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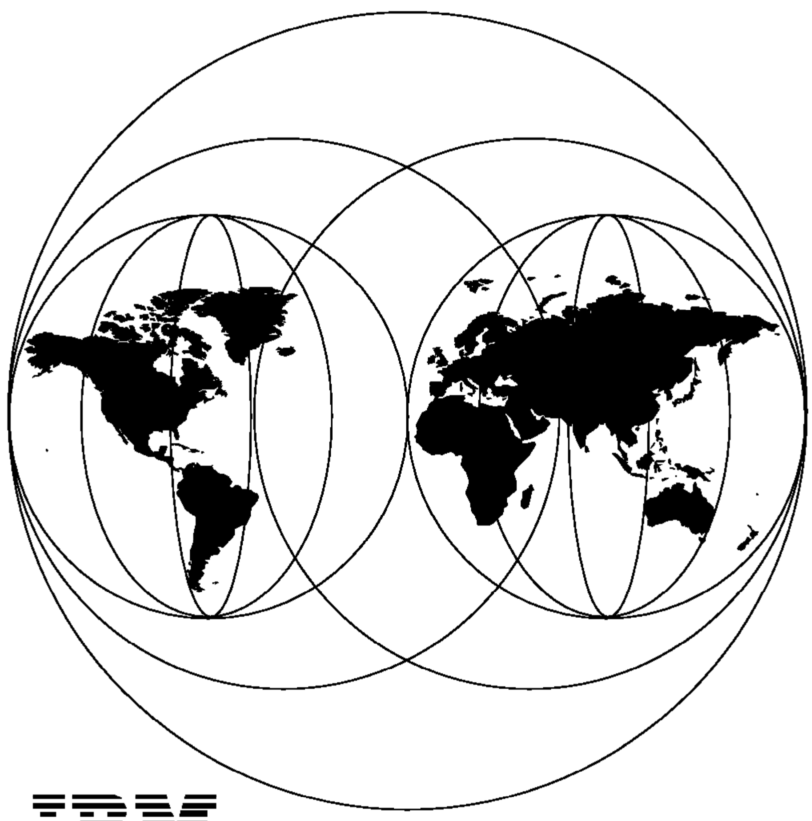
VTAM V4.3: High Performance Routing (HPR) Early User Experiences

September 1995



International Technical Support Organization
Raleigh Center

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Take Note!

Before using this information and the product it supports, be sure to read the general information under "Special Notices" on page xiii.

First Edition (September 1995)

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Abstract

This document describes the experiences gained in implementing the High Performance Routing functions of ACF/VTAM Version 4 Release 3 for MVS/ESA. Its purpose is to assist others in implementing these functions through examples and working definitions.

An overview of high performance routing is provided together with details of its implementation in VTAM and examples of test scenarios to demonstrate the functions and limitations. Other new facilities in this release are not covered in this document except where relevant to the testing shown.

This document was written for SNA systems programmers and IBM technical support personnel who plan to implement high performance routing. Some knowledge of SNA, APPN and previous releases of VTAM is assumed.

(132 pages)

Contents

Figures

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Special Notices

This publication is intended to help customers and IBM technical support personnel to implement the high performance routing functions of ACF/VTAM of MVS/ESA Version 4 Release 3. The information in this publication is not intended as the specification of any programming interfaces that are provided by ACF/VTAM for MVS/ESA V4R3. See the PUBLICATIONS section of the IBM Programming Announcement for ACF/VTAM for MVS/ESA V4R3 for more information about what publications are considered to be product documentation.

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Preface

This publication is intended to help customers and IBM technical support personnel to implement the high performance routing functions of ACF/VTAM of MVS/ESA Version 4 Release 3. It contains working examples and definitions which have been tested in a VTAM V4R3 environment at the International Technical Support Organization, Raleigh Center.

This document is intended for SNA network systems programmers and other technical support personnel, who are already familiar with VTAM and NCP customization. As a basis for the overview and implementation information in this document, a knowledge of APPN architecture is assumed.

This document is intended only to cover the high performance routing functions of VTAM V4R3 and is not intended as a reference to all functions and parameters in VTAM V4R3. It should be read in conjunction with the product installation, reference and migration manuals listed in "Related Publications" on page xvi.

How This Document is Organized

The document is organized as follows:

- Chapter 1, "Introduction"

  This chapter provides an overview of the book.

- Chapter 2, "High Performance Routing"

  This provides an overview of the concepts and facilities provided by high performance routing (HPR).

- Chapter 3, "HPR Implementations"

  This chapter describes the implementation of HPR within VTAM together with overviews of the implementations in AS/400, CM/2 and Network Control Program (NCP).

- Chapter 4, "APPN Host-to-Host Connection"

  This chapter demonstrates the basic concepts of Rapid Transport Protocol (RTP) connections between RTP capable nodes together with its limitation in a Composite Network Node (CNN) environment.

- Chapter 5, "RTP Connection through a CNN"

  This chapter shows a simple RTP connection through a CNN network with HPR capabilities.

- Chapter 6, "Non-Disruptive RTP Connection Recovery"

  This chapter demonstrates the non-disruptive path switching capability of HPR and resuming the original path after recovery of a failed link.

- Chapter 7, "APPN and HPR Interconnectivity"

  This chapter covers the setup of paths containing both Advanced Peer-to-Peer Networking (APPN) and RTP connections as parts of an overall session route.

- Chapter 8, "Multi-Platform Implementation"

This chapter shows how different platforms can work together to provide an RTP connection overall session route. A PS/2 running OS/2 and CM/2 has an RTP connection to VTAM through another CM/2. The second CM/2 is then replaced by an AS/400 as an intermediate node.

- Chapter 9, "VTAM Diagnosis"

  This chapter discusses the new VTAM internal trace options, session flows and an overview of ACF/TAP changes together with some examples.

Related Publications

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

- *Planning for NetView, NCP, and VTAM*, SC31-8063
- *Planning for Integrated Networks*, SC31-8062
- *VTAM V4R3 for MVS/ESA Network Implementation Guide*, SC31-6548
- *VTAM V4R3 for MVS/ESA Resource Definition Reference*, SC31-6552
- *VTAM V4R3 for MVS/ESA Resource Definition Samples*, SC31-6554
- *VTAM V4R3 for MVS/ESA Licensed Program Specifications*, GC31-6553
- *VTAM V4R3 for MVS/ESA Messages and Codes*, SC31-6493
- *VTAM V4R3 for MVS/ESA Release Guide*, GC31-6555
- *VTAM V4R3 for MVS/ESA Migration Guide*, GC31-6547
- *VTAM V4R3 for MVS/ESA Operation*, SC31-6552
- *VTAM V4R3 for MVS/ESA Glossary*, GC31-6556
- *VTAM V4R3 for MVS/ESA Customization*, LY43-0068 (available to IBM-licensed customers only)
- *VTAM V4R3 for MVS/ESA Diagnosis*, LY43-0069 (available to IBM-licensed customers only)
- *NCP SSP EP Trace Analysis Handbook*, LY43-0037 (available to IBM-licensed customers only)

International Technical Support Organization Publications

- *NCP V7R3: New Functions*, GG24-2592

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Chapter 1. Introduction

Following on from the introduction of APPN services into VTAM with Version 4 Release 1, VTAM Version 4 Release 2 added a number of enhancements to extend the capabilities of VTAM in Advanced Peer-to-Peer Networking (APPN) networks. These enhancements included:

- APPN Host-to-Host Connection (AHHC) permitting APPN channel connection.
- Virtual Route-Based Transmission Group (VR-TG) optimizing APPN route selection across the subarea subnetwrok.
- Composite Network Node (CNN) presenting a single network node view of the subarea network to APPN nodes.

These functions provide the basis for the evolution of the APPN network with VTAM Version 4 Release 3 and NCP Version 7 Release 3 towards the high-speed data networks of the future. With these releases, High Performance Routing (HPR) has been implemented to provide these facilities within an APPN network.

1.1 Scope and Objectives

While many customers are becoming familiar with APPN concepts and facilities, high performance routing is new to most customers and so this document has two specific functions. Chapter 2, "High Performance Routing" on page 5 provides an overview of HPR for those who are unfamiliar with HPR. The remaining chapters describe the VTAM implementation of HPR together with examples of sample implementations of HPR within a network and problem determination. Other new functions of this release are not covered other than where they have a specific relationship to the HPR functions.

