Local network ID . . . . . . . . . . . . . . . . :   USIBMRA
 Local control point name . . . . . . . . . . . . :   RALYAS4B
 Default local location . . . . . . . . . . . . . :   RALYAS4B
 Default mode . . . . . . . . . . . . . . . . . . :   BLANK
 APPN node type . . . . . . . . . . . . . . . . . :   *ENDNODE
 Data compression . . . . . . . . . . . . . . . . :   *NONE
 Intermediate data compression  . . . . . . . . . :   *NONE
 Maximum number of intermediate sessions  . . . . :   200
 Route addition resistance  . . . . . . . . . . . :   128
 Server network ID/control point name . . . . . . :   *LCLNETID   *ANY
                                                                   More...
 Press Enter to continue.
 F3=Exit   F12=Cancel
```

Figure 103. AS/400 RALYAS4B, Network Attributes

A token-ring LAN line description is needed to describe the AS/400 LAN adapter as follows:

```
CRTLINTRN  LIND(L31TR) RSRCNAME(LIN031) LINESPEED(4M) +
              ADPTADR(400010020002)
```

An APPC controller description describes the adjacent IBM 6611-140 router as an APPN network node as follows:

```
CRTCTLAPPC CTLD(R6611140) LINKTYPE(*LAN) SWTLINLST(L31TR) +
              RMTCPNAME(R6611140) ADPTADR(400006611140) +
              NODETYPE(*NETNODE)
```

11.4 Network Activation and Usage

The two IBM 6611 routers are the backbone of our APPN network. When activating and using the network for the first time it is essential that you observe the auto-creation of the configuration objects and the establishment of sessions for possible problem determination.

The APPC controller descriptions are sufficient to describe the links from the two AS/400 systems to the IBM 6611 routers. AS/400 system RALYAS4A and the two IBM 6611 routers are network nodes and represent the APPN network. As soon as they are connected, CP-CP sessions will be established to maintain the network topology.

AS/400 system RALYAS4B will establish CP-CP sessions with its adjacent network node and register itself with the network node.

With the activation of the APPC controller descriptions, the APPC device descriptions are created automatically. On AS/400 RALYAS4A for IBM 6611 router R6611170 this is the APPC device R6611170 attached to the APPC controller R6611170. As shown following:

```
CRTDEVAPPC DEVD(R6611170) RMTLOCNAME(R6611170) LCLLOCNAME(RALYAS4A) +
              CTL(R6611170) TEXT('AUTOMATICALLY CREATED BY QLUS')
```

On AS/400 RALYAS4B for IBM 6611 router R6611140 this is the APPC device R6611140 attached to the APPC controller R6611140. As shown following:

```
CRTDEVAPPC DEVD(R6611140) RMTLOCNAME(R6611140) LCLLOCNAME(RALYAS4B) +
              CTL(R6611140) TEXT('AUTOMATICALLY CREATED BY QLUS')
```

The CP-CP sessions are essential. Check whether these sessions are established. If yes, your APPN network is set up correctly. Use the command DSPMODSTS to check the conversation and sessions status.

On AS/400 RALYAS4A we entered the following command:

```
DSPMODSTS R6611170
```

```
                              Display Mode Status
                                                             System:   RALYAS4A
 Device  . . . . . . . . . :   R6611170
 Device status . . . . . . :   ACTIVE
 Type options, press Enter.
   5=Display details
             Mode             --Sessions--
 Opt  Mode      Status           Total  Local
      SNASVCMG  Started             0      0
      CPSVCMG   Started             2      1




                                                                        Bottom
 F3=Exit   F5=Refresh   F11=Display conversations   F12=Cancel
```

Figure 104. Display Mode Status, IBM 6611-170 as APPN Network Node

On AS/400 RALYAS4B we entered the following command:

```
DSPMODSTS R6611140
```

```
                              Display Mode Status
                                                             System:   RALYAS4B
 Device  . . . . . . . . . :   R6611140
 Device status . . . . . . :   ACTIVE
 Type options, press Enter.
   5=Display details
             Mode             --Sessions--
 Opt  Mode      Status           Total  Local
      SNASVCMG  Started             0      0
      CPSVCMG   Started             2      1




                                                                        Bottom
 F3=Exit   F5=Refresh   F11=Display conversations   F12=Cancel
```

Figure 105. Display Mode Status, IBM 6611-140 as APPN Network Node

As soon as the APPN network is activated, the users may request sessions from any node to any node in the network. No further manual configuration is required.

Let us look at an example. A user on AS/400 system RALYAS4A requests a 5250 passthrough session with AS/400 system RALYAS4B. The user enters the following:

```
STRPASTHR RALYAS4B
```

The first time a user requests a session between these two systems, APPC device descriptions are created automatically on both AS/400 systems.

The device description on RALYAS4A is as follows:

```
CRTDEVAPPC DEVD(RALYAS4B) RMTLOCNAME(RALYAS4B) LCLLOCNAME(RALYAS4A) +
             CTL(R6611170) TEXT('AUTOMATICALLY CREATED BY QLUS')
```

The device description on RALYAS4B is as follows:

```
CRTDEVAPPC DEVD(RALYAS4A) RMTLOCNAME(RALYAS4A) LCLLOCNAME(RALYAS4B) +
            CTL(R6611140) TEXT('AUTOMATICALLY CREATED BY QLUS')
```

The CL command DSPAPPNINF allows us to display the session parameters of successful sessions. For example, enter the following:

```
DSPAPPNINF INFTYPE(*SSN)
```

Select both a session and the option to display the APPN route chosen for a specific session. Figure 106 shows the route of a user session from AS/400 RALYAS4A to RALYAS4B via the IBM routers acting as APPN network nodes.

```
                                Display Route
                                                         System:   RALYAS4B
 PCID . . . . . . . . . . . . . . :   F64B0D2BCCCD299D
   Control point  . . . . . . . . :     RALYAS4A
   Network ID . . . . . . . . . . :     USIBMRA
         Control      Network        TG
 Hop     Point        ID            Number
   1     R6611170     USIBMRA          1
   2     R6611140     USIBMRA          0
   3     RALYAS4B     USIBMRA          1


                                                                     Bottom
 Press Enter to continue.
 F3=Exit   F6=Print information   F12=Cancel
```

Figure 106. Display APPN Information, Display Route

11.5 Client Access/400 for Windows

Client Access/400 for Windows appears as an LEN node. This is transparent to the user. However, since it is a LEN node, this node has to be configured manually on the IBM 6611 as an adjacent LEN node.

Note that no router-specific definitions are required with Client Access/400 for Windows. Basically we attach via a non-AS/400 network node to the target AS/400. We only defined the MAC address of the adjacent router. The remote system is the AS/400 with which we intended to communicate.

To configure Client Access/400 for Windows, proceed as follows:

1. In Program Manager select **Client Access/400 for Windows**.
2. In Client Access/400 select **Configuration**.
3. In Client Access Configuration select **Systems**.

```
System─Configuration
  Add Connection Information
    System Name            RALYAS4B
    LAN Address            400006611170

      Connection User ID
      empty

      Optional Parameters
      empty

      Advanced Options
      defaults

  Connection─Information
      Global Options
      defaults

  Common Options
    Connection Type      LAN
    PC Location Name     WTR31746
    PC Network ID        USIBMRA

      Advanced Options
      defaults
```

Figure 107. Client Access/400 for Windows, Network Definitions

Upon reaching the target AS/400, an APPC device description for the PC is created automatically.

```
CRTDEVAPPC DEVD(WTR31746) RMTLOCNAME(WTR31746) LCLLOCNAME(RALYAS4B) +
         CTL(R6611140) TEXT('AUTOMATICALLY CREATED BY QLUS')
```

Depending on the functions configured and active between the PC and the AS/400, you will observe different session numbers. However, you should see at least one session started with mode SNASVCMG.

```
                               Display Mode Status
                                                              System:   RALYAS4B
 Device  . . . . . . . . . :   WTR31746
 Device status . . . . . . :   ACTIVE
 Type options, press Enter.
   5=Display details
              Mode               --Sessions--
 Opt  Mode      Status           Total  Local
      SNASVCMG  Started             1      0
      QPCSUPP   Started             2      0




                                                                          Bottom
 F3=Exit   F5=Refresh   F11=Display conversations   F12=Cancel
```

Figure 108. Display Mode Status, Client Access/400 via APPN Network

AS/400 APPN Information shows the path of a session from Client Access/400 via the IBM 6611 routers to the target AS/400. It clearly documents that the IBM 6611 routers are acting as intermediate APPN network nodes.

```
                                  Display Route
                                                              System:   RALYAS4B
 PCID . . . . . . . . . . . . . . :   C4D52BEE6EFA02A7
   Control point  . . . . . . . . :     WTR31746
   Network ID . . . . . . . . . . :     USIBMRA
         Control      Network        TG
 Hop     Point        ID           Number
   1     R6611170     USIBMRA         0
   2     R6611140     USIBMRA         0
   3     RALYAS4B     USIBMRA         1



                                                                          Bottom
 Press Enter to continue.
 F3=Exit   F6=Print information   F12=Cancel
```

Figure 109. Display APPN Information, Display Route

11.6 Router Definitions

The configuration of the routers in this scenario is based on the configuration used in Chapter 8. To this configuration we added the APPN configuration which you will see included below. The APPN session traffic can be carried between the routers either via DLSw over IP or directly via IP. We chose the latter to put traffic straight over IP. The reason for this is that remote DLSw is an extra layer, and we felt performance would be better via direct IP. You still need local DLSw on the LAN adapters for bridging the SNA traffic on and off the LAN; that is for talking to adjacent nodes other than an IBM 6611.

The IBM 6611 configuration for 6611B and 6611C were created using the OS/2 MPNP Configuration Program V1R3.0. The definitions of 6611C and 6611B are shown below.

11.6.1 IBM 6611 Router Configuration - 6611C

The configuration of 6611C is as follows:

```
6611 Model 140

slot 1  2 port Token Ring card
slot 2  single port serial card
```

```
Interface Definition

   Slot 1, Port 0 - Token Ring
        Physical Interface
            - Universally Administered Address
            - Mac Address Format : Non Canonical
            - Token Ring data rate : 4 Mbps
            - Broadcast type : non-local
        Source Route Bridging
            - Enable Source Route Bridging on this port
            - Spanning tree mode : automatic
            - Ring Number : FFD
        IP
            - Enable IP routing on this port
            - IP address : 9.67.46.201
            - Subnet mask : 255.255.255.240
            - MTU : 1492
        IPX
            - Enable IPX routing on this port
            - IPX network number 00000999
        DLSw for SNA
            - Enable SNA frame forwarding on this port
            - 00 & 04 are default SAPs
              08 & 0C can be added for further SNA applications if
              required
        DLSw for NetBIOS
            - NetBIOS frames           (click to enable)
            - NetBIOS Datagram and Datagram Broadcast Messages  (enable)
```

Figure 110. 6611 MPNP Token-Ring Interface Definition - 6611C

```
Interface Definition

   Slot 2, Port 0 - Serial Port
        PPP is the serial link protocol
        Physical Interface
            - Serial line speed : 64000 bps
            - NRZI
            - Locally Administered MAC address (IPX) : 000000000002
                                                       (IPX host number)
            - Queue priority : defaults
        IP
            - Enable IP routing on this port
            - IP address : 9.67.46.225
            - Subnet mask : 255.255.255.240
            - Destination IP address : 9.67.46.226
            - MTU : 1500
        IPX
            - Enable IPX routing on this port
            - IPX network number : 00000099
```

Figure 111. 6611 MPNP Serial Port Interface Definition - 6611C

```
Node Configuration

Bridging
     Source Route
         - Enable Source Route Bridging
         - Bridge number : 1
         - Designated ring number : FFD
DLSw
     Enable SNA DLSw
     Enable NetBIOS DLSw
         - Virtual ring segment number : AAA
         - Default DLSw IP address : 9.67.46.201
         - DLSw Partners : 9.24.104.178
IPX
     Enable IPX router
Routing
     IP Static Routes
         - Default
         - Next hop : 9.67.46.226
APPN
     Enable APPN
     Network Id : USIBMRA
     Control Point Name : R6611140

     DLSw Information for this Node
         -  Locally administered MAC address : 400006611140   1
         -  SAP address : 04

     Adjacent Node Definition
         -  Accept connection requests from any node
         IP Adjacent Nodes
         -  Link Station Name   R6611170
         -  IP address   9.24.104.178   (6611 partner - R6611170)
         -  Activate link automatically
         -  Fully qualified Control Point name   USIBMRA.R6611170

     Node Tuning
         Tuning options default values are:
           Max. number of APPN Network Nodes  5
           Max. number of serviced End and Len nodes  50
           Avg. number of LUs for serviced nodes  1
         Tuning Table default is:        3
           Balanced Adjustment  max shared memory 4MB  max cached entries 200
```

Figure 112. 6611 MPNP Node Definition - 6611C

```
Node Management

IBM 6611 host name : R6611140
```

Figure 113. 6611 MPNP Node Management Definition - 6611C

11.6.2 IBM 6611 Router Configuration - 6611B

The configuration of 6611B is as follows:

```
6611 Model 170

slot 1  Single port Token Ring card
slot 2  2 port serial card
```

```
Interface Definition

   Slot 1, Port 0 - Token Ring
        Physical Interface
            - Universally Administered Address
            - Mac Address Format : Non Canonical
            - Token Ring data rate : 4 Mbps
            - Broadcast type : non-local
        Source Route Bridging
            - Enable Source Route Bridging on this port
            - Spanning tree mode : automatic
            - Ring Number : FFE
        IP
            - Enable IP routing on this port
            - IP address : 9.24.104.178
            - Subnet mask : 255.255.255.0
            - MTU : 1492
        IPX
            - Enable IPX routing on this port
            - IPX network number 00000009
        DLSw for SNA
            - Enable SNA frame forwarding on this port
            - 00 & 04 are default SAPs
              08 & 0C can be added for further SNA applications if
              required
        DLSw for NetBIOS
            - NetBIOS frames           (click to enable)
            - NetBIOS Datagram and Datagram Broadcast Messages  (enable)
```

Figure 114. 6611 MPNP Token-Ring Interface Definition - 6611B

```
Interface Definition

   Slot 2, Port 0 - Serial Port
        PPP is the serial link protocol
        Physical Interface
            - Serial line speed : 64000 bps
            - NRZI
            - Locally Administered MAC address (IPX) : 000000000001
                                                       (IPX host number)
            - Queue priority : defaults
        IP
            - Enable IP routing on this port
            - IP address : 9.67.46.226
            - Subnet mask : 255.255.255.240
            - Destination IP address : 9.67.46.225
            - MTU : 1500
        IPX
            - Enable IPX routing on this port
            - IPX network number : 00000099
```

Figure 115. 6611 MPNP Serial Port Interface Definition - 6611B

```
Node Configuration

Bridging
     Source Route
         - Enable Source Route Bridging
         - Bridge number : 15
         - Designated ring number : FFE
DLSw
     Enable SNA DLSw
     Enable NetBIOS DLSw
         - Virtual ring segment number : AAA
         - Default DLSw IP address : 9.24.104.178
         - DLSw Partners : 9.67.46.201
IPX
     Enable IPX router
Routing
     IP Static Routes
         - Default
         - Next hop : 9.67.46.225

APPN
     Enable APPN
     Network Id : USIBMRA
     Control Point Name : R6611170

     DLSw Information for this Node
         - Locally administered MAC address : 400006611170    1
         - SAP address : 04

     Adjacent Node Definition
         - Accept connection requests from any node
         DLSw adjacent nodes                        2
         - Link station name   WTR31746    (Client Access/400 PC)
         - MAC address   400031741996
         - SAP address   04
         - Activate link automatically
         - Adjacent Node type:  LEN node
         - Fully qualified control point name   USIBMRA.WTR31746

     IP Adjacent Nodes
         - Link Station Name   R6611140
         - IP address   9.67.46.201   (6611 partner - R6611140)
         - Activate link automatically
         - Fully qualified Control Point name   USIBMRA.R6611140

     Node Tuning
         Tuning options default values are:
           Max. number of APPN Network Nodes  5
           Max. number of serviced End and LEN nodes  50
           Avg. number of LUs for serviced nodes  1
         Tuning Table default is:          3
           Balanced Adjustment  max shared memory 4MB  max cached entries 200
```

Figure 116. 6611 MPNP Node Definition - 6611B

```
Node Management

IBM 6611 host name : R6611170
```

Figure 117. 6611 MPNP Node Management Definition - 6611B

NOTES:

1 The locally administered MAC address for APPN is an additional address on the LAN adapter, which the 6611 listens on for APPN traffic. It must be unique. For everything else we used the burned-in MAC address, as we did not define a MAC address in the interface definition.

2 DLSw adjacent nodes are APPN nodes on the local LAN which talk to the router via local DLSw. We had to preconfigure this for our CA/400 Windows PC. The PC is an end node with no CP-CP session, which in effect makes it a LEN node. The router requires that LEN nodes are preconfigured for local DLSw. This is why we added the configuration on router R6611170.

3 It is recommended that you do not change the tuning table default of Balanced Adjustment. You may need to change some of the other tuning defaults such as the maximum number of APPN network nodes (depending on how many nodes are on your local LAN).

11.6.3 Additional Information about 6611 APPN

The following information should be taken into consideration when planning to use the IBM 6611 APPN support.

11.6.3.1 Supplied APPN Mode Descriptions on the IBM 6611

The supplied Mode descriptions and Class of Service (COS) descriptions are shown in the following table:

Table 17. 6611 Standard APPN COS and Mode Definitions

COS	Mode(s)	Transmission Priority
#BATCH	• #BATCH	Low
#BATCHSC	• #BATCHSC	Low
#CONNECT	• #CONNECT • BLANK • QPCSUPP • IBMRDB	Medium
#INTER	• #INTER	High
#INTERSC	• #INTERSC	High
#CPSVCMG	• CPSVCMG	Network
#SNASVCMG	• SNASVCMG	Network

For an explanation of Class of Service and Modes and how they are used, refer to either of the following: *APPN Architecture and Product Implementation*, GG24-3669 or *AS/400 APPN Problem Management*, GG24-4222. The Mode defines which COS to use to select a route for an LU 6.2 session.

On the 6611, the COS descriptions/tables are held in COS files. You can view the contents of a file for a specific COS; you can set the minimum and maximum values for the user-defined TG characteristics and you can add a mode name to a COS file. You do these via fast path commands. See the 6611 manual *6611*

MPNP V1R3 Operations and Problem Management, SC31-6692 for more details on these commands.

Being able to add a non-architected mode name to a COS file gives you the flexibility to use User-Defined Modes. You may already have user-defined modes on your AS/400, which you want to continue using across the multiprotocol router network.

By modifying the user-defined characteristics for a Transmission Group, you can weight certain links from a 6611 against others. This way you can influence APPN route selection where more than one possible path is available from the 6611 to the destination node. The user-defined fields are equivalent to the user-defined Parameters in the AS/400 LIND and CTLD.

You can also retrieve a 6611 COS file and edit it via a standard text editor. However, it is recommended that you use the fast path commands, which can be included in an executable file of RSH commands (Remote Shell). For consistency it is recommended that you make similar changes to the same COS on all the 6611s in your network.

11.6.3.2 TCP/IP Ports Used by APPN on the IBM 6611

If you route APPN between the 6611s via DLSw, then it opens a TCP connection for this traffic. This connection stays established all the time and uses reserved ports 2065 and 2067. If your APPN traffic is over IP then all the traffic flows on reserved port 6611.

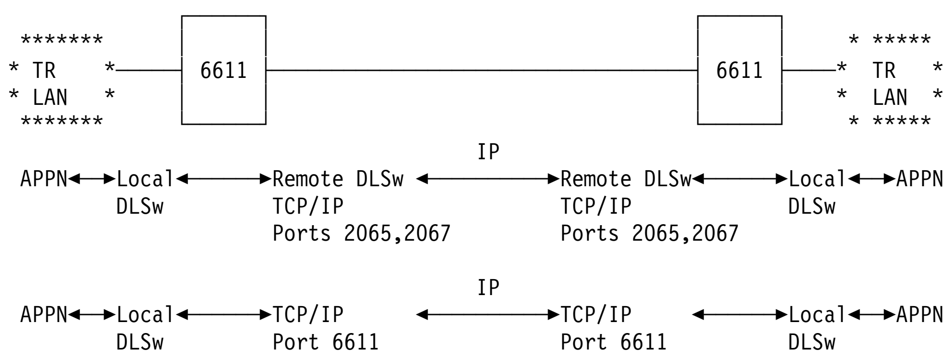


Figure 118. TCP/IP Ports Used by APPN on the IBM 6611

11.6.4 APPN Rerouting Scenario

This scenario is a simple example of where implementing APPN on the 6611 routers can be a real advantage.

We configured APPN across the IBM 6611 router network (in Figure 119) and were able to use APPN rerouting based on Location Name (LU) to reroute to the backup AS/400 B when there was a problem with the primary system AS/400 A.

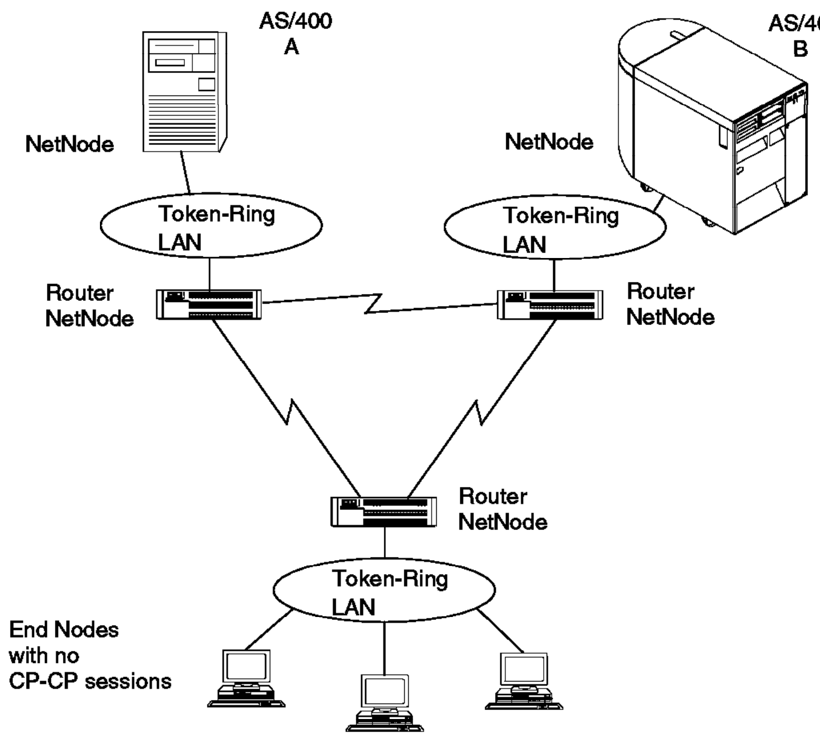


Figure 119. APPN Rerouting Scenario

In our scenario, the PCs are at one remote site and sign on to AS/400 A at the primary site where they run their main business application (Order Entry). They have a local location name of OE on AS/400 A and the PC user's session is with local location (LU) OE. AS/400 B is a backup system for AS/400 A, where the Order Entry database is continuously kept in synch with the active system. It may be at the same site on the same LAN and sharing the same 6611 or at a remote site, connected via a 6611.

If AS/400 A should fail or the Order Entry application should have some critical problem, the location name for this application OE, can be moved to the APPN local location list on AS/400 B, and the 6611 Network Node will reroute the PCs to the new destination for OE. Thus, AS/400 B takes over the running of Order Entry with minimal disturbance to the end users.

Chapter 12. IBM 2210s and IBM 5X94 in a Router Network

The environment documented in this chapter is based on the example described in Chapter 9, "IBM 2210s in a Router Network" on page 95, which has the same LAN and router structure.

The objectives of this scenario are as follows:

- To attach an IBM 5394 Remote Workstation Controller via SDLC to an IBM 2210 router
- To use DLSw to send the IBM 5394 data to the central LAN and to the AS/400

Figure 120 shows our simple router network that links a token-ring LAN with an Ethernet LAN over a wide-area connection. We implemented TCP/IP, SNA via DLSw and IPX across this router network.

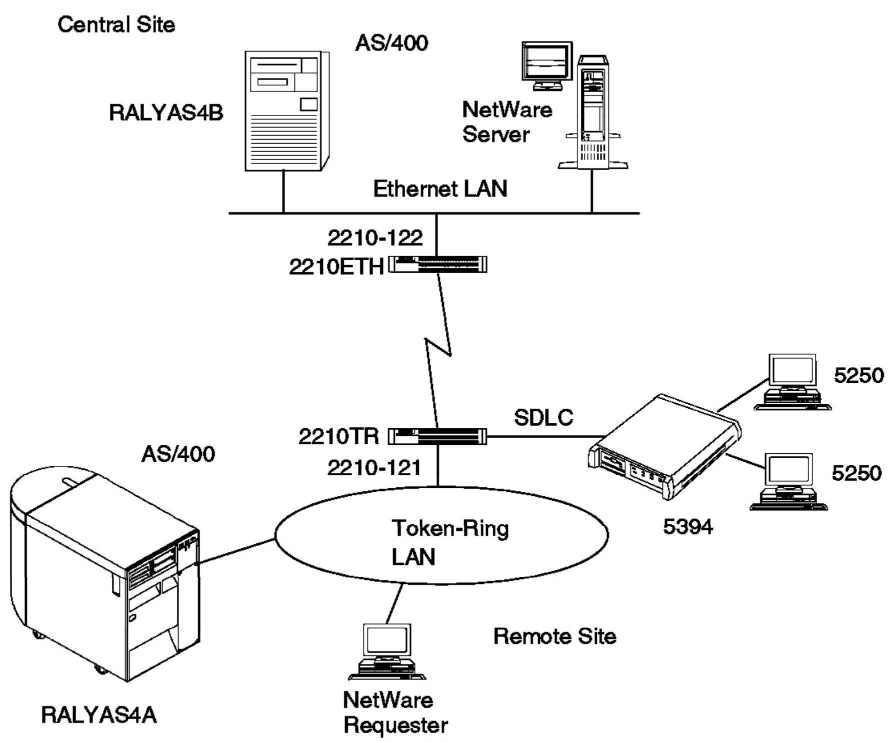


Figure 120. Overview of IBM 5394 within an IBM 2210 Router Network

Often remote sites are equipped with IBM 5X94 Remote Workstation Controllers without LAN attachment. See Figure 1 on page 3 for an example. When migrating to a multiprotocol router environment it may not be appropriate or possible to enhance the IBM 5X94 to a LAN-attached downstream controller. The SDLC support of the IBM routers allows you to integrate your current equipment easily.

The IBM 5X94 is SDLC-attached via a WAN link. Locally, you accomplish this by using a modem eliminator or modems. Instead of modems for local usage, you can order a DCE cable for the IBM 2210 router and define clocking internal to the router.

Attaching an IBM 5494 Remote Workstation Controller instead of an IBM 5394 requires almost the same configuration. If you are about to configure an IBM 5494 environment, follow our IBM 5394 example. We included the few differences as notes.

Please note that the IBM 6611 router supports DLSw for SDLC-attached devices as well. An IBM 3174 can be attach to an AS/400 via DLSw as well.

We structured this chapter as following:

- Overview of the router network configuration
- TCP/IP network, base for DLSw
- DLWs network to support the IBM 5394 SNA connection
- IPX network to support Novell requester/server
- IBM 2210 router definitions

The connections configured and tested are:

- TCP/IP between the two AS/400 systems
- IBM 5394 to AS/400 RALYAS4B, SNA using DLSw
- SNA between the two AS/400 Systems using DLSw

12.1.1 Hardware/Software Involved

- Routers
  - IBM 2210, Model 121, with MRNS V1R2
  - IBM 2210, Model 122, with MRNS V1R2
- WAN Link between routers

  The speed of the connection is 64 Kbps. We used IBM 5822-10 modems with V.35 interfaces.
- LAN Multi-Access Units
  - IBM 8228 to build the token-ring LAN segment
  - IBM 8224 to build the Ethernet LAN segment
- NetWare requester and server
- IBM 5394 Remote Workstation Controller
  - IBM 5394-01B
  - V.24 modem attachment cable
  - IBM 5812-1 base band modems, 19200 bps, to the IBM 2210 router
  - IBM 5394 Remote Control Unit T2.1 Node Support RPQ 8Q0775 (Release 2.3)
- AS/400 Systems

  With OS/400 V3R1, OS/400 includes SNA and TCP/IP support

Note: When you order an IBM 2210 from IBM, you can, at the same time, order RPQ 8Q1566 with it, which is actually RPQ 8Q0775 for the IBM 5394 but at a lower cost.

12.2 TCP/IP Network

Figure 121 shows the TCP/IP network layout as well as the IP network and host addresses involved.

This network is the prerequisite for DLSw, but it allows the two AS/400 systems to communicate using TCP/IP as well.

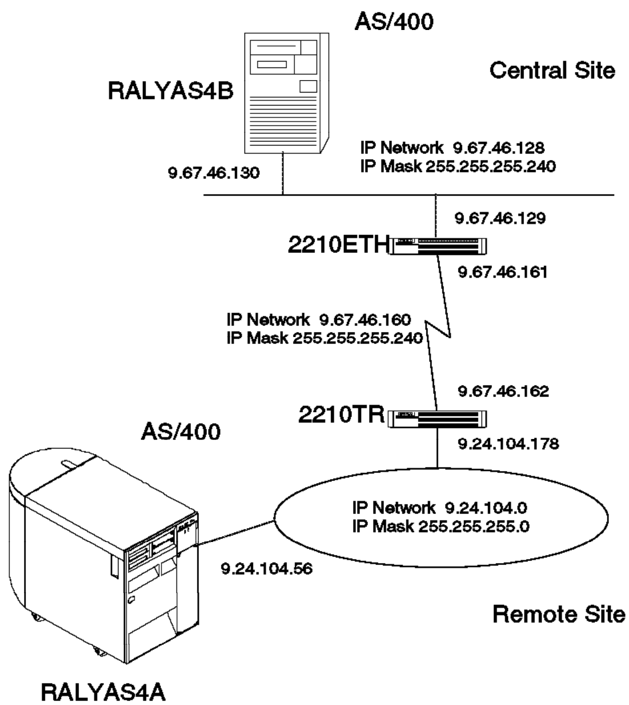


Figure 121. IBM 5394 within an IBM 2210 Router Network, TCP/IP Part

Please see the required AS/400 TCP/IP definitions in Chapter 9, “IBM 2210s in a Router Network” on page 95.

12.3 The Data Link Switching (DLSw) Network

We configured DLSw to support SNA traffic, such as the connection between the IBM 5394 and the AS/400 RALYAS4B. The DLSw network is transparent as it would be in a bridged LAN environment. SNA devices address each other using the LAN adapter MAC address. The IBM 5394 will appear to the AS/400 as if it is LAN-attached.

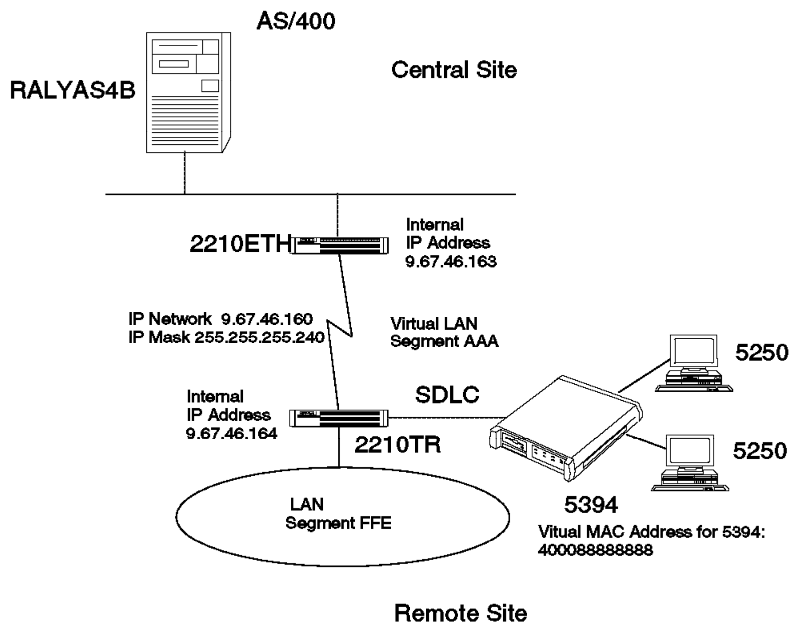


Figure 122. IBM 5394 within an IBM 2210 Router Network, DLSw Part

The router-specific definitions required to attach an SDLC device like the IBM 5394 Remote Workstation Controller are as follows:

- Definitions to describe the connection to the IBM 5394 and the SDLC characteristics of the IBM 5394
- A virtual MAC address to make the AS/400 believe that the IBM 5394 is LAN-attached

See 12.5, "IBM 2210 Router Configuration" on page 167 for more information on the router definitions.

In this section we will look at the configuration required on the IBM 5X94 and its corresponding definitions on the AS/400.

12.3.1 IBM 5394 Definitions

The IBM 5394 configuration for T2.1 support is as shown in the following panels:

```
            0       1       2       3       4       5       6
          ____________________________________________________
     0/     D       .       .       .       .       .       .

     1/     .       .       .       .       .       .       .

     2/     .       .       .       .       .       .       .




  AA─► 0  BB─► 2  CC─► 03-12898
  1─► 00      2─► 01   3─► 0 1 1 0 0 0 0      8─► 3C 0
                                         10─► 0A 06
                                                       P─► _ _
```

Figure 123. IBM 5394 T2.1 Setup Panel, 1 of 2

```
  11─► USIBMRA    12─►LU5394     13─►PU5394     14─►QRMTWSC_
  15─► USIBMRA    16─►RALYAS4B

                                                       P─► _ _
```

Figure 124. IBM 5394 T2.1 Setup Panel, 2 of 2

Table 18 shows the IBM 5394 T2.1 configuration values selected and a description of those values.

Table 18 (Page 1 of 2). IBM 5394 T2.1 Configuration Parameters

Field /Subfield	Field Description	Value Selected	Value Description
AA	Communication Mode	0	SDLC leased
BB	Operation Mode	2	LEN node
CC	Serial Number	03-12898	
1	Keyboard Code	00	US English
2	SDLC Station Address	01	**1**
3/1	reserved		

Table 18 (Page 2 of 2). IBM 5394 T2.1 Configuration Parameters			
Field /Subfield	**Field Description**	**Value Selected**	**Value Description**
3/2	Modem Mode	1	full-duplex **2**
3/3	Link Type	1	point-to-point
3/4	NRZ/NRZI	0	NRZI
3/5	Pin 20	0	DTR
3/6	Leading Pad	0	No leading pad
3/7	Local Loopback	0	no loopback
8	reserved		
10	Retries	0A 06	**3**
P	Configuration Printer		
11	Network ID of 5394	USIBMRA	
12	LU Name of 5394	LU5394	
13	CP Name of 5394	PU5394	
14	Mode Name	QRMTWSC	
15	Network ID of AS/400	USIBMRA	
16	LU Name of AS/400	RALYAS4B	

Notes:

1 Use SDLC station address ″01″. ″C1″ did not work.

2 IBM 2210 router supports full duplex only.

3 Accept the default values.

12.3.2 AS/400 Definitions for the IBM 5394

The following definitions are required on the target AS/400 RALYAS4B: An Ethernet LAN line, an APPC controller, an APPC device, a RWS controller and the DSP/PRT device descriptions.

There are no 5394-specific parameters to be entered for the Ethernet LAN line description.

```
CRTLINETH  LIND(L71ETH) RSRCNAME(LIN071) ADPTADR(08005A1A60CD) AUTOCRTCTL(*YES)
```

In a case where you attach an IBM 5X94 via a LAN to an AS/400, no further manual configuration is normally required, however, for this scenario our experience leads us to suggest that it is better to pre-create an APPC controller description for the IBM 5394. The reason for this, is that the IBM 2210 router pretends that the IBM 5394 is LAN-attached and, when automatically creating the APPC controller description, the AS/400 selects a frame size that is too large for an SDLC connection which results in a communications failure.

The manually created APPC controller and auto-created APPC device descriptions are as follows:

```
CRTCTLAPPC CTLD(CRWS5394) LINKTYPE(*LAN) SWTLINLST(L71ETH) +
   MAXFRAME(576) RMTCPNAME(PU5394) ADPTADR(020011111111) + 1
   CPSSN(*NO) NODETYPE(*LENNODE)

CRTDEVAPPC DEVD(LU5394) RMTLOCNAME(LU5394) +
   LCLLOCNAME(RALYAS4B) CTL(CRWS5394) +
   TEXT('AUTOMATICALLY CREATED BY QLUS')
```

The auto-created RWS controller and device descriptions are as follows:

```
CRTCTLAPPC CTLD(LU539RMT) TYPE(5394) MODEL(2) +
   LINKTYPE(*NONE) RMTLOCNAME(LU5394) LCLLOCNAME(RALYAS4B) +
   TEXT('CREATED BY AUTO-CONFIGURATION')

CRTDEVDSP DEVD(LU53DSP00) DEVCLS(*RMT) TYPE(3477) MODEL(FC) +
   LOCADDR(00) CTL(LU539RMT) +
   TEXT('CREATED BY AUTO-CONFIGURATION')
```

Note:

> **1** The 5394 virtual LAN connection is to a token-ring LAN, whereas RALYAS4B is connected to an Ethernet LAN. The MAC address must therefore be inverted.

12.3.3 IBM 5494 Definitions

Attaching the IBM 5494 instead of the IBM 5394 Remote Workstation Controller requires only a few changes:

- The IBM 2210 router has to include the IBM 5494 exchange ID, which is made up of ID block (x′073′) and ID number.
- The incoming IBM 5494 is recognized by its MAC address defined in the APPC controller description. Use a different virtual MAC address for the IBM 5494, or delete and recreate the AS/400 controller and device descriptions.
- You need a different RWS controller description for the IBM 5494.

The IBM 5494 configuration is as shown in the following panels:

```
          0        1        2        3        4        5        6
          ----------------------------------------------------------
    0/    00       00       00       00       00       00       00

    1/    00       00       00       00       00       00       00

    2/    00       00       00       00       00       00       00

    3/    00       00       00       00       00       00       00





 AA─► 0                              DD─► 0
 1─► 00 - -   2─► 01   3─► 0 1 1 0 0 0 0   8─► 060

                                                       P─► - -
```

Figure 125. IBM 5494 Setup Panel, 1 of 2

```
 11─► USIBMRA   12─► RAL5494_  13─► RAL5494_  14─► QRMTWSC_
 15─► _______________  16─► 010 06 1  17─► 00-00000  18─► ________
 19-> *____

 H1:1─► RALYAS4B  H1:2─► USIBMRA   H1:3─► USIBMRA   H1:4─► QRMTWSC
 H1:5─► ____________________________________________________________
                  H1:7─► 04  H1:8─► 2   H1:9─► 1

 H2:1─► ________  H2:2─► ________  H2:3─► ________  H2:4─► ________
 H2:5─► ____________________________________________________________
                  H2:7─► __   H2:8─► _   H2:9─► _

 H3:1─► ________  H3:2─► ________  H3:3─► ________  H3:4─► ________
 H3:5─► ____________________________________________________________
                  H3:7─► __   H3:8─► _   H3:9─► _

 H4:1─► ________  H4:2─► ________  H4:3─► ________  H1:4─► _______
 H4:5─► ____________________________________________________________
                  H4:7─► __   H4:8─► _   H4:9─► _
```

Figure 126. IBM 5494 Setup Panel, 2 of 2

Table 19 on page 164 shows the IBM 5494 T2.1 configuration values selected and a description of those values.

Table 19. IBM 5494 Configuration Parameters

Field /Subfield	Field Description	Value Selected	Value Description
AA	Communication Mode	0	SDLC leased
DD	LAN Gateway	0	none
1	Keyboard Code	00	US English
2	SDLC Station Address	01	**1**
3/1	Line Type	0	leased
3/2	Line Facility	1	full-duplex **2**
3/3	Connection Type	1	point-to-point
3/4	Data Encoding	0	NRZI
3/5	Connection Mode	0	DTR
3/6	Send Leading Pad	0	no
3/7	Local Loopback	0	no
8	V.25 bis Time-Out		
P	Configuration Printer		
11	Network ID of 5494	USIBMRA	
12	LU Name of 5494	RAL5494	
13	CP Name of 5494	RAL5494	
14	Mode Name	QRMTWSC	
15	5494 Connection Number		
16	Retry Parameters		**3**
17	5494 Serial Number		
18	5494 System Password		
19	5494 ID Number		
H1:1	AS/400 LU Name	RALYAS4B	
H1:2	AS/400 Network ID	USIBMRA	
H1:3	5494 Network ID	USIBMRA	
H1:4	Mode Name	QRMTWSC	
H1:5	AS/400 Connection Number		
H1:7	Token-Ring SAP	04	**3**
H1:8	TR Max Out	2	**3**
H1:9	TR Max In	1	**3**

Notes:

1 Use SDLC station address ″01″. ″C1″ did not work.

2 IBM 2210 router supports full duplex only.

3 Accept the default values.

12.3.3.1 AS/400 Definitions for the IBM 5494

The AS/400 definitions required are almost identical to the IBM 5394 definitions: An Ethernet LAN line, an APPC controller, an APPC device, an RWS controller and the DSP/PRT device descriptions are required on the target AS/400 RALYAS4B.

No 5494-specific parameters are needed with the Ethernet LAN line description.