This document covers the HPR aspects mainly from a VTAM perspective, although some areas of NCP are covered. A sister publication, *NCP V7R3 New Functions* provides details of the NCP implementation. For completeness, the NCP document also contains the same Chapter 2, "High Performance Routing" on page 5 found in this document.

1.2 Summary of New HPR-Related Functions in VTAM V4R3

New HPR-related functions in VTAM V4R3 include:

- **HPR support for network and end node**. VTAM can be configured as an HPR-supported APPN node at startup. Support can be either full Rapid Transport Protocol (RTP) or Automatic Network Routing (ANR).
- **Interchange node support**. Where VTAM supports both network node and subarea configurations as a composite network node, the NCP can provide ANR capabilities under the control of VTAM.
- **HPR Link support**. Local SNA major nodes, such as APPN Host-to-Host Channels (AHHC) and NCP APPN channel links, can support RTP connections to other HPR nodes.
- **Display of RTP connections**. There is a new major node, ISTRTPMN, which can be displayed to show all RTP connections currently active.

- **RTP route reselect**. A MODIFY can be issued with the keyword RTP to force VTAM to look for a better route for an individual RTP connection.
- **APING test display**. A new keyword on the DISPLAY command activates an APPN ping transaction to a remote node. If the node supports it, the DISPLAY results will include transaction times and rates. The results also show the route taken to the other node including the path of any RTP out of that VTAM for a new RTP connection. If the RTP connection already exists, the session ID is shown which will identify the RTP and hence the route can be found from the RTP display.
- **HPR capability on activation**. The VARY ACT command has a new keyword, HPR=, which allows you to override the default or precoded value for a GROUP, PU or LU.
- **VTAM Internal Trace support**. New entries to collect HPR related information are provided with new VIT options. Note also that there are changes to external traces and ACFTAP formatting options to support HPR information.

1.3 Conclusions

As can be seen from the testing, implementing HPR within a network is a simple task which can be done in a staged manner. However, it is built on APPN and therefore needs the customer to migrate to APPN as a prerequisite. An APPN migration is a much larger and more complex task.

Our recommendation from the results of our testing is to implement HPR on all capable nodes with some provisos:

- Ensure that your APPN network is properly defined, paying particular attention to routing and capacity definitions. This will avoid potential performance issues and route problems.
- Take note of the CNN limitations of ICN VTAMs and NCP ANR only support. In a large CNN network there may be few hosts which are RTP capable, hence few HPR-capable routes.
- Plan for HPR-capable levels of software and, in the case of the AS/400, hardware. Not all APPN-capable links can support HPR due to product implementation limitations.
- Operations staff need a clear understanding of the network. With the limitations of NetView and lack of route information in ANR intermediate nodes, the correct interpretation of the information at the endpoints becomes more important with RTP connections.
- There is a small increase in the order of 5 to 15 percent in CPU utilization where the VTAM system is an RTP endpoint. Intermediate nodes will see a reduction in CPU loading.

There are several benefits from implementing HPR:

- Non-disruptive rerouting: Provides a higher availability in the network, bringing the benefits of connectionless network rerouting to the benefits of connection-oriented SNA networks.
- Reduced storage and loading: Intermediate nodes need fewer CPU cycles to route HPR frames, and APPN session control blocks are not needed, reducing significantly the requirements in large networks.

- Staged migration: With defaults in most products to use HPR and keywords to allow controlled use, HPR can be implemented simply across the network as desired.
- Future positioning: HPR capabilities position you for the emerging high-speed technologies which rely on the new routing techniques in HPR.

In summary, HPR is a simple-to-install enhancement to the range of APPN products, with simple, staged migration capabilities. HPR positions your network for future migration to emerging high-speed technologies.

Chapter 2. High Performance Routing

High Performance Routing (HPR) is the next step in the evolution of SNA networks. Customers who migrate to VTAM Version 4 Release 3 and NCP Version 7 Release 3 are well positioned to take advantage of HPR. HPR objectives are to exploit the capabilities of very high speed, low error rate digital lines.

In the next section we will discuss HPR in general.

2.1 Introduction

HPR was referred to as APPN+ in the IBM networking blueprint. APPN+ is a powerful addition to Advanced Peer to Peer Networking (APPN) and a step toward the Networking Broadband Services (NBBS). NBBS is the IBM architecture for very high speed networking referred to as Gigabit APPN. IBM made drafts of the specifications available through the APPN Implementers Workshop (AIW) in September 1993.

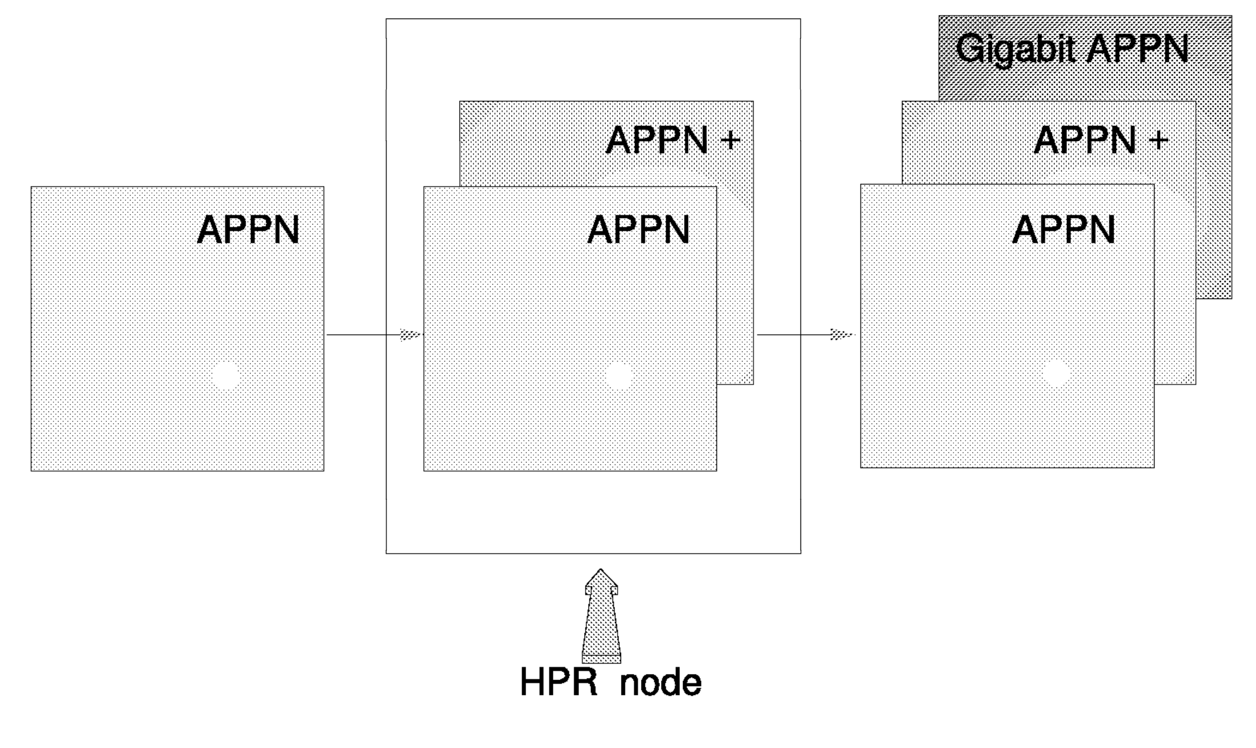


Figure 1. APPN Growth and Evolution

The demand for continuous availability of resources in the network is being addressed by the dynamics of HPR. APPN is enhanced with non-disruptive rerouting around failed links or nodes, pro-active congestion control and enhanced routing efficiencies. This makes APPN with HPR (APPN+) a very desirable routing protocol for the backbone.

HPR provides inter-operation with existing APPN nodes by sharing the existing APPN topology, control point protocols and algorithms. Implementation is designed to be a "drop in" migration for customers currently exploiting APPN function. HPR can run on existing hardware, and all features can be provided by a software upgrade.

High Performance Routing has two major components, the Rapid Transport Protocol (RTP) and Automatic Network Routing (ANR). RTP is a connection-oriented, full-duplex protocol designed to transport data in a high-speed network. RTP nodes are capable of session re-routing in case of link or node failures. To control the HPR data flow, RTP nodes will implement the Adaptive Rate Based (ARB) flow and congestion control procedures. ANR nodes use a low-level routing mechanism that minimizes cycles and storage requirements for routing packets through intermediate nodes. ANR can be implemented on network nodes only. RTP can be implemented on both end nodes and network nodes.

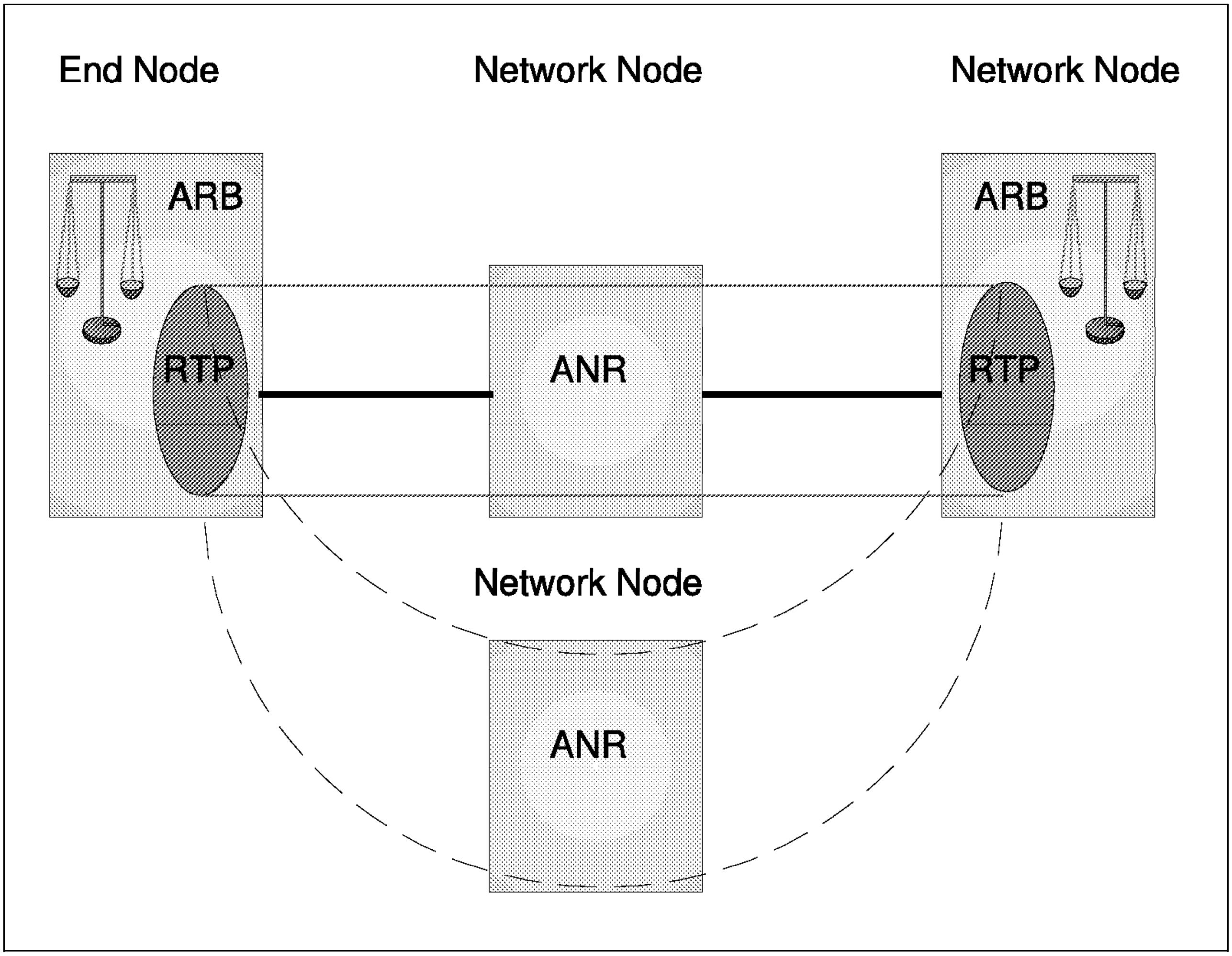


Figure 2. HPR Components

In order to identify groups of nodes that share common properties, we refer to them as subnets. VTAM and NCP can work together to form a composite network node (CNN). The CNN is a group of nodes that communicate using subarea protocols and appears as a single APPN node to other APPN nodes. A group of APPN nodes, which may include CNNs, can be grouped to form an APPN subnet.

We can now have the high performance routing subnet in which Rapid Transport Protocol connections may be established. These may be thought of as *pipes*, to transport session traffic across the subnet. Session traffic may originate in an APPN or HPR node and, likewise, may be destined for an APPN or HPR node.

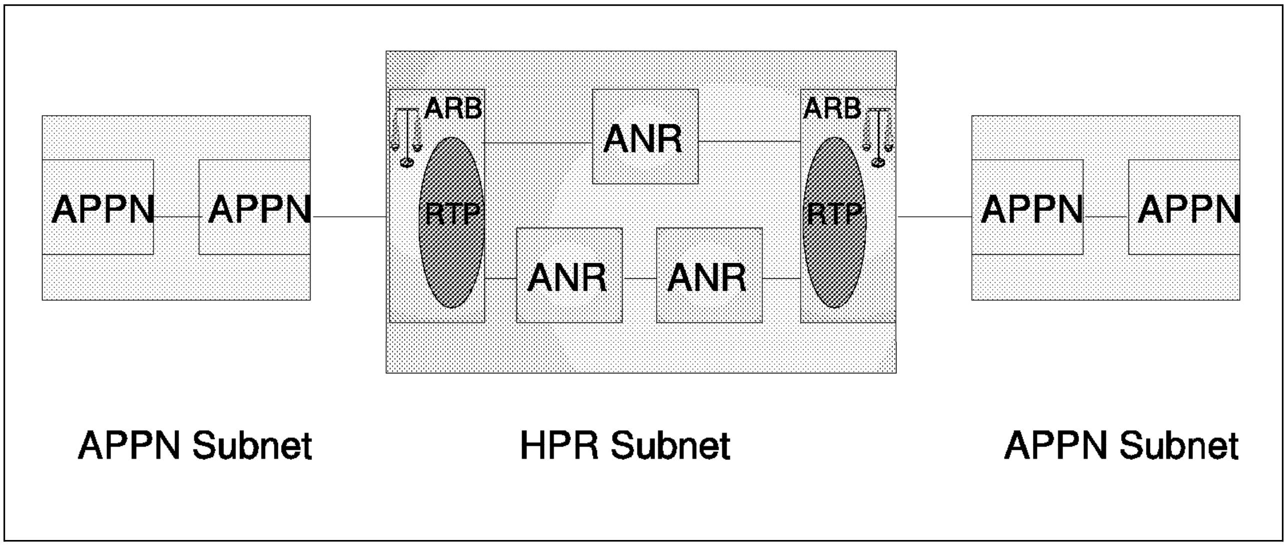


Figure 3. APPN and HPR Subnets

Automatic Network Routing (ANR) provides the transport path between any two RTP endpoints in the network. The originator of the packet explicitly defines the exact path on which the packet is to flow through the network; thus, ANR is a special implementation of a source-routing protocol.

2.2 High Performance Routing Options

In order to facilitate implementations across a wide range of products, the following (optional) portions of HPR have been identified (see also Figure 4):

- HPR Base Functions
- HPR Transport Option
- HPR Control Flows over RTP Option

Each of these will be described in the following sections.

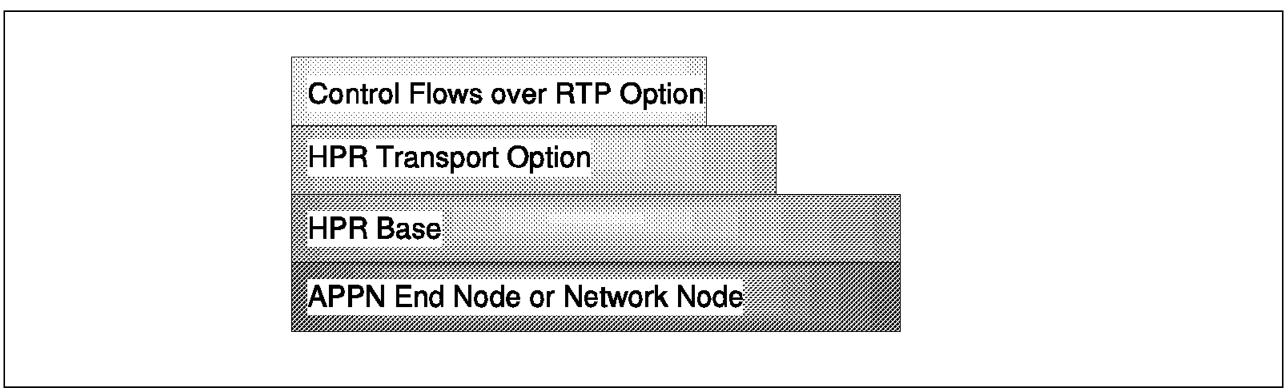


Figure 4. HPR Base and Options

2.2.1 HPR Base Functions

The primary function of the HPR base is to provide ANR routing. Products implementing only the base can participate as intermediate nodes for RTP transport connections; they cannot be endpoints of RTP connections. This is the only option that NCP 7.3 currently supports (in conjunction with VTAM 4.3) as a composite network node.