```
CRTLINETH  LIND(L71ETH) RSRCNAME(LIN071) ADPTADR(08005A1A60CD) AUTOCRTCTL(*YES)
```

Basically you don't need to manually create further descriptions. All configuration objects are created automatically. But, as with the IBM 5394, the AS/400 thinks that the IBM 5494 is LAN-attached. So, we either create the APPC controller description manually or we change the MAXFRAME parameter to an SDLC value.

The manually created APPC controller and auto-created APPC device descriptions are as follows:

```
CRTCTLAPPC CTLD(RAL5494) LINKTYPE(*LAN) SWTLINLST(L71ETH) +
   MAXFRAME(576) RMTCPNAME(RAL5494) ADPTADR(020011111111) +   1
   CPSSN(*NO) NODETYPE(*LENNODE)

CRTDEVAPPC DEVD(RAL5494) RMTLOCNAME(RAL5494) +
   LCLLOCNAME(RALYAS4B) CTL(RAL5494) +
   TEXT('AUTOMATICALLY CREATED BY QLUS')
```

The auto-created RWS controller and device descriptions are as follows:

```
CRTCTLAPPC CTLD(RAL54RMT) TYPE(5494) MODEL(2) +
   LINKTYPE(*NONE) RMTLOCNAME(RAL5494) LCLLOCNAME(RALYAS4B) +
   TEXT('CREATED BY AUTO-CONFIGURATION')

CRTDEVDSP DEVD(RAL5DSP00) DEVCLS(*RMT) TYPE(3477) MODEL(FC) +
   LOCADDR(00) CTL(RAL54RMT) +
   TEXT('CREATED BY AUTO-CONFIGURATION')
```

Note:

> **1** The 5494 virtual LAN connection is to a token-ring LAN, whereas RALYAS4B is connected to an Ethernet LAN. The MAC address must therefore be inverted.

12.4 IPX Network

The router network is set up to route IPX via the topology illustrated in Figure 127.

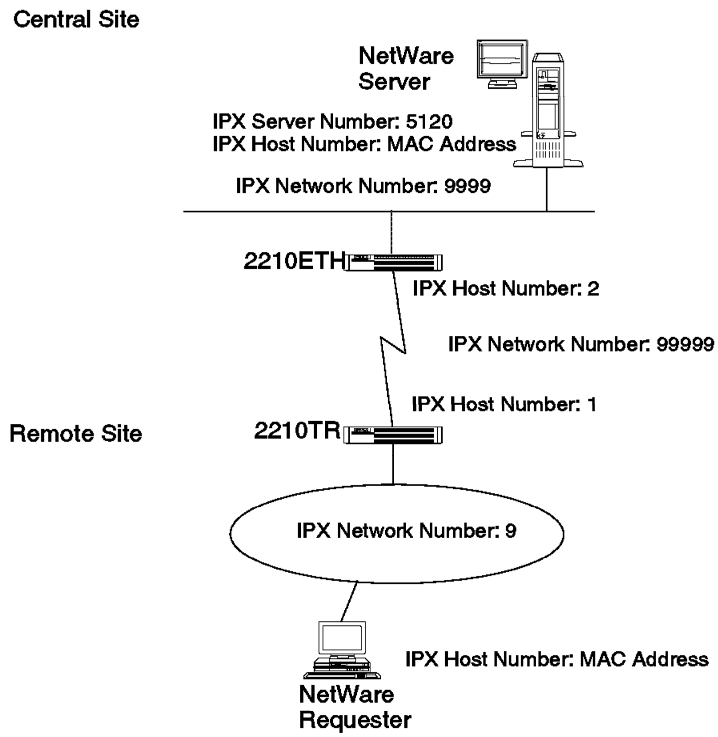


Figure 127. IBM 5394 within an IBM 2210 Router Network, IPX Part

In this section we are not going to describe the configuration of the NetWare requester and server. These were the standard configurations. Nothing extra had to be added for this network. The router network was transparent to the NetWare users.

12.5 IBM 2210 Router Configuration

The following configurations of the 2210 routers were carried out using the ASCII console attached to the 2210. Many options are *prompted for* automatically by the router but not all are, so you need to be careful. For any command you can prompt for the options allowed using a ″?″ (question mark).

The 2210 configurations here are the same as we used in 12.5, "IBM 2210 Router Configuration." However, here we have the additional configuration on the token-ring attached IBM 2210 to support the 5x94 remote workstations controller via the serial SDLC line.

We used the Quick Configuration (QCONFIG) process to build the base 2210 configurations. These base configurations were then modified as necessary.

12.5.1 Token-Ring Attached IBM 2210 with Serial SDLC Line - 2210TR

The configuration of 2210TR is as follows:

The configuration task used is `6 Config`. The `Talk 6` command is used to access this task. This gives the `Config>` prompt. Refer to Figure 128 on page 168.

```
*Talk 6
Config> QCONFIG   Quick Configuration         1
Configure interfaces? > yes
Intf 0 is Token Ring
Speed in Mb/Sec (4,16) = [4] 4
Connector (STP, UTP) = [UTP] STP
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] RS-232 modem
This is all configured device information:
Intf 0 is Token Ring, Speed 4 Mb/sec, Connector STP
Intf 1 is WAN 1 with PPP Encapsulation, V.35 modem cable
Intf 2 is WAN 2 with PPP Encapsulation, RS-232 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.24.104.178
Address mask : 255.255.255.0
Configuring Interface 1 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.162
Address mask : 255.255.255.240
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask
0             9.24.104.178    255.255.255.0
1             9.67.46.162     255.255.255.240
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Token-Ring encapsulation (frame) type? (TOKEN-RING MSB, TOKEN-RING LSB,
TOKEN-RING_SNAP MSB, TOKEN-RING_SNAP LSB) = [TOKEN-RING MSB] TOKEN-RING
Network number (hex)  (0 - FFFFFFFF) [0] 9
Configuring Interface 1 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Network number (hex)  (0 - FFFFFFFF) [0] 99999
Enable IPXWAN (Yes, No) = [No] no
Configuring Interface 2 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] no
Configure IPXWAN NodeID? (Yes,No) = [Yes] no
This is the information you have entered:
Ifc  IPX Net (hex)  Encapsulation    IPXWAN
0    9              TOKEN-RING MSB   Not Configured
1    99999                           Not Configured
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 128. 2210 MRNS Quick Configuration - 2210TR

```
*Talk 6
Config> network 1
PPP config> set HDLC encoding NRZI
PPP config> list hdlc (to verify)
Maximum frame size in bytes = 2048
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: V.35 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
PPP config> exit
```

Figure 129. 2210 MRNS WAN Configuration - 2210TR

```
Config> set data-link sdlc
Interface Number [0] 2
Config> network 2
SDLC 2 config> list link

               Link Configuration for : LINK2    (ENABLED)

Role: NEGOTIABLE  2                     Type: POINT-TO-POINT
Duplex: FULL      2                     Modulo: 8
Idle state: FLAG                        Encoding: NRZI
Clocking: EXTERNAL                      Frame Size: 576  2
Speed: 0                                Cable : RS-232-DTE

Timers:  XID/TEST response: 2.0sec
         SNRM response:     2.0sec
         Poll response:     0.5sec
         Inter-poll delay:  0.2sec
         RTS hold delay:    DISABLED
         Inter-frame delay: DISABLED

Counters:  XID/TEST retry : 4
           SNRM retry : 6
           Poll retry : 10

(The above are the working values we used.  If your values do not match these,
 use the SET command to change them.  For example, set link role neg)

SDLC 2 config> add remote-secondary
Enter station address (in hex) [C1]? 01      2
Enter remote station name [SDLC_1]? 5394
Enter max packet size [576]? 576       2
Enter receive window [7]?   (press enter to accept default)
Enter transmit window [7]?  (press enter to accept default)
Enable negotiable mode (Yes or [No]) = yes      2
SDLC 2 config> exit
```

Figure 130. 2210 MRNS SDLC Configuration - 2210TR

```
Config> prot ipx
IPX config> set host-number = 1
IPX config> enable reply-to-get           3
IPX config> enable interface 0
IPX config> enable interface 1
IPX config> exit
```

Figure 131. 2210 MRNS IPX Configuration - 2210TR

```
Config> prot ip
IP config> add route
IP destination (0.0.0.0)? (press enter to accept default)     4
Address mask (0.0.0.0)? (press enter to accept default)
Via gateway at (0.0.0.0)?  9.67.46.161
Cost (1)? (press enter to accept default)
IP config> list routes (to verify)
route to 0.0.0.0,0.0.0.0 via 9.67.46.161, cost 1
IP config> exit
```

Figure 132. 2210 MRNS IP Configuration - 2210TR

```
Config> prot ip
IP config> set internal-ip-address
Internal IP address [0.0.0.0] 9.67.46.164      5
IP config> exit

Config> prot asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config> enable bridge
ASRT config> enable source-routing
Port Number [1] (press enter to accept default)       6
Segment Number for the port in hex (1 - FFF) [1] FFE
ASRT config> enable fa-ga-mapping
ASRT config> enable dls
ASRT config> exit

Config> prot dls
DLSW config> enable dls
DLSW config> set srb
Enter segment number in hex (1-FFF) [0] AAA    7
DLSW config> add tcp
Enter the DLSw neighbor IP address [0.0.0.0] 9.67.46.163 (2210ETH internal
                                                                  IP address)
Transmit buffer size (decimal) [5120] (press enter to accept default)
Maximum segment size (decimal) [1024] (press enter to accept default)
Enable/disable keepalive (E/D) -(D)?  e         8
DLSW config> open-sap
Interface? [1] 0
Enter SAP in hex (range 0-FF) [0] 00
DLSW config> open-sap 0 04
DLSW config> open-sap 0 08
DLSW config> open-sap 0 0C
DLSW config> exit
```

Figure 133. 2210 MRNS DLSw Configuration - 2210TR

```
Config> prot dls
DLSw config> add sdlc
Interface # [0]? 2
SDLC Address [C1]? 01
Source MAC Address [000000000000]? 400088888888       9
Idblk in Hex (0-0xfff) [0] 05f        10
Idnum in Hex (0-0xfffff) [0] 00001
LLC Source SAP (0 for auto-assign) [0]? 04
LLC Destination SAP [4] 04
Destination MAC Address [000000000000]? 08005A1A60CD
DLSw config> list sdlc (to verify)
DLSw config. exit
```

Figure 134. 2210 MRNS DLSw SDLC Configuration - 2210TR

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No]): yes
```

For notes see page 174.

12.5.2 Ethernet-Attached IBM 2210 - 2210ETH

The configuration task used is 6 Config. The Talk 6 command is used to access this task. This gives the Config> prompt. Refer to Figure 135 on page 172.

```
*Talk 6
Config> QCONFIG   Quick Configuration         1
Configure interfaces? > yes
Intf 0 is Ethernet
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
This is all configured device information:
Intf 0 is Ethernet, Connector (10baseT, AUI) auto-configured
Intf 1 is WAN 1 with PPP Encapsulation, V.35 modem cable
Intf 2 is WAN 2 with PPP Encapsulation, V.35 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Ethernet)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.129
Address mask : 255.255.255.240
Configuring Interface 1 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.161
Address mask : 255.255.255.240
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask
0             9.67.46.129     255.255.255.240
1             9.67.46.161     255.255.255.240
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] yes
Configuring Interface 0 (Ethernet)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Ethernet encapsulation (frame) type? (ETHERNET_II, ETHERNET_SNAP,
ETHERNET_8022, ETHERNET_8023) = [ETHERNET_8023] ETHERNET_8023
Network number (hex)  (0 - FFFFFFFF) [0] 9999
Configuring Interface 1 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] yes
Network number (hex)  (0 - FFFFFFFF) [0] 99999
Enable IPXWAN (Yes, No) = [No] no
Configuring Interface 2 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] no
Configure IPXWAN NodeID? (Yes,No) = [Yes] no
This is the information you have entered:
Ifc  IPX Net (hex)  Encapsulation    IPXWAN
0    9999           ETHERNET_8023    Not Configured
1    99999                           Not Configured
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 135. 2210 MRNS Quick Configuration - 2210ETH

```
*Talk 6
Config> network 1
PPP config> set HDLC encoding NRZI
PPP config> list hdlc (to verify)
Maximum frame size in bytes = 2048
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: V.35 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
PPP config> exit
```

Figure 136. 2210 MRNS WAN Configuration - 2210ETH

```
Config> prot ipx
IPX config> set host-number = 2
Which interface (0)? 0
IPX config> enable interface 0
IPX config> enable interface 1
IPX config> exit
```

Figure 137. 2210 MRNS IPX Configuration - 2210ETH

```
Config> prot ip
IP config> add route
IP destination (0.0.0.0)? (press enter to accept default)    4
Address mask (0.0.0.0)? (press enter to accept default)
Via gateway at (0.0.0.0)?  9.67.46.162
Cost (1)? (press enter to accept default)
IP config> list routes (to verify)
route to 0.0.0.0,0.0.0.0 via 9.67.46.162, cost 1
IP config> exit
```

Figure 138. 2210 MRNS IP Configuration - 2210ETH

```
Config> prot ip
IP config> set internal-ip-address
Internal IP address [0.0.0.0] 9.67.46.163      5
IP config> exit

Config> prot asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config> enable bridge
ASRT config> enable transparent
Port Number [1] (press enter to accept default)
ASRT config> enable fa-ga-mapping
ASRT config> enable dls
ASRT config> exit

Config> prot dls
DLSW config> enable dls
DLSW config> set srb
Enter segment number in hex (1-FFF) [0] AAA    7
DLSW config> add tcp
Enter the DLSw neighbor IP address [0.0.0.0] 9.67.46.164 (2210TR internal
                                                                IP address)
Transmit buffer size (decimal) [5120] (press enter to accept default)
Maximum segment size (decimal) [1024] (press enter to accept default)
Enable/disable keepalive (E/D) -(D)?  e          8
DLSW config> open-sap
Interface? [1] 0
Enter SAP in hex (range 0-FF) [0] 00
DLSW config> open-sap 0 04
DLSW config> open-sap 0 08
DLSW config> open-sap 0 0C
DLSW config> exit
```

Figure 139. 2210 MRNS DLSw Configuration - 2210ETH

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No]): yes
```

Notes:

1 When you power up a brand new IBM 2210 router, which has not been configured previously, you will automatically go into the QCONFIG program. This part of the configuration must always be done via the console.

2 Important points for configuring the IBM 5x94 remote workstation controller on the serial link are as follows:

- The 5394 requires Type 2.1 Node Support RPQ 8Q0775 microcode. This support is included in Release 3 microcode for the 5494.
- The link must be defined as FULL DUPLEX both on the 2210 and on the 5394 or 5494 configuration. Although, neither the 5394 nor 5494 supports full duplex; this will keep CD (carrier detect) up all the time between the modems.

- The maxframe size on the AS/400 APPC controller description for the 5x94 must match the value on the 2210. The XID exchange does not negotiate the frame size.
- The IDNUM must match the station address configured on the remote controller. As there is only one remote link station supported for PU 2.1, use 01 for the station address. We tested C1 but found that it did not work.
- The source MAC address used to configure DLSw for the SDLC link station is a virtual MAC address. It must be unique. To the target AS/400 - RALYAS4B, it will appear that the 5x94 remote controller is attached via a token-ring, and this is its MAC address.
- Setting the link role to negotiate and enabling negotiable mode on the remote secondary makes the connection type 2.1.

3 *Enable reply-to-get* is done on the router in an IPX serverless LAN. This allows the router to respond to *get nearest server* requests, so the client can access servers in remote LANs.

4 A route with an IP destination and address mask of 0.0.0.0 defines a default route.

5 The 2210 uses a unique IP address for DLSw, not one of the addresses associated with its interfaces. We recommend that you choose an IP address that is valid for one of the subnets it belongs to. This is to avoid having to deal with routing for this address.

6 This is the port number/segment number. Port 1 is on interface 0 which is the token-ring interface. This segment number is the real segment number for the token-ring. The bridge number must be unique on the token-ring segment.

7 The segment number is the virtual segment number used by DLSw. Any two routers with a DLSw connection between them must use the same virtual segment number. It is easiest to use the same virtual segment number throughout the network for DLSw purposes.

8 We enabled *keep alive*, to force the router to poll the partner in the DLSw session every 10 seconds ensuring that the other end is still there. This can be useful for SNMP as a trap can be configured to report a partner dropping out of a session.

9 This is the virtual LAN address for the 5394/5494.

10 For a 5494 connection, the Idblk value used would be 073. In the configuration example shown, the Idnum value used is the same for both the 5394 and the 5494. The remote station name is only a symbolic name but for completeness should be changed to 5494.

12.5.3 Session Establishment over the SDLC Link

This section looks at session establishment via the SDLC link into the router backbone to a remote LAN.

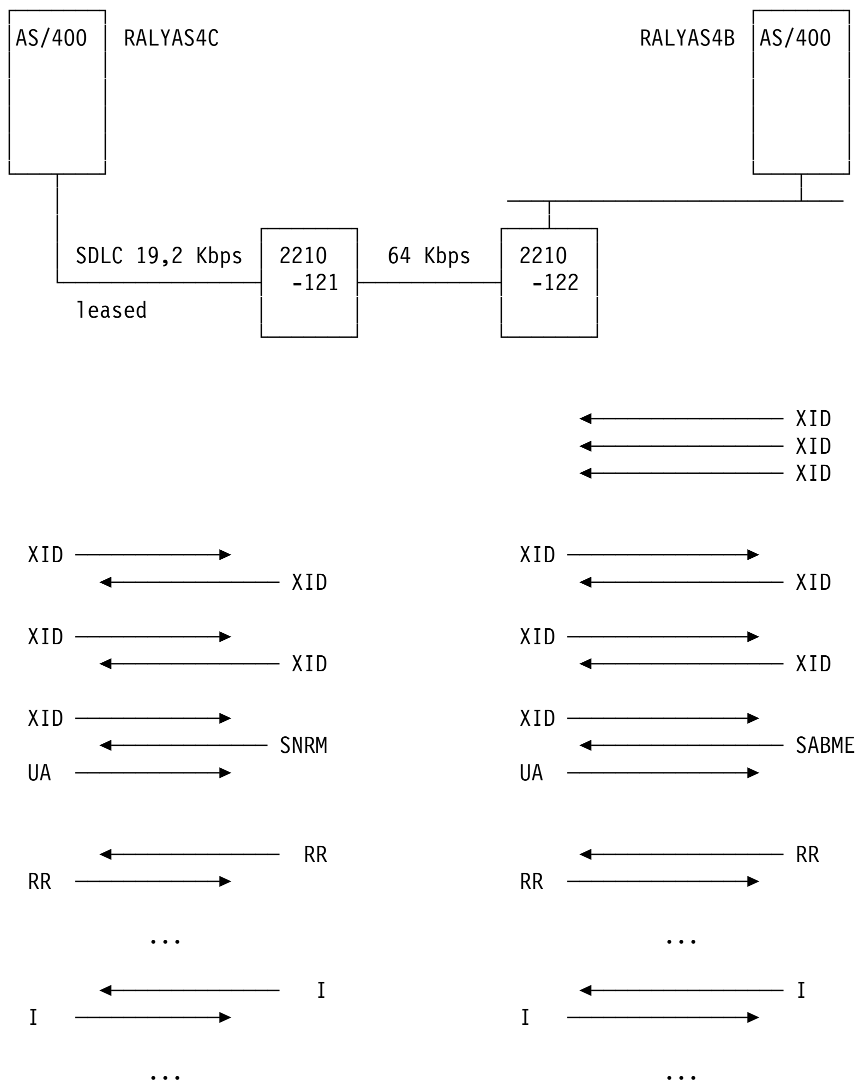


Figure 140. AS/400 Communicating via Serial Link to the Router Network

Figure 140 illustrates a trace of the session startup between the two AS/400 systems RALYAS4C and RALYAS4B. We used the AS/400 communications trace facility to trace the SLDC link on RALYAS4C and the Ethernet link on RALYAS4B.

First the controller description for RALYAS4C on RALYAS4B was varied-on. The SDLC line and controller descriptions for RALYAS4B were then varied-on on RALYAS4C. The exact flow we saw is shown in the trace above.

We noticed that the XID from RALYAS4C is sent out saying its role is negotiable. However, the XID that arrives at RALYAS4B has the role set to secondary non-negotiable. RALYAS4B also sends out an XID saying its role is negotiable. However, the XID which arrives at RALYAS4C has the role set to primary non-negotiable. It appears that the 2210 sets the roles of the stations before forwarding the XIDs, even though in the 2210 Link Configuration we defined the role as negotiable.

Chapter 13. IBM 2210s, IBM 5394 and SDLC Relay

When migrating from an SNA/SDLC network to a multiprotocol router network, in some cases devices can not be turned into LAN capable ones. If two devices, for example a System/36 and an IBM 5394, still need to communicate via an SNA/SDLC connection, the SDLC Relay function of the IBM 2210 router can be used. This function supports the transport of SNA/SDLC via a multiprotocol router network. SDLC frames are imbedded into TCP/IP frames. This includes not only SDLC data frames but also the polling traffic.

DLSw is generally a better solution for the connection of SDLC devices. It provides SDLC to LLC2 conversion and prevents the transmission of SDLC polling across the wide area network connections. But DLSw is unable to support connections between two SDLC devices.

The objectives of this scenario are as follows:

- To connect two IBM 2210 routers using a WAN link
- To configure SDLC Relay to support SDLC tunneling

Figure 141 provides an overview of the IBM 2210 multiprotocol router network we established. Please note that the routers include LAN adapters (interface number 0) which are configured but not used in this scenario.

TCP/IP is configured for communications between the routers.

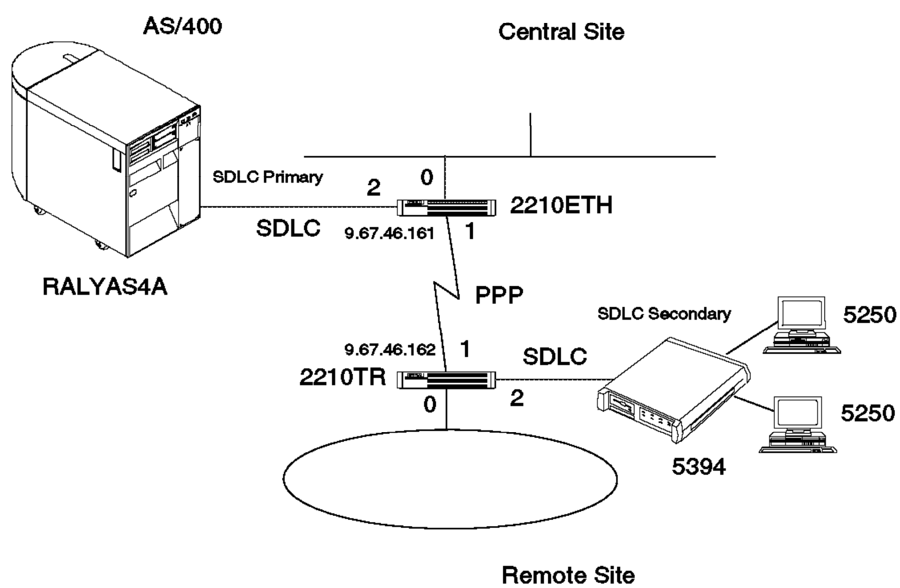


Figure 141. IBM 2210 Router Network, SDLC Relay

13.1 Hardware/Software Involved

- Routers
  - IBM 2210, Model 121 (Token-Ring), with MRNS V1R2
  - IBM 2210, Model 122 (Ethernet), with MRNS V1R2
- WAN link between routers

  The connection speed is 64 Kbps. We used IBM 5822-10 modems with V.35 interfaces.
- SDLC links between routers and SDLC devices

  The speed of the two connections is 19200 bps. We used IBM 5812 modems.
- IBM 5394 Remote Workstation Controller

  With microcode release 2.3.

  Note that the T2.1 Node Support RPQ 8Q0775 is not required.
- AS/400 System

  With OS/400 V3R1, OS/400 includes SNA and remote workstation controller support.

13.2 AS/400 and IBM 5394 Configuration

We configured an SDLC-leased connection between the AS/400 and the IBM 5394. The router network is fully transparent to the two devices. The IBM 2210 routers support full-duplex connections only, which we have included in the definitions.

The AS/400 SDLC line, remote workstation controller and display device descriptions are as follows:

```
CRTLINSDLC LIND(L0625394) RSRCNAME(LIN062) ROLE(*PRI) +
             CNN(*NONSWTPP) DUPLEX(*FULL)
CRTCTLRWS CTLD(RWS5394) TYPE(5394) MODEL(1) + LINKTYPE(*SDLC) +
             LINE(L0625394) EXCHID(05F00001) STNADR(01) +
CRTDEVDSP DEVD(DSP3477) DEVCLS(*RMT) TYPE(3477) MODEL(FC) +
             LOCADR(00) CTL(RWS5394)
```

Please note that the SDLC Relay does not require the T2.1 Node Support RPQ.

```
          0        1        2        3        4        5        6
          ____________________________________________________________
    0/    D        .        .        .        .        .        .

    1/    .        .        .        .        .        .        .

    2/    .        .        .        .        .        .        .





 AA→ 0  BB→ 0
 1→ 00      2→ 01   3→ 0 1 1 0 0 0 0      8-→ 3C 0

                                           P→ _ _
```

Figure 142. IBM 5394 Setup Panel

Table 20 shows the IBM 5394 configuration values selected and a description of those values.

Table 20. IBM 5394 Configuration Parameters

Field /Subfield	Field Description	Value Selected	Value Description
AA	Communication Mode	0	SDLC leased
BB	Operation Mode	0	5394 Mode
1	Keyboard Code	00	US English
2	SDLC Station Address	01	
3/1	Connection Type	0	non-switched
3/2	Modem Mode	1	full-duplex
3/3	Link Type	1	point-to-point
3/4	NRZ/NRZI	0	NRZI
3/5	Pin 20	0	DTR
3/6	Leading Pad	0	No leading pad
3/7	Local Loopback	0	no loopback
8	V.25bis Autodial		not used
P	Configuration Printer		

13.3 IBM 2210 Router Configuration

The following 2210 router configuration was carried out using the ASCII console attached to the 2210. Many options are *prompted for* automatically by the router but not all are, so you need to be careful. For any command you can prompt for the options allowed using a ″?″ (question mark).

We used the Quick Configuration (QCONFIG) process to build the base 2210 configuration. This base configuration was then modified as necessary.

13.3.1 Token-Ring Attached IBM 2210 with Serial SDLC Line - 2210TR

The configuration of 2210TR is as follows:

The configuration task used is 6 Config. The Talk 6 command is used to access this task. This gives the Config> prompt. Refer to Figure 143.

```
Talk 6
Config> QCONFIG   Quick Configuration         1
Configure interfaces? > yes
Intf 0 is Token Ring
Speed in Mb/Sec (4,16) = [4] 4
Connector (STP, UTP) = [UTP] STP
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] RS-232 modem
This is all configured device information:
Intf 0 is Token Ring, Speed 4 Mb/sec, Connector STP
Intf 1 is WAN1 with PPP Encapsulation, V.35 modem cable
Intf 2 is WAN2 with PPP Encapsulation, RS-232 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.24.104.178
Address mask : 255.255.255.0
Configuring Interface 1 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.162
Address mask : 255.255.255.240
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask
0             9.24.104.178    255.255.255.0
1             9.67.46.162     255.255.255.240
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] no

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 143. 2210 MRNS Quick Configuration - 2210TR

```
Talk 6
Config> network 1
PPP config> set HDLC encoding NRZI
PPP config> list hdlc (to verify)
Maximum frame size in bytes = 2048
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: V.35 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
PPP config> exit
```

Figure 144. 2210 MRNS WAN Configuration - 2210TR

```
Config> set data-link srly
Interface number [0]? 2
Config> network 2
SDLC relay interface user configuration
SRLY2 Config> set frame-size 1033
SRLY2 Config> set encoding NRZI
SRLY2 Config> list link (to verify)
Maximum frame size in bytes = 1033
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: RS-232 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
SRLY2 Config> exit
```

Figure 145. 2210 MRNS SDLC Relay Configuration 1/2 - 2210TR

```
Config> prot ip
IP config> add route
IP destination (0.0.0.0)? (press enter to accept default)     2
Address mask (0.0.0.0)? (press enter to accept default)
Via gateway at (0.0.0.0)?  9.67.46.161
Cost (1)? (press enter to accept default)
IP config> list routes (to verify)
route to 0.0.0.0,0.0.0.0 via 9.67.46.161, cost 1
IP config> exit
```

Figure 146. 2210 MRNS IP Configuration - 2210TR

```
Config> prot sdlc
SDLC Relay protocol user configuration
SDLC config> add group
Group number: [1]? 1
SDLC config> add local-port
Group number: [1]? 1
Interface number: [0]? 2
(P)rimary or (S)econdary: [S]? secondary
SDLC config> add remote-port
Group number: [1]? 1
IP address of remote router: [0.0.0.0]? 9.67.46.161
(P)rimary or (S)econdary: [S]? primary
SDLC config> list all (to verify)
SDLC config> exit
```

Figure 147. 2210 MRNS SDLC Relay Configuration 2/2 - 2210TR

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No])yes
```

For notes see page 185.

13.3.2 Ethernet-Attached IBM 2210 - 2210ETH

The configuration task used is 6 Config. The Talk 6 command is used to access this task. This gives the Config> prompt. Refer to Figure 148 on page 183

```
Talk 6
Config> QCONFIG   Quick Configuration        1
Configure interfaces? > yes
Intf 0 is Ethernet
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] RS-232 modem
This is all configured device information:
Intf 0 is Ethernet, Connector (10baseT, AUI) auto-configured
Intf 1 is WAN1 with PPP Encapsulation, V.35 modem cable
Intf 2 is WAN1 with PPP Encapsulation, RS-232 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Ethernet)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.129
Address mask : 255.255.255.240
Configuring Interface 1 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] yes
IP address : 9.67.46.161
Address mask : 255.255.255.240
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask
0             9.67.46.129     255.255.255.240
1             9.67.46.161     255.255.255.240
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] no

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 148. 2210 MRNS Quick Configuration - 2210ETH

```
Talk 6
Config> network 1
PPP config> set HDLC encoding NRZI
PPP config> list hdlc (to verify)
Maximum frame size in bytes = 2048
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: V.35 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
PPP config> exit
```

Figure 149. 2210 MRNS WAN Configuration - 2210ETH

```
Config> set data-link srly
Interface number [0]? 2
Config> network 2
SDLC relay interface user configuration
SRLY2 Config> set frame-size 1033
SRLY2 Config> set encoding NRZI
SRLY2 Config> list link (to verify)
Maximum frame size in bytes = 1033
Encoding: NRZI
Idle State: Flag
Clocking: External
Cable type: RS-232 DTE
Internal Clock Speed: 0
Transmit Delay Counter: 0
SRLY2 Config> exit
```

Figure 150. 2210 MRNS SDLC Relay Configuration 1 of 2 - 2210ETH

```
Config> prot ip
IP config> add route
IP destination (0.0.0.0)? (press enter to accept default)    2
Address mask (0.0.0.0)? (press enter to accept default)
Via gateway at (0.0.0.0)?  9.67.46.162
Cost (1)? (press enter to accept default)
IP config> list routes (to verify)
route to 0.0.0.0,0.0.0.0 via 9.67.46.162, cost 1
IP config> exit
```

Figure 151. 2210 MRNS IP Configuration - 2210ETH

```
Config> prot sdlc
SDLC Relay protocol user configuration
SDLC config> add group
Group number: [1]? 1
SDLC config> add local-port
Group number: [1]? 1
Interface number: [0]? 2
(P)rimary or (S)econdary: [S]? primary
SDLC config> add remote-port
Group number: [1]? 1
IP address of remote router: [0.0.0.0]? 9.67.46.162
(P)rimary or (S)econdary: [S]? secondary
SDLC config> list all (to verify)
SDLC config> exit
```

Figure 152. 2210 MRNS SDLC Relay Configuration 2 of 2 - 2210ETH

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No])yes
```

Notes:

1 When you power up a brand new IBM 2210 router, which has not been configured previously, you will automatically go into the QCONFIG program. This part of the configuration must always be done via the console.

2 A route with an IP destination and address mask of 0.0.0.0 defines a default route.

Chapter 14. IBM 2210, Frame Relay and AS/400

In this scenario, we will look at how the AS/400 can connect via frame relay to a remote LAN. The frame relay support we are using here to transport SNA and TCP/IP is Boundary Access Node (BAN) which is IBM′s name for RFC1490. RFC1490 describes the encapsulation of different protocols in frame relay packets.

There are two basic types of data packets that travel within a frame relay network, routed packets and bridged packets. These packets have distinct formats and therefore must contain an indicator that the destination may use to correctly interpret the contents of the frame. This indicator is imbedded within the header. Refer to 3.3, "Boundary Access Node Function" on page 40 for more information on this function.

In our example, we have an AS/400 (RALYAS4A) with a High-Speed WAN Adapter (feature number 2666) linked via frame relay to a 2210 which is LAN attached to our second AS/400 (RALYAS4B). See Figure 153. Both AS/400s view each other as being on the same LAN. The 2210 *bridges* the traffic between the frame relay DLCI and the token-ring. See Figure 154 on page 188.

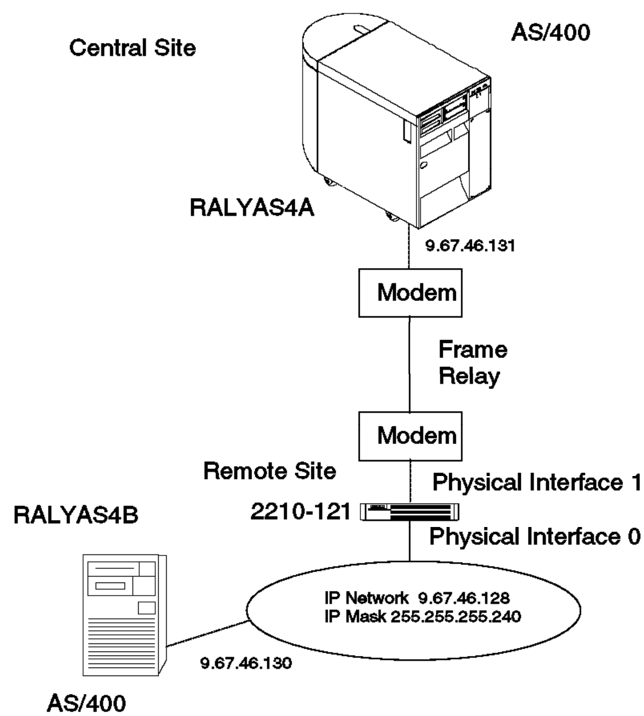


Figure 153. IBM 2210, Frame Relay and AS/400

For simplicity, we used a point-to-point frame relay connection without going through an actual frame relay network.

With RFC1490 support, the frame relay connection will appear as a LAN connection so the view will look as is shown in Figure 154.

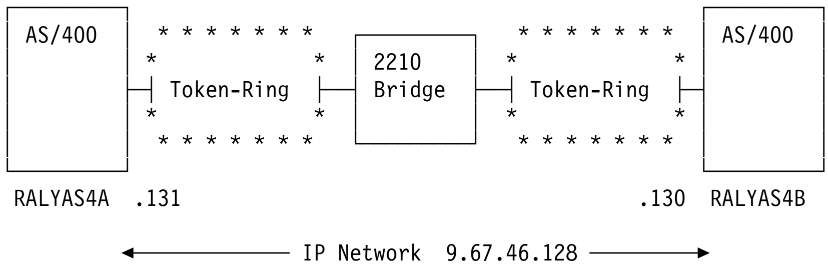


Figure 154. IBM 2210, Frame Relay and AS/400 - Virtual View

14.1 Hardware/Software Involved

- Router
  - IBM 2210, Model 121 (token-ring), with MRNS V1R2
- WAN Link between router and AS/400

  The connection speed is 64 Kbps. We used IBM 5822-10 modems with V.35 interfaces.
- AS/400 Systems

  High-Speed WAN Adapter, FC 2666

  With OS/400 V3R1, OS/400 includes SNA and TCP/IP support.

14.2 AS/400 Configuration

In this section we show the AS/400 configurations for RALYAS4A and RALYAS4B.

RALYAS4A

This is the configuration required on the AS/400 attached to the frame relay link via the High-Speed WAN Adapter. Frame relay requires a Networking Interface (NWI) and a line description attached to this. In our case the LIND is a token-ring, because this is the LAN type at the remote site. The frame relay appears to us as a LAN and the AS/400 acts as if it is *bridged* LAN to LAN to the remote site. This is achieved via RFC1490 support.

We also require an APPC Controller and device description for SNA and an interface for TCP/IP.

```
CRTNWIFR   NWID(FRNWI) RSRCNAME(LIN111) NRZI(*YES) +
             INTERFACE(*V35) LINESPEED(64000) +
             LMIMODE(*NONE)

CRTLINTRN  LIND(FR16TR) RSRCNAME(*NWID) NWI(FRNWI) +
             NWIDLCI(16) LINESPEED(*NWI) +
             ADPTADR(4AFF00000000)

CRTCTLAPPC CTLD(RALYAS4B) LINKTYPE(*LAN)  +
             SWTLINLST(FR16TR) MAXFRAME(16393) +
             RMTCPNAME(RALYAS4B) +
             ADPTADR(400010020002)
```

Note: Since we are not using an actual frame relay network, the LMIMODE used is *NONE.

```
                         Display TCP/IP Interface
                                                          System:   RALYAS4A
 Internet address . . . . . . . . . . . . . . . . :   9.67.46.131
 Subnet mask  . . . . . . . . . . . . . . . . . . :   255.255.255.240
 Line description . . . . . . . . . . . . . . . . :   FR16TR
 Line type  . . . . . . . . . . . . . . . . . . . :   *TRLAN
 Interface status . . . . . . . . . . . . . . . . :   Active
 Type of service  . . . . . . . . . . . . . . . . :   *NORMAL
 Maximum transmission unit  . . . . . . . . . . . :   *LIND
 Automatic start  . . . . . . . . . . . . . . . . :   *YES
 TRLAN bit sequencing . . . . . . . . . . . . . . :   *MSB


 Press Enter to continue.
 F3=Exit   F12=Cancel
```

Figure 155. TCP/IP Interface on RALYAS4A for Frame Relay Link

RALYAS4B

This AS/400 has a token-ring adapter and sees RALYAS4A as being connected to the same LAN.

On the target AS/400 (RALYAS4B) we must create a token-ring line description and a TCP/IP interface. The APPC controller and device descriptions are auto-created but have been included here for reference.

```
CRTLINTRN  LIND(L31TR) RSRCNAME(LIN031) LINESPEED(4M) +
    ADPTADR(400010020002) TEXT('4M TR for RALYAS4B') +
    LINKSPEED(4M) AUTOCRTCTL(*YES)

CRTCTLAPPC CTLD(RALYAS4A) LINKTYPE(*LAN) SWTLINLST(L31TR) +
    RMTCPNAME(RALYAS4A) ADPTADR(4AFF00000000) +
    TEXT('CREATED BY AUTO-CONFIGURATION')

CRTDEVAPPC DEVD(RALYAS4A) RMTLOCNAME(RALYAS4A) LCLLOCNAME(RALYAS4B)
    RMTNETID(USIBMRA) CTL(RALYAS4A) +
    TEXT('CREATED BY AUTO-CONFIGURATION')
```

```
                          Display TCP/IP Interface
                                                        System:   RALYAS4B
Internet address . . . . . . . . . . . . . . . . :   9.67.46.130
Subnet mask  . . . . . . . . . . . . . . . . . . :   255.255.255.240
Line description . . . . . . . . . . . . . . . . :   L31TR
Line type  . . . . . . . . . . . . . . . . . . . :   *TRLAN
Interface status . . . . . . . . . . . . . . . . :   Active
Type of service  . . . . . . . . . . . . . . . . :   *NORMAL
Maximum transmission unit  . . . . . . . . . . . :   *LIND
Automatic start  . . . . . . . . . . . . . . . . :   *YES
TRLAN bit sequencing . . . . . . . . . . . . . . :   *MSB


Press Enter to continue.
F3=Exit   F12=Cancel
```

Figure 156. TCP/IP Interface on RALYAS4B for Token-Ring Link

14.3 IBM 2210 Router Definitions

The configuration of 2210TR is as follows:

The configuration task used is 6 Config. The Talk 6 command is used to access this task. This gives the Config> prompt. Refer to Figure 157.