A new packet format, called a Network Layer Packet (NLP), is used to transport data in the HPR subnet.

NLPs flowing over RTP connections may be efficiently routed through the node using ANR routing. The CP-CP session traffic flows still use FID2 PIUs and APPN LU-LU session traffic not flowing over RTP connections will also use FID2 PIUs. Both FID2 PIUs and NLPs may flow over a single link and are distinguished from one another by the first four bits in the packet.

Prior to establishing an RTP connection, a route setup protocol is done over the desired path. Link and node APPN topology update information indicates the appropriate level of HPR support by means of a new HPR control vector. Base-level nodes participate by adding the appropriate ANR information for the inbound and outbound links. When the route setup messages are exchanged between two nodes where one or both are base-level nodes, they flow in a FID2 PIU.

2.2.2 HPR Transport Option

Nodes supporting the HPR transport option are able to transport session traffic across HPR networks over RTP connections when the rapid transport protocol is supported with all its functions. An RTP connection can *only* be established between nodes that *both* support the HPR transport option.

When setting up a search for an LU, and the session to the LU can traverse over an RTP connection, the search reply will contain the ANR label of the network connection endpoint (NCE) at the end of the RTP associated with that LU.

If the current path being used for an RTP connection fails, the RTP connection is switched to a new path (whenever possible). Sessions transported over the RTP connection are not disrupted.

The APPN/HPR boundary function provides the mapping of APPN (FID2 PIU) traffic to HPR (network layer packet) traffic and vice versa.

When VTAM 4.3 is started as an end node (EN) or network node (NN) it will support the HPR transport option. It does not support RTP as an interchange node (ICN). The HPR transport option is not yet supported by NCP.

2.2.3 HPR Control Flows over RTP Option

Nodes supporting the HPR control flows over RTP option use RTP connections (if both adjacent nodes support this option) for CP-CP sessions. When a link connecting two nodes that both support this option is activated, a long-lived RTP connection is established that is used to forward route setup messages. VTAM and NCP currently does not support this option.

2.2.4 APPN/HPR Boundary Function

Each HPR network node that supports the transport option, such as a VTAM NN, includes an APPN/HPR boundary function for traffic passing through it from or to APPN nodes connected to the HPR subnetwork. All protocols between the APPN/HPR boundary function and connected APPN nodes are today′s APPN protocols. The protocols between the boundary function and other HPR nodes are HPR protocols. The APPN/HPR boundary function is limited to network nodes.

2.3 Connection Networks

Connection network (CN) purposes and concepts are the same in HPR as they are in APPN. When a route is calculated that crosses a CN, "dial" information (such as a MAC address) is included in the TG descriptor vector for the link across the CN and added to the RSCV.

When the route setup request arrives at the node adjacent to the connection network, the link across the CN and the long-lived RTP connection (if supported) is activated. The route setup request is then forwarded to obtain routing information.

2.4 HPR Link Support

Since HPR is an enhancement of APPN it will operate over links supported by today′s APPN. That means, existing hardware adapters and DLCs currently being used for APPN communications can continue to be used for HPR.

During link activation, DLCs are used by HPR in the same manner as by APPN. That is, XID3s are exchanged and the appropriate set mode signals are sent when the exchange is complete. For HPR, a new control vector is included in the negotiation-proceeding XID3 that contains additional HPR-specific information. If both sides include the new control vector the link is referred to as an HPR link. If both nodes indicate support for the HPR transport option, then HPR Transport option protocols are used; otherwise, HPR base protocols are used.

CP-CP sessions are established in the same manner as in APPN when the link is activated.

Immediately after an HPR link is activated and both nodes support the HPR Control Flows over RTP option, an RTP connection is activated across the link (also if no CP-CP sessions are activated over this link) in order to carry route setup messages. This RTP connection remains active as long as the link remains active (hence "long-lived" RTP connection).

To avoid the necessity to segment the transport layer header, the minimum "maximum packet size" that has to be supported for an HPR link is 768 bytes. For performance reasons it might be advisable to support larger packet sizes.

2.4.1 DLC Error Recovery Procedures (ERP)

In the past, error recovery on each link of a network route has been necessary because of high link error rates from poor quality communication lines. However, improvements in link error rates have allowed end-to-end, rather than hop-by-hop, error recovery. HPR provides this capability by utilizing existing links and data link control procedures (for example HDLC and IEEE 802.2 LLC) so that they do not perform link-level error recovery, and by doing end-to-end error recovery on RTP connections by retransmitting only those packets that have failed to reach the intended receiver. This is referred to as selective retransmission.

Data may be sent over an HPR link using either full error recovery or no error recovery. NCP supports non-error recovery procedures on frame relay and token-ring links. The format of non-HPR, and HPR frames without link level error recovery procedures (ERP) sent on boundary (FID2) and subarea (FID4) token-ring, frame relay, and SDLC links, are depicted in Figure 5 and Figure 6 on page 11 respectively.

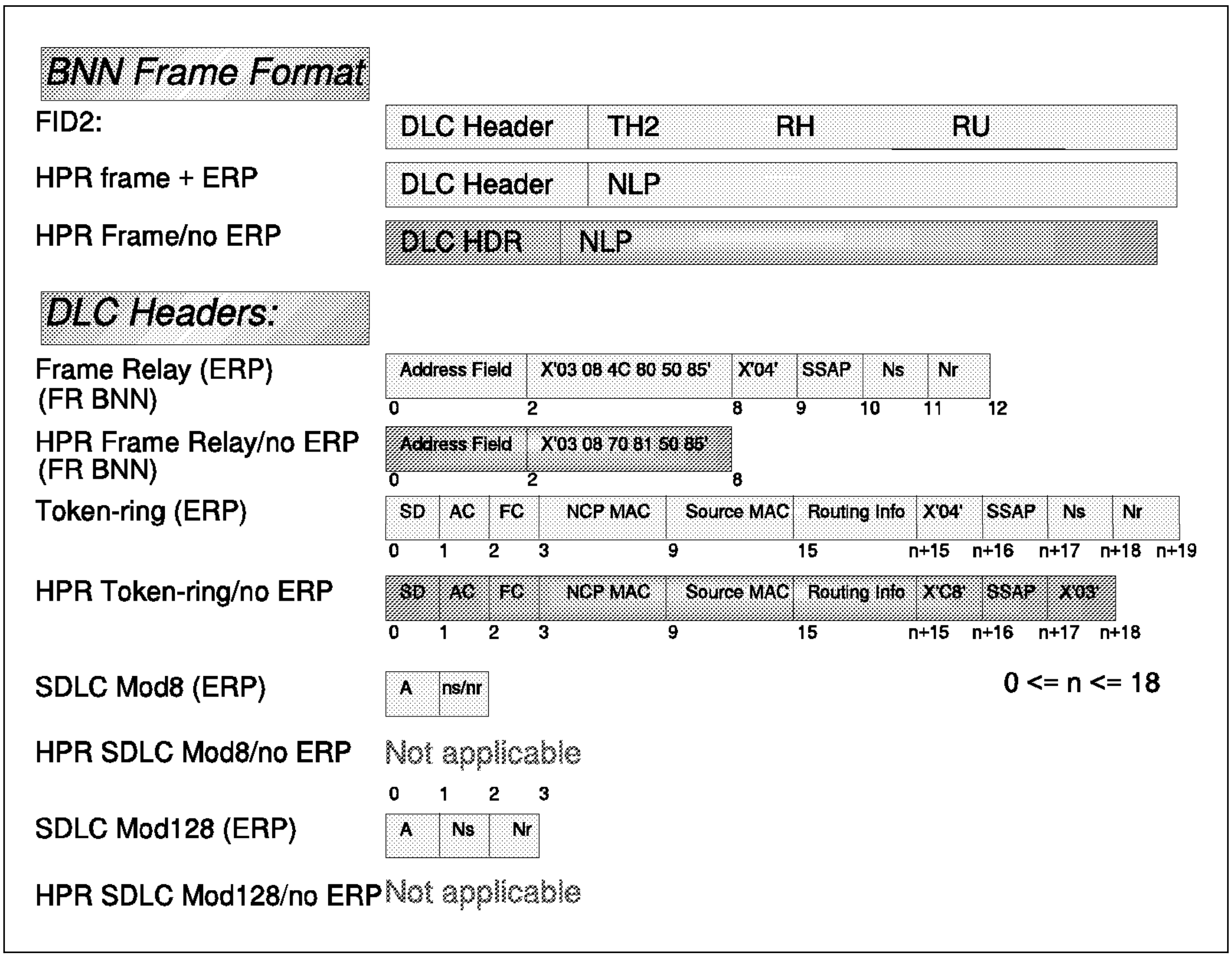


Figure 5. HPR Frame Formats on Boundary Connections

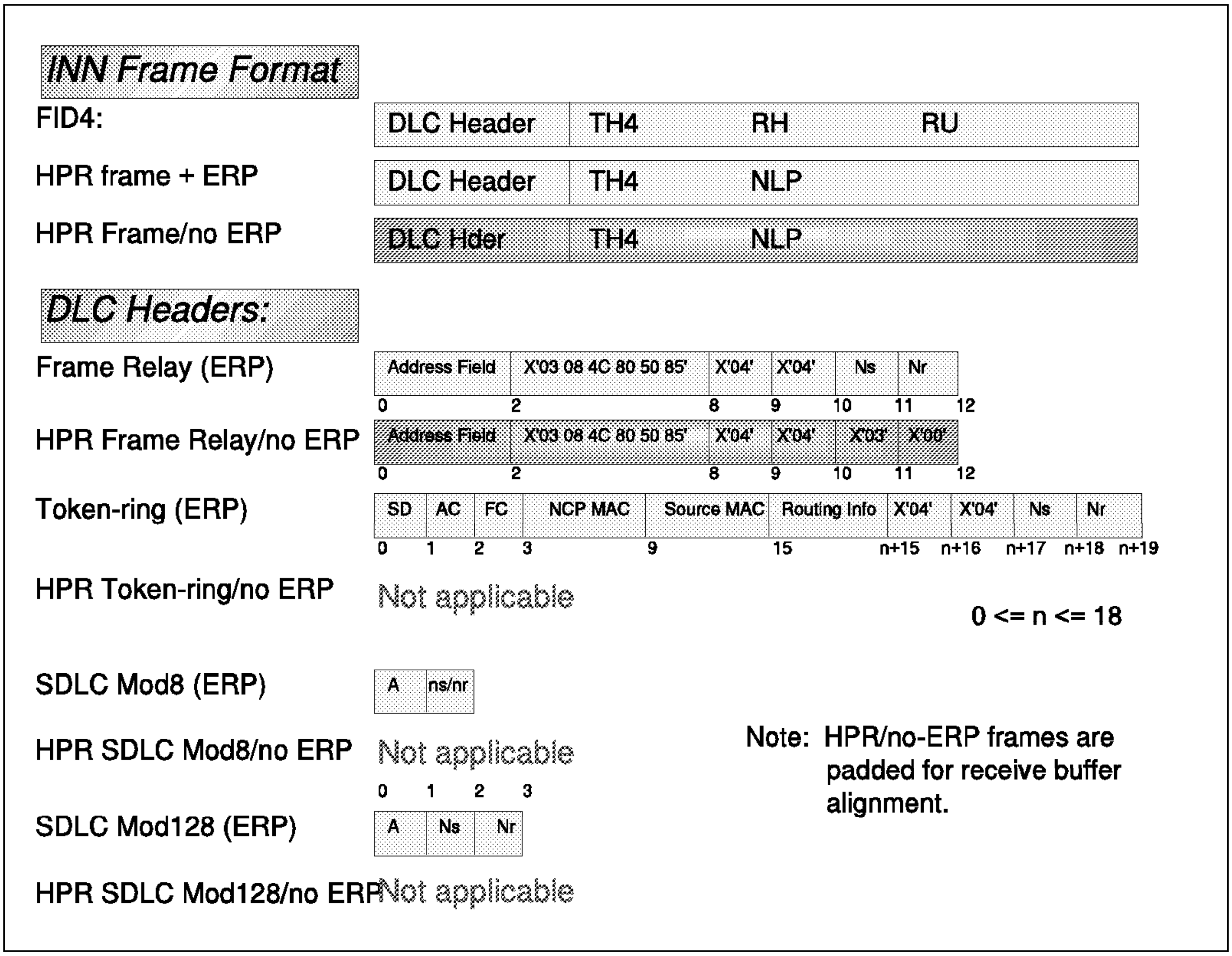


Figure 6. HPR Frame Formats on Subarea Connections

2.4.2 Error Recovery Procedures (ERP)

For HPR links on which full error recovery is deployed, data frames are sent in the same manner as today′s APPN where the LLC (logical link control) elements of procedure provide full error recovery. For example, on SDLC links I-frames are used. This method is used on links when at least one of the adjacent nodes requires link-level error recovery. Link-level error recovery is negotiated during XID exchange when activating a link. The use of link-level error recovery is only recommended for links with high error rates.

Although SDLC does have the capability to bypass link error recovery, by sending user data in Unnumbered Information (UI) frames, NCP has not implemented this function for HPR.

The QLLC option is used when transmitting HPR traffic over X.25 virtual circuits. Because there is no way to “turn off” error recovery on an X.25 physical link and on X.25 virtual circuits, error recovery is always used on X.25 - even for HPR traffic.

2.4.3 No Error Recovery Procedures (non-ERP)

For HPR links on which no error recovery is deployed, data frames are sent in a manner such that the LLC will not perform error recovery. The way in which this is done varies for the different LLC types.

For LAN, LLC frames are sent using a new service access point (SAP) for HPR, using a shortened 802.2 header (includes only the DSAP, SSAP, and a control field X′03′). During link activation, XIDs are exchanged using the “normal” SAP (default X′04′); in the XIDs each node informs the adjacent node of its SAP (default X′C8′) to be used for HPR traffic that does not require link-level error recovery. Frame relay frames (except XIDs) are sent using new L2 and L3 indicators for HPR indicating that no L2 protocol (802.2) is used.

The selection of running with or without error recovery is made when the link is activated. No link-level error recovery is used only if both sides agree on it.

Because we use the same DLC protocols, we can mix APPN and HPR traffic over the same link. For SDLC links, APPN traffic would use I-frames. HPR traffic would also be scheduled on the same link using I-frames or UI-frames depending on error recovery.

2.5 Automatic Network Routing

Automatic Network Routing (ANR) Mode is a low-level routing mechanism that minimizes cycles and storage requirements for routing packets through intermediate nodes. ANR routing is significantly faster than current APPN routing. No intermediate node storage is required (APPN requires 200-300 bytes per session) and no pre-committed buffers are necessary, which APPN recommends should be used.

HPR uses the ANR Routing Mode to route session traffic, including binds and unbinds, through an HPR network between nodes supporting the High-Performance Routing Transport Option.

HPR employs a route setup protocol in order to obtain ANR and RTP connection information of the selected path.

Each packet is routed through the network as a self-contained unit and is independent of all other packets. There is no table lookup or processing necessary at transit nodes such as the LFSID swapping procedure used by APPN. Any processing of packets required at the network connection and transport connection sub-layers is the responsibility of the origin and destination endpoints of the packets. Endpoint processing includes flow control, segmentation and reassembly, and recovery of lost packets.

ANR is designed to be simple enough so high-performance switching can be accomplished. A major goal is to optimize the design for hardware implementation to get the appropriate performance level which is required by the new generation of high-speed networks.

2.6 Rapid Transport Protocol (RTP)

RTP is a connection-oriented, full-duplex protocol designed to transport data in a high-speed network. HPR uses RTP connections to transport LU-LU and optionally CP-CP session traffic.

Rapid Transport Protocol provides end-to-end error recovery with selective retransmission, non-disruptive path switch and adaptive rate based (ARB) flow control. RTP may be implemented on network nodes or end nodes.