```
*Talk 6
Config> QCONFIG   Quick Configuration          1
Configure interfaces? > yes
Intf 0 is Token Ring
Speed in Mb/Sec (4,16) = [4] 4
Connector (STP, UTP) = [UTP] STP
Intf 1 is WAN Frame Relay
Encapsulation for WAN 1 (PPP, Frame Relay) = [Frame Relay] frame relay
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] V.35 modem
Intf 2 is WAN Frame Relay
Encapsulation for WAN 2 (PPP, Frame Relay) = [Frame Relay] PPP
Cable type (RS-232 modem, RS-232 direct attach, V.35 modem,
   V.35 direct attach, V.36, X.21) = [V.35 modem] RS-232 modem
This is all configured device information:
Intf 0 is Token Ring, Speed 4 Mb/sec, Connector STP
Intf 1 is WAN 1 with Frame Relay Encapsulation, V.35 modem cable
Intf 2 is WAN 2 with PPP Encapsulation, RS-232 modem cable
Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure bridging? (Yes, No, Quit) = [Yes] no

Configure protocols? (Yes, No, Quit) = [Yes] yes     2
Configure IP? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IP on this interface? (Yes, No) = [Yes] no
Configuring Interface 1 (WAN Frame Relay)
Configure IP on this interface? (Yes, No) = [Yes] no
Configuring Interface 2 (WAN PPP)
Configure IP on this interface? (Yes, No) = [Yes] no
Enable dynamic routing? (Yes, No) = [Yes] no
This is the information you have entered:
Interface #   IP Address      Address Mask

Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure IPX? (Yes, No) = [Yes] yes
Configuring Interface 0 (Token Ring)
Configure IPX on this interface? (Yes, No) = [Yes] no
Configuring Interface 1 (Frame Relay PPP)
Configure IPX on this interface? (Yes, No) = [Yes] no
Configuring Interface 2 (WAN PPP)
Configure IPX on this interface? (Yes, No) = [Yes] no
This is the information you have entered:
Ifc  IPX Net (hex)  Encapsulation    IPXWAN

Save this configuration? (Yes, No) = [Yes] (press enter to save)

Configure booting? (Yes, No, Quit) = [Yes] no
Enable console modem control? (Yes, No, Quit) = [Yes] no
Restart the router? (Yes,No) = [Yes] (press enter to restart the router)
```

Figure 157. 2210 MRNS Quick Configuration

```
*Talk 6
Config> network 1
Frame-Relay user configuration
FR config> add permanent-virtual-circuit
Circuit-number [16]? 16  3
Committed Information Rate (CIR) in bps [64000]? 64000
Committed Burst Size (Bc) in bits [64000]? 64000
Excess Burst Size (Be) in bits [0]? 0
Assign circuit name [ ]? as400
FR config> disable lmi  4
FR config> list all (to verify)
FR config> exit
```

Figure 158. 2210 MRNS Frame Relay Configuration

```
Config> prot asrt  5
Adaptive Source Routing Transparent Bridge user configuration
ASRT config> add port
Interface Number [0]? 0
Port Number [1]? 1
ASRT config> disable transparent  6
Port Number [1]? 1
ASRT config> enable source-routing 1 FFE 1  6
ASRT config> add port
Interface Number [0]? 1
Port Number [0]? 2
Assign Circuit Name [ ]? as400
ASRT config> disable transparent  6
Port Number [1]? 2
ASRT config> enable source-routing 2 123 321  6
ASRT config> list port (to verify)
ASRT config> exit
```

Figure 159. 2210 MRNS SRTB Configuration

```
Config> prot asrt
Adaptive Source Routing Transparent Bridge User Configuration
ASRT config> ban
BAN (Boundary Access Node) Configuration
BAN config>  add  7
Port Number [1]? 2
Enter BAN DLCI MAC Address [ ]? 4AFF00000000
Enter Boundary Node Identifier MAC Address [4FFF00000000]? 4AFF00000000
Do you want the traffic bridged (b) or DLSw terminated (t) (b/t) [b]? bridged
BAN config> list (to verify)
BAN config> exit
ASRT config> exit
```

Figure 160. 2210 MRNS BAN Configuration

The restart command is used (from the OPCON prompt) to read and activate the 2210 configuration. Press Ctrl P to access the OPCON prompt (*). For example:

```
Config> Ctrl P
* restart
Are you sure you want to restart the gateway? (Yes or [No]): yes
```

Notes:

1 When you power up a brand new IBM 2210 router, which has not been configured previously, you will automatically go into the QCONFIG program. This part of the configuration must always be done via the console.

2 The process of going through the steps to configure protocols and then specifying no for each interface will delete any existing interface protocol configurations. In practice, you might want to configure IP support to manage the router.

3 Since this is a point-to-point frame relay connection, the DLCI number configured on AS/400 must be the same.

4 Only a real frame relay network is able to provide LMI services. LMI has to be inactivated on the IBM 2210 as well as on AS/400.

5 Enable source-route bridging on the LAN and WAN interface.

6 By default, a new port added bridges packets using STB. To change the bridging method to SRB we disable transparent and enable source-routing. For the first port added we assign it port number 1. The segment number assigned to port 1 is FFE and the bridge number is 1. For the second port added we assign it port number 2. The segment number assigned to port 2 is 123 and the bridge virtual segment is 321.

7 Boundary Access Node capability has to be activated on the WAN port. The AS/400 supports bridged traffic via frame relay only. The IBM 2210 provides flexible assignment of MAC addresses to the frame relay-attached devices, however, we experienced problems when using different MAC addresses. We suggest that you set the BAN DLCI, BAN Identifier and the AS/400 line description MAC address to the same value.

14.4 Bridged FR versus Interconnected Routers

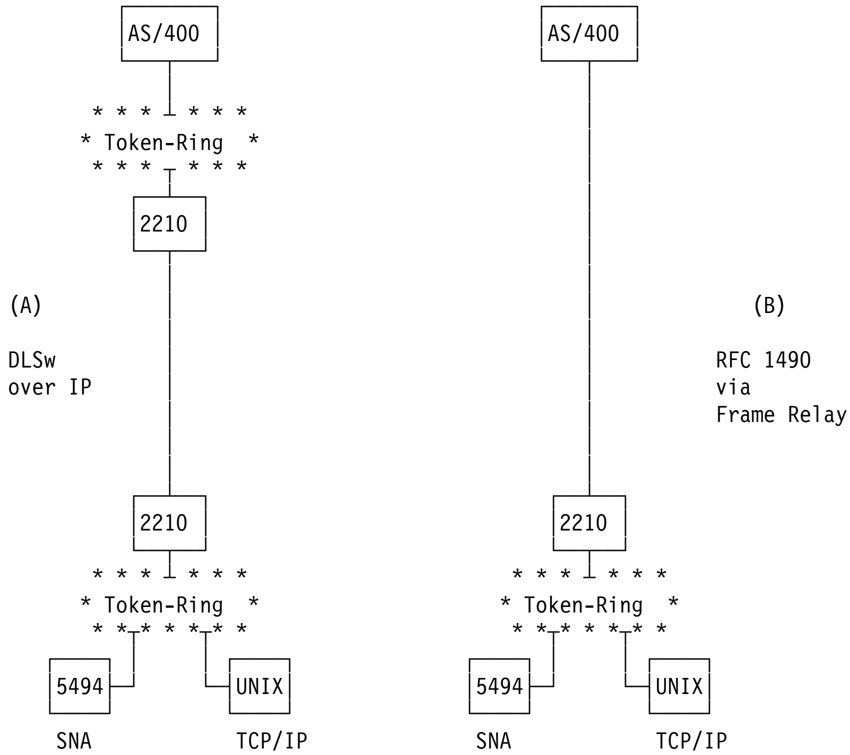


Figure 161. RFC1490 via Frame Relay versus DLSw over an IP Backbone

Let′s examine a situation where you have an AS/400 at the local site; and a 5494 and UNIX system at the remote site. Both of these need to communicate with the AS/400. The 5494 will use SNA/APPN and the UNIX system will use TCP/IP. If you want a wide area link that you can share between both protocols, then the two solutions in Figure 161 can be considered.

The question is, ″Should I use (A) DLSw over an IP WAN connection or should I use (B) a bridged RFC1490 over a frame relay connection?″ With (A) you require two routers such as IBM 2210s with a PPP link between them providing the WAN connection. In (B) the WAN link is provided by the AS/400 High-Speed WAN Adapter (feature code 2666) running a frame relay DLCI to the remote site router (an IBM 2210).

We cannot say which one is better. The answer to this is, it depends. We will look at some pros and cons of both DLSw and RFC1490 and some considerations from an AS/400 perspective. For a real life situation you would have to use these points against your own requirements and criteria such as cost, central LAN access, etc.

14.4.1 DLSw

PROS

- Practical in IP-based backbones, built around PPP over leased lines or X.25.
- Dynamic alternate rerouting provides resilience during link outages, reroutes around failed intermediate nodes (routers) and links.
- Works across any WAN, not just frame relay.
- Can automatically locate destinations using MAC addresses via a search protocol.

CONS

- Not a standard, defacto I-RFC1795.
- Involved configuration: administration of all the IP addresses; all of the DLSw routers serving all potential destination LANs have to be defined at each source DLSw router; all the SRB parameters such as LAN segment numbers, bridge numbers and MAC addresses of all destinations also must be defined.
- Cannot reroute around a failed destination router (no hot backups).
- DLSw adds 56 additional bytes to an SNA PIU and for DLSw over frame relay adds another 10 bytes giving an overhead of 66 bytes. Some non-IBM implementations of DLSw add an even larger overhead for frame relay.
- DLSw requires two TCP connections between every router. In a hub and spoke (star) topology, the central hub system′s router may limit the number of remote TCP connections to remote sites. This may require more than one router at the central hub site which could be a costly solution.
- The TCP/IP sessions for DLSw are always connected wasting bandwidth and incurring excessive line charges.

14.4.2 RFC1490

PROS

- RFC1490 is an industry standard.
- It is highly optimized, has a very low overhead and is cost-effective.
- It provides a standard encapsulation technique for all protocols, not just SNA/APPN and NetBIOS.
- It is easy to configure in that layer two PVCs; setup and definition are all that is required.
- Frame relay networks are robust networks in that rerouting in the event of path failure is handled by the frame relay network.
- Overhead is just 16 bytes in total on an SNA PIU.
- It has no scalability issues. WAN and access link bandwidth is the only factor. As the number of SNA sessions grow you can increase the DLCI capacity and/or the number of DLCIs/PVCs. There is no limit on the number of frame relay partners you can have.

CONS

- RFC1490 is currently available only for frame relay.
- DLCI costs can be expensive.
- RFC1490 can result in additional broadcast traffic over the WAN.

14.4.3 AS/400 Considerations

- The AS/400 in (B) is not a bridge. The High-Speed WAN adapter will not bridge frame relay traffic to an AS/400 LAN adapter so you cannot access non-APPN or non-IP systems behind the AS/400. APPN or IP packet forwarding would give access to APPN or IP systems behind the AS/400.
- Solution (A) allows you to have connections across the WAN to a LAN at the AS/400 site which gives you access to more systems on the LAN.
- The cost needs to be considered. Frame relay on AS/400 requires an expensive adapter whereas the DLSw solution requires a 2210, a MAU and a LAN adapter at the AS/400 site.
- Via frame relay DLCIs in (B) you can reach a lot more remote sites than via the 2210 in (A) where there is a limit on the number of DLSw partners based on memory in the 2210 itself.
- In (B) where IP is being bridged over the WAN link, ARPs will get forwarded over the link as broadcast traffic. This could have an impact on a large IP network if you have a lot of PCs routing through the AS/400. When IP is actually routed as in (A), the ARP does not cross the router and hence puts no extra traffic on the WAN link.

Part 3. 2217 Scenarios

Part 3 contains tested and documented AS/400 networking scenarios using the IBM 2217 Multiprotocol Concentrator.

At the time of writing this book, the 2217 was not generally available. Therefore, our time and access to the product was limited. Because of this, we could not explore all the functions and scenarios that are possible.

Two scenarios are covered. In Chapter 16, "IBM 2217 as a LAN/WAN Gateway" on page 205, the 2217 is used as a LAN/WAN gateway. In Chapter 17, "IBM 2217 as Multiprotocol Network Concentrator" on page 223, 2217s are added to an existing AS/400 APPN network.

Each chapter has the following layout:

- An overview showing the entire network.
- A list of the hardware and software components involved.
- Sections that review the network based on a specific protocol. For example, we look at the layout of the TCP/IP network which is sitting within the multiprotocol network.

  In each of the above sections we include the configuration definitions of the 2217 and any device communicating with it.

In each chapter we include a variety of components apart from the 2217s and AS/400 systems (for example, OS/2 LAN Requester and CM/2). The protocols included are SNA/APPN, NetBIOS, TCP/IP and IPX.

The section starts by giving an overview of the 2217 configuration tool and ends by introducing how the configuration tool can be used to manage remote 2217s.

Note

This book covers only 2217 Release 1.

Chapter 15. IBM 2217 Configuration Tool

The 2217 is configured and administered via the 2217 Remote Control Utility (RCU). The 2217 RCU runs on an OS/2 workstation which has an LU6.2 connection with the 2217. The 2217 RCU is shipped with each 2217 and provides the following configuration/operation options:

- Local 2217 configuration creation
- Modification or remote 2217 configuration
- Operation and administration of remote 2217
- Apply configuration to remote 2217
- Reboot remote 2217

The 2217 RCU is an OS/2-based program. It has the following hardware and software requirements:

Hardware Requirements:

- 2 MB hard drive space
- Intel 386 or higher (486 or higher is recommended)
- 12 MB of RAM (minimum)
- LAN adapter or asynchronous modem

Software Requirements:

- OS/2 2.1 or later
- Communications Manager/2 V1.11 or later

15.1 Initial 2217 Configuration

The 2217 is configured via an LU6.2 connection using the 2217 RCU. Each 2217 is shipped preconfigured such that it can accept an LU6.2 connection from the RCU. Prior to creating the required multiprotocol configuration, it is recommended that an initial configuration is done which changes the preconfigured values. The initial LU6.2 connection can be established in one of the following ways:

- Over a telephone line (2217s shipped to the US and Canada have a 14.4K asynchronous mode installed)
- Over a token-ring LAN
- Over an Ethernet LAN

Once inserted into the network, the 2217 can be configured/managed via any LU6.2 connection or via a telephone line.

During our residency the initial configuration was carried out via a token-ring connection.

The initial 2217 configuration involves the following steps:

1. Establish a modem or LAN connection between the RCU Workstation and the 2217 MpC.
2. Set up the OS/2 Communications Manager of the RCU workstation to reach the IBM 2217 MpC.

3. Load the IBM 2217 MpC Remote Control Unit (RCU) onto the RCU Workstation.

4. Personalize the factory settings: LAN adapter address and SNA values.

5. Update the RCU CM/2 configuration to reflect the new IBM 2217 values.

6. Reconnect and configure the IBM 2217 for the planned multiprotocol network.

In order to communicate with a new unit, each new 2217 comes preconfigured with its LAN adapter (token-ring or Ethernet) and SNA communications enabled. The factory settings of the parameters are as follows:

Token-Ring 2217

- MAC Address: 40002217FFFF
- NETID: ANYBOX
- CPNAME: IBM2217

Ethernet 2217

- MAC Address: 020044E8F888
- NETID: ANYBOX
- CPNAME: IBM2217

Obviously, as all new 2217s of the same LAN adapter type have the same preconfigured MAC address, only one can be active on your network at any one time. In order to configure the 2217, it is suggested that an initial configuration is built which changes the above basic parameters to installation-specific values.

15.1.1 Configuration of RCU Workstation CM/2 for a New IBM 2217

The first step required is the configuration of Communications Manager/2 to establish an SNA connection between the RCU workstation and the new 2217. As the RCU program requires an LU 6.2 session between the configuration workstation and the 2217, CM/2 must be configured to establish an SNA *link station* to the new 2217.

CM/2 is configured from within the Communications Manager Setup icon in the Communications Manager/2 folder on the OS/2 desktop. It is recommended that a new CM/2 configuration is created for the 2217 to avoid overwriting any definitions that may already exist. In the following examples, the new configuration file is called ″2217″.

To enter the required definitions to establish the SNA link station to the 2217, proceed as follows:

1. Select the **Communications Manager/2** icon.

2. Select **Communications Manager Setup**.

3. Select **Setup** to create or modify a configuration.

4. Open a new configuration called ″2217″.

5. Select **Options** and **Configure any profile or feature**.

Enter the following information to configure the SNA profiles:

DLC - Token-Ring or other LAN Types

- Accept defaults.

SNA Local Node Characteristics
Enter values as shown in the following panel:

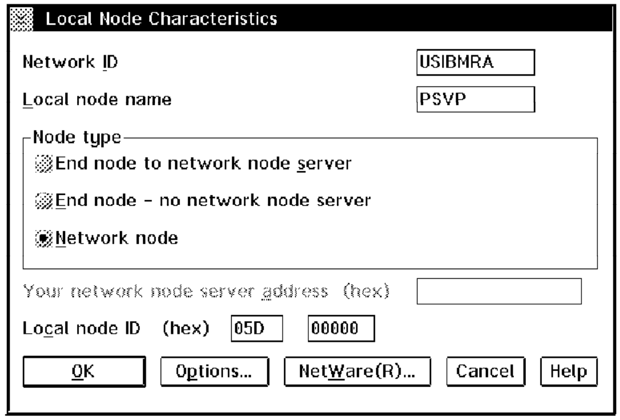


Figure 162. CM/2 Local Node Characteristics

Note: Replace the values of Network ID and Local Node Name with your own specific values.

SNA Connection
Define a LEN node as shown in the following panel:

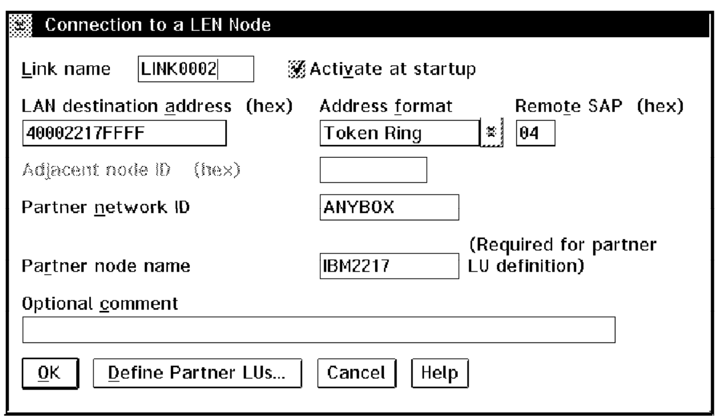


Figure 163. CM/2 Connection to a LEN Node Definition

Now select the **Define Partner LUs** button and enter the corresponding values for the Partner Network ID (define ANYBOX), LU Name (define IBM2217) and Alias (define IBM2217).

Once the above definitions have been created, select **CLOSE** to verify the configuration, shut down CM/2 if it is already running and type the following at an OS/2 command prompt:

```
cmstart 2217
```

15.1.1.1 Monitoring the SNA Link Station

The SNA link station to the 2217 needs to be in *Active* status before the RCU program can establish the LU 6.2 session to perform configuration. To check that the link station is active, perform the following:

1. Select the **Communications Manager/2** icon.
2. Select **Subsystem Management**.
3. Select **SNA Subsystem**.
4. Select **Logical Links**.

The following diagram shows the link to the IBM 2217 in an Active state. In our scenario, the link identifier to the new 2217 is LINK0003.

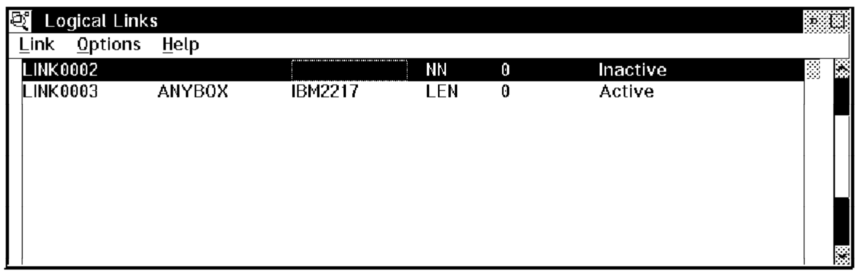


Figure 164. CM/2 Logical Links Showing Active DLC Connection

Use the drag-downs from the Link field to activate and deactivate the link station as required.

Note: Following a reboot of the 2217, the link station will automatically deactivate. A manual activation of the link station from this panel is required before the RCU program can communicate with the 2217.

15.1.2 Configuring the IBM 2217 with the RCU

Install the 2217 RCU by inserting the first diskette into the *A* drive and entering `a:install`.

Once the RCU is installed and the RCU workstation CM/2 definition has been created and is active, the RCU program can be used to configure and operate the IBM 2217. It is recommended that a first initial configuration is made that simply changes the MAC address, SNA Network ID and SNA Local Node Name.

After installing the RCU program onto your OS/2 workstation, select the **2217 Remote Control** icon and the following panel will appear:

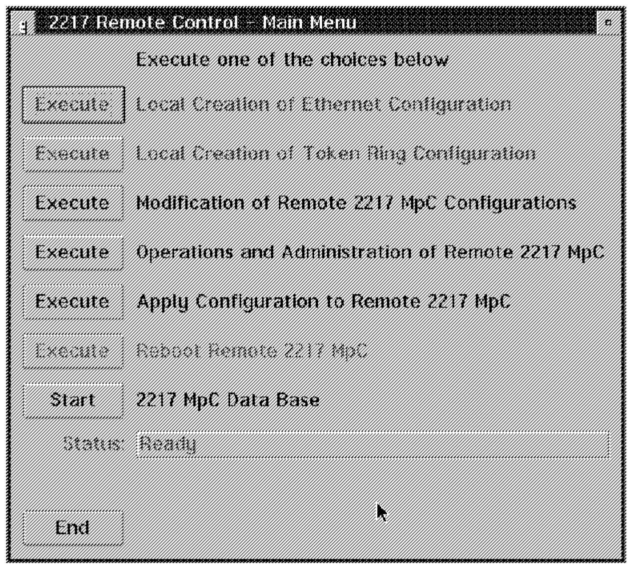


Figure 165. RCU Main Menu

To configure the 2217, select **Modification of Remote 2217 MpC Configurations**, select **Execute** and enter the following values:

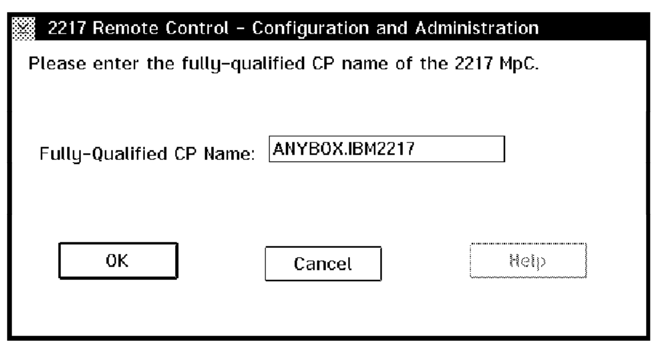


Figure 166. RCU Configuration and Administration

Once you select **OK** the RCU program will use the CM/2 link station to establish several LU 6.2 sessions with the 2217 to upload the current configuration files onto the workstation.

In order to check the current status of the LU 6.2 sessions, perform the following:

1. Select the **Communications Manager/2** icon.
2. Select **Communications Manager Setup**.

3. Select **Subsystem Management**.
4. Select **LU 6.2 Sessions**.

The following panel should be displayed showing the LU 6.2 session status:

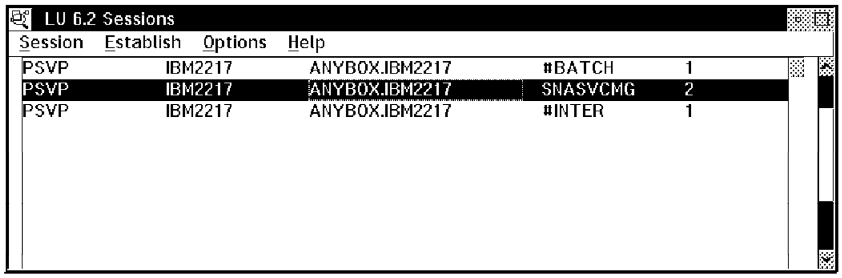


Figure 167. CM/2 LU 6.2 Sessions During RCU Configuration

The loading of the configuration files from the 2217 will take several minutes. After the loading is complete, the following panel will be displayed:

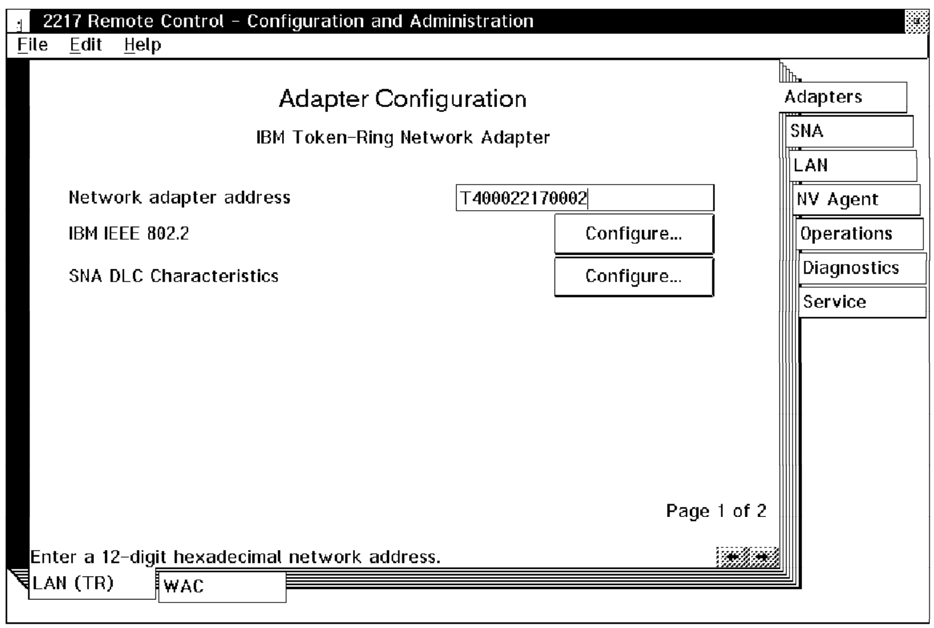


Figure 168. RCU Configuration and Administration Main Menu

Note: Initially, the previous panel will show an adapter address of 40002217FFFF.

We can now use the RCU to configure the 2217.

Chapter 16. IBM 2217 as a LAN/WAN Gateway

The objectives of this scenario are as follows:

- To interconnect two token-ring LAN segments using IBM 2217 MpCs
- To set up an APPN Network with the IBM 2217 MpCs as APPN network nodes
- To transport TCP/IP, NetBIOS, IPX and SNA traffic via the IBM 2217 LAN interconnection

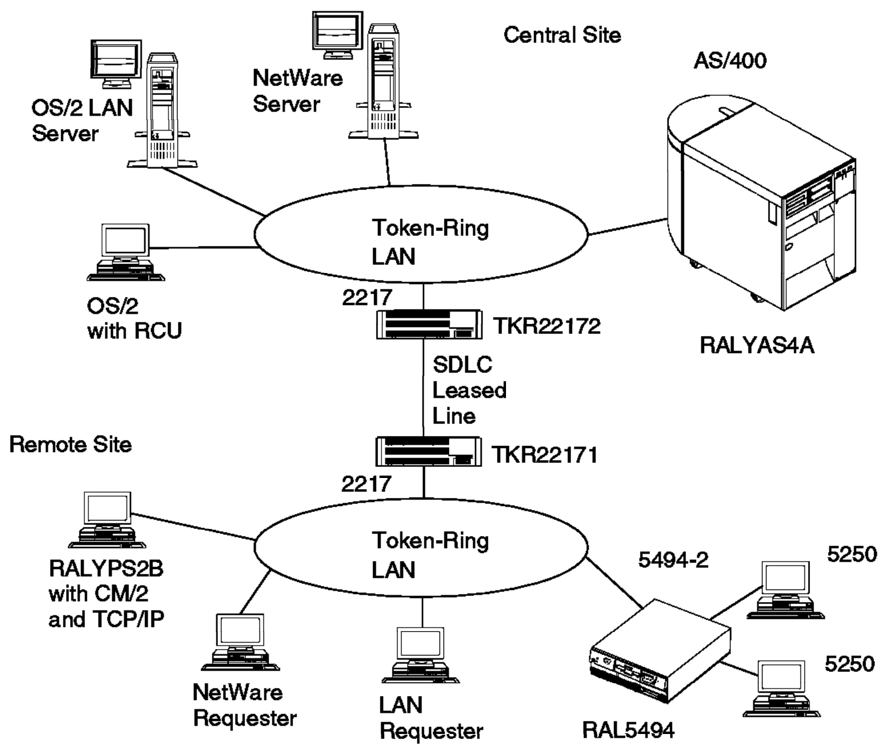


Figure 169. IBM 2217 as Multiprotocol Concentrator and LAN/WAN Gateway

The program to configure the IBM 2217 MpCs is called Remote Control Utility (RCU), and it runs on an OS/2 workstation.

This next section gives an overview of our test network and the hardware and software involved.

16.1 Hardware/Software Involved

- IBM 2217 Multiprotocol Concentrators, Model 200

  Equipped with token-ring LAN adapters and WAN adapters

- OS/2 workstation used to configure the IBM 2217 MpC

  OS/2 V2.1

  Communications Manager/2 V1.11

  Remote Control Utility (RCU)

- WAN Link between MpCs

  The speed of the connection is 9.6 Kbps.

  We used IBM 5866-2 modems.

- LAN Multi-Access Units

  – IBM 8228s used to build token-ring LAN segments

- OS/2 LAN requester and server
- NetWare requester and server
- AS/400 System

  With OS/400 V3R1, OS/400 includes SNA and TCP/IP support.

- 5494-2

  With microcode release 3.0 installed

- PS/2 Workstation

  – OS/2 V2.1

  – Communications Manager/2 V1.11

  – OS/2 TCP/IP V2.0

16.1.1 Changing the Preconfigured Values

Prior to configuring the 2217 for the multiprotocol network, we changed the preconfigured token-ring address, SNA network ID and SNA local node name. Similar configurations must be done on both 2217s (TKR22171 and TKR22172). However, we only show the configuration panels for TKR22172. To change the preconfigured values, perform the following:

1. Change the Network Adapter Address to the required MAC Address from the initial configuration panel as shown in Figure 170.

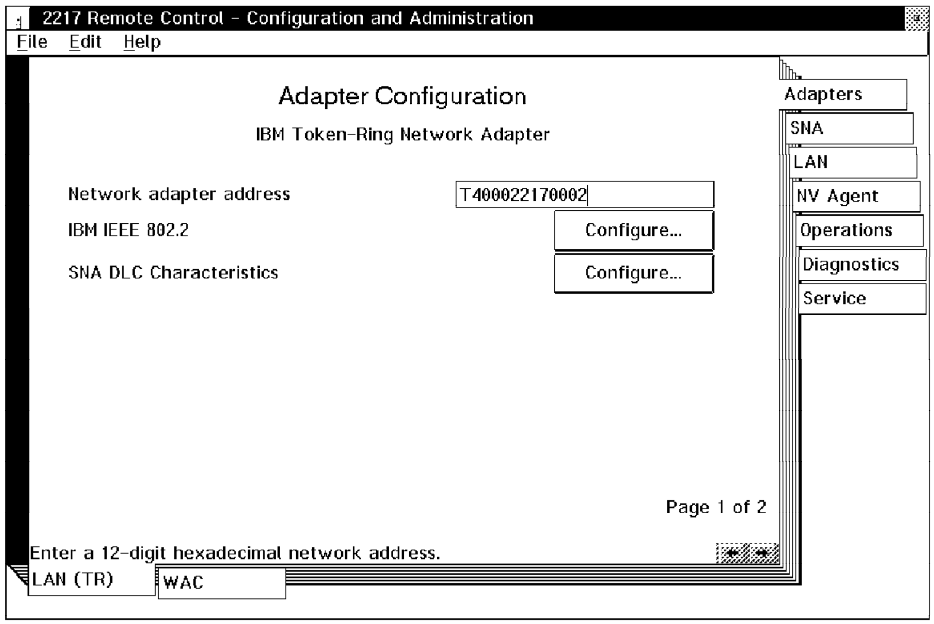


Figure 170. RCU Configuration and Administration Main Menu

2. Select **SNA**.

3. Change the Network ID and Node Name fields to the required values as in the following example:

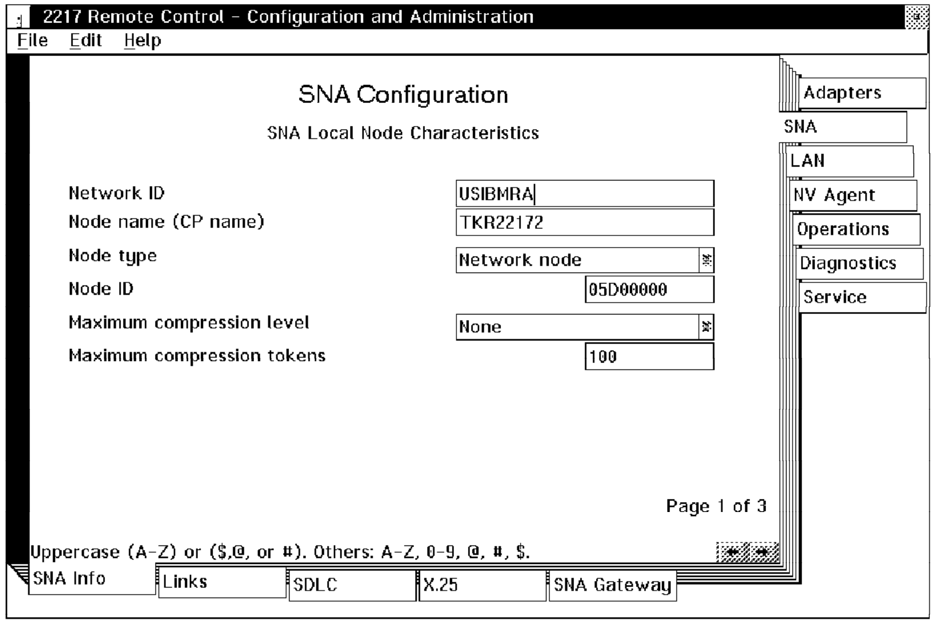


Figure 171. RCU SNA Local Node Configuration

:.*

4. Select **File** and **Save and Close**.
5. Select **Yes** to save this configuration to disk.
6. Select **Yes** to apply this configuration on the remote 2217.
7. Select **Yes** to reboot the remote 2217.

The 2217 will now reboot and reinitialize with the new values.

You will now have to repeat the steps described in 15.1.1, "Configuration of RCU Workstation CM/2 for a New IBM 2217" on page 200 to create a new CM/2 definition which reflects the new values that you have coded.

We can now build the required multiprotocol configuration.

16.2 Configuring the IBM 2217 for the Multiprotocol Network

Here we show the configuration required to support APPN, TCP/IP, NetBIOS and IPX via the 2217 backbone. You need to plan your network in advance for all four protocols (for example, decide on naming and addressing strategies).

You can configure all four protocols in a single configuration run through, or you can do each protocol individually and test each in turn. Here we configure all four and then do a single application. Similar configurations must be done on both 2217s (TKR22171 and TKR22172). However, we only show the configuration panels for TKR22172.

This section is divided into four subsections:

- APPN
- TCP/IP
- NetBIOS
- IPX

16.2.1 APPN Part of Network

Figure 172 shows the layout of the APPN network. In this section we will configure the wide area link and configure the 2217 as a network node so that it can do APPN routing.

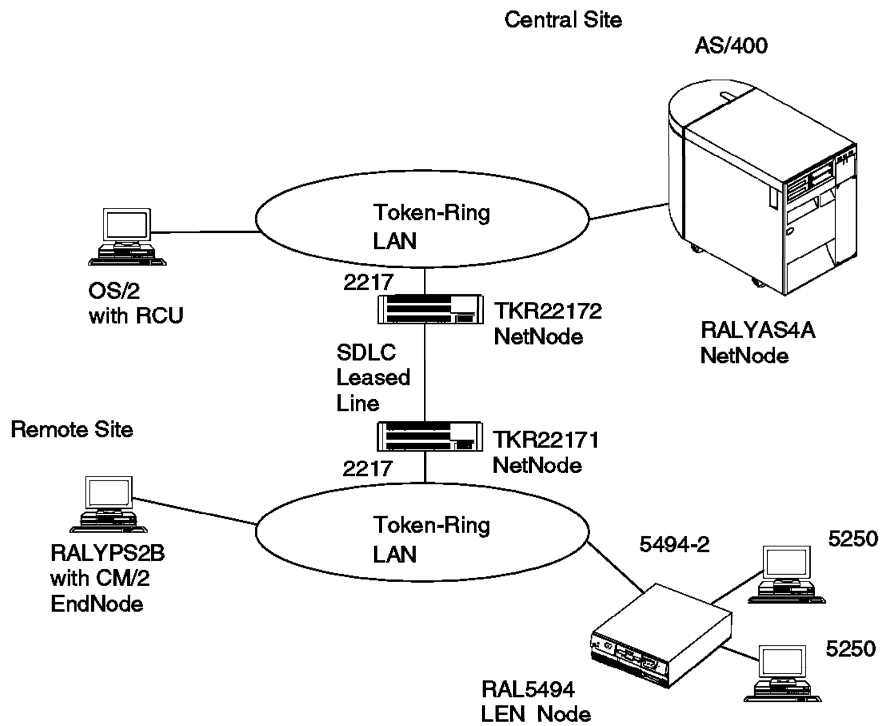


Figure 172. IBM 2217 Multiprotocol Network, APPN Part

The AS/400 configurations for the OS/2 system, 2217 (TKR22172) and 5494 were auto-created and are not shown here.

The 5494 configuration is as shown in 8.3.2, "IBM 5494 Definitions" on page 83. With the exception that in this scenario the H1:5 parameter has a value of 400022170001 which is the MAC Address of TKR22171.

The CM/2 configuration is as shown in 8.3.3, "OS/2 Communications Manager" on page 85. With the exception that in this scenario the network node (your network node) parameter has a value of 400022170001 which is the MAC Address of TKR22171.

With the SNA connection in place between the 2217s, the TCP/IP, NetBIOS and IPX configuration of TKR22171 was carried out via this connection as was the subsequent operation of TKR22171.

First we configure the WAN link between the two 2217s which is an SDLC leased line. Select **Adapters** and then **WAC** to configure the Wide Area Connector (WAC card) for the WAN link. Figure 173 shows the required fields and values we used for our network.

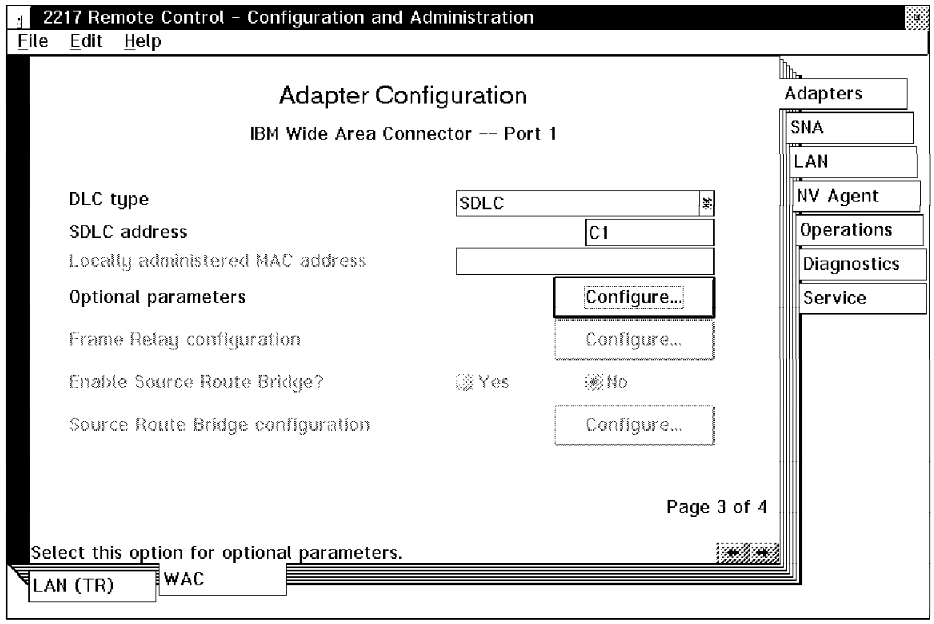


Figure 173. WAC Adapter Port 1 Configuration

Configure the SNA connection (logical link) by selecting **SNA**. Figure 174 shows the required fields with our values. The other 2217 is also a Network Node, and so the value for link type is therefore NN. The permanent connection WAC port = 1 which is the RS232 port on the card. Port 0 is the V.35 port.

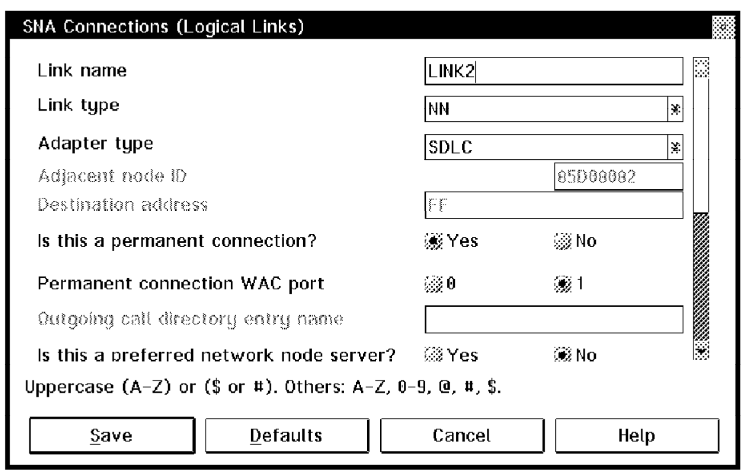


Figure 174. SNA/SDLC Link Configuration

Note: The TKR22171 configurations for RALYPS2B and RAL5494 were auto-created.

16.2.2 TCP/IP Part of Network

The following figure shows the TCP/IP network layout including the IP network and host addresses involved.

The objective is for each TCP/IP host to be able to reach any other host included in this network across the SNA wide area link.

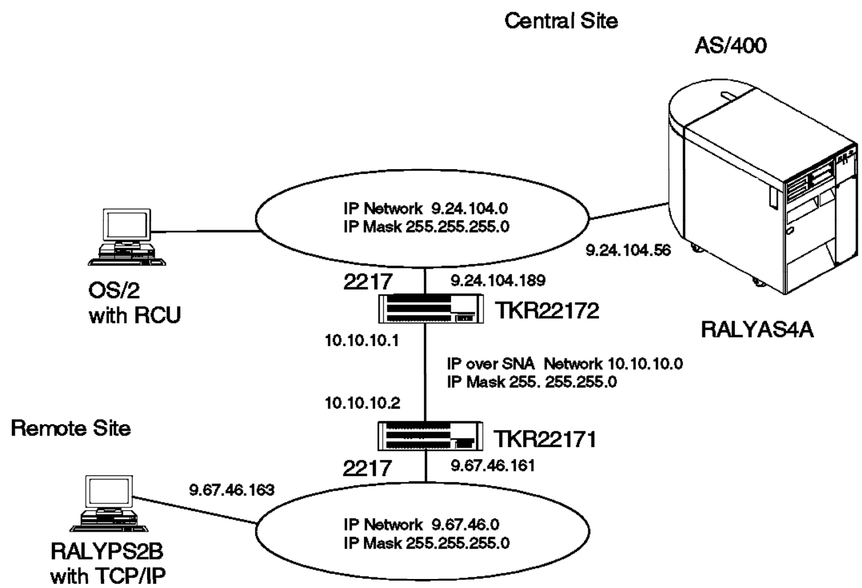


Figure 175. IBM 2217 Multiprotocol Network, TCP/IP Part

First we need to configure the 2217 as a TCP/IP host. Then we configure sockets over SNA which is an implementation of AnyNet and is the function used to transport the IP traffic across the SNA backbone.

To configure TCP/IP, select **LAN** and then **TCP/IP** to get the panel shown in Figure 176. Enable TCP/IP and enter the IP address and subnet mask according to your TCP/IP network plan. You can also assign a host name to this address.

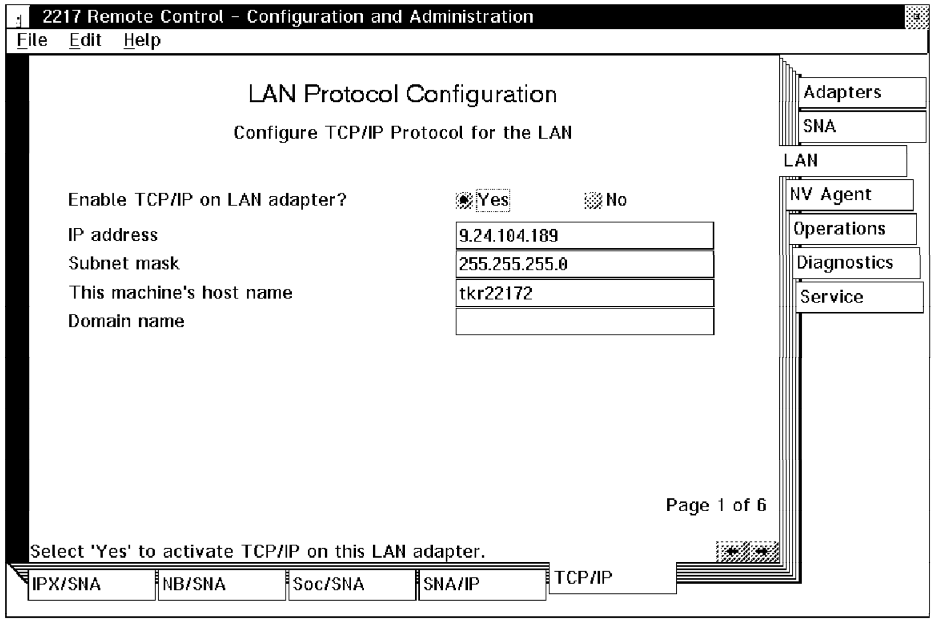


Figure 176. Native TCP/IP Configuration

Select **SOC/SNA** to configure Sockets over SNA. Figure 177 shows the required fields and our values. The Sockets over SNA IP address is the address given to the 2217 for the transport of IP over the SNA connection. This is a virtual IP address for the 2217, it is not associated with a particular LAN/WAN interface. Regardless of how many LAN/WAN interfaces there are, there will only be one Sockets over SNA IP address.

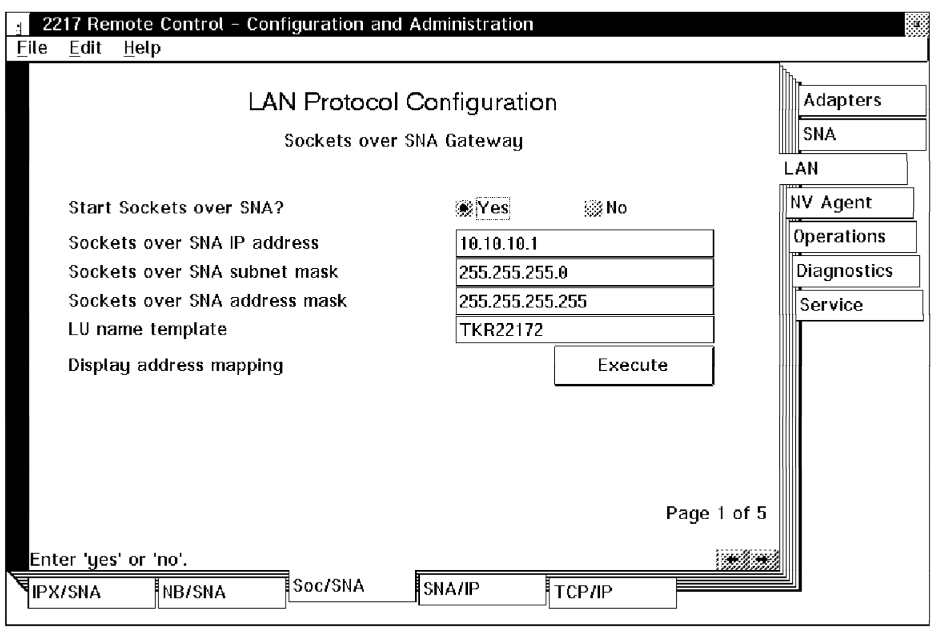


Figure 177. Sockets over SNA Gateway Configuration

For the purpose of AnyNet, we map an LU name to the Sockets over IP address. This LU name will be used by the SNA conversations carrying IP traffic. You can explicitly define the name in the LU name Template field by making the Sockets over SNA address mask 255.255.255.255 as we have done in Figure 177.

If you wish, you can have the system generate the LU name. This is generated from a combination of the IP address and the value specified in the LU Name Template field. The Sockets over SNA address mask defines which bits from the IP address to use in generating the LU name. Where bits are set to zero in the Sockets over SNA address mask, the corresponding bits from the IP address are used in the LU name. The LU name template defines fixed characters within the LU name.

For example, given the following:

```
IP Address                        10.10.10.2
Sockets over SNA address Mask     255.255.255.0
LU name template                  SX......
```

10.10.10.2 maps to LU name SX000002.

Attention: This LU name generation is done for all IP addresses in the virtual Sockets over SNA subnet. For this reason, *all* systems in the same AnyNet virtual subnet for Sockets over SNA must use the same name template and address mask. Otherwise, one 2217 might know itself by one LU name and another one would know it by some other LU name and no conversation could take place.

Page 2 of the SOC/SNA configuration is where you define the remote nodes. Here we defined the second 2217 in our network with an IP address of 10.10.10.2 and an LU name TKR22171, (see Figure 178).

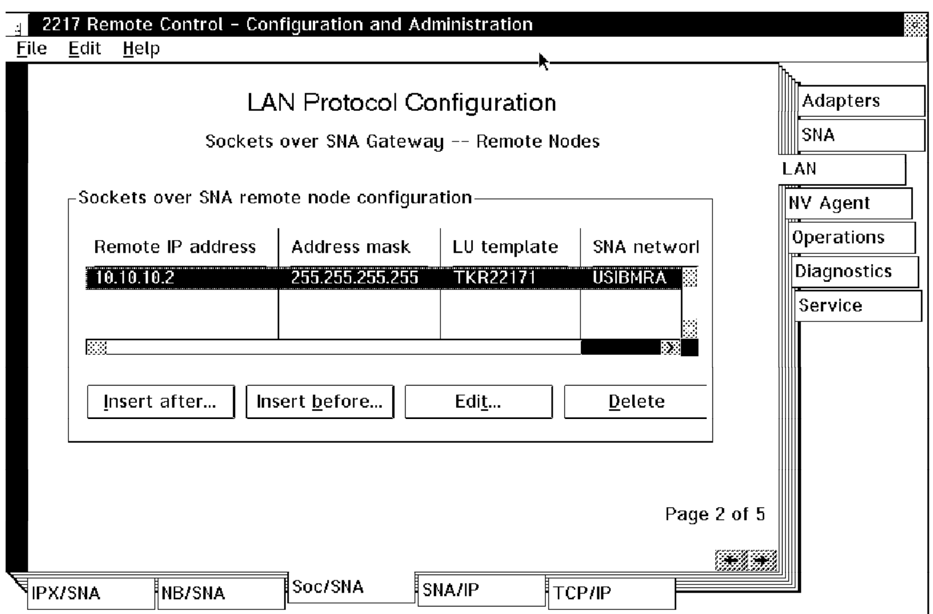


Figure 178. Sockets over SNA, Remote SNA Nodes

Figure 179 shows the static routes we defined.

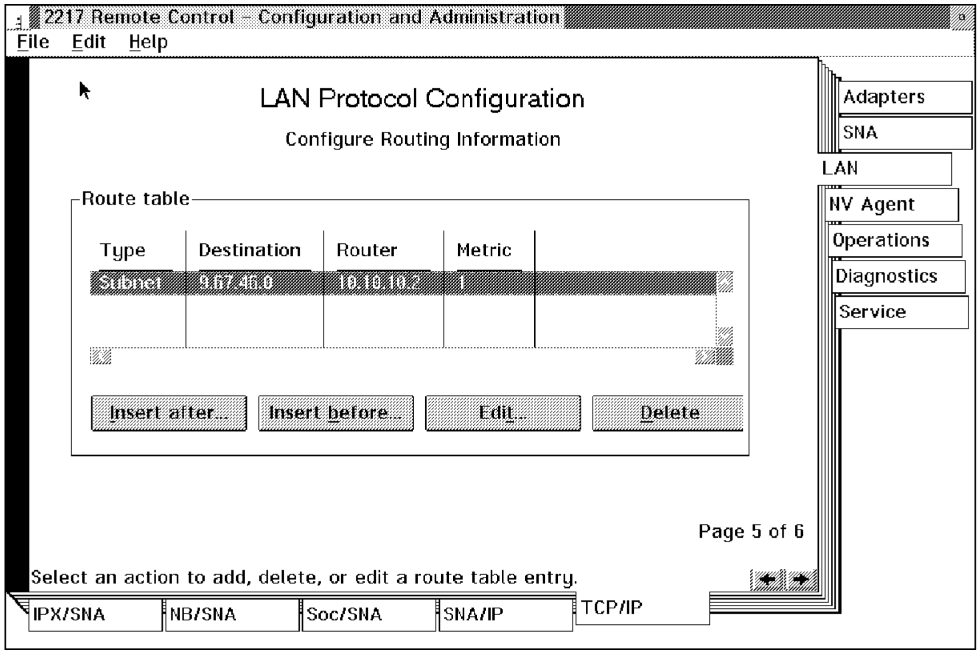


Figure 179. TCP/IP Routing Information

This subnet route table entry directs requests for the 9.67.46.0 network to sockets over SNA by directing the requests to 10.10.10.2 which, in Figure 178 on page 214, is mapped to LU name TKR22171.

The following route configuration was added to RALYAS4A:

```
ADDTCPRTE RTEDEST('9.67.46.0') SUBNETMASK('255.255.255.0') NEXTHOP('9.24.104.189')
```

The OS/2 TCP/IP configuration of RALYPS2B is as follows:

```
Network
   Configure Network Interface Parameters
      Enable LAN Adapter:  0
      IP address:  9.67.46.163
      Subnet Mask:  255.255.255.0
      MTU:  1500

Routing
   Configure Routing Information
      Route Type:  DEFAULT
      Router:  9.67.46.161
```

Figure 180. OS/2 TCP/IP Definitions

16.2.3 NetBIOS Part of Network

Figure 181 shows the layout of the NetBIOS network. NetBIOS is carried over the SNA backbone via the 2217 NetBIOS over SNA Gateway function.

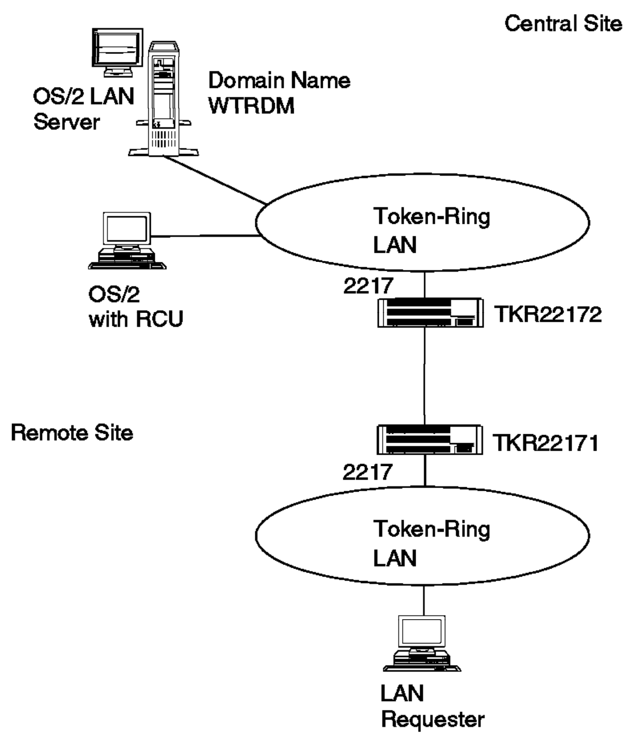


Figure 181. IBM 2217 Multiprotocol Network, NetBIOS Part

The LAN requester and server configurations are not included in this section. No specific configuration changes are required to allow them to work in this scenario.

To configure NetBIOS over SNA, select **LAN** and then **NB/SNA**. Figure 182 shows the first panel presented and our values. For our NetBIOS region name, we have used the 2217 CP name.

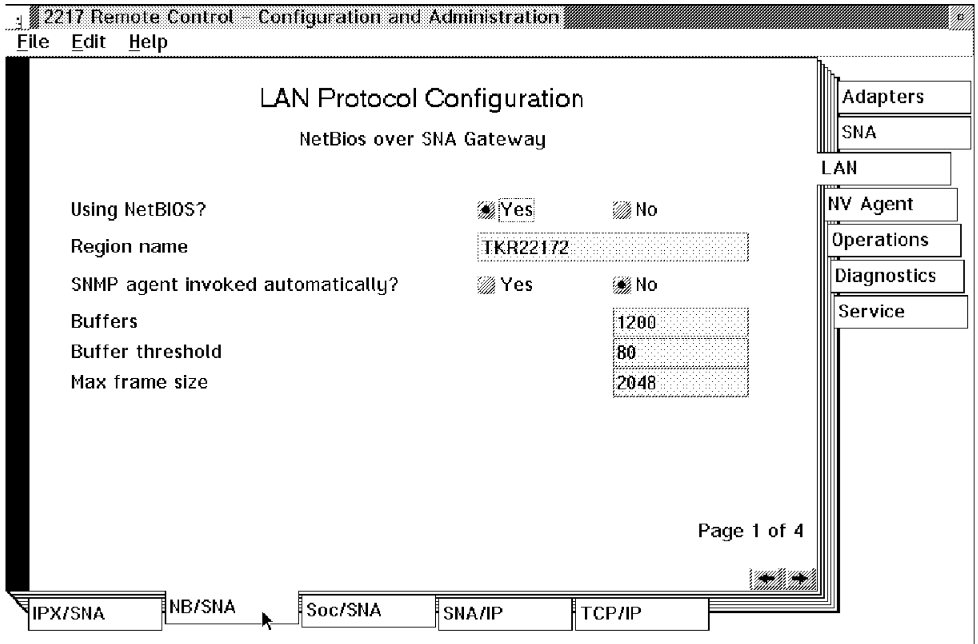


Figure 182. NetBIOS over SNA Gateway

For NetBIOS traffic to flow over SNA, a partner SNA LU name must be configured. This is the other 2217 and is configured using NB/SNA page 3 (as shown in Figure 183).

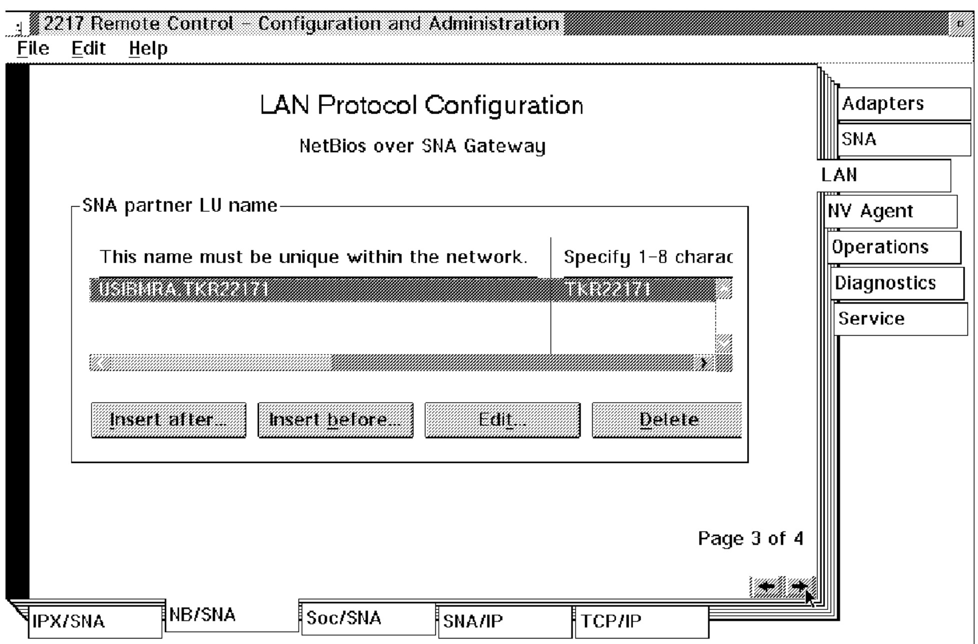


Figure 183. NetBIOS over SNA Gateway, Partner LU

Local NetBIOS servers and domains that are to be accessed via the SNA connection must be configured in the name qualifiers list. To give access to server WTRDM, we entered a name qualifier of WTR as shown in Figure 184.

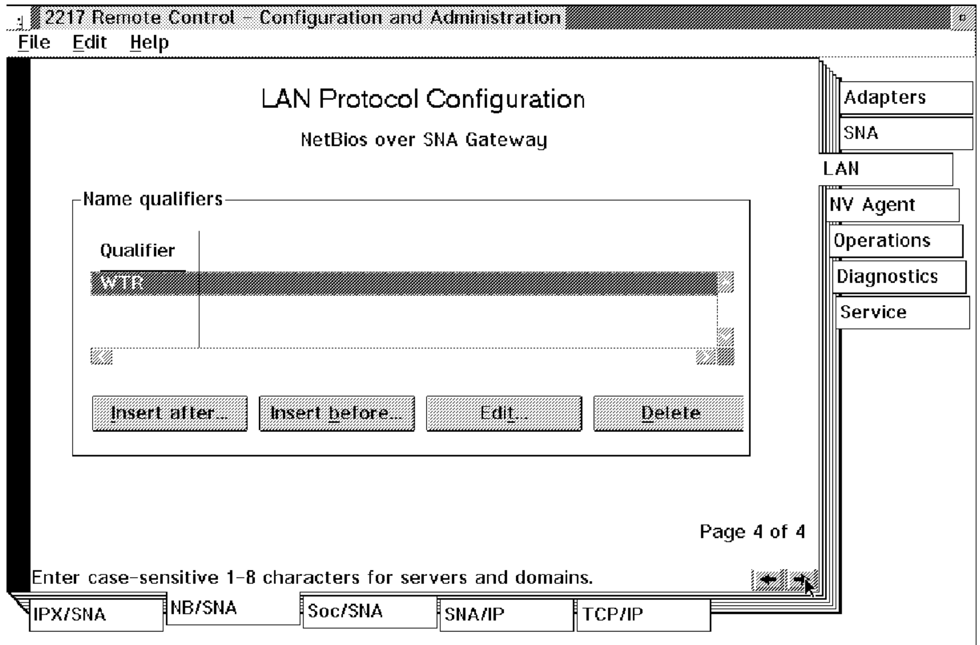


Figure 184. NetBIOS over SNA Gateway, Name Qualifiers

TKR22172 will send the above name qualifier list to its partner 2217s. In this way, TKR22171 will learn that requests for resources starting with the characters WTR should be routed to TKR22172.

16.2.4 IPX Part of Network

Figure 185 shows the layout of the IPX network. IPX is carried over the SNA backbone via the IPX over SNA Gateway function.

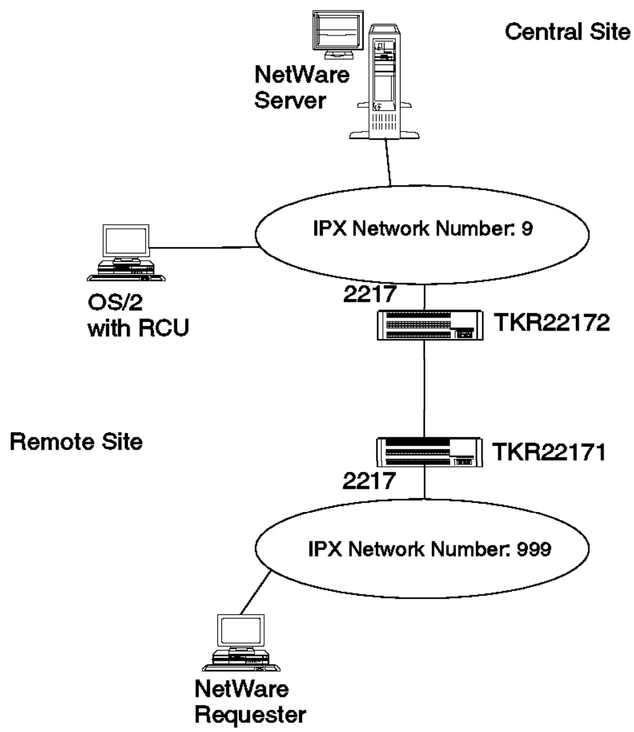


Figure 185. IBM 2217 Multiprotocol Network, IPX Part

The NetWare requester and server configurations are not included in this section. No specific configuration changes are required to allow them to work in this scenario.

To configure IPX, select **LAN** and then **IPX/SNA**. You will get the panel shown in Figure 186. Select which IPX protocol stack you wish to use and specify the IPX Network ID.

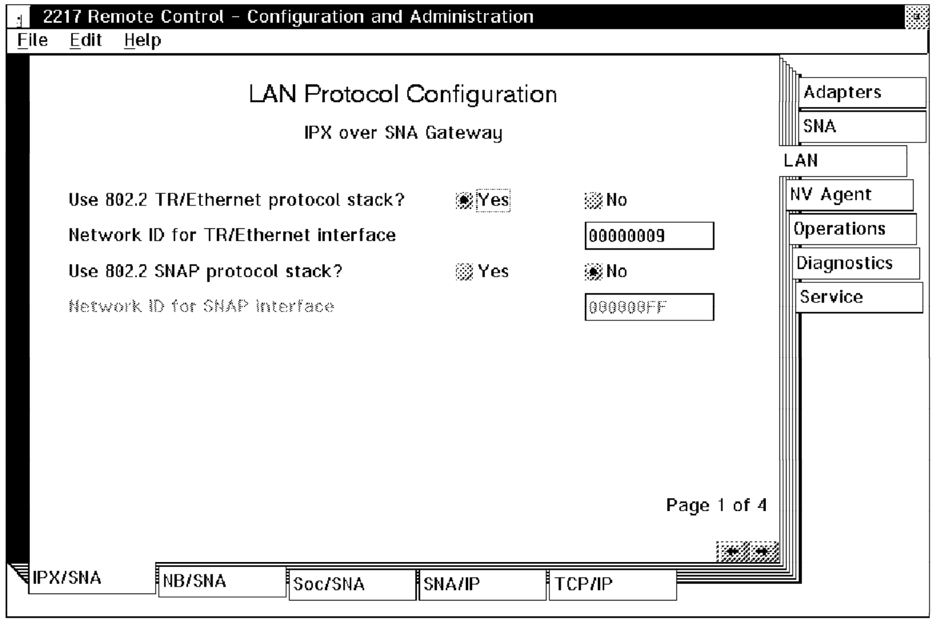


Figure 186. IPX over SNA Gateway

Move to page 3 and add the SNA partner for IPX which is the other 2217. Figure 187 shows the required fields and the values we used in our network. This is the minimum requirement for transport of IPX over the SNA backbone.

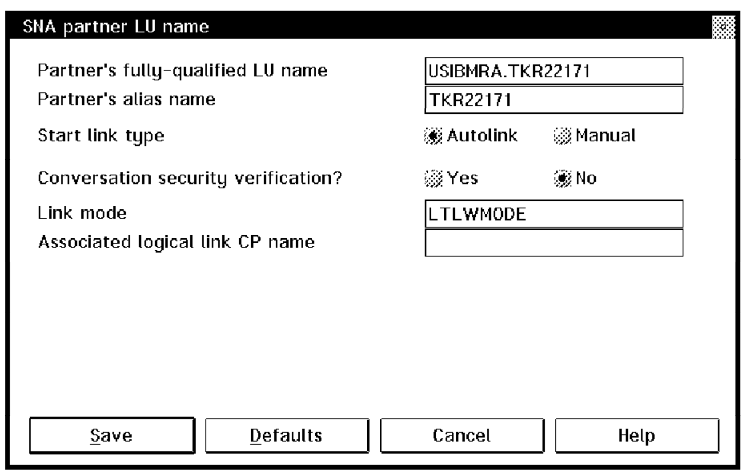


Figure 187. SNA Partner LU Name for IPX

The NetWare server will be advertised to all 2217s. In this way, TKR22171 will learn of the server resources associated with TKR22172.

16.2.5 Saving and Applying the Configuration

Now that the four protocols have been configured, click on the top left corner and select **Save**. You will then get the prompt shown in Figure 188. Select **Yes** to apply the configuration to the 2217. When the configuration has been applied, restart the 2217 from the RCU. You will get a prompt for this.

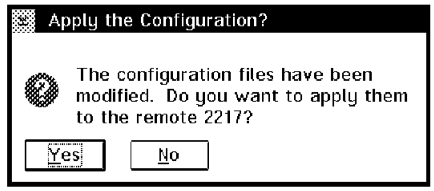


Figure 188. Do You Want to Apply the Configuration?

Chapter 17. IBM 2217 as Multiprotocol Network Concentrator

The objectives of this scenario are as follows:

- To interconnect two 2217 MpCs via an existing APPN network
- To transport TCP/IP, NetBIOS, IPX and SNA traffic via the IBM 2217 LAN interconnection

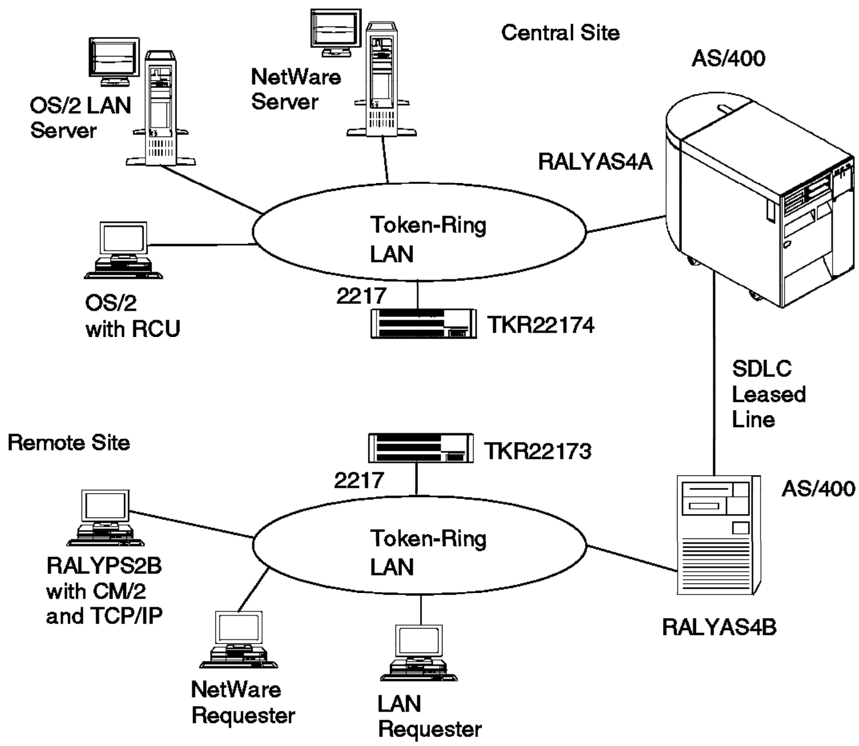


Figure 189. IBM 2217 as Multiprotocol Concentrator

The program to configure the IBM 2217 MpCs is called Remote Control Utility (RCU), and runs on an OS/2 workstation.

This next section gives an overview of our test network and the hardware and software involved.

17.1 Hardware/Software Involved

- IBM 2217 Multiprotocol Concentrators, Model 200

  Equipped with token-ring LAN adapters and WAN adapters
- OS/2 workstation used to configure the IBM 2217 MpC

  OS/2 V2.1

  Communications Manager/2 V1.11

  Remote Control Utility (RCU)
- LAN Multi-Access Units
  - IBM 8228s used to build token-ring LAN segments
- OS/2 LAN requester and server
- NetWare requester and server
- AS/400 System

  With OS/400 V3R1, OS/400 includes SNA and TCP/IP support.
- PS/2 Workstation
  - OS/2 V2.1
  - Communications Manager/2 V1.11
  - OS/2 TCP/IP V2.0

17.1.1 Changing the Preconfigured Values

Prior to configuring the 2217 for the multiprotocol network, we changed the preconfigured token-ring address, SNA network ID and SNA local node name. Similar configurations must be done on both 2217s (TKR22173 and TKR22174). However, we only show the panels for TKR22174. To change the preconfigured values, perform the following:

1. Change the Network Adapter Address to the required MAC Address from the initial configuration panel as shown in Figure 190.

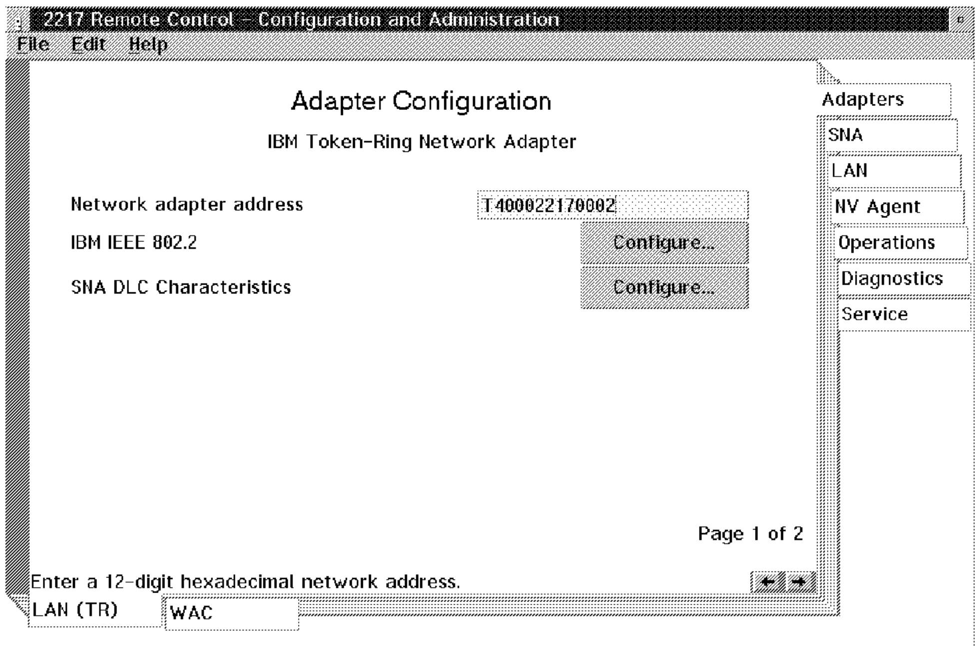


Figure 190. IBM Token-Ring Network Adapter

2. Select **SNA** and change the Network ID and Node Name fields to the required values as in the following example:

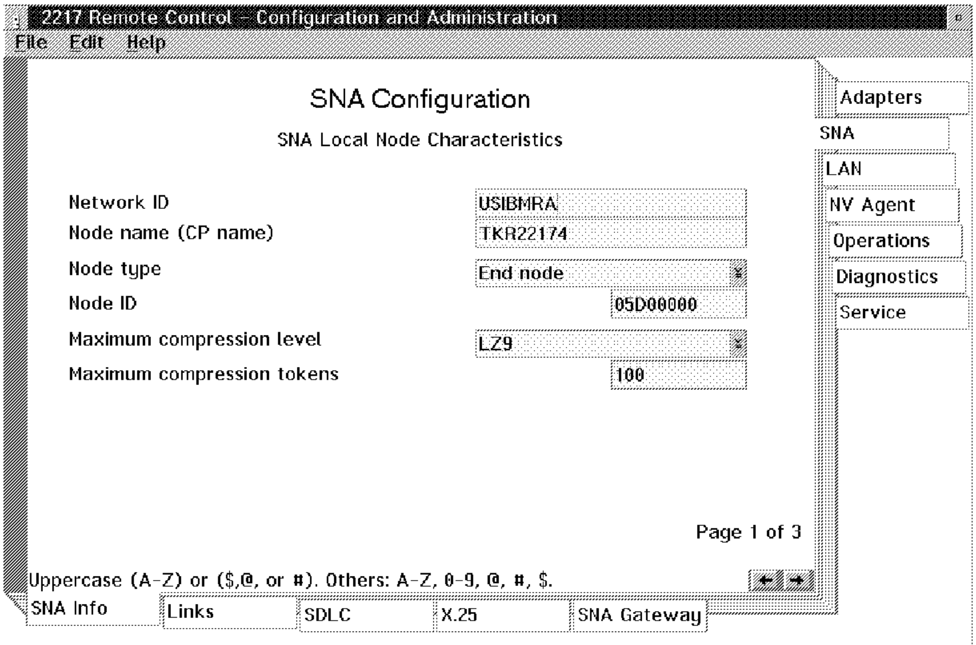


Figure 191. SNA Local Node Characteristics

Note that in this scenario we have configured the 2217 as an APPN End node.

3. Select **File** and **Save and Close**.
4. Select **Yes** to save this configuration to disk.
5. Select **Yes** to apply this configuration on the remote 2217.
6. Select **Yes** to reboot the remote 2217.

The 2217 will now reboot and reinitialize with the new values.

You will now have to repeat the steps as described in 15.1.1, “Configuration of RCU Workstation CM/2 for a New IBM 2217” on page 200 to create a new CM/2 definition which reflects the new values that you have coded.

We can now build the required multiprotocol configuration.

17.2 Configuring the IBM 2217 for the Multiprotocol Network

Here we will show the configuration required to support APPN, TCP/IP, NetBIOS and IPX using a 2217 multiprotocol concentrator. You need to plan your network in advance for all four protocols (for example, decide on naming and addressing strategies).

You can configure all four protocols in a single configuration run through, or you can do each protocol individually and test it in turn. Here we configure all four and then do a single application. Similar configurations must be done on both 2217s (TKR22173 and TKR22174). However, we only show the panels for TKR22174.

This section is divided into four subsections:

- APPN
- TCP/IP
- NetBIOS
- IPX

17.2.1 APPN Part of Network

Figure 192 shows the layout of the APPN network. In this section we will configure an APPN link between the 2217 (TKR22174) and RALYAS4A where the AS/400 is the 2217′s network node server. The APPN connection between the AS/400s is already in place.

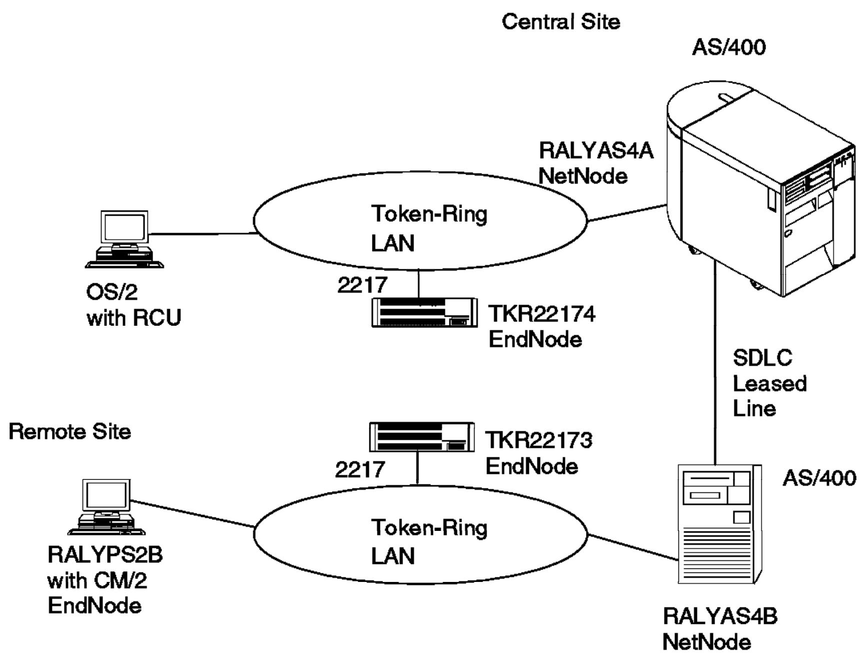


Figure 192. IBM 2217 Multiprotocol Network, APPN Part

The AS/400 configurations for the 2217s and OS/2 workstation were auto-created and are not shown here.

With the SNA connection in place between TKR22173 and RALYAS4B, the TCP/IP, NetBIOS and IPX configuration of TKR22173 was carried out via the APPN network (via RALYAS4A and RALYAS4B) as was the subsequent operation of TKR22173.

First we configure the Logical Link between the 2217 and AS/400. Select **SNA** and then **Links** to configure the link. To add a definition, select **Edit** and you will be presented with the first Logical Link panel. Figure 193 shows the panel presented and the values we used for our network.

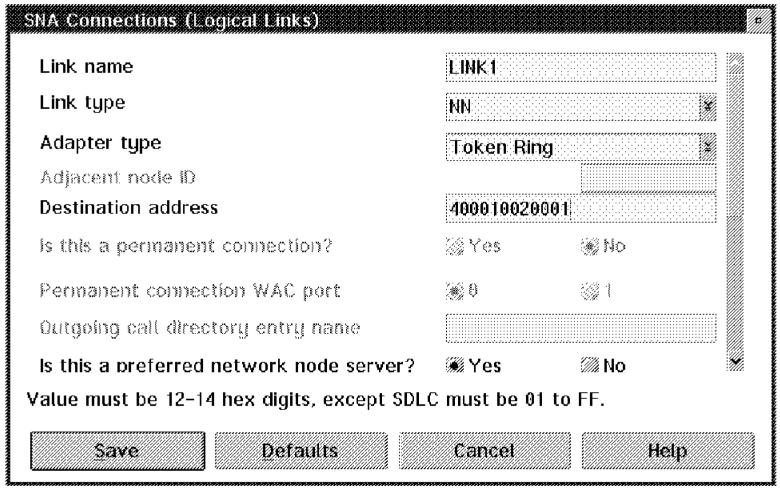


Figure 193. SNA Logical Links, 1 of 2

The AS/400 is an APPN network node hence we have selected a link type of NN. 400010020001 is the MAC address of RALYAS4A.

Scroll down to display further options as shown in Figure 194.

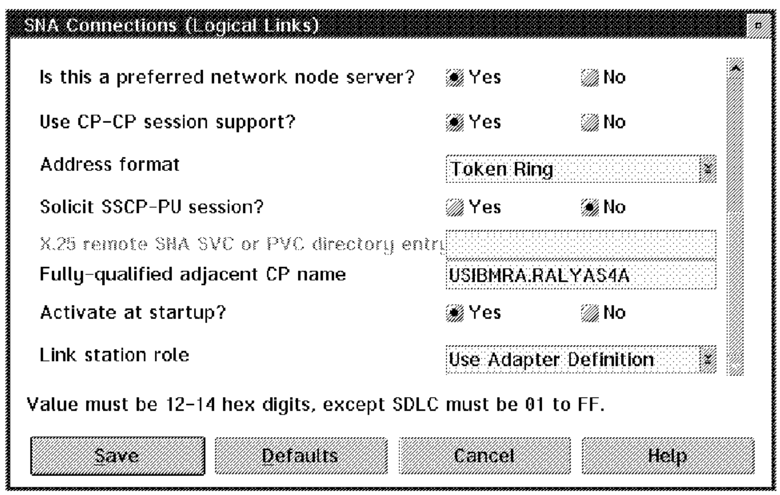


Figure 194. SNA Logical Links, 2 of 2

Here we define RALYAS4A as the preferred network node server for this 2217 (TKR22174) and specify that CP-CP session support is required.

17.2.2 TCP/IP Part of Network

The following figure shows the TCP/IP network layout as well as the IP network and host addresses involved.

The objective is for each TCP/IP host to be able to reach any other host included in this network across the SNA wide area link.

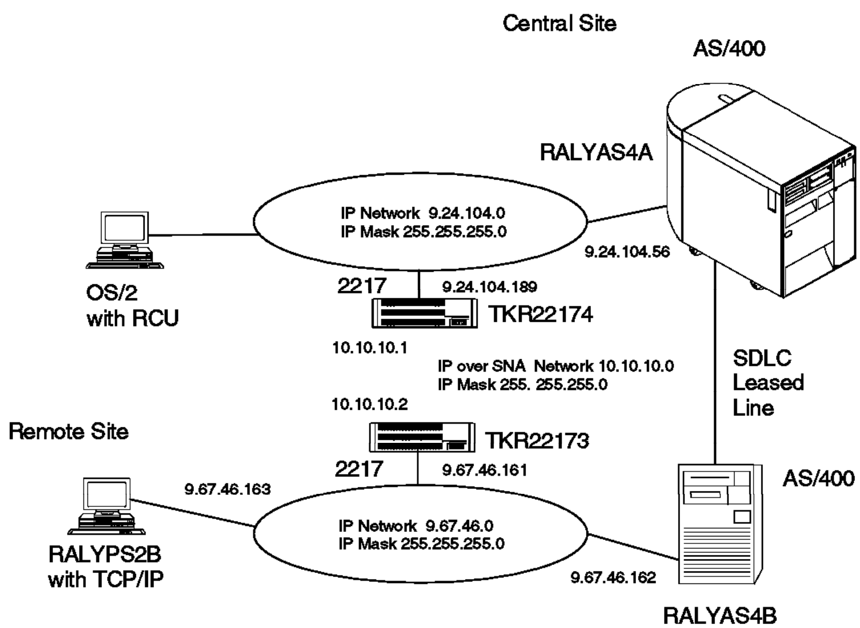


Figure 195. IBM 2217 Multiprotocol Network, TCP/IP Part

First we need to configure the 2217 as a TCP/IP host. Then we configure Sockets over SNA, which is an implementation of AnyNet and is the function used to transport the IP traffic across the SNA backbone.

To configure TCP/IP, select **LAN** and then **TCP/IP** to get the panel shown in Figure 196. Enable TCP/IP and enter the IP address and subnet mask according to your TCP/IP network plan. You can also assign a host name to this address.

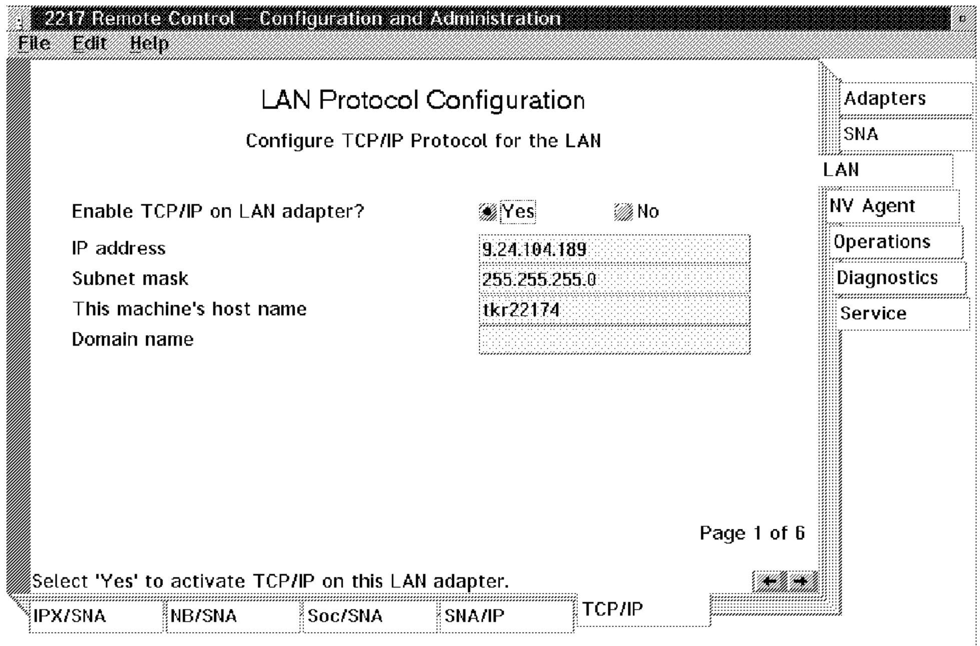


Figure 196. Native TCP/IP Configuration

Select **SOC/SNA** to configure Sockets over SNA. Figure 197 shows the required fields and our values. The Sockets over SNA IP address is the address given to the 2217 for the transport of IP over the SNA connection. This is a virtual IP address for the 2217, it is not associated with a particular LAN/WAN interface. Regardless of how many LAN/WAN interfaces there are, there will only be one Sockets over SNA IP address.

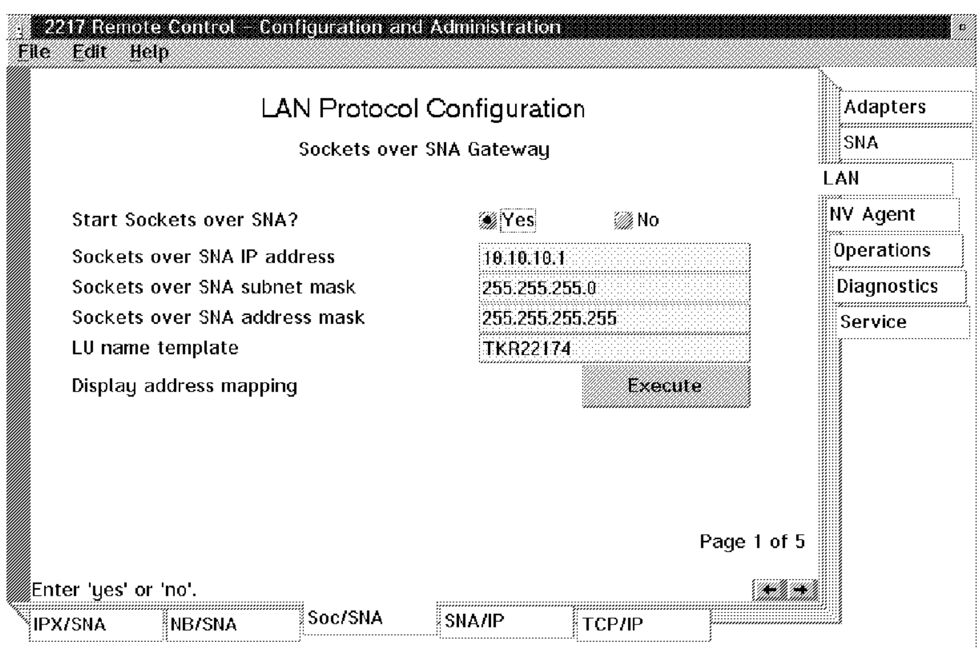


Figure 197. Sockets over SNA Gateway Configuration

For the purpose of AnyNet, we map an LU name to the Sockets over IP address. This is the LU name used in SNA conversations carrying IP traffic. You can explicitly define the name in the LU Name Template field by making the Sockets over SNA address mask 255.255.255.255 as we have done in Figure 197.

If you wish, you can have the system generate the LU name. This is generated from a combination of the IP address and the value specified in the LU Name Template field. The Sockets over SNA address mask defines which bits from the IP address to use in generating the LU name. Where bits are set to zero in the Sockets over SNA address mask, the corresponding bits from the IP address are used in the LU name. The LU name template defines fixed characters within the LU name.

For Example, given the following:

```
IP Address                       10.10.10.2
Sockets over SNA address Mask    255.255.255.0
LU name template                 SX......
```

10.10.10.2 maps to LU name SX000002.

Attention: This LU name generation is done for all IP addresses in the virtual Sockets over SNA subnet. For this reason, *all* systems in the same AnyNet virtual subnet for Sockets over SNA, must use the same name template and address mask. Otherwise, one 2217 might know itself by one LU name and another one would know it by some other LU name and no conversation could take place.

Page 2 of the SOC/SNA configuration is where you define the remote nodes. Here we defined the second 2217 in our network with an IP address of 10.10.10.2 and an LU name TKR22173 (see Figure 198).

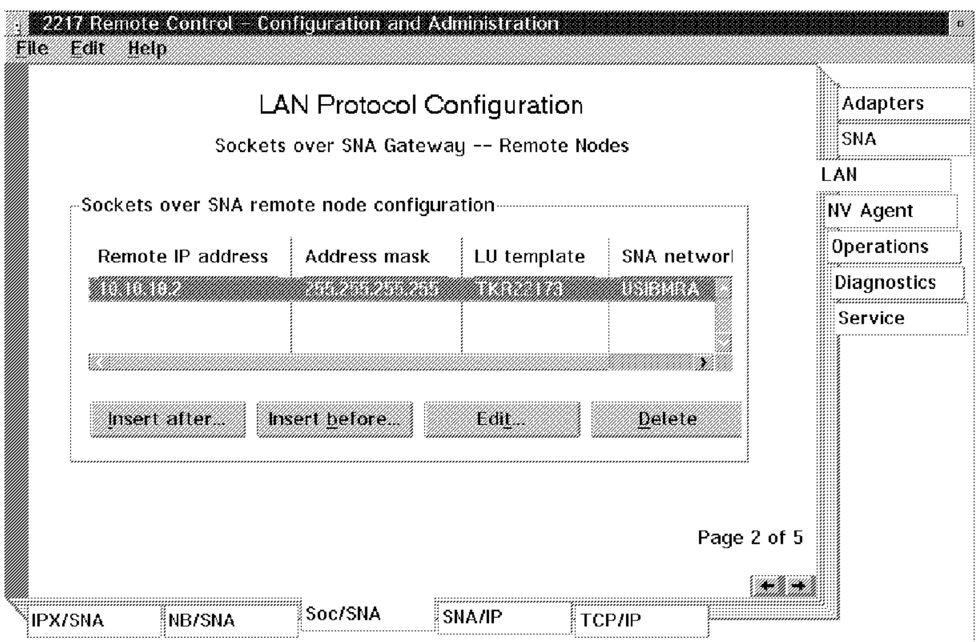


Figure 198. Sockets over SNA, Remote Nodes

Figure 199 shows the static routes we defined.

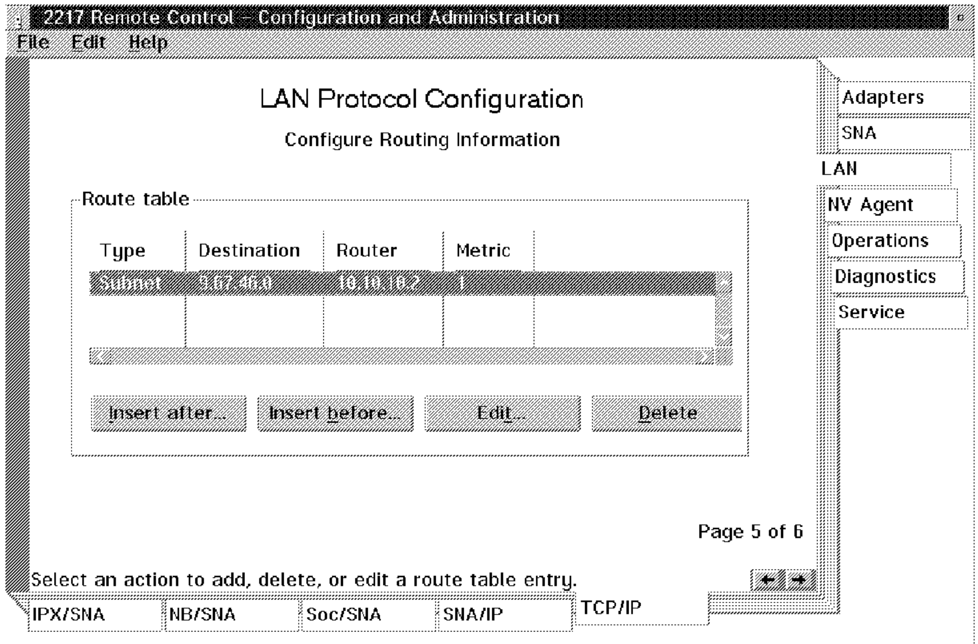


Figure 199. TCP/IP Routing Information

This subnet route table entry directs requests for the 9.67.46.0 network to Sockets over SNA by directing the requests to 10.10.10.2 which, in Figure 198 on page 232, is mapped to LU name TKR22173.

The following route configurations were added to RALYAS4A and RALYAS4B:

RALYAS4A:

```
ADDTCPRTE RTEDEST('9.67.46.0') SUBNETMASK('255.255.255.0') NEXTHOP('9.24.104.189')
```

RALYAS4B:

```
ADDTCPRTE RTEDEST(*DFTROUTE) SUBNETMASK(*NONE) NEXTHOP('9.67.46.161')
```

The OS/2 TCP/IP configuration of RALYPS2B is as follows:

```
Network
   Configure Network Interface Parameters
      Enable LAN Adapter:  0
      IP address:  9.67.46.163
      Subnet Mask:  255.255.255.0
      MTU:  1500

Routing
   Configure Routing Information
      Route Type:  DEFAULT
      Router:  9.67.46.161
```

Figure 200. OS/2 TCP/IP Definitions

17.2.3 NetBIOS Part of Network

Figure 201 shows the layout of the NetBIOS network. NetBIOS is carried over the SNA backbone via the 2217 NetBIOS over SNA Gateway function.

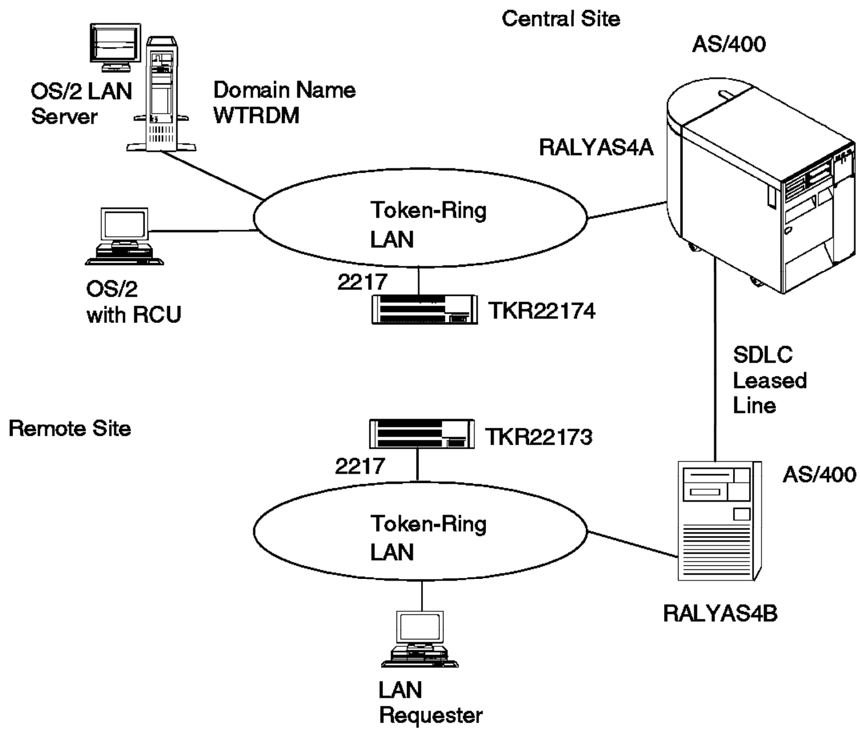


Figure 201. IBM 2217 Multiprotocol Network, NetBIOS Part

The LAN requester and server configurations are not included in this section. No specific configuration changes are required to allow them to work in this scenario.

To configure NetBIOS over SNA, select **LAN** and then **NB/SNA**. Figure 202 shows the first panel presented and our values. For our NetBIOS region name, we have used the 2217 CP name.

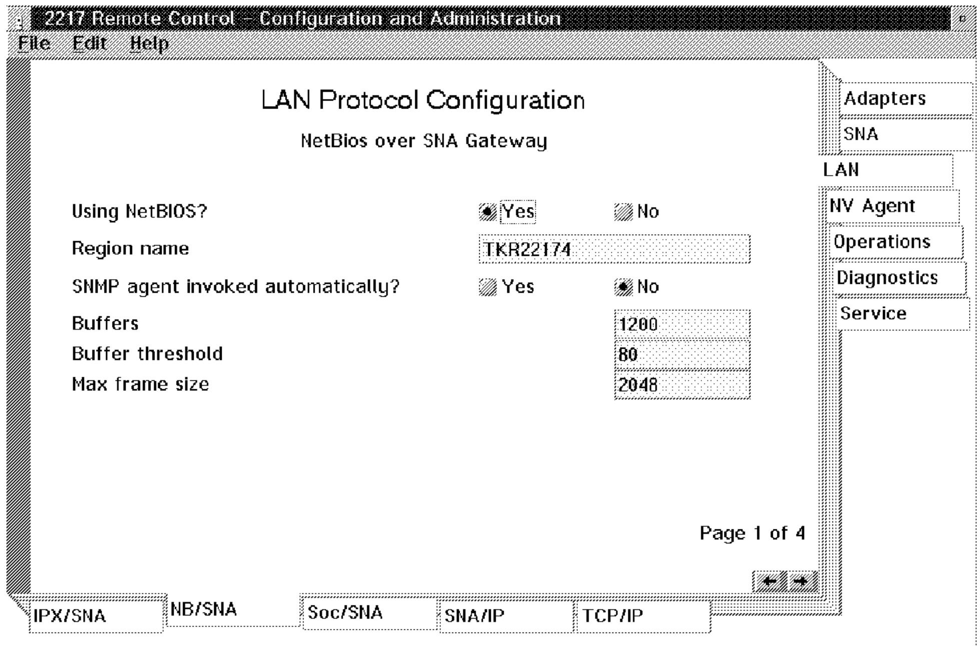


Figure 202. NetBIOS over SNA Gateway

For NetBIOS traffic to flow over SNA, a partner SNA LU name must be configured. This is the other 2217 and is configured using NB/SNA page 3 (as shown in Figure 203). The edit panel is shown here.

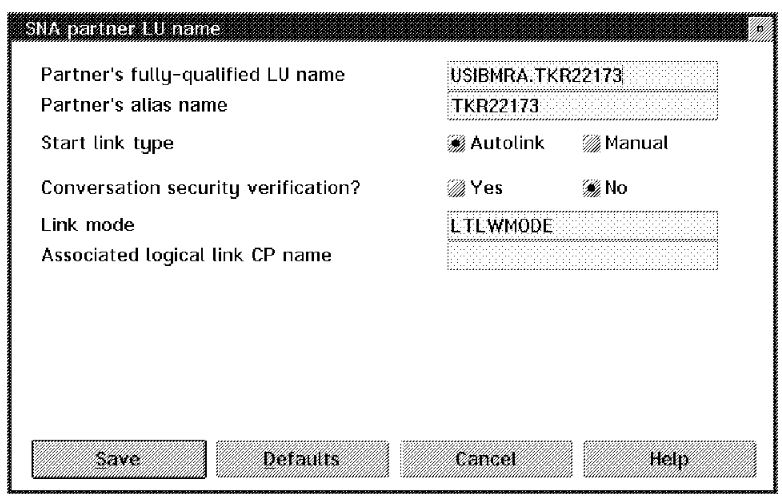


Figure 203. NetBIOS over SNA Gateway, Partner LU

Local NetBIOS servers and domains that are to be accessed via the SNA connection must be configured in the name qualifiers list. To give access to server WTRDM, we entered a name qualifier of WTR as shown in Figure 204.

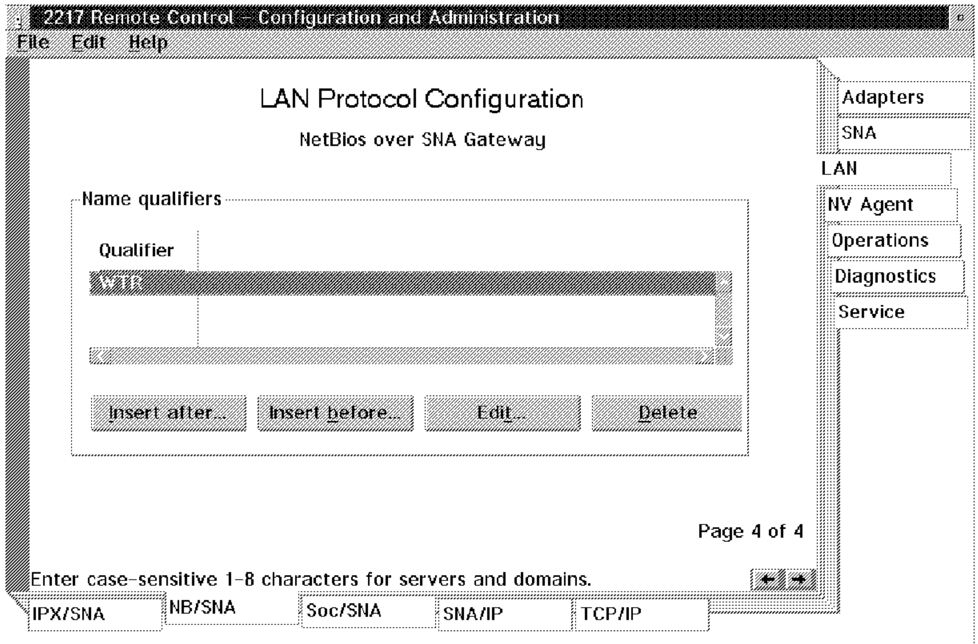


Figure 204. NetBIOS over SNA Gateway, Name Qualifiers

TKR22174 will send the above name qualifier list to its partner 2217s. In this way, TKR22173 will learn that requests for resources starting with the characters WTR should be routed to TKR22174.

17.2.4 IPX Part of Network

Figure 205 shows the layout of the IPX network. IPX is carried over the SNA backbone via the 2217 IPX over SNA Gateway function.

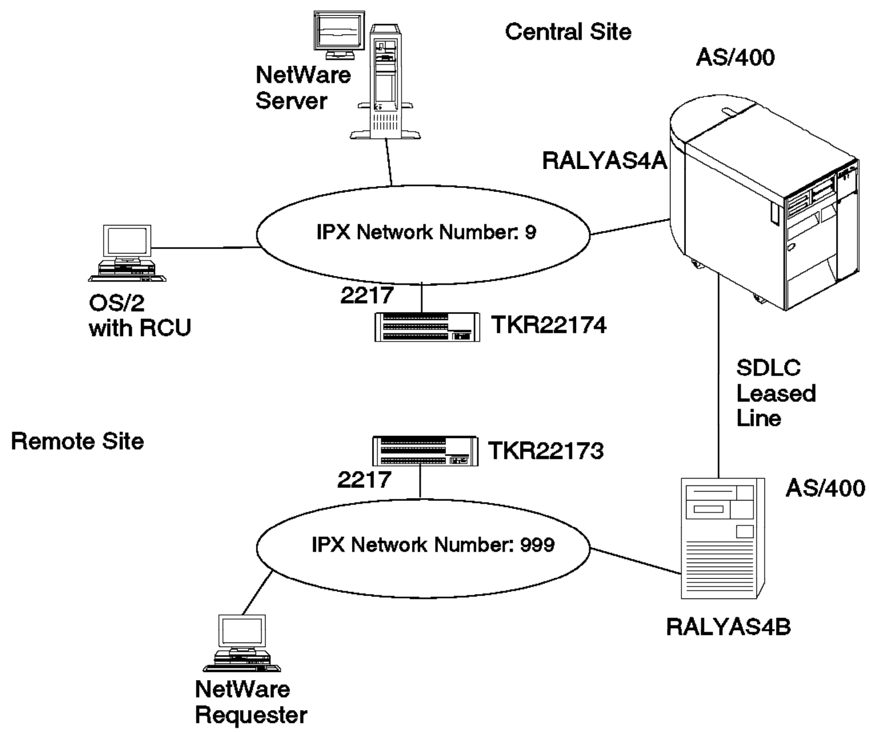


Figure 205. IBM 2217 Multiprotocol Network, IPX Part

The NetWare requester and server configurations are not included in this section. No specific configuration changes are required to allow them to work in this scenario.

To configure IPX, select **LAN** and then **IPX/SNA**. You will get the panel shown in Figure 206. Select which IPX protocol stack you wish to use and specify the IPX Network ID.

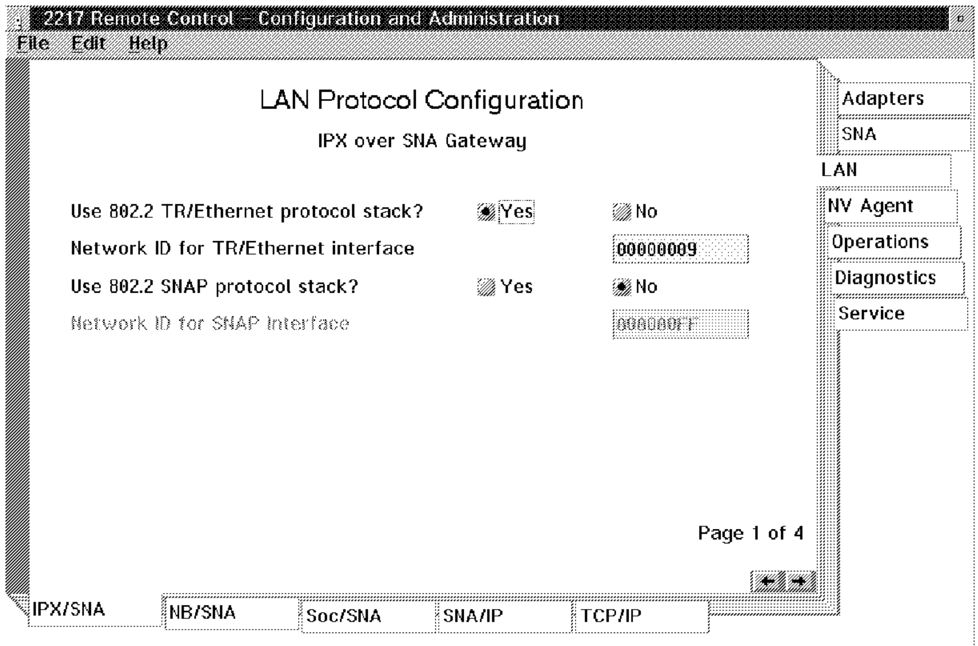


Figure 206. IPX over SNA Gateway Configuration

Move to page 3 and add the SNA partner for IPX which is the other 2217. Figure 207 shows the required fields and the values we used in our network. This is the minimum requirement for transport of IPX over the SNA backbone.

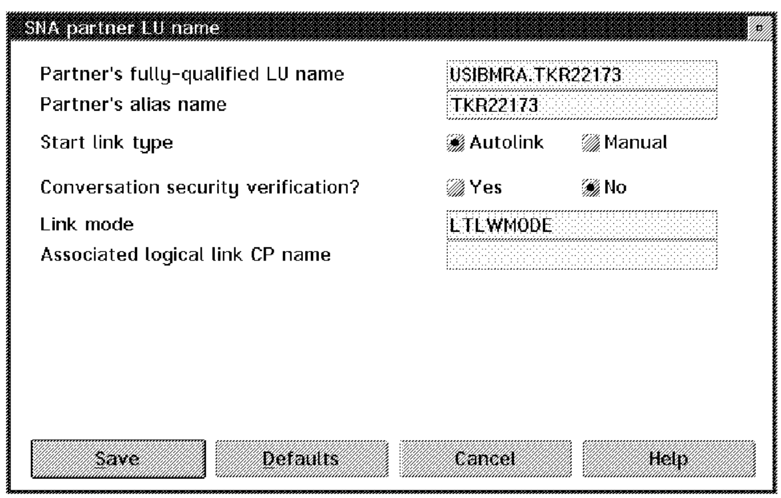


Figure 207. IPX over SNA Gateway, Partner LU

The NetWare server will be advertised to all 2217s. In this way, TKR22173 will learn of the server resources associated with TKR22174.

17.2.5 Saving and Applying the Configuration

Now that the four protocols have been configured, click on the top left corner and select **Save**. You will then get the prompt shown in Figure 208. Select **Yes** to apply the configuration to the 2217. When the configuration has been applied, restart the 2217 from the RCU. You will get a prompt for this.

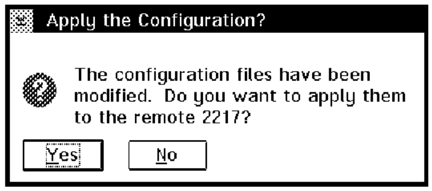


Figure 208. Do You Want to Apply the Configuration?

Chapter 18. IBM 2217 Operation

The IBM 2217 Remote Control Utility (RCU) offers many different functions to operate and control the IBM 2217 MpC. The operational panels for the 2217 RCU are organized by protocol and function. Figure 209 and Figure 210 show only two examples out of the many different possibilities.

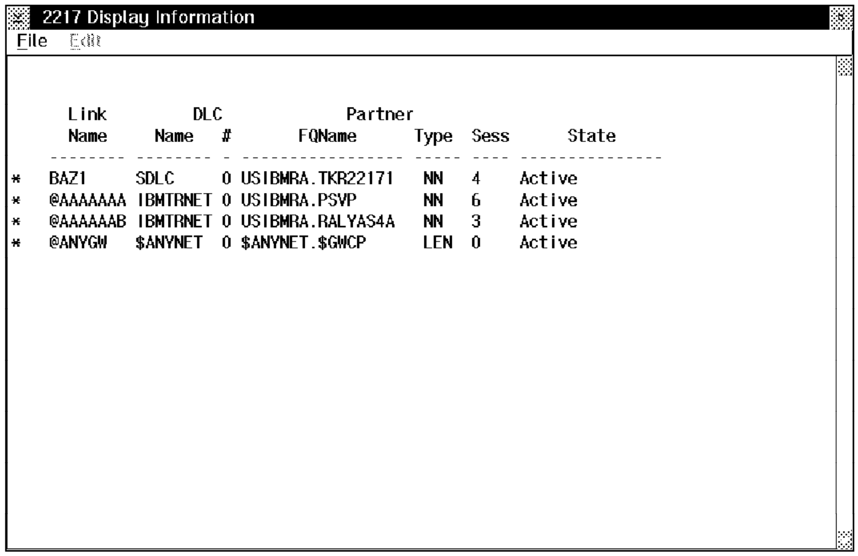


Figure 209. 2217 SNA Link Station Status

Figure 209 shows the status of the APPN links and the number of active LU 6.2 sessions.

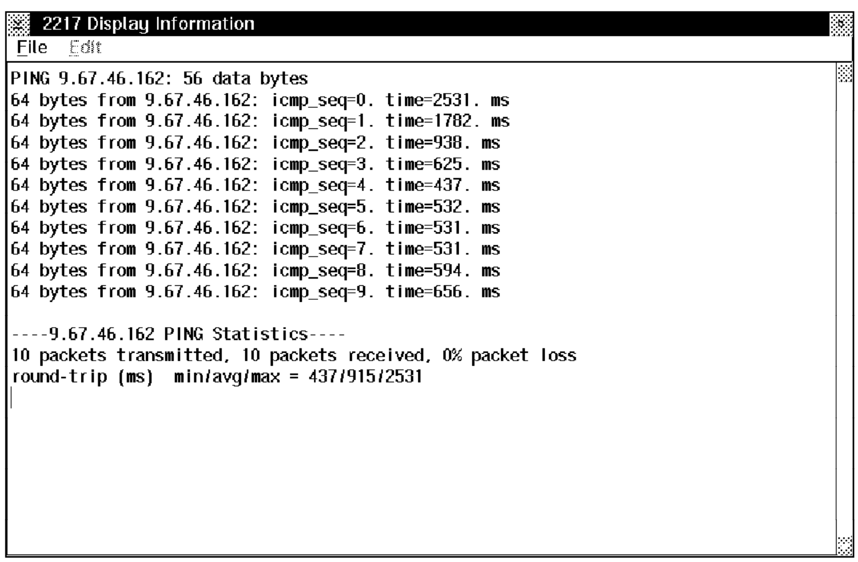


Figure 210. TCP/IP PING Function of IBM 2217

Figure 210 shows the result of a remote PING that was issued from the RCU workstation.

Part 4. Additional Considerations

Part 4 contains additional considerations, particularly for router-based multiprotocol networks. The section includes a chapter on providing backup in router-based networks and a chapter on performance considerations for router-based networks.

Chapter 19. X.25 Support in Router Networks

The question often arises, ″How do I integrate my X.25 devices in router networks?″ If we already have some X.25 devices, for example, PADs that require network connectivity, how do we support these within a router network?

Generally, router products do not provide full X.25 support. Both the IBM 2210 and IBM 6611 provide the X.25 DTE function which allows them to connect to X.25 services but not to function as an X.25 switch. They, therefore, do not allow easy integration of X.25 devices at a customer site.

Two noticeable exceptions to this are the Cisco 25xx and the BBN T10 range. Both of these routers provide extensive X.25 DCE and DTE support that supports simple integration of X.25 devices into router networks. Both of these products provide X.25 tunnelling in IP, that is, X.25 encapsulation in IP and transport across an IP network. This is shown in the following diagram:

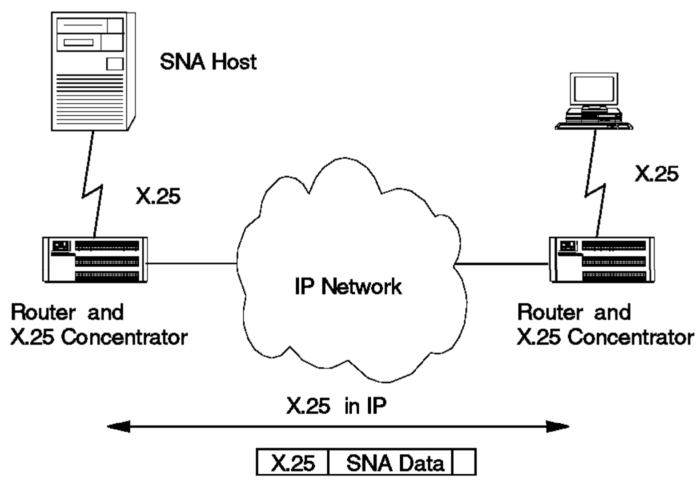


Figure 211. X.25 Support in Router Networks

Both products can also be used to route IP natively. This means that they can be attached to the LAN at the customer site and route IP traffic between sites as well as be used to provide X.25 concentrator functions.

Chapter 20. LAN Dial Access to AS/400

A fast growing scenario is that of providing remote workstation access to a central AS/400. This is the kind of scenario where installing dedicated switching hardware and circuits is not economic. For example, it may be used to support home working.

One possible solution to this situation is the IBM 8235 Dial-In Access to LANs (DIALs) system. The IBM 8235 allows single workstations to dial into a central LAN-attached server and access resources on that LAN using the following protocols:

- SNA
- NetBIOS
- IP
- IPX
- Appletalk

The following example illustrates this configuration:

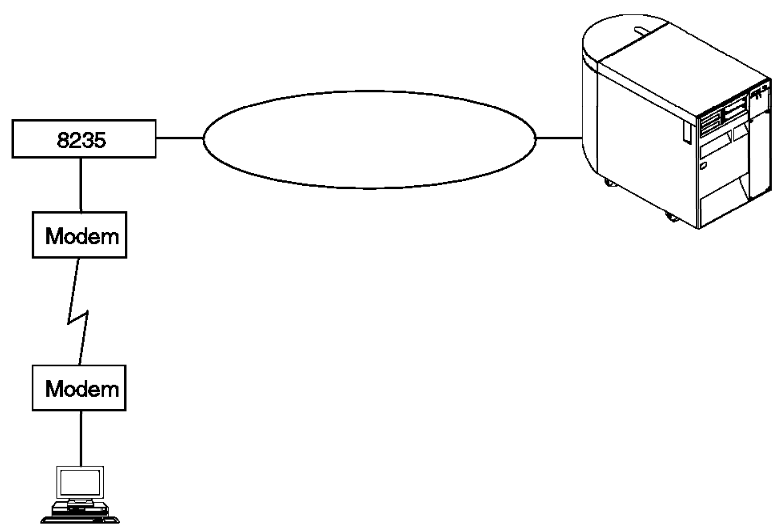


Figure 212. 8235 Dial-In Access to LANs

The remote workstation requires installation of Dial-In Access to LANs (DIALs) Client which is supported under OS/2, DOS and Windows environments. The 8235 server allows the remote workstation to use the central LAN services as if it were directly attached to the local LAN.

Client Access/400 and TELNET 5250 are both supported for access to the AS/400.

The 8235 server supports inbound asynchronous dial-in at up to 115.2 Kbps if compression is used on the modems and it has up to eight V.24 ports.

The IBM 8235 can also be used for LAN to LAN traffic as well as the workstation to LAN traffic shown in this scenario.

Chapter 21. Providing Backup in Router Networks

This chapter deals with the provision of backup in router-based networks. This backup can be provided at different levels including physical link, node backup and dynamic protocol backup.

To assist us in examining each of the techniques, we looked at a sample network consisting of three sites: one central site (site A) and two remote sites (sites B and C).

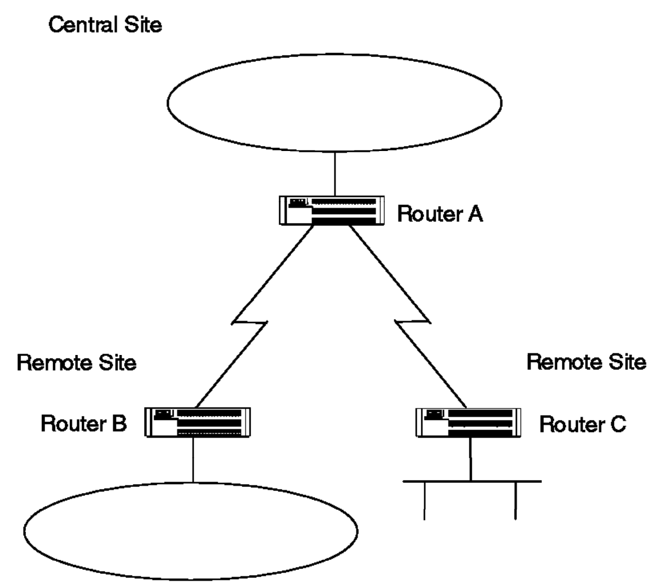


Figure 213. Basic Router Network: The Minimum Configuration for a Network

Figure 213 shows the simplest network that could be used to link together the three sites. While this network will satisfy the basic protocol requirements, it suffers from the following potential problem areas:

1. Failure of the telecommunications link(s)
2. Failure of router ports
3. Failure of routers

In the following sections in this chapter, we will look at ways to provide backup for each of these using a variety of different techniques and facilities.

21.1 ISDN Circuit Backup

Telecommunications failures are probably the most common point of failure within networks and are the cause of the most network down time.

ISDN backup provides a simple form of link level backup available at the least cost. The most straightforward way of achieving this is to simply provide automatic backup for the circuit by placing an ISDN call around a failed circuit, and switch the router devices to use it. Once the circuit has been repaired, the mechanism should switch back to using the leased line and drop the ISDN call.

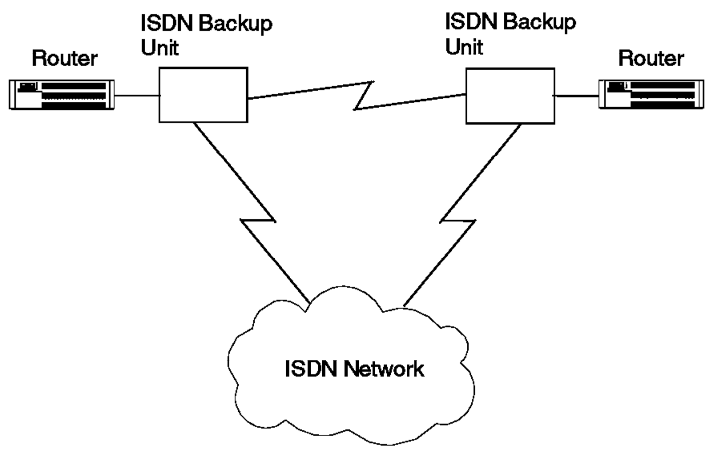


Figure 214. ISDN Link Backup: The Simplest Form of Link Backup

The IBM 2210 supports such a scenario automatically with its WAN Restoral function (WRS) and integrated ISDN adapter (which is available on certain models). We should note, however, that the automated ISDN backup is only available on the 2210 when using PPP as the layer two protocol. Please see 22.2.3, "WAN Restoral Feature (WRS) - Dial Backup" on page 261 and 22.2.4, "Dial on Demand" on page 261 for a discussion of the IBM 2210 dial support. When using frame relay or the IBM 6611, other techniques must be used which involve the use of external ISDN Backup units. These units are placed between the router and the circuit and continuously monitor the line to check for failures. In the event of circuit failure, they will automatically place the call and switch over the devices to use ISDN once the call is connected. Once the circuit has been re-established, they switch back and the call is dropped.

The major advantages of this kind of backup are simplicity and cost. No special considerations need to be given to any of the protocols being run because all we are providing is physical backup of the telecommunications circuit.

Going back to our list of events that we wished to protect ourselves from, we have satisfied number 1. We have not yet solved numbers 2 and 3.

21.2 Second Telecommunications Circuit

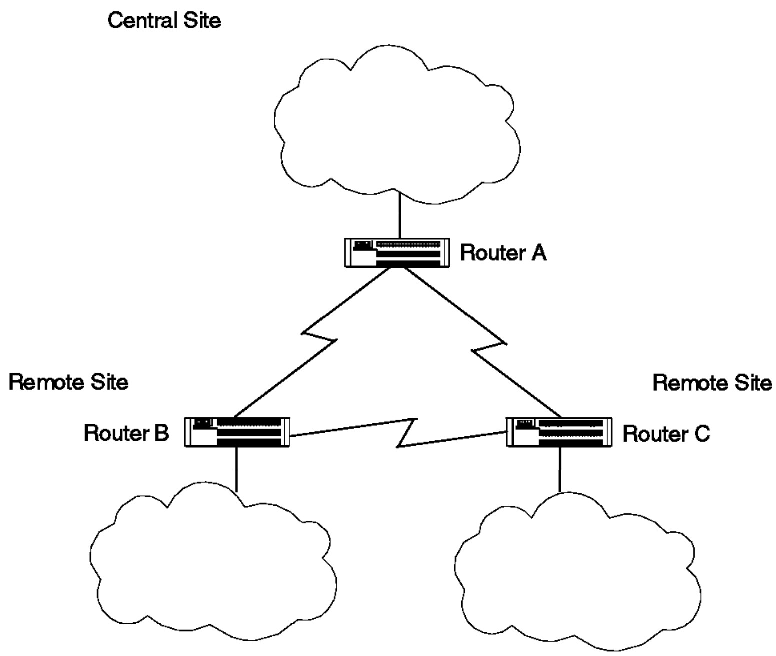


Figure 215. Second Communications Link: Updated Diagram Showing Second Circuit

With this technique, we provide a second circuit between the remote routers as well as the primary circuit into the central site. In the event of the primary circuit failing, we should like to provide automated recovery for each of the protocols. We may also want to use the secondary circuit for traffic between the two remote sites rather than traversing the links to the center.

Let us examine each of the protocols in turn to see which ones will support such a configuration.

21.2.1 IPX

We take IPX first as it is the simplest. The routing mechanisms internal to IPX (such as, the RIP and SAP updates) will automatically route around the failure of one of the links. The route update will normally be triggered by the level two protocol (PPP or frame relay normally) reporting the failure of the link to the IPX protocol.

We should also note that IPX routing (the RIP process) will calculate the optimum route between destinations based upon the number of hops within the network. Therefore in this example (see Figure 215 on page 251) we will route directly between the remote sites for traffic between the two as this is one hop less than the indirect route.

21.2.2 IP and DLSw

IP (and DLSw as it uses IP as transport over the wide area) will reroute around a link failure if a dynamic routing protocol is being used between the routers or LQM. The two most common dynamic routing protocols are RIP (Route Information Protocol) and OSPF (Open Shortest Path First). With static routes and PPP, LQM (Link Quality Monitor) provides a method to re-route dynamically without having to use RIP or OSPF.

21.2.3 Summary

Overall, what does this solution provide us that the simple link level backup does not? In this case, we protect ourselves from link failure (item 1), port failure (item 2) but not router failure (item 3).

Additionally, we also get the benefit of being able to use the second circuit for traffic between the two remote locations rather than having to go to the central site first. The ability to do this is dependant on running routing protocols that allows this kind of configuration. IPX will do this by default, for IP we would again have to use a dynamic routing protocol such as RIP or OSPF.

21.3 Twin Routers

Finally, we look at a more complex solution which introduces a second router at the central site.

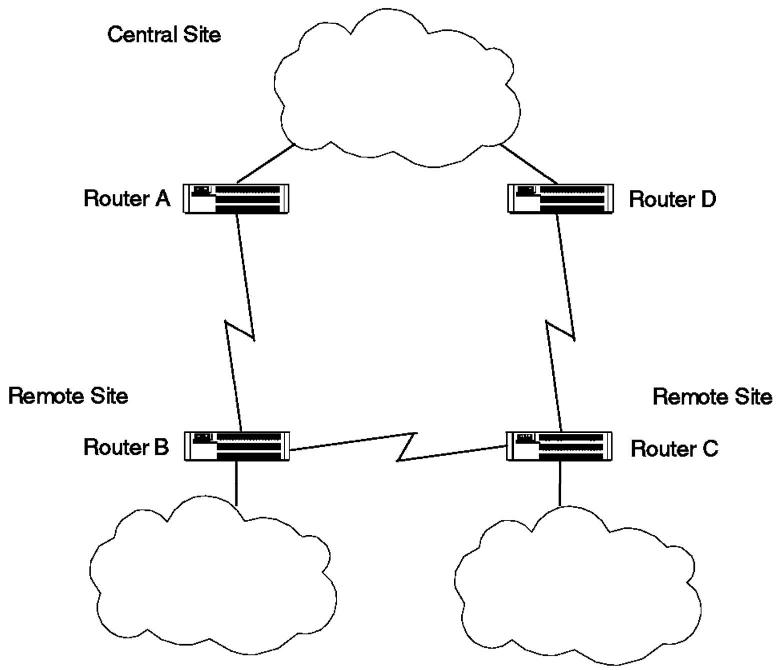


Figure 216. Twin Routers: Two Routers at the Central Site

The advantage of this solution is that it provides protection from each of the three failure points listed at the start of this chapter. What we should note, however, is that we have not protected ourselves from a router failure at the remote sites.

Again, let us look at each of the protocols in turn to find out what we need to do to get them to utilize the backup that we have provided.

21.3.1 IPX

Again, IPX will automatically route around any node, link or port failures within the network without manual intervention. In the event of the central site router, the router port or the telecommunications link failing, IPX will automatically change its routing to route through its secondary link.

21.3.2 IP

IP will only route around failures if a dynamic routing protocol is used like RIP or OSPF. Static routing alone will not provide the backup that we require. Please refer to a previous section for a comparison of RIP versus OSPF (see 3.1.3, “Summary of OSPF versus RIP” on page 34).

We should note that IP routing will be responsible for the integrity of the DLSw sessions between the routers.

Finally, we need to consider devices on the central LAN to understand what needs to be done in order to allow them to utilize a backup router at the central site. To provide full automated backup in the event of one of the routers failing, a dynamic routing protocol must be run on the central site LAN. The most common protocol to run in this situation would be RIP (as OSPF is not supported on most workstations). If static routes were used, then any routes which pointed to the failing router would have to be changed to point at the alternate.

Because IP is a connectionless protocol, there should be no session loss in the event of router failure. Also, providing that the network reroutes within the TCP timeout period (default 120 seconds) then there will be no loss of TCP sessions (FTP, TELNET, etc.) either.

21.3.3 SNA and NetBIOS

As explained above, TCP is responsible for maintaining the integrity of the DLSw sessions within the backbone.

Further to this, we again need to consider what will happen to devices on the central LAN should one of the central routers fail. In the event of a central router failure, any sessions that are running through the DLSw of that router will be lost. However, after this session has failed, another logon attempt will automatically be processed by the alternate router.

21.4 Summary

We close this chapter with a summary of the techniques used to provide degrees of backup in router networks. We are looking to provide backup for the scenarios of circuit failure, router port failure and total router failure. Backup facilities are available for each of these starting with simple ISDN circuit backup, moving through secondary links and finally ending with alternate routers. Generally speaking, the more backup that is required, the greater the cost of achieving it.

Finally, each of the protocols must be configured to support the backup you require. For some (IPX) this is automatic, for others (IP) this involves the use of special dynamic routing protocols.

Chapter 22. Performance in Router Networks

In this chapter we will first present some general performance considerations for multiprotocol networks. We then review some of the useful features available on the IBM 2210 and 6611 routers. We cannot offer solutions as the subject of performance is every bit as diverse as the world of multiprotocol networking itself. Our aim is to make you think of areas that may affect your choices.

22.1 General Network Performance

Here we look at why understanding performance on your network is important and what things can contribute to the overall performance and overhead. We also explain circuit pacing which is important to understand for performance in SNA networks.

22.1.1 Why Network Performance Is Important

The idea that networking overhead is no longer important since networks are becoming faster, links are becoming more reliable and bandwidth is becoming more cost effective, is not a good business practice. Unnecessary overhead wastes bandwidth, increases network congestion and impacts response times. Minimizing congestion and overhead allows you to do more with a given amount of bandwidth. Tightening overhead will also reduce the frequency at which you need to acquire more bandwidth as usage of the network grows. Making more bandwidth available for actual work, by reducing overhead, will not only ensure that more business can be done, but it will also influence the level of service to your client.

Different reasons lead companies to choose different networks, such as cost, technical strengths, applications/systems, tradition, corporate strategy, etc. Whatever the reason, network performance needs to be considered in each network. With different native networks coming together in a multiprotocol network, performance understanding and assessment becomes more complicated and more important.

It is one thing to have performance in mind when you are building a network from scratch and you have a free hand to select the best performing protocols, the most efficient techniques for transporting different protocols across the network, the fastest boxes, links with greatest throughput and so on, however, in the real world you don′t design a network from the ground up. The network is built around preferred systems, preferred applications, availability of products, availability of physical links or public network types, cost and so on. Generally you are tuning performance on pre-designed, existing networks or perhaps redesigning your current network.

22.1.2 General Considerations

This section is a mixed list of general points to be considered. They do not imply any specific network, but they are worth keeping in mind as you review your network options. One of the main things is that you understand what your principle needs are; they may be availability, reliability, cost, response time and so on.

Areas to consider are LANs, WAN links, routers, and factors limiting network capacity such as limiting LAN and WAN capacity to less than the link bandwidth.

Consider the effect of the physical media, data link layer protocols, practical management and actual usage patterns.

- The network′s physical media characteristics impose a limit on the network capacity.
- The data link layer protocols impose a lower limit on network capacity than physical media characteristics.
- Practical management needs and actual usage patterns impose a lower limit on network capacity than data link layer protocols.

Without knowledge of media and DLC throughput limitations, users overestimate their networking equipment requirements and subsequently purchase networking equipment with excess capacity. Excess capacity should not be chosen in lieu of functions such as enhanceability, scalability, reliability, configurability, networking management, long term investment, life time ownership costs, after sales service, etc.

Traffic prioritization is important. Can you prioritize traffic from a specific application over other traffic of the same protocol, or are you only able to prioritize by protocol?

Encapsulation requires processing overhead.

Encapsulation means data is transported through all the layers of two protocols.

Compression provides higher data rates thus improving response times at lower costs. Check whether compression is available on the routers or on the end systems.

The Keep-Alive traffic requires processing overhead.

SNA and TCP/IP both support timeouts. SNA is more precise since it was designed around the assumption that network bandwidth is expensive and scarce for organizations with many branches. TCP/IP is more relaxed; it was originally designed for large campus-site networks.

IP networks typically throw away data when congestion occurs, and then endpoints retransmit causing further congestion.

Due to flow control (windowing), SNA link utilization can reach a maximum of around 90% whereas for TCP/IP this maximum is around 50%.

Sockets over SNA has been shown to be faster than native TCP/IP with file sizes over 8 KB.

Should ARP storms occur, processing the ARP requests and responses requires overhead.

Another performance consideration is protocol broadcast traffic and the overhead of router to router exchanges. As each protocol is added, so is new flow between the routers. Network management is another internal flow to be considered.

RFC1490′s overhead is minimal compared to that of DLSw (including other router manufacturer′s versions of DLSw).

Consideration must also be given for the future. New applications are likely to require greater bandwidth. New graphics and multi-media applications are becoming available with ever increasing bandwidth needs.

22.1.3 Router Considerations

Performance is a hot subject in the multiprotocol router market today. However, it is difficult to make valid comparisons. Many vendors quote theoretical box throughput. Performance reports often come without specification of the test environment or the complete network in which the tests were made. A test environment generally has no resemblance to real environments. Traffic may have been one way only. Measurements are often done with 64-byte packets only, whereas much larger frames are common on typical router networks. Performance varies by protocol and packet size.

How a router performs is much more than a statement of top speed. When router capacity is less than the actual link demand, the router is the bottleneck; the router needs reasonable headroom (unused capacity) for future expansion. However, the maximum useable capacity of the media connections should be considered, as there is no point having headroom you can never use. The maximum useable capacity of a media may be much less than its bandwidth.

A customer perceives the network performance by the response time and/or throughput the end user sees for his applications. The router is one of the many contributors to the response time and its performance in the customer environment is really defined by its contribution to overall system response time and its effect on throughput.

A minimum of 64 KB lines are recommended for links between routers. The result of moving from 9.6 or 19.2 lines on a single protocol network to 64 KB lines in the multiprotocol environment is usually equivalent but never greater. A multiprotocol network is never faster than a native network.

For a more detailed understanding of performance in router networks refer to *Monitoring Performance in Router Networks*, GG24-4157.

22.1.4 SNA Circuit Pacing

SNA circuit pacing can be useful when applications that do not use fixed end to end SNA pacing transfer large files across a relatively slow speed WAN. As the routers involved are performing local acknowledgements for LLC2 packets on the faster LAN side, the application believes that all the packets that it has sent have been received and processed by the recipient and proceeds to send even more data. This can cause the bulk data being sent to build up on the router′s transmit queues and block interactive traffic.

There are two ways in which to overcome this problem which can be used in parallel. First, the SNA applications should perform end-to-end pacing. This will ensure that even if local LLC2 acknowledgements are received the application will not send more data until its SNA pacing window is opened by the remote application. In the AS/400, this support is enabled in the following PTFs:

- OS/400 Release 2.2 - MF08140
- OS/400 Release 2.3 - MF07545

- OS/400 Release 3.05 - MF08495
- OS/400 Release 3.1 - Fixed in base code

The second way of eliminating this problem is by the use of SNA circuit pacing on IBM router products. While the implementation of circuit pacing on the IBM 6611 and IBM 2210 varies slightly, the basic fundamentals of its operation are the same. Circuit pacing is enabled by specifying the number of LLC2 frames that can be acknowledged by the router locally before an LLC2 RNR (Receive Not Ready) is sent back to the sending application asking it to suspend transmission. Once the outbound queues on the router have been cleared, an LLC2 RR (Receive Ready) is then sent to the application asking it to resume transmission.

22.1.5 6611 Circuit Pacing Support

Circuit pacing can be enabled on the 6611 either by the MPNP configuration program or by an online command. The default value for Circuit pacing is 20 frames, which means that 20 frames will be accepted from each source station locally before an RNR is issued. An RR is issued once the WAN transmit queues on the 6611 have cleared.

Circuit pacing is enabled on the 6611 by default when DLSw is configured.

22.1.6 2210 Circuit Pacing Support

The equivalent function on the 2210 works in a slightly different manner. The 2210 specifies an LLC window size which can be changed either by an online command or by the MRNS Configuration Program.

The LLC window size (Transmit Window) specifies the number of I frames that can be sent by the 2210 over the TCP connection before an RR is received from the remote router. If this window expires, an RNR is sent back to the sending station until the RR is received from the remote router. The default window size is set to 2 for SAP X ′00′. If DLSw is being used, then an additional window size should also be configured for SAP X′04′. To perform this operation please refer to the 2210 product manuals.

22.2 2210 Features

We will look at some useful functions on the 2210 which can assist with performance. We will then see how we improved interactive response time over batch traffic on the AS/400s in our 2210 scenario in Chapter 9. This is a shortened version of the information that can be found in chapter 9 of *IBM 2210 Nways Multiprotocol Router Description and Configuration Scenarios*, SG24-4446. For more detailed information refer to the product manuals.

22.2.1 2210 Bandwidth Reservation (BRS)

The idea of BRS is to reserve specific amounts of the WAN bandwidth for certain types of traffic. This will allow you to prioritize traffic and ensure WAN availability to your most important traffic when your network is congested. BRS is supported over PPP serial links only and applies to the outbound traffic. You assign a name to a percentage of the bandwidth called the class name.

There are two default classes, which you cannot delete or change the names of. You can change the percentage bandwidth for these. They are:

LOCAL with a default of 10% Bandwidth

DEFAULT with a default of 40% Bandwidth

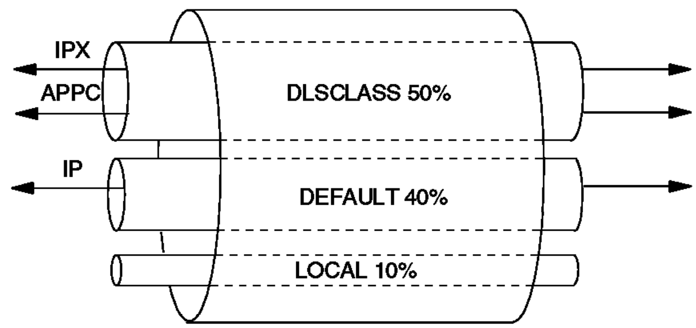


Figure 217. Example of Bandwidth Assigned Classes

Note: Class names are case sensitive.

The reserved percentage of bandwidth is the guaranteed minimum. If the network is running at full capacity and the bandwidth is full for a specific class, messages for this class get held up and queued. If the network is running at a low capacity but one class is busy, that class can exceed its assigned bandwidth and use some of the unused bandwidth assigned to other classes.

Within a class you can assign priority to specific types of traffic. Class and priority can be assigned to protocols, filters and tags.

- Protocols - IP, ARP (with ASCII console only, not available on MRNS), IPX, ASRT (bridged traffic) and APL, AP2 (AppleTalk phase 1 and 2)
- Filters such as RLOGIN-IP, TELNET-IP, NetBIOS, SNA bridged, SNMP-IP, DLSW-IP (SNA in DLSw), SDLC-IP and others
- Tags - Five tags - tag1... tag5 - these come from MAC filtering on bridged traffic, which will be made clearer in that section

You assign BRS thru the BRS feature in the TALK 6 Config function, using commands like - feature brs, add-class, assign, enable, interface, list, etc. We will look at an example configuration of BRS in 22.3, "IBM 2210 Performance Scenario - User Response Time versus Batch" on page 264.

22.2.2 MAC Filtering (MCF)

Filters based on source and destination MAC addresses are applied during bridging. The advantage of MCF is to stop unwanted traffic from crossing the WAN part of your network. It will allow you to cut out frames such as broadcasts, and in this way it helps with the load on the WAN where bandwidth is expensive in terms of cost and availability. It can also be used for low level security to stop traffic from particular LAN segments from accessing your LAN segment.

MCF is supported over token-ring, Ethernet, and PPP serial link only. MAC filtering over dial on demand serial interface is not supported because dial on demand is not supported over bridging, MAC filtering is supported only over bridging.

You can have INPUT and OUTPUT filters on interface 0 (LAN) and interface 1 and 2 (serial). A filter can:

- Include bridge packets as normal.
- Exclude packets.
- Tag packets with a number 1 to 64, so BRS (bandwidth reservation) can be based on these tag numbers.

Tagged packets are always forwarded via the bridge. BRS applies to tagged packets that will go over the PPP link.

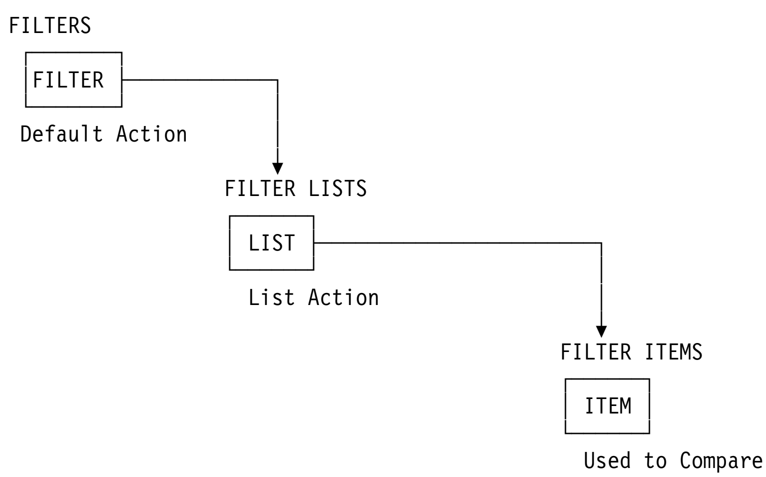


Figure 218. MAC Filtering

To implement MCF you define a filter with a default action. You create lists of items based on MAC addresses which are used for comparing against the incoming or outgoing MAC frame. You assign an action to the list, and you assign one or more lists to a filter. You can have more than one filter in place.

The 2210 matches a frame to the first matching filter item found (the order of lists/entries is therefore important). It performs the filter action for that list. If no match is found, it performs the default action for the filter.

You do not have to specify every single MAC address you want as an item; you can specify a range. The filter list item is defined with a corresponding hex mask, saying which bits to compare for a match. This is similar to IP subnet masking.

You configure MCF via talk 6, the configuration utility and commands such as:

```
Feature MCF
Create
Attach
Enable
Add
Set-action
etc...
```

22.2.3 WAN Restoral Feature (WRS) - Dial Backup

WRS on the 2210 allows you to backup your primary leased PPP serial link via a switched V.25 bis PPP serial link, or via ISDN. It means that you will be able to provide constant performance and availability to your users, in the event of a failure on your primary link. When the primary link fails, all protocols automatically switch over and survive the switchover. When the primary PPP link comes back, the 2210 automatically drops the switched link and swaps the protocols back transparently to the user.

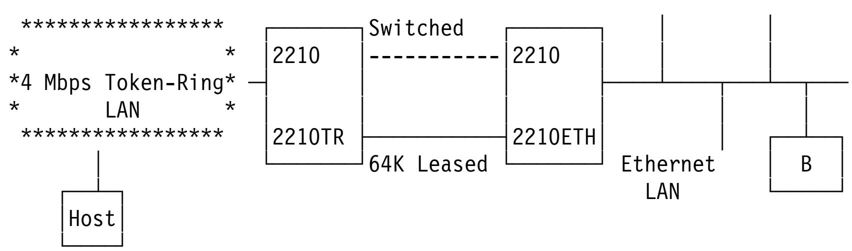


Figure 219. Dial Backup (WRS) via V.25bis Switched Serial Link

The performance of WRS via V.25 bis switched serial link as shown in Figure 219 was tested for IBM 2210 Nways Multiprotocol Router. They found that while the routers were switching over to the backup switched link, the VTAM user, (B in Figure 219) was in pending clock for 40 seconds. When the primary link came back up, WRS switched back without any waiting on the part of the SNA session.

For two 2210s, Dial Backup must be configured on both 2210s. Dial Backup is not available on 6611. If a 2210 is talking to a 6611 over a PPP serial link, then the 2210 could have Dial Backup configured, and it is up to it to detect the failure and dial the 6611.

Refer to Chapter 21, "Providing Backup in Router Networks" on page 249 for more detailed information on backup in router networks.

22.2.4 Dial on Demand

As the name implies, dial on demand allows an IBM 2210 to dial into the backbone router network as and when it needs to communicate. This is ideal for a remote site which only needs wide area connectivity intermittently. You can take advantage of the cost saving of using a switched network for low usage instead of a leased line. When the 2210 detects that a packet needs to be sent over the switched link, it automatically dials the customized phone number. You can customize different phone numbers corresponding to different remote locations, but only one can be used at a time.

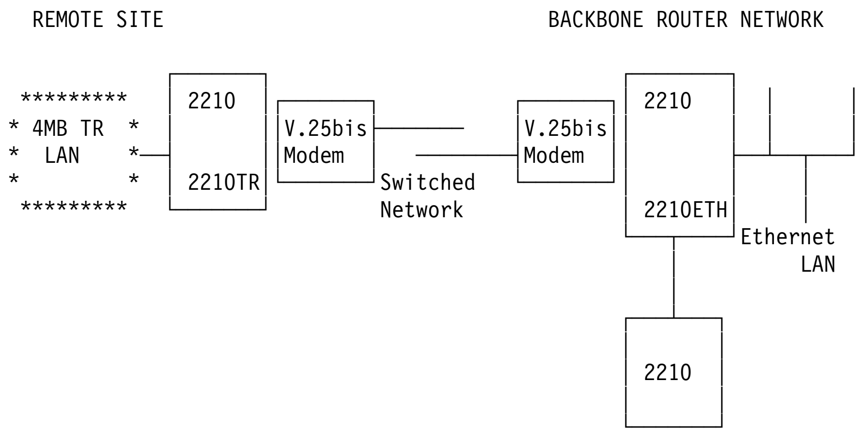


Figure 220. Dial on Demand

Dial on demand is only supported over a switched V.25 bis serial link. It is not supported on the IBM 6611 router. This means the 2210 can dial a 6611 when it has data to send but not the reverse. The 6611 has to wait for a 2210 initiated connection before it can send data. Dial on demand supports TCP/IP (DLSw and Tunnel) and IPX protocols only. It does not support bridging except for Tunnel Bridging.

Performance Considerations

Some performance considerations when configuring dial on demand are as follows:

- The switched line is automatically dropped when no data is sent for the length of time equal to the configured idle timer. You should configure a realistic value but not leave the link up unnecessarily.
- Use Static Routes for IP routing over dial on demand. This prevents establishing connections for every routing update.
- For DLSw over dial on demand, do *not* enable the Keepalive parameter. Keepalive messages could keep the connection up permanently.
- For IPX routing specify large RIP and SAP update intervals, to ensure dial on demand circuits are not established too frequently for RIP and SAP messages.
- Dial on demand cannot be used to provide additional bandwidth over a switched link where the primary link is over utilized.

Dial on demand is configured via the ASCII Console on the 2210. You must configure two interfaces, the V.25 bis Physical Interface and the Logical Dial-Circuit Interface. To do this, you first define the interfaces, then customize the V.25 bis interface, and then customize the dial circuit interface, as shown in the following example.

```
Define The Interfaces:
*Talk 6
Config> set data-link V25bis 2                 (using serial interface 2)
Config> add device dial circuit     (to define one or more dial circuits)
Config> list devices             (to find the dial circuit interface number)
Config> add v25-bis-address local-site 12345678   (define a phone number and
                                             give it the name local-site)
Config> add v25-bis-address remote-site 87654321  (define a phone number and
                                             give it the name remote-site)
Config> list v25-bis-address            (to verify the list of numbers added)

Customize the V.25 bis Interface:
Config> network 2                          (the physical v.25 bis interface)
V.25bis Data Link Configuration
V.25bis Config> set local local-site           (assigns this number locally)
V.25bis Config> set timeout-no-answer 60
V.25bis Config> set retries-no-answer 5
V.25bis Config> list  (to verify)
V.25bis Config> exit

Customize the Dial Circuit Interface:
Config> network 3             (or whatever interface number was assigned
                                                    to the dial circuit)
Circuit Configuration
Circuit Config> set net 2    (map the logical dial circuit to the physical
                                                   V.25 bis interface)
Circuit Config> set calls outbound (or inbound or both - to specify in what
                            direction the switched connections can be made)
Circuit Config> set idle 30                  (the idle-timer)
Circuit Config> set destination remote-site       (sets remote phone number
                                                      for the dial circuit)
Circuit Config> encapsulator   (to set the PPP parameters for the switched link)
PPP Config> list all
              Change any PPP parameters required with the set command
PPP Config> exit
Circuit Config> list  (to verify)
Circuit Config> exit
```

Figure 221. IBM 2210 V.25 bis Configuration

Refer to Section 9.4 in *IBM 2210 Nways Multiprotocol Router Description and Configuration Scenarios*, SG24-4446 for more information on dial on demand.

22.2.5 NetBIOS Facilities

NetBIOS, like some other protocols, was designed for a LAN and sends out a lot of broadcast-type traffic which can have an impact on performance when it goes across a WAN. There are two NetBIOS facilities available on the IBM 2210 to help:

- NetBIOS Name Caching
- NetBIOS Filtering

We will summarize briefly what these facilities offer. For more detail and information on configuring, refer to section 9.5 in *IBM 2210 Nways Multiprotocol Router Description and Configuration Scenarios*, SG24-4446 and the related product manuals.

For a 2210 configured as a bridge, you can implement the following two types of NetBIOS name caching:

- Name Caching for Name-Query Frames - The name caching process allows the IBM 2210 to convert All Route Broadcast name-query frames into specifically routed name-query frames.
- Duplicate Frames Filtering for add-name, add-group-name and name-query frames to reduce the amount of these frames over the WAN.

If both of the above are enabled then duplicate frame filtering is performed first.

NetBIOS Filtering Facility

- Filters are applied during bridging.
- They are based either on the NetBIOS host name or on certain bytes contained in the NetBIOS header frame.
- They can be specified for traffic in either direction, input or output on one or more interfaces.
- A filter can include or exclude frames.
- Host Name Filter - This means you filter based on the source or destination name fields in name query packets.
- Byte Filter - This means you filter using a byte string which will be compared against all NetBIOS packets.

As with MCF described earlier, a filter is made up of filter lists (which are made up of filter items). Here, however, actions are assigned to a filter item and a default action is assigned to the filter list.

22.3 IBM 2210 Performance Scenario - User Response Time versus Batch

For all the reasons we have discussed earlier in this chapter, measuring performance realistically in a lab environment is difficult. However, we did some testing and will present some results which may be useful to give you a general feel for what user response times you might expect.

We used the network we built in Chapter 9, “IBM 2210s in a Router Network” on page 95. There was no traffic on the network apart from our test traffic. The aim of our test was to see how interactive response between the two AS/400s (RALYAS4B and RALYAS4A) performed when there was concurrent batch traffic between the two. We wanted to tune the performance so that the interactive passthrough user was not aware of the batch transfers across the WAN.

The network used in the tests is as shown in Figure 222.

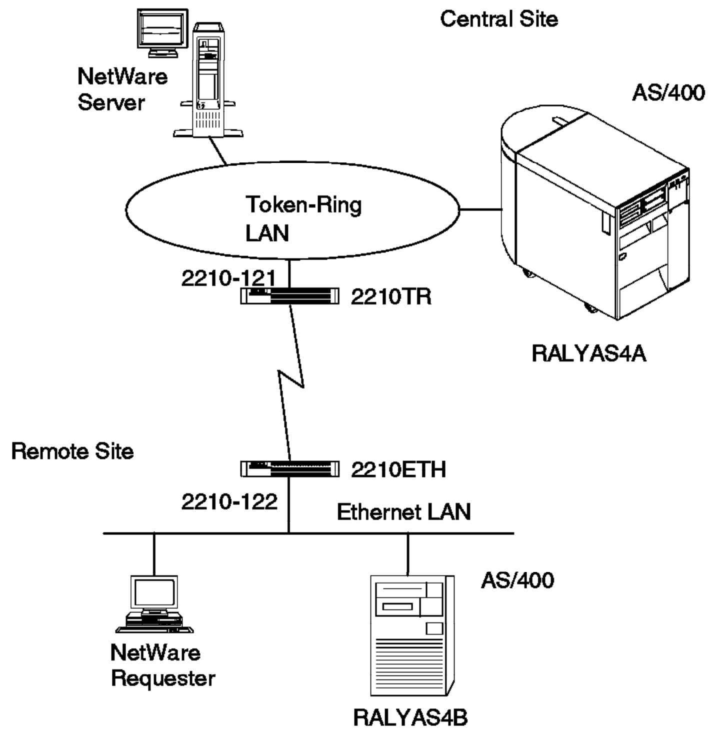


Figure 222. IBM 2210 Router Network, Overview

Tests

The test user was signed on at RALYAS4A and was in a passthrough session to RALYAS4B. The normal response time in the passthrough session was 2 seconds. The user pressed F4 and F3 in succession continuously and measured the response times in receiving these panels. We then put batch traffic over the WAN by transferring files between the two AS/400s and measured the response time for the passthrough user. We used the same physical file in all the tests. Our tests and findings are as follows:

```
1)  FTP session from B to A, GET of a file of approx 4 MB, Name Format 0,
ASCII transfer
Results -  4042012 bytes in 707.599 seconds, transfer rate 5.712KB/sec
           Passthrough user R.T. (response time) = 5 seconds

2)  ASCII, pre-created file on target to receive data
Results -  4042012 bytes in 626.374 seconds, transfer rate 6.453 KB/sec
           Passthrough user R.T. = 5

3)  Changed Maxframe size for SAP AA to 265 from 1496, Name Format 0,
file not pre-created, ASCII first, then binary and EBCDIC.
Results -  4042012 bytes in 793.865 seconds, transfer rate 5.092 KB/sec
           Passthrough user R.T. = 5
Binary  -  4327488 bytes in 756.395 seconds, transfer rate 5.721 KB/sec
EBCDIC  -  4009228 bytes in 766.497 seconds, transfer rate 5.231 KB/sec

4)  Same as above but sent two FTPs of the same file concurrently
Results -  Passthrough R.T. varied from 5 to 8 seconds
           1) 4042012 bytes in 1210.505 seconds, transfer rate 3.339KB/sec
           2) 4042012 bytes in 1211.909 seconds, transfer rate 3.335KB/sec

5)  SNDNETF of the same file from RALYAS4B to RALYAS4A, SNADS was
using Mode Blank with a pacing value of 3, maxframe for SAP 04 = 1496
Results -  Passthrough user R.T. varied from 4 to 7, but more often 7 seconds
           SNADS transfer rate, based on dstlog, the time between *SND and *ARV
                                                  entries = 6 mins 3 secs

6)  Above test but changed SNADS to use mode #Batch with pacing = 1
Results -  Passthrough user R.T. = 2 (same as with no batch traffic)
           SNADS transfer rate, based on dstlog, the time between *SND and *ARV
                                              entries = 19 mins 40 secs

7)  Same as test 1, but set Bandwidth Reservation on the 2210 to give
DLSw traffic 60% of bandwidth.
Result -  Passthrough user R.T. = 2 seconds (same as with no batch traffic)
```

22.3.1 Setting Bandwidth Reservation

The 2210 bandwidth reservation is set via talk 6 as shown in the following example.

```
*Talk 6
Config> feature brs
Bandwidth Reservation User Configuration
BRS Config> interface 1  (WAN interface)
BRS [i 1] Config> enable brs
Please restart router for this command to take effect.
BRS [i 1] Config> exit
Config> exit
Ctrl P
*RESTART
Are you sure you want to restart the gateway? (Yes or [No]): yes
*Talk 6
Config> feature brs
Bandwidth Reservation User Configuration
BRS Config> interface 1
BRS [i 1] Config> change-class
Class name [DEFAULT]? DEFAULT
Percent of bandwidth to reserve [40]? 30
BRS [i 1] Config> add-class
Class name [DEFAULT]? dlsclass
Percent of bandwidth to reserve [10]? 60
BRS [i 1] Config> assign
Protocol or filter name [IP]? dls
Class name [DEFAULT]? dlsclass
Priority (URGENT/HIGH/NORMAL/LOW) [NORMAL]? high
BRS [i 1] Config> list  (to verify)
BRS [i 1] Config> exit
BRS Config> exit
Config> exit
Ctrl P
*RESTART
Are you sure you want to restart the gateway? (Yes or [No]): yes
```

Figure 223. IBM 2210 BRS Configuration Example

Note: Class names are case sensitive.

22.3.2 Summary

With SNADS traffic using mode #Batch with pacing set to 1, and BRS implemented on the routers allocating 60% of bandwidth to DLS traffic, the passthrough user experiences no change in response time, when SNA or TCP/IP batch file transfers are running concurrently.

22.4 IBM 6611 Performance Facilities

In this chapter we briefly cover the IBM 6611 facilities that can be used to enhance the routers performance.

22.4.1 APPN Performance Tuning

With APPN, the better the performance the more storage that is required on the router. However, because you are also running other protocols, you have to compromise. The parameters that affect tuning are:

1. Maximum Shared Memory
2. Maximum Cached Directory Entries

1) Max Shared Memory is the amount of shared memory in the 6611 that is allocated to the APPN Network Node to operate, and manage directory tables. The shared memory available is limited by available paging space and the number of different protocols running.

2) Cached Directory entries are held in the Local Directory Cache for LUs that have been located. The more LUs it has information on, the less likely is the need to send out directory search broadcasts. Hence, a large cache speeds up session establishment and reduces network overhead, but it requires additional storage.

Manual tuning allows you to specify the maximum shared memory and maximum cached entries. Automatic Tuning allows the system to set it for you. However, you can choose an option from best performance to minimum storage to influence automatic tuning. The default is mid-way, or balanced adjustment. We recommend you leave it at the default.

22.4.2 IP Priority Queueing and Port Prioritization

You can configure priority queueing for IP datagrams on serial ports, over PPP and frame relay. There are four priority queues defined on the 6611:

Network, High, Medium and Low.

Network is for network control messages. High, medium and low can be user assigned. The user configures the number of buffers for sending and the number of messages to transmit for each queue.

When the serial adapter is used lightly, each traffic priority (high, medium and low), queues as many datagrams as it can for transmission. As soon as there are 54 datagrams queued for the adapter port, the 6611 begins to ensure that each priority only uses its allocated percentage of buffers, which is based on user-defined values in the QBR (Queue Bandwidth Reservation) parameter.

There are 64 buffers (Buffer Control Blocks) for each port. This allows you to queue a maximum of 64 datagrams on that port (one datagram per buffer). There is a pre-defined threshold of 54. For each priority you configure how many out of 64 datagrams can be queued. That is the 64 buffers must be shared between the high, medium and low priority queues.

There is one big queue for the port up to 64 datagrams. It is made up of the priority queues.

What happens when 54 is reached?
When an IP datagram is received for transmission, one of the following occurs:

- If the queue for the port is greater than 54 but the number for this datagram′s priority is less than its configured allocation, the datagram is queued.
- But, if the number queued of this priority is greater than its configured allocation, then the datagram is discarded.

What happens if the queue for the port is at 64 (full)?
When a new datagram arrives, it checks the number already queued for the priority of this datagram.

- If that priority has already exceeded its configured allocation, the new datagram is discarded.
- If it hasn′t used up its allocation, other priorities are checked (starting at the lowest) and if any queue is using more than its configured allocation, a datagram is deleted from that queue (LIFO) and the new datagram is queued.
- If no queue is using more than its allocation, the new datagram is discarded. (This situation could arise if there was a lot of network control messages because they share the same 64 buffers).

When the link is free, the network priority queue is transmitted first (FIFO) until is becomes empty. Then the other queues are transmitted, high priority first until its QBA counter is reached, then medium likewise and then low.

QBA - Queue Bandwidth Allocation - This is the number of datagrams transmitted from each queue in relation to the other queues.

QBR - Queue Bandwidth Reservation - This is the percentage of the overall queue which can be allocated to priority queues, high, medium and low. The total must be 100% (the minimum 10% for an individual queue, and the maximum 80%).

Configure these values using the MPNP Configuration Program V1R3.0 as follows:

```
Click on the Serial Port (PPP)
   Physical Interface
     Queue Priority

       Queue Priority
       Link Bandwidth Allocation
       Enter number of packets to process from each queue
          High Priority (1 -10)      4
          Medium Priority (1 -10)    4
          Low Priority (1 -10)       4

       Queue Bandwidth Reservation
          High Priority Queue (10 - 80)       30
          Medium Priority Queue (10 - 80)     30
          Low Priority Queue (10 - 80)        30

     OK
```

You can assign high, medium or low priority to any or all of the well-known ports (0-1023), and up to 8 not-well-known ports (1024-65535), for example 2065 and 2067 for DLSw.

By default, only DLSw traffic is on the medium queue while all the protocols and bridged data traffic are on the low queue.

Assign priorities for IP traffic via the MPNP Configuration program as follows:

```
Click on the Serial Port (PPP)
   IP panel
     IP priority
       Enable IP Priority
       Default priority for IP   Low    (default)
       List of prioritized ports
       ADD
          IP port number   ?
          Port Type    ?      TCP or UDP
          Priority     ?      low, medium or high
       APPLY
```

22.4.3 Two Ports as One Transmission Group

You can specify two serial ports/links on the same adapter as one transmission group. This is for IP over PPP only. This is useful for backup/redundancy if one link in the group goes down. It also helps with load balancing (the 6611 queues one datagram in turn on each serial link of the transmission group). The same line speed, TCP/UDP port priority and default IP priority should be set on both links. Filters and the list of prioritized ports are merged into one list. The values for both should be the same to avoid inconsistencies. If the MTU value differs between the two, the lowest value will be used.

Configure this via the MPNP configuration program as follows:

```
Click on the Serial Port (PPP)
   Physical Interface
     Enable port for Transmission group
     Transmission group name : TG1
```

22.4.4 TCP/IP Filtering

Filtering on the 6611 is involved, and there are several different types of filters which can be applied. We will summarize these here and point you to where in the MPNP Configuration program each option is configured. However, for more information, you need to refer to product manuals such as the *6611 Introduction and Planning Guide*, GK2T-0334.

For TCP/IP, the following filters are possible:

- IP packet filters
- Inbound port filters
- Well-known port filters
- IP export filters
- Import Filters
- UDP broadcast forwarding

IP packet filters - These are applied at the node level to inbound traffic that is received on any 6611 port which is configured for IP and supports filters. Configure IP Packet Filters via the MPNP Configuration program as follows:

```
Node
  Routing
   IP Packet Filters
```

You will get the panel shown in Figure 224, where you can specify an IP address or range of addresses to filter via the subnet mask, and choose to omit or permit these frames. If you select singular, this means that the 6611 compares the filter address 1 with both the source and destination addresses in a frame to find a match. Dual means that you specify two addresses, and these are used to compare against both the source and destination, allowing you to filter frames travelling between a specific pair of IP hosts. These filters can be combined with well-known port filters.

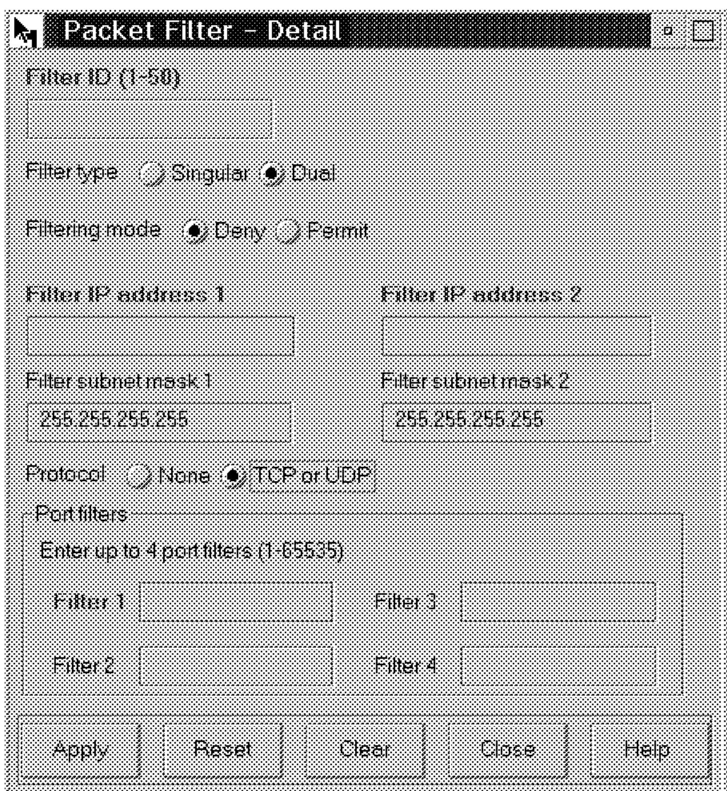


Figure 224. IBM 6611 Configuration Panel for IP Packet Filtering

Inbound port filters - These filters work in the same way as IP packet filters, but they are applied at port level (that is the physical port on the adapter). You can permit or deny incoming IP traffic on the specific port. You can combine these filters with well-known port filters.

Configure Inbound Port Filters via the MPNP Configuration program as follows:

```
Click on the selected port
  Click on IP
    Click on inbound port filters button to enable and then click
    to configure.
    ADD
      the panel is exactly the same as for IP packet filters, see
      Figure 224 on page 271
    APPLY
    OK
```

Well-known port filters - Here we mean filtering against TCP and UDP well-known port numbers and not the actual physical adapter ports. You can configure up to 4 well-known port filters in combination with the IP packet filters and inbound port filters, described above. See Figure 224 on page 271, where if you select TCP/UDP for the Protocol option, you will be able to enter the Port Filters.

IP export and import filters - Both these filters affect the backbone traffic and protocols, which is not within the scope of this book. They are explained in greater detail in the product manuals. Export filters provide the ability to share routes that are learned by one protocol with another protocol, for example between RIP and OSPF. You can filter all routes or specific routes. When export filters are defined on multiple 6611s in your network, it may be a good idea to restrict the sources from which routes are accepted. Import filters are defined at the protocol level for BGP, EGP, OSPF and RIP. They deny route imports on the basis of the destination IP address.

UDP broadcast filtering - Client/server type applications use UDP broadcasting when either a server wishes to communicate with many clients, or a client wishes to obtain a particular service and the available server is unknown. Normally, these broadcasts stay on the local LAN, but this is a problem when the server for a particular service is on a remote LAN. When a 6611 port has UDP broadcast forwarding enabled, that port will monitor received IP broadcast datagrams. When an IP broadcast datagram is received with a destination UDP port corresponding to one of those configured, a separate IP broadcast is forwarded over each physical port configured in the Target Port IP address list. You select the physical port you are going to enable to listen for incoming UDP broadcasts. You say what UDP ports it will forward broadcasts for, and on what physical ports the broadcasts exit from the 6611. Configure UDP Broadcast Forwarding via the MPNP Configuration program as follows:

```
Click on the Port
Click on IP
   Click on UDP Broadcasts
    enable UDP broadcast forwarding
     enter and apply the UDP ports and the IP addresses of the physical ports
   OK
```

Figure 225 shows the UDP broadcast forwarding panel.

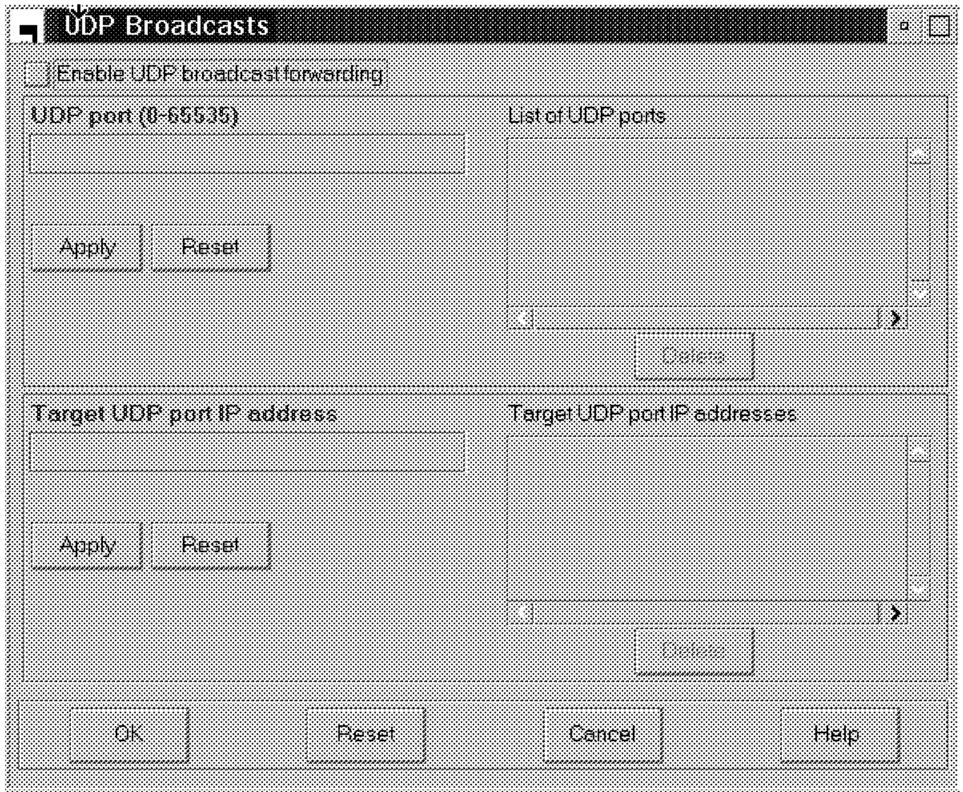


Figure 225. IBM 6611 Configuration Panel for UDP Broadcast Forwarding

22.4.5 IPX Filtering

At the system level you can define filters for IPX to control SAP and RIP packets. At the port level you can define IPX filters which act on header information.

System-Level Filters:

- SAP Filters - These define the server name and server type to be filtered on a specified IPX interface. These filters operate on the server entries in the SAP header.
- RIP Router Filters - These determine the networks from which the 6611 accepts RIP packets, based on the source network number in the RIP header.
- Inbound RIP Filters - These determine which networks received in a RIP packet are retained in the 6611 routing database. These filters operate on the network entries in RIP packets. You can specify a specific port to apply this filter on.
- Outbound RIP Filters - These determine which networks the 6611 advertises in RIP packets, based on the network entries in the RIP packets. You can specify a specific port to apply this filter on.

Configure system level filters via the MPNP Configuration Program as follows:

```
Node Configuration
   Routing :  Click on IPX bar
              enable IPX filters
              select filter type
              Add
                 add filter, see Figure 226 on page 274
              Apply
              OK
```

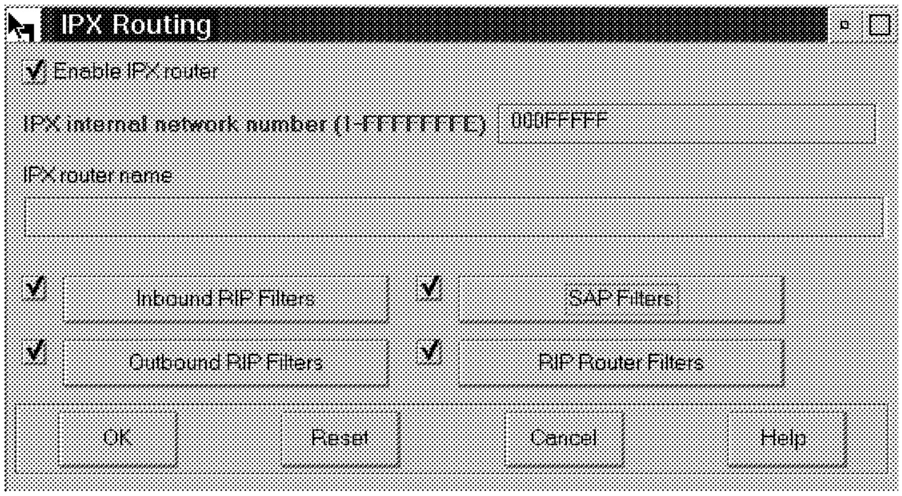


Figure 226. IBM 6611 Node Configuration for IPX Filters - System Level

Port-Level Filters:

Via the IPX inbound port filters you can permit or deny packets entering the 6611 from either a LAN or WAN interface. You can filter on the following fields in the IPX header information:

Hop Count
Packet Type
Destination Network
Destination Host
Destination Socket
Source Network
Source Host
Source Socket

Configure port-level filters via the MPNP configuration program as follows:

```
Port Level    click on selected port
    Inbound Port Filter
      enable inbound port filters  see Figure 227 on page 275
      ADD  appropriate filter      see Figure 228 on page 275
      APPLY
    OK
```

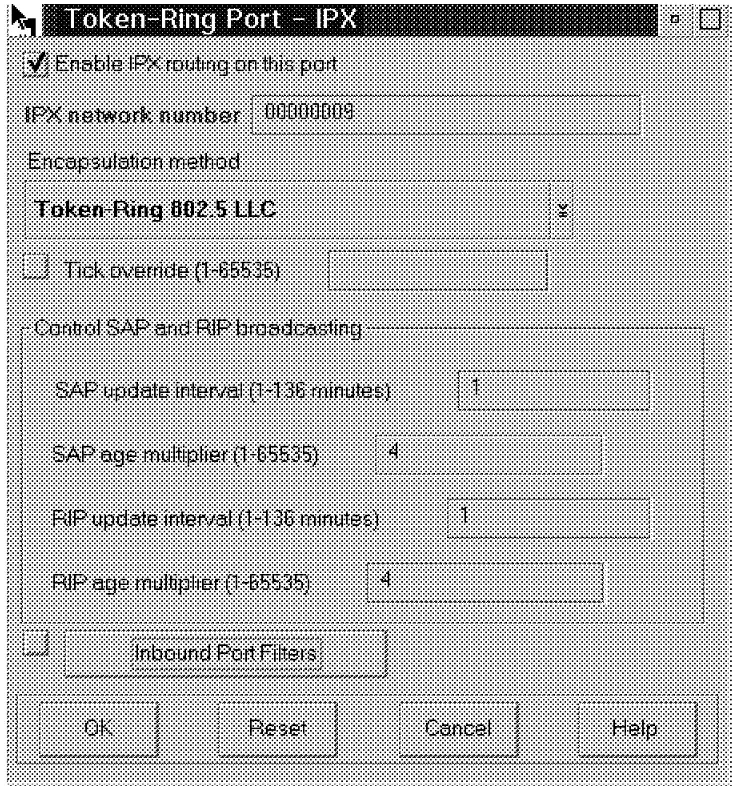


Figure 227. IBM 6611 Node Configuration for IPX Filters - Port Level

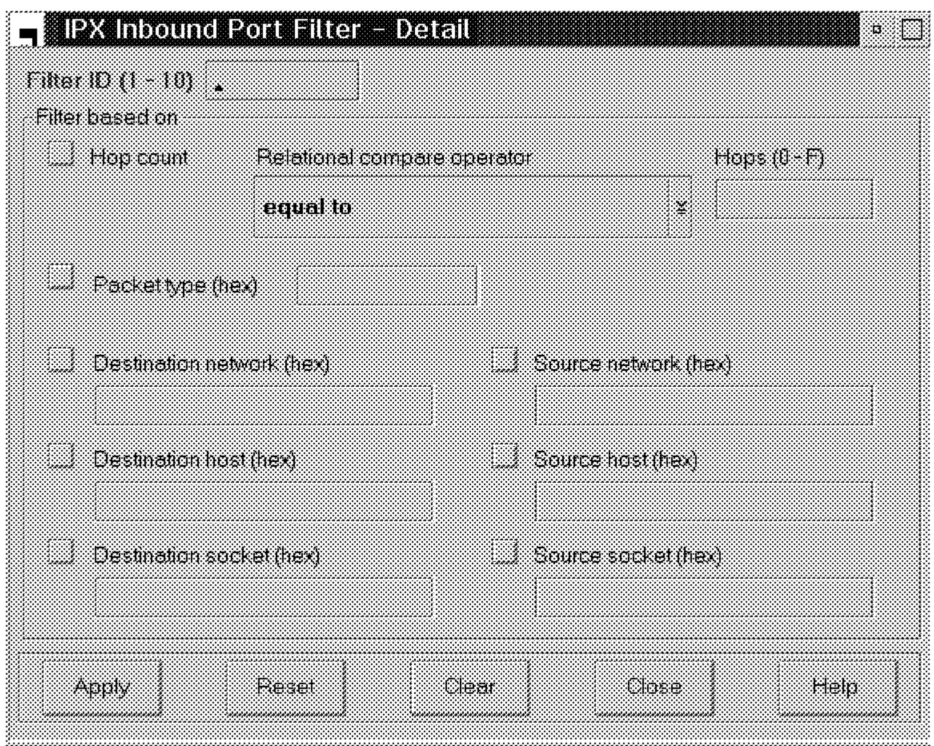


Figure 228. IBM 6611 Configuration for IPX Inbound Port Filters

You can see in Figure 227 that you can also configure your own Tick Value for a particular port. In the case of parallel routes of equal hops, this could be used to weigh one line against the other for the route selection for IPX traffic.

SAP and RIP broadcasts are sent out in periodic bursts. This can affect the flow of other traffic, particularly on the DLCI in a frame relay network. You can change SAP and RIP pacing by changing the RIP and SAP intervals. See Figure 227 on page 275. It is recommended that you do not change the RIP and SAP values on LAN adapters because you can′t change these values on Novell Servers.

22.5 General Points for 2210 and 6611

With DLSw, the router is sending link level pacing acknowledgments to the AS/400 inviting it to send more frames if session level pacing permits. The AS/400 uses the session pacing window set in the Mode Description at the start of a conversation, but it uses adaptive pacing so the window may change. This could cause the AS/400 to send frames too frequently which leads to congestion on the router queues or across the network. With the PTFs listed in 22.1.4, "SNA Circuit Pacing" on page 257 and with base V3R1.0 OS/400, the AS/400 will use fixed pacing exclusively, when the Class of Service Description (COSD) specifies low transmission priority.

DLSw frames are processed by the main processor on the routers and not handled on the card. Processor utilization becomes the primary throughput limiting resource as traffic loads increase. The data flow and TCP buffering increase the latency through the router. TCP consumes relatively large amounts of router memory and processing power since it requires end to end acknowledgements and sequence number tracking. DLSw requires two TCP connections between every router pair.

Chapter 23. Network Management in Router Networks

This chapter will address some of the areas of network management. The management of router networks is a large and complex issue; we will focus in on the following points:

- Router Configuration and Maintenance
- Router Operation and Problem Determination
- Network Monitoring

23.1 Router Configuration and Maintenance

In this section we will address the areas of router configuration and router maintenance. In Router Configuration we will look at ways of updating router definitions to ensure that we do not cause disruption. Router Maintenance will cover software maintenance issues.

23.1.1 Router Configuration

Over time, router configurations generally do change. This change may be the result of some extra IP routing that is required or maybe some SNA traffic is now required between two sites that previously did not need it. Whatever the details of the changes that are required to the router definitions, it is vitally important that the updates are made causing the least possible disruption.

Dynamic change is the key to this point. If we can make changes to the router definitions without causing any impact to users, then our task is easy. If, however, a change causes a restart of a particular protocol, or even worse a restart of the router, then we have to be very careful how we manage such activities.

We take the IBM 6611 and IBM 2210 respectively regarding these points.

23.1.1.1 IBM 6611

All configuration updates to the 6611 should be made by the MPNP Configuration Program (the software utility that runs on a central workstation). It is not recommended that any changes be made using the online configuration menus on the 6611 due to the strong possibility of introducing errors. As a result, configuration changes can be made on the central workstation at any time. Activation of those changes on the 6611, however, requires some planning.

Some changes on the 6611 are dynamic, however, many changes are not dynamic and will cause a protocol restart or in some cases a reboot. Obviously, we would want to schedule non-dynamic changes outside of normal working hours.

In order to determine which changes on the 6611 are dynamic and which are not, please refer to *IBM Multiprotocol Network Program Operations and Problem Management,* SC31-6692 which lists all changes in detail. However, a quick guide is given in the following non-definitive list:

Dynamic Changes

- IP Filter updates

- IP Static Route changes
- IPX filter updates
- Bridge filter updates
- SNMP updates
- User ID and Password updates

Non-Dynamic Changes

- Enable or disable physical interfaces
- Changing protocol addresses
- Changing DLSw settings
- Enable or disable a protocol

Note: IP Static Route updates are dynamic if you are not running OSPF. If you are running OSPF, then it will be restarted with a static route change.

In order to determine the impact of a non-dynamic change, we look, in detail, at the previous entries.

Table 21. 6611 Non-Dynamic Change Implications

Change	**Result**
Enable/Disable Interface	Reboot of router
Changing protocol addresses	Restart of that protocol
Changing DLSw settings	Restart of DLSw with loss of SNA sessions
Enable/Disable Protocol	Reboot of router

Finally in this section, we will look at scheduling a non-dynamic change on the 6611 so that the change is activated at an agreed time.

The easiest way to achieve this result is to use the AIX version of the MPNP Configuration Program. When using this version of the program an automated option is available that allows you to specify when (minute, hour, day, month) the configuration will be activated.

If the AIX version of the configuration program is not available to you then the easiest way of performing a timed configuration update is to utilize the following steps:

1. Create a configuration file on your management stations hard disk.
2. Use the TCP/IP file transfer program (FTP) to transfer this file to the remote 6611.
3. Use the 6611 `config install` command to activate the configuration.

The 6611 config install command activates the configuration immediately, so the issuing of this command needs to be automated. The best way is to get your management machine to run some resource scheduling software (various programs exist under Windows and OS/2) and schedule a TCP/IP rexec command like the following:

```
rexec 6611_host_name 'config install configuration_name'
```

where 6611_host_name is the host name of the 6611 and configuration_name is the name given to the configuration file that you created.

23.1.1.2 IBM 2210

Like the IBM 6611, some of the 2210 parameters are dynamic, but most are not. However, the position with the 2210 becomes more complicated due to the fact that there are two methods of configuration, either online or by the 2210 MRNS Configuration Program.

We take the 2210 MRNS Configuration Program first. When making updates to *any* parameters using this utility, the router must be rebooted to bring any changes into effect. This means that the router will have to be rebooted manually at some prearranged time. The 2210 Configuration Program currently does not allow you to activate configurations at a set time and day like the 6611 program.

When configuring 2210 parameters online, any parameters that are changed using the talk 5 option are regarded as dynamic. Most parameters that are changed using the talk 6 option are not and require a router restart. Please note that any parameters that are changed using talk 5 are not permanent and will be lost when the router is rebooted next. You must remember to make the changes permanent either by use of talk 6 commands or via the MRNS Configuration Program.

Virtually all DLSw parameters within the 2210 are dynamic, even those changed by talk 6 commands.

23.1.2 Software Maintenance

Software Maintenance covers the area of applying new software levels, PTFs etc. Like router configuration, this area is very complex and full details should be gained from the 2210 and 6611 product manuals. This section will briefly outline the procedures required to maintain software on the IBM 6611 and IBM 2210.

23.1.2.1 IBM 6611

The IBM 6611 has very similar software maintenance techniques to a conventional AIX machine. Software can either be loaded via the network, diskette or tape. All software updates on the 6611 are disruptive and require a reboot of the machine after the software has been applied.

A recent enhancement to the 6611 MPNP Program is the Shadow Maintenance software install program. This allows the actual application of the software component to be done in the background while the router is functioning as opposed to previous releases which required the router to be offline. After the software apply has finished, the router again must be rebooted to load the new code.

One should take care when transferring large software images over the network. The TCP/IP file transfer program (FTP) is normally used to distribute images; unfortunately, this can lead to network congestion due to the size of the files. A useful tip to perform is to reduce the TCP window sizes on the machine from where you are performing the software distribution. Under AIX an example of the commands that you could use are:

```
no -o tcp_sendspace=512
no -o tcp_mssdflt=128
```

These commands reduce the throughput that TCP (and hence FTP) can achieve and protects your network from congestion. You should remember to set the values of their parameters back to their original values after the transmission has been completed.

23.1.2.2 IBM 2210

Software can only be distributed to the 2210 over the network. Two options are possible here. First, the 2210 can be configured to retrieve its load module from a BOOTP server somewhere in the network, this means that to perform maintenance you simply need to update the module on the BOOTP server. However, this means that the 2210 will load the code over the network each time it is rebooted, which can again cause network congestion. The second method is to use the tftp program to transfer the new load module to the 2210 when an upgrade is required. The 2210 can store multiple load modules in its flash memory, and you can select which image to load at reboot time.

The 2210 requires a reboot to activate any new code updates.

23.2 Router Operation and Problem Determination

This section of the document covers the areas of router operation and problem determination. Again, like the preceding section, this is a very complex and difficult area and you should refer to the IBM 6611 and IBM 2210 product manuals.

23.2.1 Logging on to a Router

The following are the three general ways of logging on to a router:

1. Local console
2. Remote modem connection
3. TCP/IP TELNET

The first two options above are very similar. A local ASCII console or ASCII terminal emulator can be attached to the serial port of the router using standard emulator settings. The IBM 2210 and IBM 6611 will both work with the following settings:

- 8 data bits
- 1 stop bit
- No parity
- Speed 9600 bps

A remote modem connection may be useful to monitor a remote router. Both the IBM 2210 and IBM 6611 support the attachment of a V.24 modem to the serial port and connection to a remote terminal emulator using the same settings as those shown above.

In a normal mode of operation, however, the easiest way to log on to the router is by TCP/IP TELNET. Both the IBM 2210 and IBM 6611 support TELNET VT100 servers in their base code.

23.2.2 Operating the IBM 6611

The IBM 6611 supports logged-on users by means of an application that has been written to run on top of routing software called System Manager. System Manager provides the ability to perform the following kinds of tasks:

- Operation
- Problem determination
- Software maintenance

The following figure shows the main System Manager panel that is received when logging on to an IBM 6611.

```
IBM 6611
                                System Manager

Move cursor to desired item and press Enter.

  Operations
  Problem Determination

  Configuration
  Software Installation and Maintenance
  Hardware Maintenance

  System Manager Help









F1=Help             F2=Redraw Screen    F3=Fast Path        F4=SysID
Esc+0=Logoff                            Esc+L=Turn Log On
```

Inside the Operations option, the following activities are available:

```
                                  Operations

Move cursor to desired item and press Enter.

  Protocol and Interface Monitor
  Routing Information
  Remote Host Echo (Ping)/Route Trace
  Network Statistics
  ARP Table Management
  Filters
  Network Management Information (MIBs)