The physical path utilized by the RTP must satisfy the class of service (COS), associated with the session traffic it is carrying. Session traffic is carried over the RTP connection in such a way that intermediate nodes are not aware of the SNA sessions, or even the transport connection itself. Traffic from many sessions may be carried by a single RTP connection provided they all use the same COS. An RTP connection provides two important advantages:

1. It transports data at very high speeds by using low level intermediate routing and by minimizing the number of flows over the links for error recovery and flow control protocols. The flows are minimized by performing these functions at the RTP connection endpoints rather than at each hop (link) along the path. Data resequencing takes place at the RTP endpoints.

2. An RTP connection′s path may automatically be switched to reroute data around a failed node or link without disrupting the sessions. The new path for the RTP connection is selected that best fits the same class of service as the failed connection. Higher layer protocols are not even notified of the rerouting.

The endpoints of an RTP connection must support the RTP transport option whereas intermediate nodes need only support HPR base functions. APPN session endpoints can be in APPN or HPR nodes.

2.6.1 Segmenting

RTP performs the necessary segmenting and reassembly. Each link has a maximum BTU size which may differ from link to link. When RTP sends a Network Layer Packet, (which includes the Network Layer Header (NHDR), Transport Layer Header (THDR), and data), its size must not exceed the smallest link BTU size along the path. This size will be used for segmenting. Each segment contains the NHDR, THDR and portions of the data. The receiving RTP will reassemble the pieces into the original user message. Start-of-message and end-of-message indicators in the THDR are used for this purpose.

The smallest packet size allowed for any link supporting HPR is 768 bytes.

2.6.2 Network Connection Endpoint (NCE)

An RTP connection is between Network Connection Endpoints (NCE). Hence, where a product such as VTAM 4.3 or CM/2 implements a single NCE for all functions, including LUs and boundary functions, only one RTP pipe would normally be set up for a specific COS.

The last label in the ANR routing field is always an identifier for a network connection endpoint (NCE), in the destination node. The following NCEs are available:

1. Control Point (CP) NCEs are used when CP-CP sessions are flowing over RTP connections. Each node assigns an NCE label for its CP. Adjacent nodes exchange their labels during link activation on the XID3 flow. This is supported in the *Control Flows over RTP Option*, which is not currently available in CM/2 or VTAM.
2. Logical Unit (LU) NCEs are used when the destination LU is located in a node that supports the *HPR Transport Option.*
3. Boundary function NCEs are used to identify a component within nodes that perform the HPR to APPN boundary function transformation. Such function is required for links to APPN or HPR nodes that do not support the *High-Performance Routing Transport Option.*

HPR employs a route setup protocol in order to obtain ANR and RTP connection information. When route setup messages flow over a RTP connection, the component within the node that processes route setup messages is identified by a special label, NCE_RS, which is exchanged when links are activated.

Route setup as well as control point NCEs may never be changed. LU and boundary function components may change their NCE if they are not processing any sessions.

2.7 Sessions over the RTP

RTP connections are used to transport session data between HPR nodes operating within an HPR subnetwork. They provide a full-duplex logical connection or *pipe* between two HPR nodes over a specific path through the HPR subnetwork.

2.7.1 Class of Service

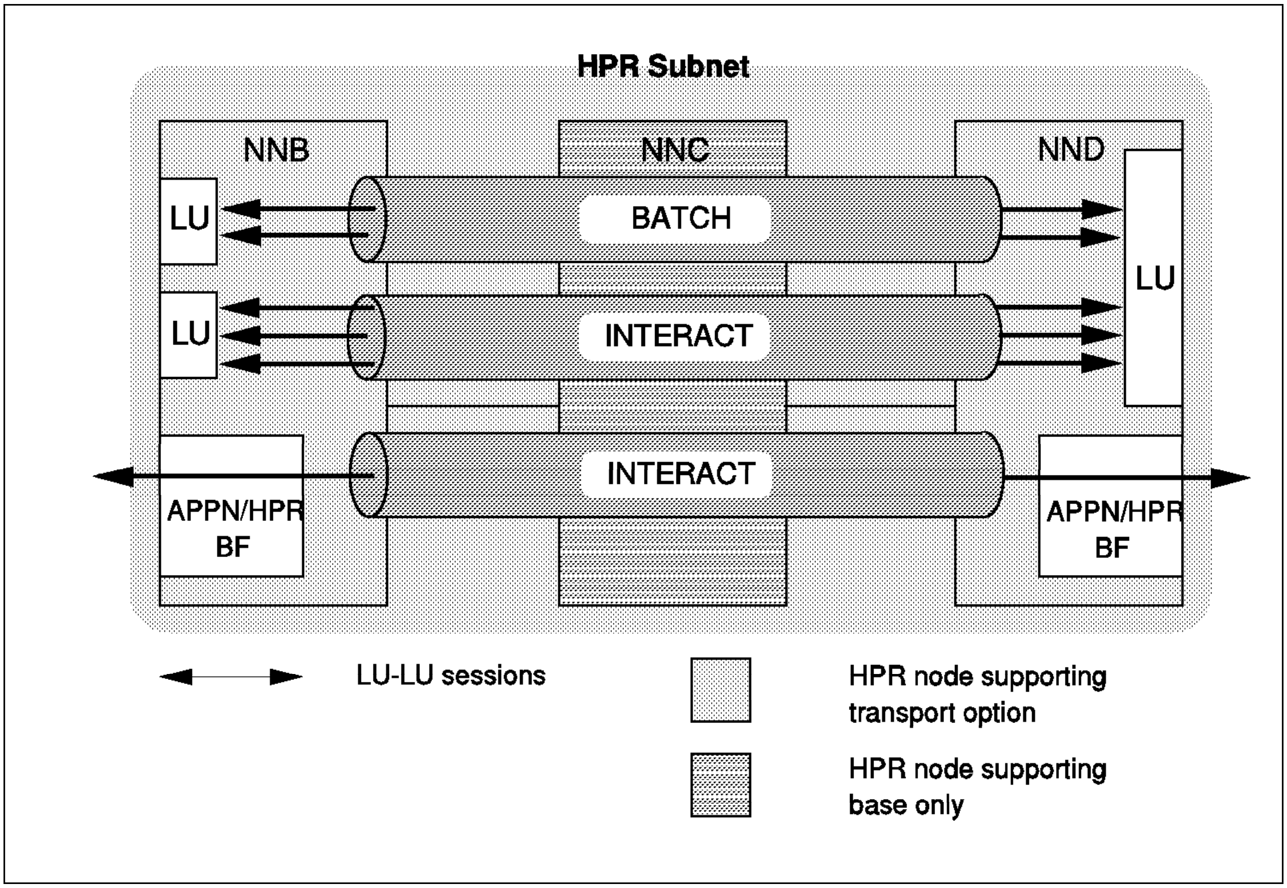


Figure 7. RTP Connections for Different COS

Each RTP connection transports session data between two RTP-capable endpoints for a single class of service (COS) as specified in the BIND. An RTP connection is not used for more than one COS, in order to simplify the route selection process during path switching. A node may activate multiple RTP connections (using different paths) to the same partner node for the same COS in order to distribute the traffic over multiple physical paths.

The same RTP connection that was activated by a node to carry sessions to the remote node may be used for the remote node to establish its sessions along. All traffic from an individual session flows over a single RTP connection, but many sessions may be multiplexed over a single RTP connection. All sessions requesting the same COS and following the same path through the HPR subnetwork are transported over a single RTP connection between the HPR nodes containing the session endpoints.

2.7.2 ARB Flow Control and Congestion Control

In HPR, sessions with the same COS are multiplexed over a single RTP connection. The ARB flow control mechanism, used by RTP, addresses the fairness issue among multiple RTP connections through the network. It does not address the fairness issue among multiple sessions using one RTP connection.

In order to provide this fairness, we not only use the ARB mechanism for RTP connections but also use the existing session pacing over an RTP connection to prevent one session from monopolizing buffers in the two RTP components. In an APPN sense, the RTP connection can be seen as one stage (hop) on the session path.

The APPN hop-by-hop window-based flow control protocol, known as adaptive session pacing, is inadequate for high-speed data routing. HPR uses a protocol suitable for high speed routing called Adaptive Rate Based (ARB) Flow/Congestion Control. It regulates the flow of data over an RTP connection by adaptively changing the sender′s rate based on feedback on the receiver′s rate. This protocol allows for high link utilization and prevents congestion before it occurs.