  File Systems
  File and Diskette Operations
  Remote Access to Other Nodes
  Login Information
  System Activity Report
  EIA 232 Serial Ports
  System Shutdown
  Date and Time
```

Some of the more useful sections available here are:

- Protocol and Interface monitor
  - Overview display of router activity
- Routing Information
  - Display of route table for each protocol
- Remote Host Echo (Ping)/Route Trace
  - Perform IP Ping or Traceroute
  - Perform IPX Ping
- System Shutdown
  - Shutdown the system with optional re-IPL

In the Problem Determination option, the 6611 allows the display of error logs, collection of protocol traces and the viewing of the 3 digit display on the front panel of the 6611. The last option sounds trivial, but it can be very useful when attempting to analyze problems on remote routers.

23.2.3 Operating the IBM 2210

Like the IBM 6611, the IBM 2210 provides operational and problem determination support for a logged-in user. Unlike the 6611 though, the 2210 provides this support in a line mode display rather than full panels.

All of the operational options with the exception of reboot are held under talk 5. The following table lists some of the more common activities that you may want to perform:

Table 22. 2210 Operational Commands

Action	**Commands**
Reload router code and restart router	reload
Restart router	restart
Check network interface	• talk 5 • interface interface_number
IP Ping	• talk 5 • protocol ip • ping ip_address
Check DLSw sessions	• talk 5 • protocol dlsw • list tcp sessions
Check protocol routing table	• talk 5 • protocol protocol_name • dump
Check IPX Server table	• talk 5 • protocol ipx • slist

23.3 Network Monitoring

The final topic that we will cover in this chapter is that of network monitoring. Most routers today, including the IBM 2210 and 6611, provide extensive management and reporting data. Most routers can be configured to send this management data to a central reporting function known as a network manager. This network manager is generally a networked application responsible for receiving the management data and providing real-time reports and alerts from it. Generally the protocol used to send data to and from the network manager is SNMP (the Simple Network Management Protocol) which runs over an IP network.

Each router maintains all of its management information in its Management Information Base (MIB). The MIB is a standard defined database format which is supported by most routers. This means that a network management application, which understands the MIB format, is capable of managing most router products. The current MIB standard is known as MIB II and contains details about all of the router's functions.

IBM has three SNMP Management Platforms in the market today:

- NetView for AIX
- NetView for OS/2
- NetView for Windows

All of these platforms offer a graphical interface automatically updated with the current network status. Color coding on the network map highlights problem areas within the network allowing problem determination to focus in on the correct areas quickly.

NetView for AIX is designed to meet the management requirements of a large router network. It has extensive management capabilities including the following:

- Automatic discovery of new network devices
- SNMP management of bridges, routers and workstations
- Built in SNMP applications
- Allows direct queries of any MIB variable
- Integration with other network management platforms including:
  - IBM LAN Network Management Utilities; allows monitoring of NetBIOS, IPX and IP resources
  - IBM RMONitor for AIX; allows collection of detailed performance data from Ethernet and token-ring networks
  - IBM Systems Monitor; allows collection of detailed performance data from AIX workstations
  - IBM Router and Bridge Manager; allows collection of detailed performance data from routers and bridges and display of system resources
- Automatic alert generation when SNMP traps are received
- Full compatibility with mainframe NetView

For smaller networks, NetView for OS/2 and NetView for Windows are more suitable. Although they neither provide the rich suite of functions that NetView for AIX does nor the capability to monitor as many resources, they do provide the same basic function.

Highlights of these two products include:

- Graphical Network Topology map
- Built in SNMP applications
- Integration with IBM LAN Management Utilities to provide management of IPX, NetBIOS and IP devices
- Direct query of any MIB variable
- Automated alert generation

23.4 Summary

This chapter has briefly looked at some of the aspects of network management. We have looked at router configuration and software maintenance procedures for the IBM 2210 and IBM 6611 highlighting some ways in which activities can be done non-disruptively. We have moved on to cover some of the simple techniques that can be used from the router devices to perform simple operational activities and problem determination. Finally, we have closed by looking at some of the network management platforms available from IBM for router networks.

Chapter 24. Multiprotocol Network Services from IBM Global Network

Multiprotocol Network Services from the IBM Global Network provide a variety of managed protocol solutions for data networking. These solutions include high-speed, cost-effective wide-area network (WAN) connectivity and gateway services for diverse customer systems, workstations and local area networks (LANs). Both Ethernet and token-ring LANs are supported.

Today, more and more applications are being downsized to the desktop and distributed servers. This evolution has created a demand for enterprise networks that can support client/server processing and LAN to LAN communications. Due to the implementation characteristics of these applications, high-speed WAN connectivity is often required.

IBM Global Network Multiprotocol Network Services provide a single link to support all these communication requirements. Multiprotocol communication is achieved with fixed-price, leased-line connections that provide the high-speed data rates needed for many new client/server and technology driven applications designed for the LAN environment. Client/server, file server and file transfer applications are all supported.

The IBM Global Network multiprotocol backbone network can carry a variety of protocols across a single transport. The network supports Transmission Control Protocol/Internet Protocol (TCP/IP), NetBIOS, Novell IPX, X.25 and SNA. Designed for resilience, the network has dynamic routing to minimize the impact of component failure. Connections to the customer′s locations are made with an IBM Global Network router installed, configured and tested as part of the service.

24.1 Highlights

IBM Global Network Multiprotocol Network Services (MPN) are an integral part of the total network solutions offered by the IBM Global Network. This means that your organization needs just one supplier for all your network requirements. Anything from an electronic mail connection for an agent in Australia to taking on the management of your entire corporate network - the IBM Global Network has the solution.

Here are some of the highlights of MPN:

- Fixed-price connections for customer′s connectivity requirements
- Connectivity options for Ethernet or token-ring LANs
- 64 kbps digital connections - with higher speeds available on request
- Support for TCP/IP, SNA, IPX, X.25 and NetBIOS network protocols
- Access to existing SNA Networking Services from the customer′s LAN
- Gateway functions for TCP/IP and SNA, providing application inter-operation

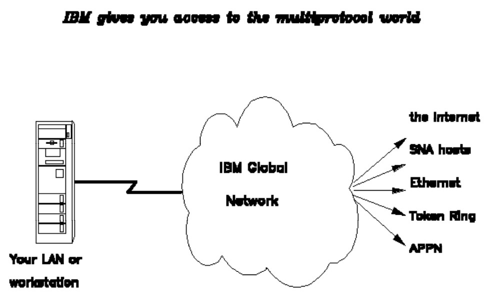


Figure 229. Access the Multiprotocol World

24.2 Benefits

These services give you the benefits of a multi-vendor backbone data network without having to invest in the resources necessary to install and manage the network. In addition, a single fixed annual charge helps you budget and plan your expenses.

IBM Global Network Multiprotocol Network Services can also help you do the following:

- Focus your resources on strategic business applications
- Keep pace with rapid business expansion
- Implement new applications and technologies easily with minimal network impact
- Reduce staffing for network operations, planning and help desks
- Take advantage of inter-enterprise solutions through the same network connections

24.3 Total Network Solutions

Through your single network connection you can take advantage of the whole spectrum of IBM Global Network solutions for international networking and business to business communications.

These include messaging services:

- Information Exchange for electronic data interchange (EDI)
- IBM Mail Exchange for electronic mail
- IBM Community Exchange for bulletin boards and community messaging

Computing capacity services, commercial databases and a host of other services which would be complex and costly to implement on your own are all available from IBM Global Network solutions. With the IBM Global Network you can put these capabilities to work quickly without worrying about technical details and with complete confidence of availability and performance.

Through IBM Global Network services you can make almost all these services available to company users and trading partners anywhere in the world.

The IBM Global Network can offer you a total network solution whatever your networking requirements.

24.4 Gateway Services

IBM Global Network Multiprotocol Network Services include a gateway between SNA 3270 users and TCP/IP TELNET-based applications. There is also a gateway for TCP/IP TELNET users to gain access to SNA 3270 applications.

IBM Global Network Multiprotocol Network Services also provide dial access for TCP/IP workstations. This method of access is controlled by user ID and password authorization similar to that provided by the IBM Global Network for other dial users.

TCP/IP workstation dial facilities can be used by customers wishing to gain access to SNA 3270 applications or to TCP/IP applications for which they are authorized.

24.5 Network Management and Operation

IBM Global Network Multiprotocol Network Services include:

- **Configuration, planning and installation**. The IBM Global Network will provide configuration design and performance modelling, compatibility testing and documentation, ongoing monitoring of the configuration, ordering, installation and testing of leased-line connections and required Channel Service Unit/Data Service Unit (CSU/DSU) facilities.

  The IBM Global Network will also supply, install, configure and test the customer site router as part of the MPN service.

- **Resilient backbone network**. Customer sites are connected to router nodes throughout the world. This backbone carries traffic among customer sites. It includes the following equipment and facilities: duplicate multiprotocol routers, CSU/DSUs, data scopes, line impairment equipment trace facilities, uninterrupted power supplies (UPS), and network management workstations.

- **Staffing and support of backbone sites**. The IBM Global Network provides support 365 days a year, 24 hours a day. Backbone nodes are remotely managed from the IBM Global Network operation centers to keep the network operating at all times.

- **Sophisticated network management tools**. Highly automated tools provided by IBM manage the components of the IBM Global Network multiprotocol network solutions. These include: NetView management architecture for control and monitoring network resources as well as a graphical interface for reporting the status of router components and a management system for monitoring the backbone CSUs in the network.

- **Problem Management**. The Customer Support System (CSS) and its NOTIFY function enable users to report problems, issue inquiries, and receive status and resolution information via their terminals; and network management software collects data about network events, interprets failure information, and issues commands to reactivate failing components automatically.

24.6 Technical Support

IBM Global Network support personnel have years of experience in network communications. Using state-of-the-art network hardware and software support tools, they are available 24 hours a day, seven days a week to assist with problems.

The technical background and the job experience of the IBM Global Network personnel and related support organizations involved in managing the backbone nodes and remote site communications equipment is extensive. Many of the support and management personnel have previously worked in IBM as Customer Engineers and Network Operations technicians. For this reason, they provide a strong background in communications hardware which can be utilized to your advantage in resolving backbone as well as remote site problems. The opportunity for your company to take advantage of the expertise of the IBM Global Network in the management of the telecommunications facilities and circuits of the backbone network will be invaluable in the on-going implementation and support of your multiprotocol network solution.

24.7 Performance and Availability

The IBM Global Network has an excellent track record for performance, availability and reliability. The network is monitored 24 hours a day and managed by network professionals using sophisticated network management software.

The multiprotocol network gives the performance demanded by todays high-speed applications. The network is designed for a maximum network added delay of 500 milliseconds.

High levels of resilience are built into the network for backup and to help assure continuous service, including duplication of such key network components as control centers and transmission links. The multiprotocol network is available 24 hours a day, seven days a week, with a network management objective to exceed 99.8% availability of each network component during these service hours.

24.8 More Information

For more information about the IBM Global Network Multiprotocol Network Service contact your IBM representative.

Chapter 25. AS/400 and Printing in a Multiprotocol Network

In this chapter we look at the large and complex issue of printing support in multiprotocol networks. We discuss some of the potential printing problems faced when migrating from a pure SNA network to a multiprotocol environment. The key point to focus on during any migration exercise is to ensure that we provide the same level of print support, in terms of function and performance, that is present in any existing solution.

This is not a straightforward proposition. Print support within multiprotocol networks has to cater to a wide variety of print applications, network connectivity options and printing hardware. In particular, we have to look at support for different printer data streams (for example, IPDS), different applications, and different network connectivity such as twinax, token-ring and Ethernet.

This chapter does not address all of the issues within printing support over multiprotocol networks. It is intended to help networking specialists understand the concepts of printing in a multiprotocol environment and examine some of the available options.

Printer specialists will understand the applications, the printer data streams and the capabilities of the printers. However, when printing is done across the network, the following responsibilities falls on the networking specialist:

- To ensure performance is maintained and to improve response times for printer output over the network
- To understand the interoperability of different printers attached to different systems around the network
- How print output is transported using different protocols
- To what extent the AS/400 can be used as a central print server or how AS/400 print output can be transferred to other print servers

This chapter provides you, from a networking and AS/400 perspective, with information to help you answer these questions.

25.1 Overview

Many different applications produce output that needs to be printed. This could be the result of a remote database query or the result of a user requiring hardcopy output of some mail. Whatever the source of the data to be printed, the path that the data flows is always the same. An application is responsible for actually controlling the overall print operation and the print device. This application will create a print data stream which consists of the following two components:

- The set of instructions used to control printer functions (for example, highlighting and fonts)
- The actual data to be printed

The print data stream will be handed down to a communications protocol (for example, SNA or TCP/IP) which is responsible for delivering it to the destination print device. The communications protocol then has to use network connectivity, token-ring for example, to physically transmit the data to the required destination.

Each of these three independent layers needs to be interoperable between the printer driver and the printing device as illustrated by the Figure 230.

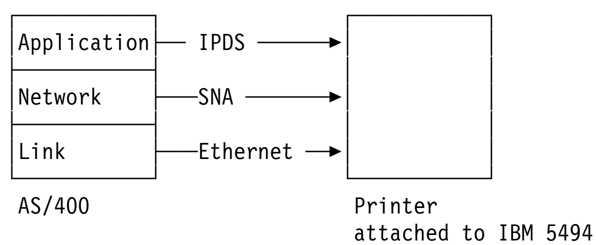


Figure 230. Interoperability in Printing

The above example is of a printer (printing device) which is twinax attached to an IBM 5494. The 5494 connects to an AS/400 (printer driver) by an Ethernet LAN connection. We need to achieve interoperability here on the following three levels:

- First, the 5494 and AS/400 must be able to share the same physical communications medium (here it is LAN attachment).
- Second, the 5494 and AS/400 must be able to share the same network protocol (here it is SNA).
- Finally, and most important, the printer must be able to understand the printer data stream that the AS/400 application generated and sent to it.

In the following sections, we look at solutions which can satisfy the three interoperability requirements.

25.2 Migrating the Current Environment

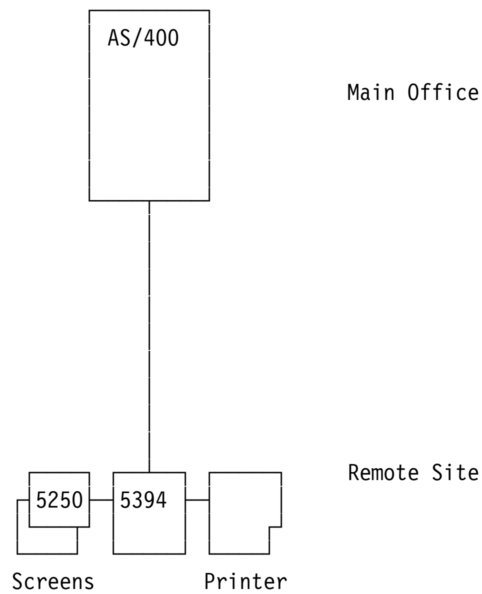


Figure 231. Classic AS/400 Networking Environment

When migrating from a classic AS/400 network scenario to a multiprotocol environment, we must always ensure that we consider the question of how to accomplish equivalent printing support.

The following questions must be addressed at the design stage of the new network:

- Can the current printers still be used?

  Twinax printers, especially twinax IPDS printers, offer a sophisticated level of printing functions. This level cannot always be achieved by ASCII printers.

- Can the current printers be used by other systems in the new network?
- How can the printers or workstation controllers be integrated into the new network?

  The 5394 does not offer simple migration into a router network as it cannot be LAN-attached.

- Is the network protocol (for example SNA) supported by the new network?
- What effect will sending large print files have on the network?

There are many potential ways in which we can design a network to answer the previous questions for the scenario shown in Figure 231. These methods could include the following scenarios:

- Attaching the IBM 5394 via SDLC to the router
- Replacing the IBM 5394 with a LAN-attached IBM 5494
- Replacing the twinax printer with a LAN-attached printer

The best solution will depend on the individual's requirements. The following diagram illustrates one potential solution.

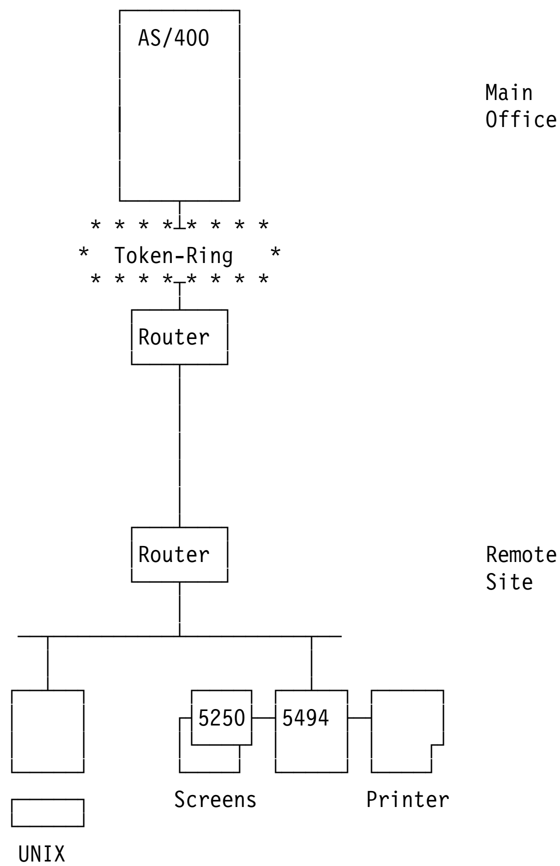


Figure 232. Migrated Printing Environment

If we consider the replacement of actual printers, interoperability has to be checked between the printer and the application. The following questions must be addressed:

- What printer data stream do we use currently?
- Will the new printer also support this data stream?
- Will the new printer support this data stream over the multiprotocol network that we install?

We may also be opening up the printing environment to other users. For example, if we LAN attach a new printer, we may require that other LAN users be able to use this facility. Again, we need to ensure that the printer will support and work with any new print applications.

One of the biggest factors is performance. The printing of large volumes of data can influence interactive traffic and performance in any environment. Multiprotocol network environments also suffer from the same problems as to how to minimize the impact of printing on interactive users.

In the next sections we will attempt to answer the following questions. This information should help you to propose solutions to the previous questions.

- What are the various printer data streams that AS/400 applications generate?
- Which printer data streams is the AS/400 able to receive as print server?

- Which printer data streams are understood by which printers and how can printers be connected to the AS/400?

25.3 AS/400 and Printer Data Streams

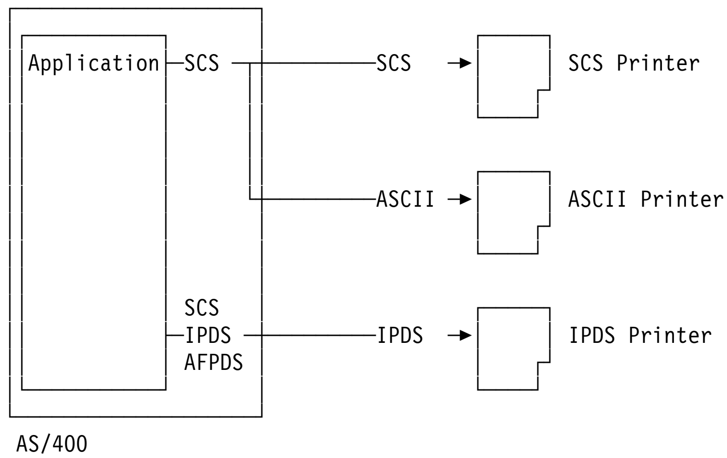


Figure 233. AS/400 and Printer Data Streams

The AS/400 can generate the following printer data streams:

- SNA Character Stream (SCS)
- Intelligent Printer Data Stream (IPDS)
- Advanced Function Printing Data Stream (AFPDS)

SCS mainly covers line printing. SCS printers are twinax attached printers.

The AS/400 is able to translate SCS into ASCII printer data streams, such as PPDS, PCL4, PCL5, by using the Host Print Transform function which is part of the OS/400. Printers understanding ASCII printer data streams are sometimes referred to as ASCII printers, PC printers, personal or workstation printers. On the AS/400, the term USERASCII is used to represent all ASCII printer data streams such as PPDS, PCL4, PCL5.

AFPDS allows the printing of complex documents and allows the integration of graphics, forms and text. Before it is transmitted to the printer, the AFPDS format is converted into the IPDS data stream.

The IPDS generated by AS/400 applications is a subset of the full IPDS with the same functions but without the two-way dialog with the print driver.

We also mention PostScript, which is a printer data stream similar to AFPDS used mainly by PC printers. Note that AS/400 does not generate PostScript printer data streams.

25.4 AS/400 as Print Server

The AS/400 is also capable of receiving print output from other systems and sending it to printers controlled by the AS/400. The AS/400 can receive print output from many different sources in the network including the following list:

- From a Client Access/400 user
- From a TCP/IP user via TCP/IP LPR
- From another AS/400 via SNADS ODF
- From a System/390 via VM/MVS Bridge

The received print output is queued on one specified queue. Each queue usually only services one specific printer.

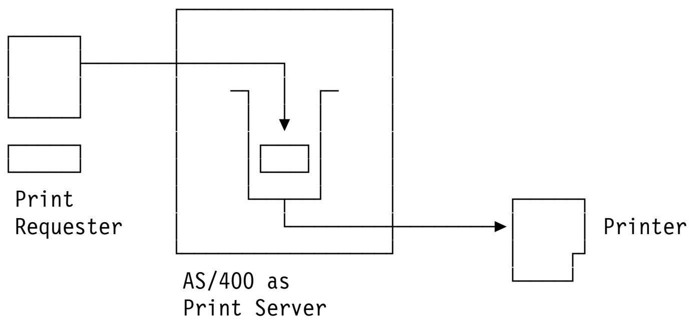


Figure 234. AS/400 as Print Server

The AS/400 is able to receive and handle the following data stream types: SCS, IPDS, AFPDS, LINE, AFPDSLINE and ASCII. AFPDSLINE is also named mixed mode.

The AS/400 can perform some conversions on received printer data streams such as the following:

- SCS to ASCII with the Host Print Transform function
- SCS, AFPDS, LINE, AFPDSLINE to IPDS

In addition, any ASCII data stream, even PostScript, can be spooled on AS/400 and forwarded to, or printed on, an ASCII printer without alteration.

In all cases, the target printer must *always* be able to understand the data stream which is sent to it.

25.5 AS/400 Printer Support

Print output generated by AS/400 applications is put into a print output queue. Print output received from other systems and workstations is queued the same way.

The following subsections will provide an overview on the various printers supported by the AS/400.

- Printers attached to local and remote workstation controllers
- LAN-attached printers
- Printers attached to workstations such as PCs
- Printers managed by LAN print server
- Printers controlled by other systems

From a networking point of view, the following three aspects have to be observed:

- Link type: twinax, LAN or WAN. What is the connection between the AS/400 and the printer?
- Network type: SNA, TCP/IP or other protocols. What is the network protocol between the AS/400 and the printer?
- Printer data stream: ASCII, SCS, IPDS or AFPDS. What is the data stream supported by the printer?

With this information the networking specialist can take printer requirements into account when designing a network. Some of the areas that are not covered in this section include:

- Printer functions
- Printer sharing among different workstations and servers
- Printer capacity

These are printer-specific aspects which you need to discuss with printer specialists.

25.5.1 Printers Attached to a Local or Remote Workstation Controller

Local AS/400 printers are attached via twinax cabling. The AS/400 has no channel-attached system printers.

Twinax printers are also attached to the IBM 5494 or IBM 5394 Remote Workstation Controller. The IBM 5494 can be LAN or WAN attached. The IBM 5394 is WAN attached only.

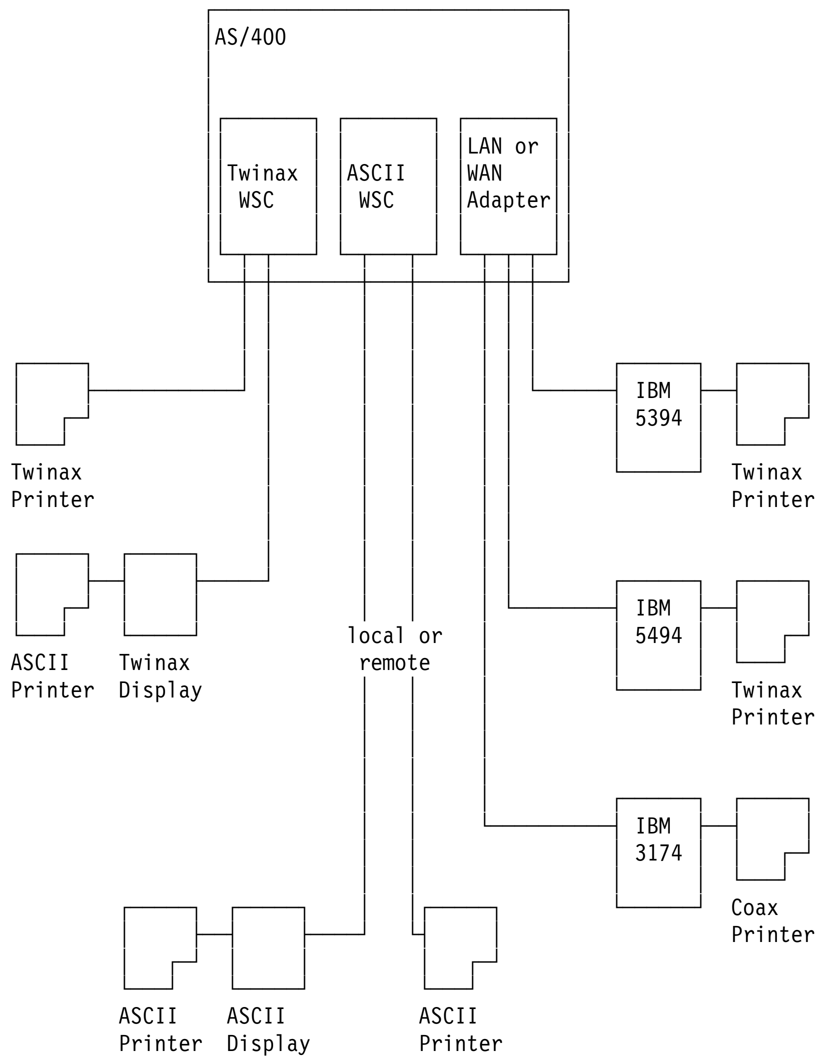


Figure 235. Printers Attached to a Local or Remote Workstation Controller

Type of Printer		Connection to Printer		Printer Data Stream Support		
	Attached to	Link	Network	ASCII	SCS	AFPDS /IPDS
Twinax	Twinax WSC	Twinax	SNA	—	yes	yes
Twinax	IBM 5X94	LAN/WAN	SNA	—	yes	yes
ASCII	ASCII WSC	Serial	ASYNC	yes	yes **1**	—
Coax	IBM 3174	Coax	SNA	—	yes	—

Note:

1 This is the conversion from SCS to ASCII performed by the OS/400 Host Print Transform function.

25.5.2 LAN-Attached Printers

There may be a requirement to attach printers directly to a LAN without a controlling server system. A large variety of printers in this area can receive print output from the AS/400.

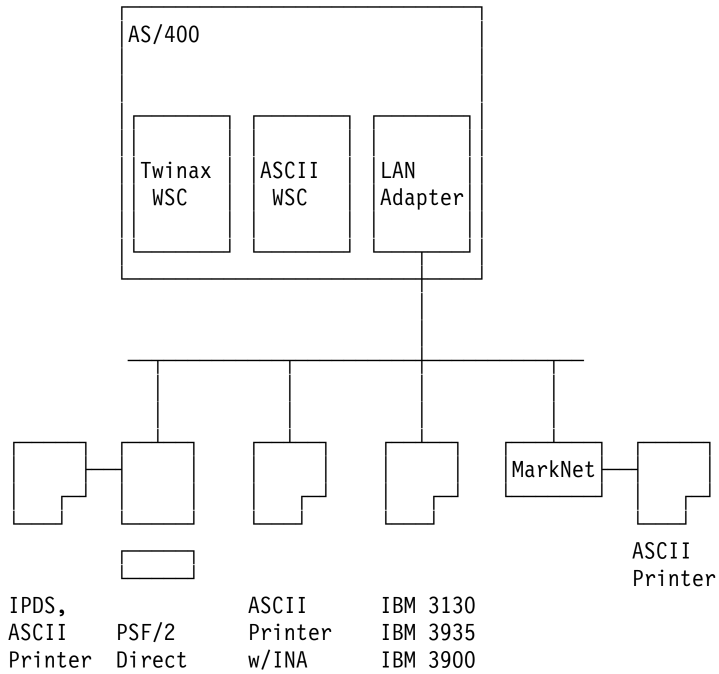


Figure 236. LAN-Attached Printers

- Directly attached printers with an integrated LAN adapter.

  IBM/Lexmark ASCII printers with the Integrated Network Adapter (INA) card, such as IBM 4039 or IBM 3112.

  IBM IPDS printers such as the IBM 3130, 3935 and 3900.

- ASCII printers attached via the Lexmark MarkNet XLe LAN Adapter.

  IBM/Lexmark and OEM printers like IBM 4019, HP III, HP IV.

  MarkNet XLe replaces the IBM 4033 LAN Printer Adapter.

- Printer attached to PSF/2 V2 Direct.

  PSF/2 is an OS/2 application which provides a print server function.

  PSF/2 Direct allows the attachment of any IPDS printers, and PPDS or PCL5 compatible ASCII printers. With PSF/2 Direct, the AS/400 operator controls the remote IPDS printers. For instance, printer messages are returned to the AS/400.

  PSF/2 Direct replaces the Remote Print Manager (RPM) V2 and offers more possibilities.

  PSF/2 Direct does not support matrix IPDS printers, like IBM 4230, 6408 or 6412.

- Printer attached to PSF/2 Distributed Print Function (DPF).

PSF/2 DPF differs from PSF/2 Direct mainly in printer operator control. With PSF/2 DPF the PC administrator controls the printer. This means that no printer messages are returned to the AS/400.

Type of Printer		Connection to Printer		Printer Data Stream Support		
	Attached to	Link	Network	ASCII	SCS	AFPDS /IPDS
ASCII	Printer with INA	LAN	TCP/IP or LexLink [2]	yes	yes [1]	-
ASCII	MarkNet XLe	LAN	TCP/IP or LexLink [2]	yes	yes [1]	-
ASCII	PSF/2 Direct	LAN	SNA	-	yes	yes
IPDS	PSF/2 Direct	LAN	SNA	-	yes	yes
IPDS	Printer with INA	LAN	SNA	-	yes	yes

Notes:

[1] This is the conversion from SCS to ASCII performed by the OS/400 Host Print Transform function.

[2] LexLink protocol is not routable, and so it has to be bridged.

25.5.3 Printers Attached to Workstations

PCs and other workstations usually have directly attached ASCII printers. The AS/400 sends either SCS or ASCII printer data streams to the workstation-attached printer in one of the following ways:

- SCS is converted by the printer emulation program of the workstation.
- Depending on the specified printer, before sending, the AS/400 converts SCS to ASCII printer data streams.

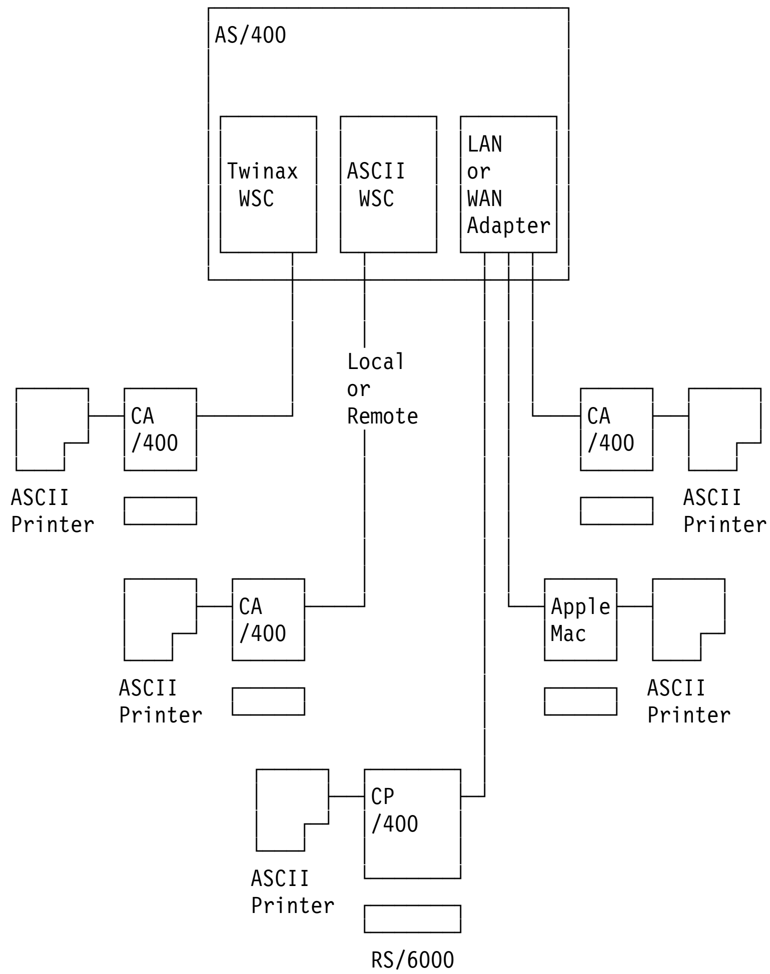


Figure 237. Printers Attached to Workstations

Type of Printer		Connection to Printer		Printer Data Stream Support		
	Attached to	Link	Network	ASCII	SCS	AFPDS /IPDS
ASCII	Client Access/400	direct, LAN/WAN	SNA	yes	yes **1**	-
ASCII	Apple Mac	LAN/WAN	AppleTalk, SNA, TCP/IP	yes	yes **1**	-
ASCII	Connection Program/400	LAN/WAN	SNA, TCP/IP	yes	yes **1**	-

Note:

1 This is the conversion from SCS to ASCII performed by the OS/400 Host Print Transform function.

25.5.4 PSF/2, PSF/6000 and AS/400

PSF/2 and PSF/6000 are LAN print server programs. PSF/2 runs on an OS/2 system, and PSF/6000 runs on an RS/6000 system. They support the spooling and conversion of AFPDS to PC printer data streams and allow the AS/400 to send print output to both the PC and the RS/6000 to be printed.

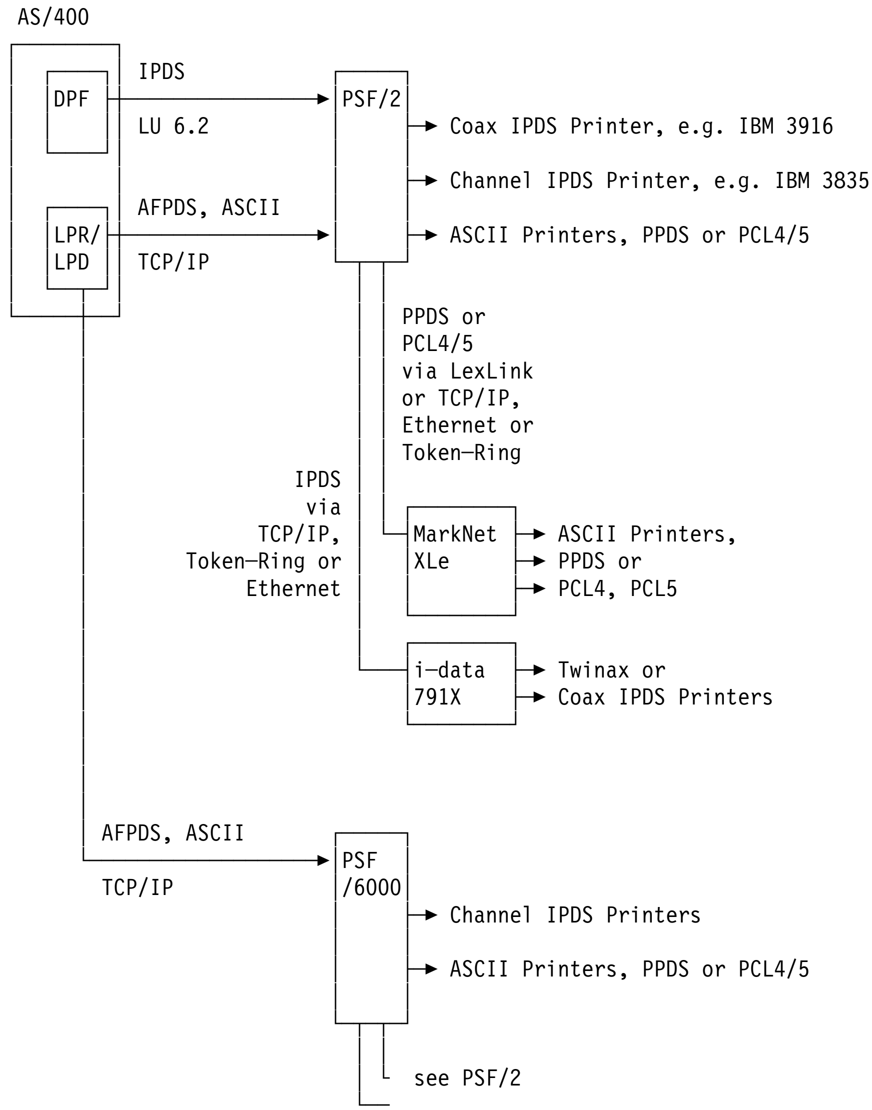


Figure 238. PSF/2, PSF/6000 and AS/400

PSF/2 converts the following:

- AFPDS to IPDS
- IPDS to PCL4, PCL5, PPDS
- PostScript to IPDS

PSF/6000 converts the following:

- AFPDS to PCL4, PCL5, PPDS
- PostScript to IPDS

Type of Printer		Connection to Printer		Printer Data Stream Support		
	Attached to	Link	Network	ASCII	SCS	AFPDS /IPDS
IPDS 1	PSF/2	LAN/WAN	SNA, TCP/IP	-	yes	yes
ASCII 2	PSF/2	LAN/WAN	SNA, TCP/IP	yes	yes 3	yes
IPDS	PSF/6000	LAN/WAN	TCP/IP	-	yes	yes
ASCII	PSF/6000	LAN/WAN	TCP/IP	yes	yes 3	yes

Notes:

1 This is any IPDS printer directly attached to PSF/2 or connected via i-data.

2 This is any ASCII printer directly attached to PSF/2 or connected via MarkNet XLe.

3 This is the conversion from SCS to ASCII performed by the OS/400 Host Print Transform function.

MarkNet XLe supports up to three PC printers (two parallel and one serial) via LexLink (802.2), TCP/IP or IPX.

i-data (IBM 731X) supports up to two printers but only one active printer at a time.

With OS/400 V3R1, the Remote System Printing function allows spooled files to be automatically sent to PSF/2 or PSF/6000 for printing.

IPDS spooled files created by AS/400 applications (parameter Printer Device Type in Printer File set to *IPDS) cannot be sent to PSF/2 or PSF/6000. You can circumvent the problem by changing the Printer Device Type to *AFPDS.

25.5.5 Print Output to Printers Controlled by Other Systems

AS/400 as a print requester can forward print output to other systems using facilities like TCP/IP LPR, SNA/DS Object Distribution Facility (ODF) or Network Job Entry (NJE).

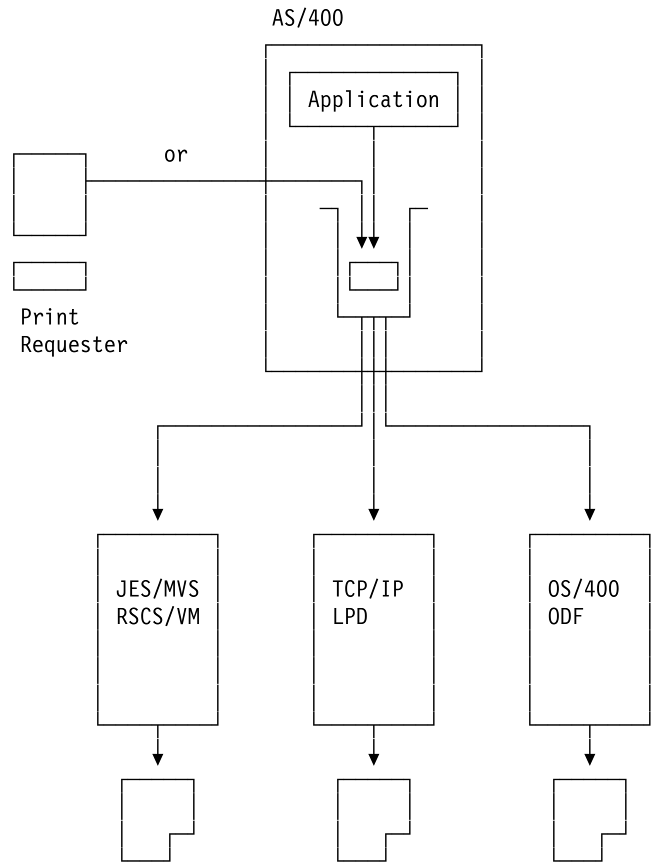


Figure 239. Print Output Transfer to Other Systems

Type of Printer	AS/400 transfers	Connection to Printer: Link	Network	Printer Data Stream Support: ASCII	SCS	IPDS	AFPDS
ASCII	as TCP/IP LPR	LAN/WAN	TCP/IP	yes	yes **1**	-	-
IPDS	using SNADS/ODF	LAN/WAN	SNA	-	yes	yes	yes
IPDS	using NJE VM/MVS Bridge	LAN/WAN	SNA	-	yes	yes **2**	yes

Notes:

1 This is the conversion from SCS to ASCII performed by the OS/400 Host Print Transform function.

2 IPDS data cannot be sent if any special device requirements are present such as fonts, bar codes rotation, or graphics. You can send the data by copying the spooled file to a database file (CPYSPLF command) and then using the SNDNETF command to send it as a network file.

With OS/400 V3R1, the Remote System Printing function allows spooled files to be automatically sent to other systems.

Part 5. Appendix

Appendix A. MPTN Architecture and AnyNet Product Family

The IBM 2217 Multiprotocol Concentrator implements AnyNet functions to allow the transport of TCP/IP, NetBIOS and IPX over SNA. AnyNet is an implementation of the MPTN (Multiprotocol Transport Networking) architecture.

A.1.1 Networking Blueprint

The Networking Blueprint framework was introduced by IBM in 1992. MPTN is a component of the Common Transport Semantics layer of the Networking Blueprint.

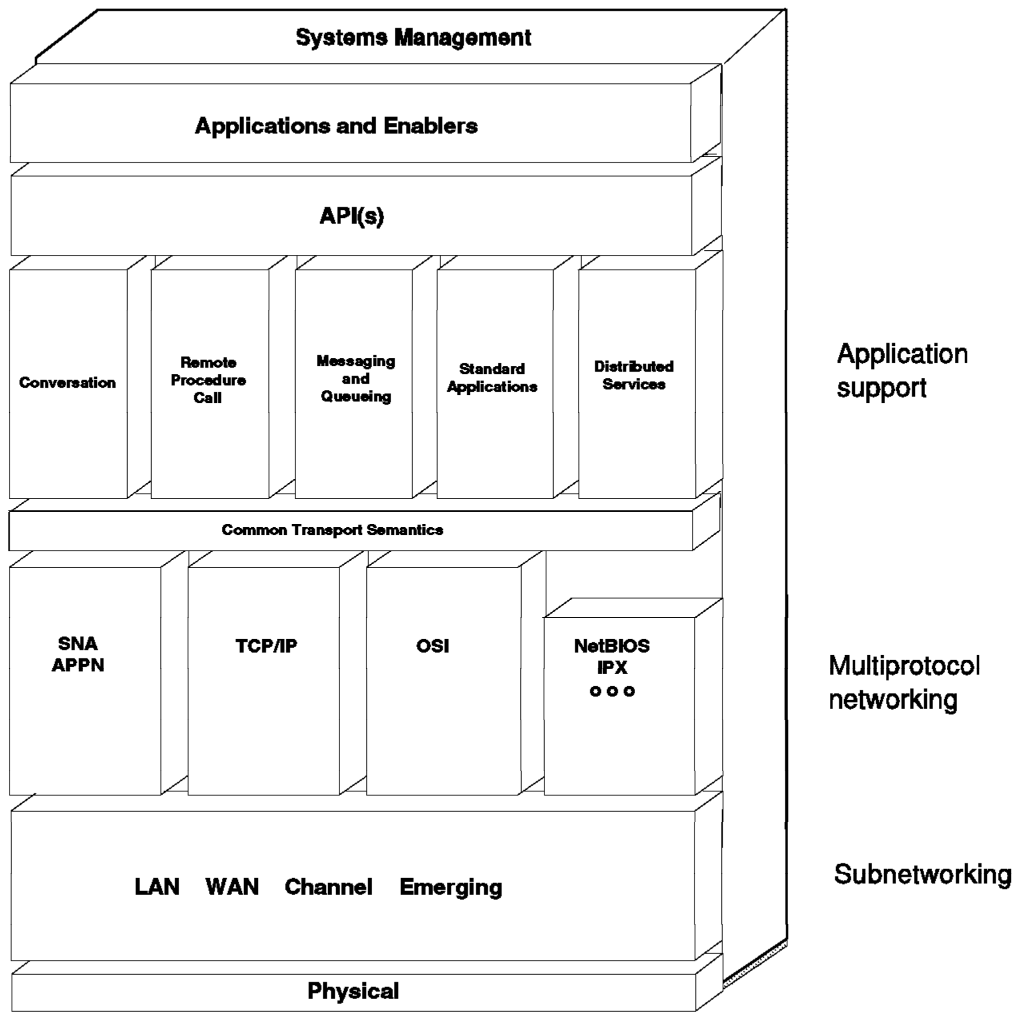


Figure 240. The IBM Networking Blueprint

The Blueprint puts forth a framework for integrating applications, using different types of communications protocols, into a single network. In this way, customers can concentrate on productivity enhancing applications to strengthen their business′ competitiveness without being constrained by networking issues.

The Application and Enablers layer represents the applications that make use of the underlying capabilities of the network. These applications may be customer applications or they may be application services, such as distributed database, print, store-and-forward messaging services, etc., that are commonly used by applications.

The API (Application Programming Interfaces) boundary serves the application process and application services. One purpose of this boundary is to make the application process and supporting application services independent of the underlying system architecture. This boundary currently includes three common application programming interfaces for conversations, remote procedure calls and message queuing. In the Blueprint, any application or application service can use one (or more) of these interfaces to obtain appropriate communications support.

The Application Support layer represents the range of application interfaces and services in use today. Typically, these interfaces and services are only able to operate in a specific network environment. For example, Remote Procedure Call (RPC) would only operate in a TCP/IP environment. The Blueprint contains a structure for extending the reach of many different types of applications throughout many different networking environments.

The Common Transport Semantics (CTS) boundary is below the application support layer. The purpose of this boundary is to give the application, with its end-to-end application support facilities, the opportunity to use alternative transport service providers below this boundary. MPTN (of which AnyNet is an implementation) delivers a CTS function.

The Multiprotocol Networking layer represents the variety of networking protocols in use today for sending and exchanging information throughout the network. The Blueprint contains a structure to build a single network that will support all these protocols.

The Subnetworking layer represents a piece of a larger network, for instance a bridged local area network, or a frame relay network. It is in this layer where dramatic change to high-speed cell/packet switching will occur.

The Systems Management entity represents a comprehensive management capability encompassing all the elements of the Blueprint.

A.1.2 Open Blueprint

Introduced by IBM in 1994, the Open Blueprint is IBM′s technical approach for integrated, open, client/server and distributed computing across systems platforms. The structure includes industry standard interfaces, protocols and formats, and IBM extensions to provide the flexibility to accommodate new technologies as they emerge in today′s dynamic open computing environment.

The Open Blueprint incorporates the lower layers and Systems Management backplane of the Networking Blueprint and provides more detail and structure to the software components in the Application Enabling services. In the future, the Networking Blueprint and Open Blueprint will be converged. The Open Blueprint will be used to position new networking technologies in the same way as the Networking Blueprint has been used.

A.1.3 Multiprotocol Transport Networking (MPTN) Architecture

The MPTN architecture is defined in the terminology of the Networking Blueprint. In Figure 241, the arrows depict the way the MPTN architecture, by delivering the CTS (Common Transport Semantics) function, allows applications designed to run over one transport network to run over another. The arrows depict APPC applications over TCP/IP, sockets applications over SNA and NetBEUI applications over SNA.

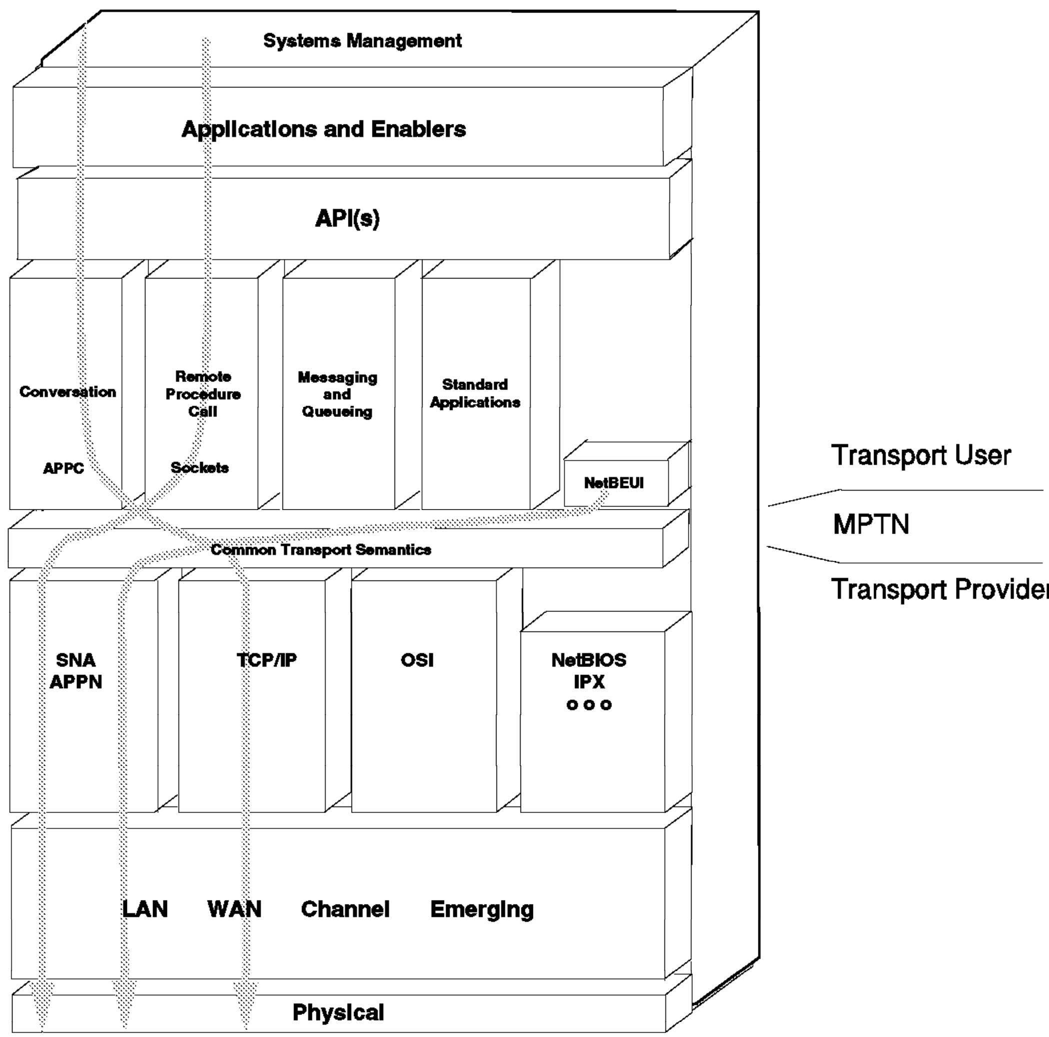


Figure 241. IBM Networking Blueprint - MPTN Implementations

In Networking Blueprint terminology, the term transport user means application programs and application support functions. The term transport provider means a provider of communication service at the transport layer. A transport provider uses one transport protocol to govern the exchange of information between nodes, thus providing a transport network of that type. The terms native and non-native describe a vertical relationship between a transport user and a transport provider. Application programs, designed assuming a particular transport provider, are native to that transport provider. At the same time, they are non-native to another transport provider. A native node is a node with no MPTN capability. For example, a node with SNA application programs running over an SNA transport is a native node.

Common Transport Semantics (CTS) in the Networking Blueprint divides the protocol stacks at layer 4, the Transport layer. The applications, APIs and application support layers are above the CTS while the transport network is below the CTS.

CTS includes all of the functions in the underlying transport providers in the Networking Blueprint. If needed functions are missing from any of the transport providers, CTS itself provides those functions. CTS functions can be achieved in different ways depending on the following situations:

1. Where the installed application program is native to a transport protocol, CTS does not interfere with the native flows.
2. The CTS function can be achieved using industry standard compensation methods for particular transport-user/transport-provider combinations such as a Request for Comment (RFC) 1006 for OSI over TCP/IP and RFCs 1001 and 1002 for NetBIOS over TCP/IP.
3. The MPTN architecture formats and protocols deliver the CTS function where the installed application programs are not native to the installed transport protocol. For example, the MPTN architecture defines how SNA can be the transport provider for sockets applications and how TCP/IP can be the transport provider for CPI-C applications.

Figure 242 illustrates the three situations.

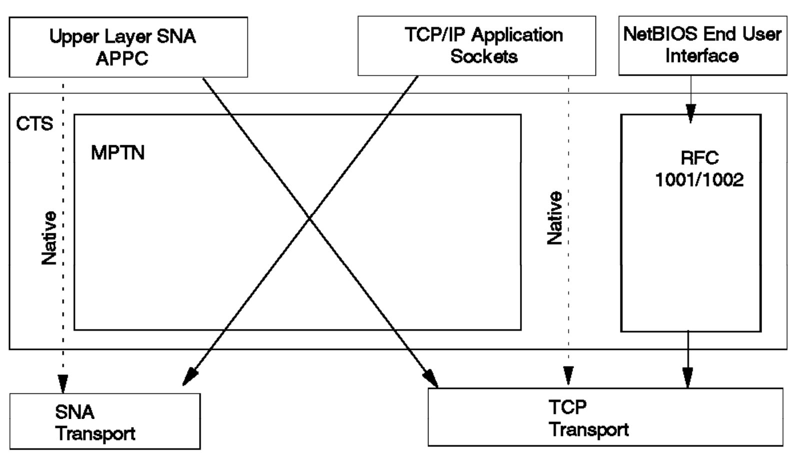


Figure 242. Common Transport Semantics (CTS) Example

A.1.4 Function Compensation in MPTN

Every transport provider lacks some functions supported by other transport providers. For example, SNA, NetBIOS and OSI all support a record model which is lacking in TCP/IP while TCP/IP supports a stream model which is lacking in SNA, NetBIOS and OSI. In order to support multiple transport users over a common transport provider, MPTN provides function compensation when a transport user requests services that are not provided by the transport provider.

A.1.5 Address Mapping in MPTN

Address mapping is required when the transport user (application) and the transport provider (network protocol) have different addressing schemes.

For example, APPC applications use SNA fully qualified LU names to communicate with each other. If the transport provider is TCP/IP, MPTN needs to perform some address mapping.

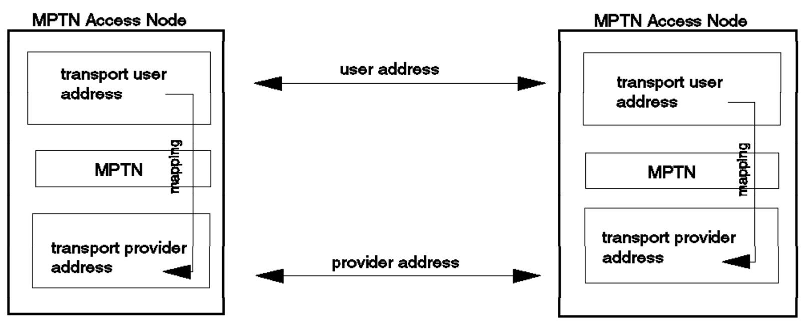


Figure 243. MPTN Address Mapping

In MPTN, there are three architected approaches to address mapping:

- **Algorithmic**

  MPTN uses an algorithm to generate a transport provider address based on the transport user address. This approach is appropriate when the user′s address space is smaller than the provider′s address space. Sockets over SNA uses algorithmic mapping with IP host addresses mapped to SNA LU names.

- **Extended protocol-specific directory**

  This is the extending of a protocol-specific directory to handle transport addresses of other formats. This approach is appropriate when the transport providers directory supports the registration of different address types. APPC over TCP/IP and SNA over TCP/IP support this form of addressing; the TCP/IP domain name server can be used to support SNA names. For example, NETA.LU1 could be registered in the domain name server as LU1.NETA.SNA.IBM.COM.

- **Address mapper**

This is basically a database which holds the transport user to transport provider mappings. This is the most general approach but also the most costly one.

Figure 244 illustrates the three mapping methods.

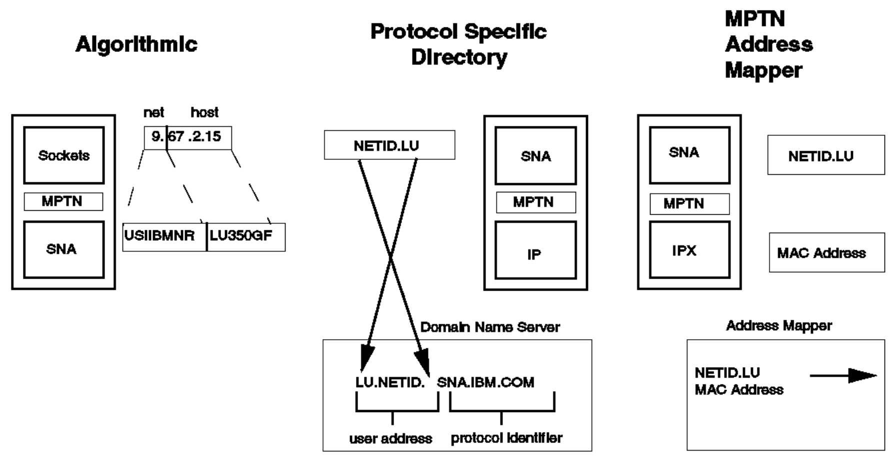


Figure 244. MPTN Address Mapping Examples

The algorithmic example shows how, for Sockets over SNA, the TCP/IP address is mapped into an SNA network-qualified name. This is a two step process. First, by using a mask, the TCP netID is determined and then mapped to an SNA network name via table lookup. Next, an algorithm is used to determine the LU name from the host ID which is the remaining portion of the TCP/IP address.

The second part of the example illustrates the method used by an extended native directory to generate the TCP/IP address. The TCP/IP domain name server (DNS) is extended to store the user address and protocol identifier. DNS is used to support SNA name types and provide IP addresses for these names when requested. Thus, when the SNA network-qualified name NETID.LU is presented to the name server for address resolution, the SNA name is used as an index into an address mapping table. In this case, the user address portion of the IP address is simply the bit reversed form of the network-qualified SNA name LU.NETID, and the protocol identifier is preset, in this case, to SNA.IBM.COM.

The third part of the example illustrates the method used by an MPTN address mapper. In this case, the transport user and transport provider association is registered in the address mapper. This occurs dynamically each time a transport user registers a transport-user address, causing a (user-provider) address pair to flow to the address mapper for registration. Thus, when the NetBIOS name is presented to the MPTN address mapper for resolution, the associated SNA name NETID.LU is returned.

A.1.6 MPTN Access Node

The MPTN access node is a component that allows application programs to run on a non-native transport network. For example, a node that allows APPC to run over TCP/IP is an MPTN access node.

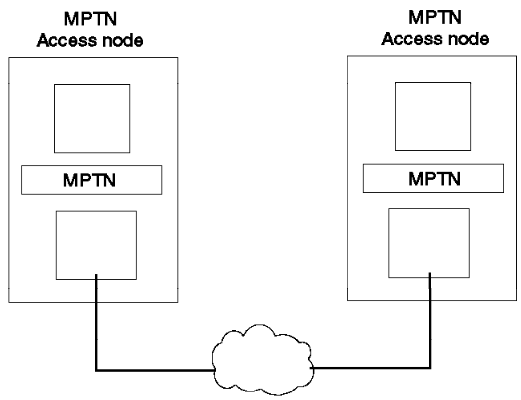


Figure 245. MPTN Access Nodes

Figure 245 shows two MPTN access nodes attached to the same transport network. An MPTN access node can also interoperate with a native node through an MPTN gateway (Figure 246 on page 316).

A.1.7 MPTN Gateway

An MPTN transport gateway connects two dissimilar networks to provide an end-to-end service over their concatenation. Figure 246 shows a single MPTN gateway providing communication between an MPTN access node and a native node. Figure 247 shows two MPTN gateways providing communication between two native nodes. No changes are required at the native nodes in either case.

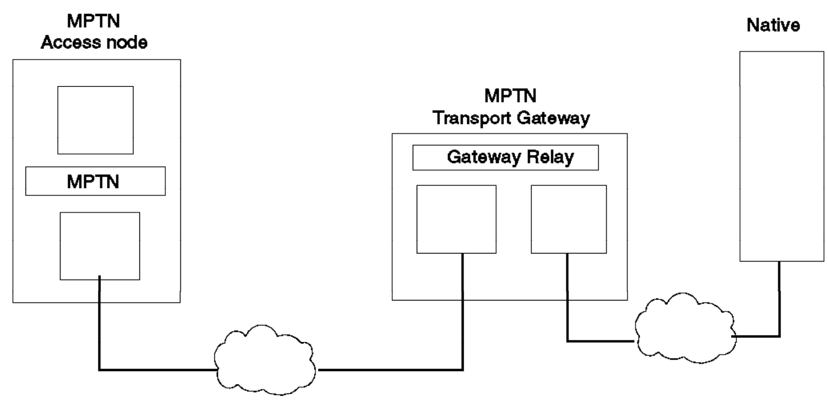


Figure 246. MPTN Transport Gateway

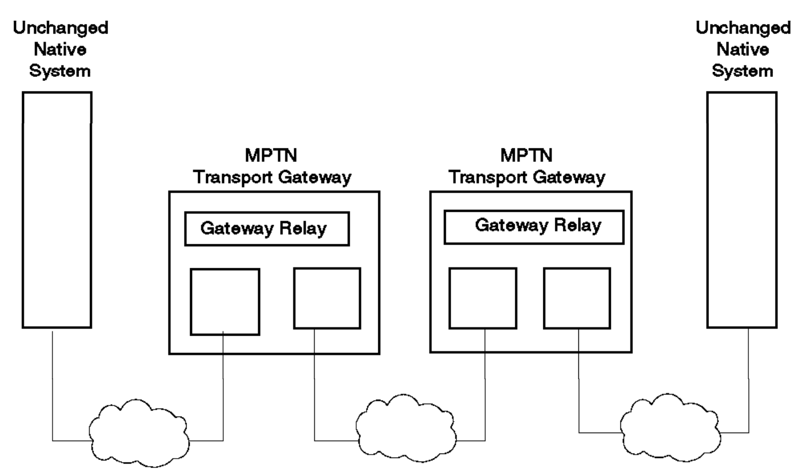


Figure 247. Multiple MPTN Gateways

A.2 What Is AnyNet?

AnyNet is a family of software products designed to make it easier for customers to choose the applications that meet the needs of their business regardless of what transport protocol is used in their local or wide area network. AnyNet products implement the Multiprotocol Transport Networking (MPTN) architecture. The following members of the AnyNet family make possible these communication paths on various platforms:

- APPC over TCP/IP
- SNA over TCP/IP
- Sockets over SNA
- NetBEUI over SNA

In addition to the above access node solutions, the following gateway solutions are also currently available:

- SNA over TCP/IP Gateway
- Sockets over SNA Gateway
- IPX over SNA Gateway

Each member of the AnyNet family will work in conjunction with another member of the family within the same family group (APPC over TCP/IP, Sockets over SNA, etc.). For example, AnyNet/2 Sockets over SNA will work in conjunction with AnyNet/400 Sockets over SNA. The current members of the family are as follows:

APPC over TCP/IP

- AnyNet/2
- AnyNet/MVS
- AnyNet/400
- AnyNet/6000
- AnyNet/Windows

APPC over IPX

- AnyNet/400

SNA over TCP/IP

- AnyNet/2
- AnyNet/MVS

SNA over TCP/IP Gateway

- AnyNet/2
- AnyNet/MVS

Sockets over SNA

- AnyNet/2
- AnyNet/MVS
- AnyNet/400
- AnyNet/6000

Sockets over SNA Gateway

- AnyNet/2

Sockets over IPX

- AnyNet/2
- AnyNet/400

Sockets over NetBIOS

- AnyNet/2

NetBEUI over SNA

- AnyNet/2

IPX over SNA Gateway

- AnyNet/2

A.2.1 Usage of AnyNet/400, Sample Scenarios

The following scenarios show the AS/400 system taking advantage of AnyNet in different networking situations. The AS/400 has implemented the MPTN capabilities of an AnyNet access node. As an access node it is able to do the following:

- Communicate with another access node
- Communicate via an AnyNet gateway with a native node (a node without AnyNet capabilities)

AnyNet allows APPC applications to traverse a TCP/IP network. For instance, in this scenario we could imagine DRDA (Distributed Relational Database Architecture) traffic between DB2/6000 and DB2/400.

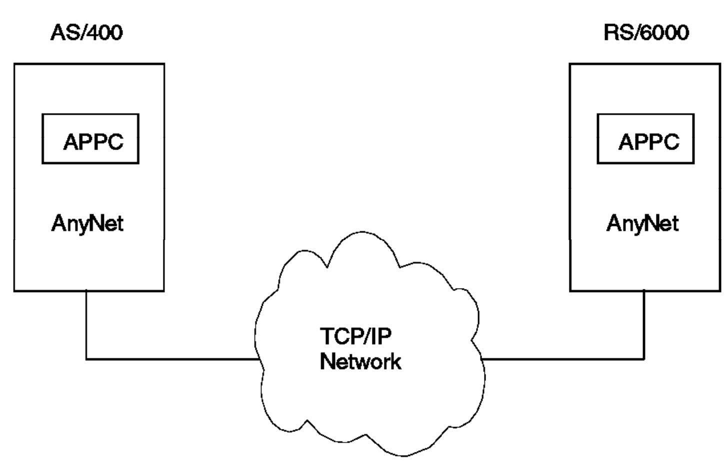


Figure 248. APPC Application via a TCP/IP Network

IBM 5494 has no AnyNet capabilities. However, using an AnyNet gateway node the IBM 5494 is able to communicate via a TCP/IP network with an AS/400 system.

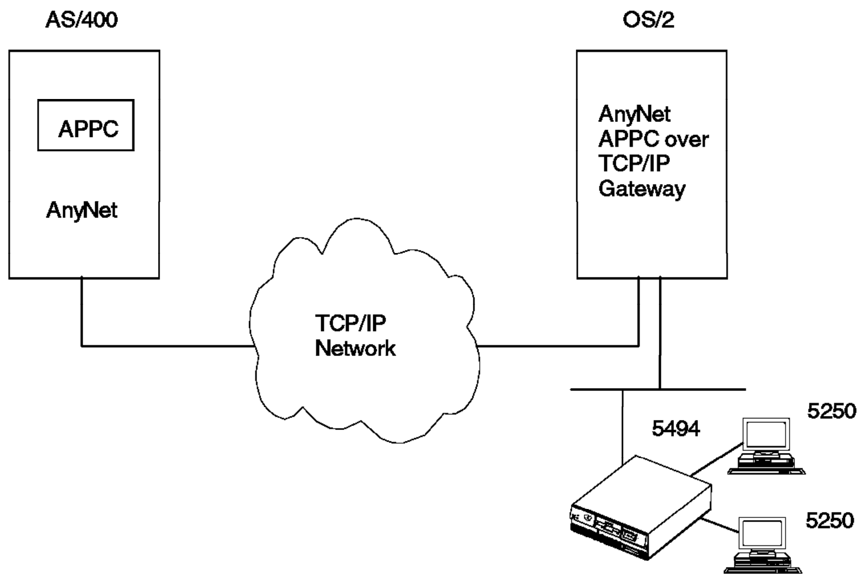


Figure 249. APPC Application via an APPC over TCP/IP Gateway

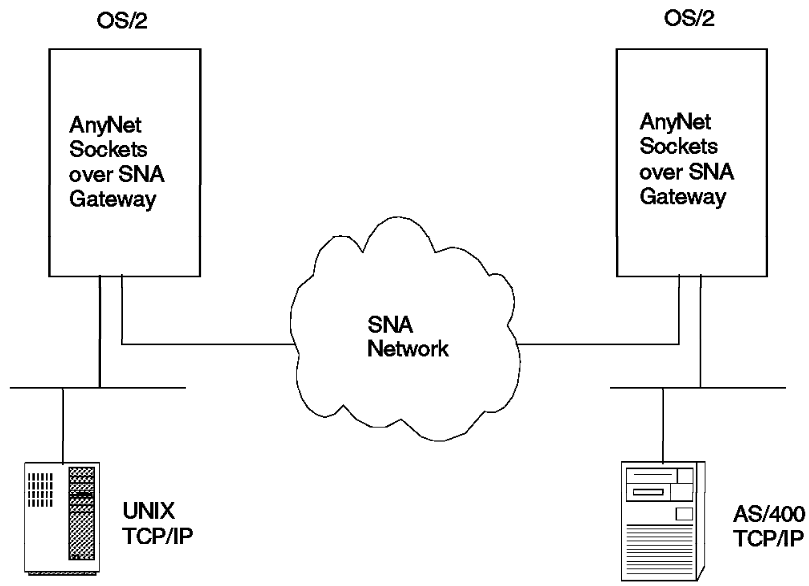


Figure 250. TCP/IP Application via an SNA Network

In this example, two TCP/IP devices are communicating via an SNA network. Two AnyNet gateway nodes accomplish the crossing of the SNA network.

Appendix B. Sample CISCO RSRB Configuration

This appendix shows a sample Cisco Remote Source Route Bridging definition. RSRB is a Cisco variant of Data Link Switching (DLSw) although it is not compatible. The RSRB definition is for a token-ring attached router.

Some points on the definition are as follows:

- Ring number 555 is the ″virtual segment″ number.
- ″local-ack″ specifies that the router will perform LLC2 termination.
- Segment numbers should be coded in Hex.
- ″my_ip_address″ is the IP address of this Cisco Router.
- ″partner_ip_address″ is the IP address of an RSRB partner Cisco Router.

```
version 9.14
!
hostname xxxxxx
!
enable password
service timestamps
service password-encryption
!
source-bridge remote-peer-keepalive 60
source-bridge ring-group 555
source-bridge remote-peer 555 tcp partner_ip_address local-ack
source-bridge remote-peer 555 tcp my_ip_address
!
!
interface Serial 0
description Free format description in here
ip address ip_address subnet_mask
encapsulation encapsulation_type (ppp)
bandwidth speed_kbps
!
Interface TokenRing 0
description Free format description in here
ip address ip_address subnet_mask
ring-speed speed_mbps
source-bridge seg_number_in_hex bridge_number virtual_ring_number
multiring all
!
```

Index

Numerics

A

B

C

D

F

G

H

T

U

V

W

X

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