The input traffic entering the network is regulated by the ARB algorithm based on the conditions in the network and the partner RTP endpoint. An increased delay and decreased throughput indicates that congestion is occurring, and so input traffic is reduced. When the capacity of the network or partner RTP endpoint increases, input traffic is increased.

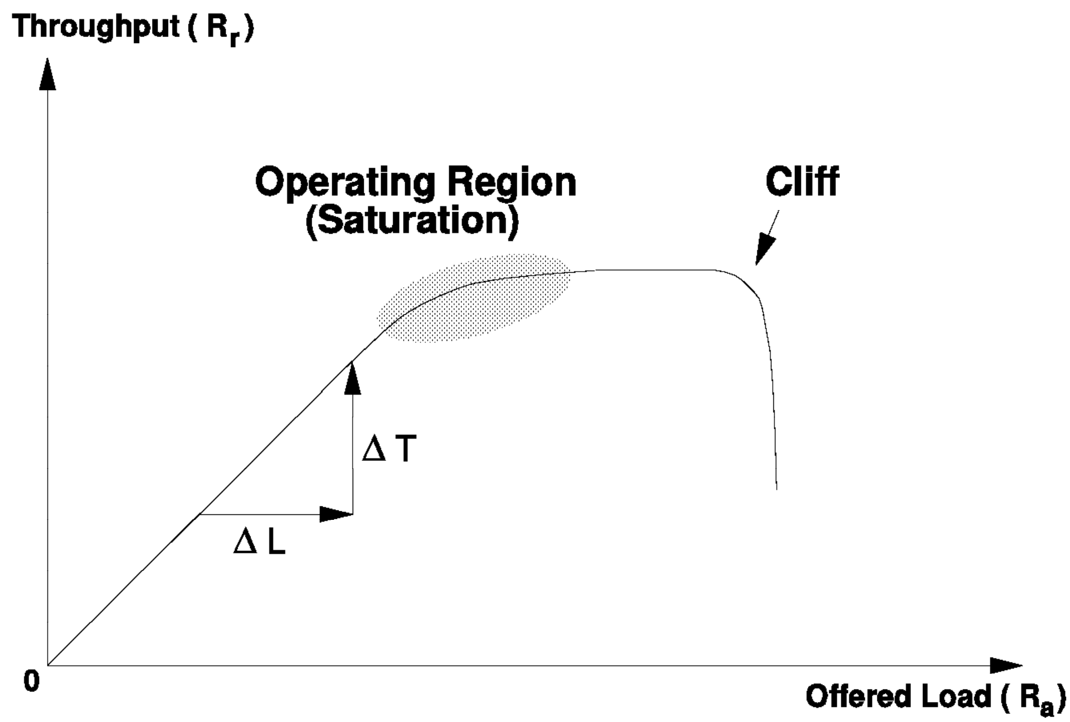
As the input traffic or offered load increases, we will see the throughput increase in a linear fashion. Refer to Figure 8 on page 17 for a description of the ARB operation. A point will be reached where throughput remains constant for an increase in offered load. This is the Operating Region. It is at this point that transmission queues are developing along the path, and should the offered load continue to increase, we will get into a situation where the queues are of such a nature that data will be discarded. This is depicted by the Cliff in Figure 8 on page 17. Because of the discarding of data and subsequent end to end recovery required, the overall throughput will decrease sharply at this point.

The ARB algorithm is designed to operate in the region where maximum throughput is attained. The ARB algorithm has the following properties:

- It adapts to network conditions in such a way as to maximize throughput and minimize congestion. It therefore operates within the operating region.
- It smooths the input traffic into the network, avoiding bursts when the physical capacity of the access link to the network is larger than the allowed input rate. This prevents long queues from developing in the network and helps minimize oscillation in the network traffic patterns.
- It provides end-to-end flow control between the RTP endpoints so that one endpoint does not flood the other.
- It requires minimum overhead in both processor cycles and network bandwidth.
- It provides equal access, or fairness, to all RTP connections.

The ARB algorithm is implemented on the RTP endpoints of a connection. There are two components at the RTP endpoints, an ARB sender and ARB receiver.

The intermediate nodes have no awareness of the ARB protocol and therefore do not participate in it.



$$\frac{\Delta T}{\Delta L} = \frac{R_r(n+1) - R_r(n)}{R_a(n+1) - R_a(n)} \longrightarrow 0 \quad \text{(as we approach the cliff)}$$

Figure 8. ARB Operating Region

The sender continually queries the receiver by sending a *rate request* along with the data in order to determine the state of the network and state of the receiver node. The sender may reduce or increase its send rate depending upon the information it gets in the *rate reply* received from the receiver. Fixed characteristics, such as speed of the slowest link in the path and transmission time, are factored into the algorithm when the RTP connection is set up. These path characteristics are communicated by using an ARB *setup* message. Either RTP endpoint may send a setup message as a result of a path switch.

2.7.3 RTP Alive Timer

The RTP *ALIVE* timer is used to make sure that both the partner endpoint of the RTP connection and the path between the endpoints are operational after a period of inactivity. When this timer expires and no packet has arrived from the partner since it was last set, a packet with a status indicator will be sent and the SHORT_REQ timer is started. Should a status segment be received from the partner, the SHORT_REQ timer is stopped. Otherwise, when the SHORT_REQ timer expires the status request is retransmitted. After a predetermined number of retries and no response, an attempt will be made by the sender to find a new path for the connection. If the partner is not operational or there is no suitable path to the partner, the sender will eventually terminate the connection.

The purpose of the ALIVE timer is as follows:

- Keep limited resource links active, where limited resource links are automatically deactivated in HPR when no traffic flows over the link for a specified period of time. So when there is no session traffic, RTP sends *liveness* messages at intervals set by the ALIVE timer.
- If the partner RTP endpoint or a link on the path fails, and the RTP endpoint is idle awaiting session traffic from the partner, then the RTP connection is "hung." The ALIVE timer triggers a liveness message that is used to detect this condition. Such a detection triggers a path switch.

2.7.4 Non-Disruptive Path Switch

The HPR path switch function is used to automatically route data around a failed link or node. This function only operates within an HPR subnetwork and is supported by all HPR network nodes and end nodes. When a failure occurs and an alternate path exists that satisfies the class of service for the failed RTP connection, a new RSCV is calculated and the RTP connection is switched; session traffic will be rerouted over the new path without disrupting the existing sessions.

2.8 HPR CP-CP Sessions

CP-CP sessions in HPR are used the same as in APPN. Only a few additions have been made to the CP-CP session formats and protocols for HPR nodes which implement the HPR transport option. There is no change for the CP-CP sessions when one of the partners supports only the HPR base functions. There is a contention winner LU 6.2 session established by each of the adjacent CPs. CP-CP sessions between HPR end nodes and HPR network nodes are used to provide NN services to ENs just as in APPN. And, just as in APPN, CP-CP sessions between HPR network nodes are used to transport directory and topology information.

Between two adjacent HPR network nodes that both have the HPR control flows over RTP option implemented, the CP-CP traffic flows over RTP connections. If one of the nodes, or both nodes, have only the HPR base or transport functions implemented or if one node is an APPN node, the CP-CP session traffic is carried in FID2 PIUs using the current APPN routing functions.

CP-CP session activation between two HPR nodes that have implemented the control flows over RTP option is triggered the same as in APPN (for example, when the first link supporting CP-CP sessions is activated). One or two RTP connections (depending on the timing) are activated to transport the two CP-CP sessions. Two RTP connections might be activated when both sides activate their contention-winner session simultaneously. If one node initiates the activation, the RTP connection established to transport the BIND can be used by the second node to transport its contention-winner session, which is activated in response to receiving this BIND.

2.8.1 Topology and Routing Services

The topology formats and protocols in HPR are the same as in APPN, except that an HPR transmission group is indicated as such in a topology data unit (TDU). Two HPR TG types have been added to the TG descriptor control vector: one is to indicate that the HPR TG is toward a partner who has implemented the transport tower; the second is to indicate that the HPR TG is toward a partner that has implemented the HPR base functions. Both indicators are reported only by HPR nodes. These indicators are also stored and forwarded by APPN nodes.

When a route is calculated through a combined HPR/APPN network the RSCV will contain these indicators in the TG descriptor CVs, which are used by HPR transport nodes to understand the scope of the HPR subnetwork.

HPR routes are not given any preference over standard APPN routes, so if two equally weighted routes exist, one HPR capable and the other non-HPR capable, there is no guarantee that the HPR route will be selected.

2.8.2 Directory Services

Directory search protocols are the same as in APPN except for the following:

- HPR nodes that support the transport option always include the NCE associated with the LU on the directory search. The node sending the Locate-Find or Locate-Found includes the NCE for the LU residing in its node.
- HPR nodes include in end node TG vectors (tail vectors) the indication whether the TGs are HPR capable. These TG descriptor CVs may eventually become part of an RSCV where the HPR indicator is used to understand the scope of HPR subnetworks.
- A new indicator in the CD-Initiate GDS variable indicates whether or not an HPR route (a route passing only HPR nodes) is desired. This indicator is used when doing a path switch. The setting of this indicator by end nodes will cause their network nodes servers to calculate routes consisting entirely of HPR-capable links. If the directory server cannot interpret this indicator (such as a back-level VTAM), the new route may not be HPR capable, and the path switch will fail.

2.9 LU-LU Session Activation

Activating an LU-LU session within an HPR network is done as follows.

A directory search is performed to locate the target LU. The directory search formats and protocols are identical to those for APPN except that HPR nodes provide the originating LU and destination LU NCEs in the search requests and replies.

Perform a route setup (if necessary). Once the RSCV is calculated (using the same algorithm as in APPN), the desired route is known. A route setup protocol is used to obtain routing information, such as forward and reverse ANR labels and the largest packet size supported by all links on this route.

Activate RTP connection (if necessary). An RTP connection is activated (if none exists already for the requested COS) to carry the LU-LU traffic. A connection setup request (segment in THDR) can be sent with the BIND (in the data portion) to the partner.

It might be possible to use an already active RTP connection for the LU-LU session, in which case it is not necessary to perform the route setup protocol and establish the RTP connection. The BIND is simply sent as normal data over the existing RTP connection.

2.9.1 Route Setup Protocol

The route setup protocol is initiated whenever it is necessary to obtain information about a route over which an RTP connection is to be established. The protocol consists of a route setup request and a route setup reply. Requests and replies stop at each intermediate node along the path to gather information (ANR label and maximum packet size of the next hop) associated with the forward (for the request) and backward path (for the reply).

When the origin node receives the route setup reply, it has all the information it needs to establish an RTP connection and can be sure that all links along the path are active and operational.

The route setup request and reply is forwarded hop-by-hop, from route setup function to route setup function in the nodes along the path, over the links selected by route selection services. If both nodes, connected by the respective link, support the HPR control flows over RTP option, the request and the reply are transported over the link′s long-lived RTP connection. If at least one node has implemented only the HPR base or transport functions, request and reply flow in FID2 PIUs. The FID2 PIU for route setup contains indicators so it can easily be distinguished from other FID2 PIUs flowing over the same link.

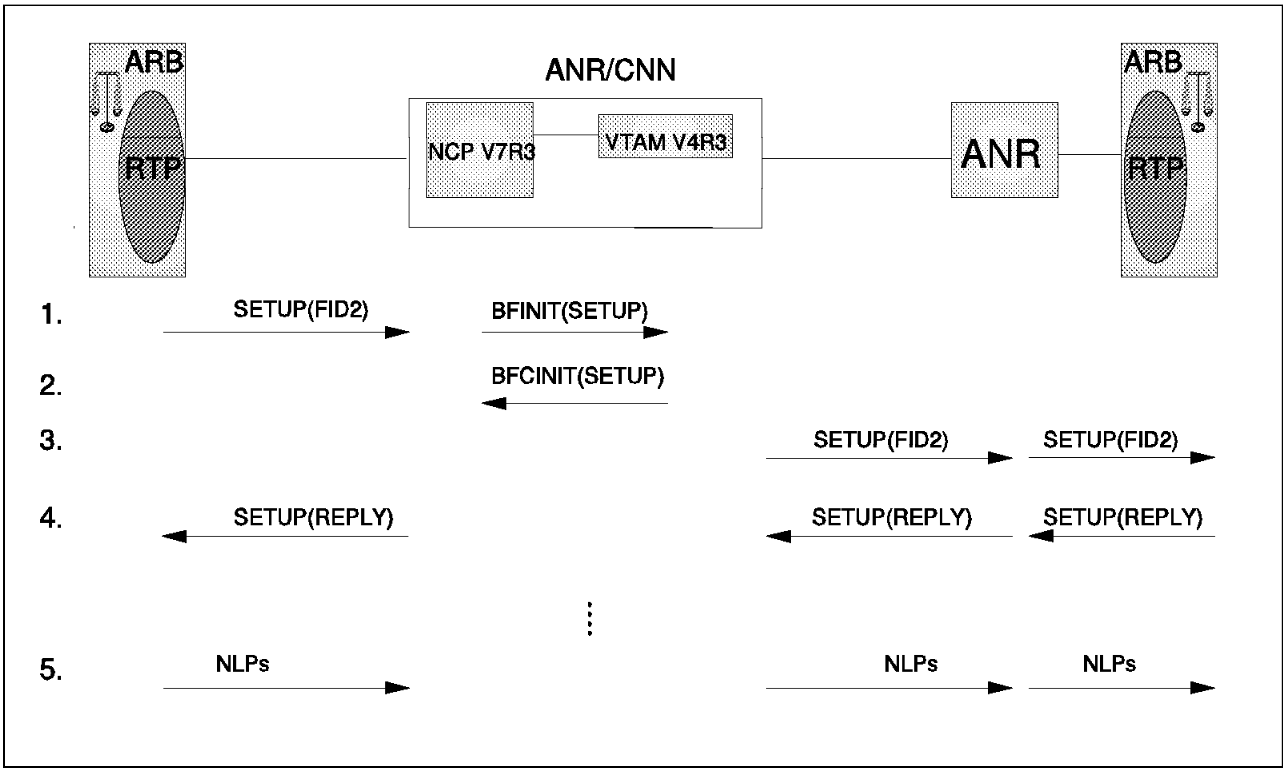


Figure 9. HPR Data Flow

1. RTP node sends route setup to the adjacent HPR node. If the adjacent node is a VTAM/NCP composite network node, NCP forwards the setup to VTAM inside a BFINIT.
2. VTAM locates the exit link station and sends BFCINIT.
3. Each ANR node on the path updates the route setup, and forwards it on until it reaches the destination RTP endpoint.
4. Route setup reply flows back, updating itself along the route.
5. After the RTP connection has been established, only NLPs will flow.

The exchange of the route setup request and reply allows the RTP nodes to establish the RTP connection before sending session data. The HPR nodes forwarding the route setup request and reply will add ANR labels to enable the efficient NLP routing. In addition, they indicate the maximum packet size that can be handled on, and the capacity and delay imposed by, each of the intermediate links.

The maximum packet size, which is acceptable to each node along the RTP connection, will avoid segmenting in the intermediate nodes. When a node receives a route setup, it checks to see if the maximum packet size for the next node is less than the current value in the received route setup. If it is, the maximum packet size for the next node replaces the current value and is stored in the route setup.

The values for the maximum link capacity and delay will help the RTP ARB flow control and congestion procedures to decide on the initial transmission rate. ARB will eventually update its transmission rate depending on the actual delay experienced and capacity available. Route setup processing for the link capacity is similar to processing for the maximum packet size. If the link capacity for the next node is less than the current value in the received route setup, then this lesser value replaces the current value and is stored in the route setup. The delay of the link will be added to the value contained within the route setup or route setup reply.

2.9.2 Directing the Route Setup

The determination of where to send the route setup is based on the RSCV that is associated with the BIND request triggering the activation of the RTP connection. Each TG within the RSCV indicates whether the link is capable of carrying HPR traffic and whether the TG goes to a node that supports the HPR transport tower. The route request will be sent to the last node along the path that supports the HPR transport option with the additional constraint that all TGs between the node initiating the route setup and this furthest node are HPR capable.

If both nodes, connected by a specific link on the route setup path supporting the HPR control flows over RTP option, the (existing) long-lived RTP connection over this link is used to forward the request (or reply); if not, FID2 routing is used.

2.10 HPR Format Overview

There are various types of packets that can flow between two adjacent HPR nodes. A packet for HPR may contain either an XID3 I-Frame, a FID2 PIU, or a Network Layer Packet (NLP). See Figure 10.

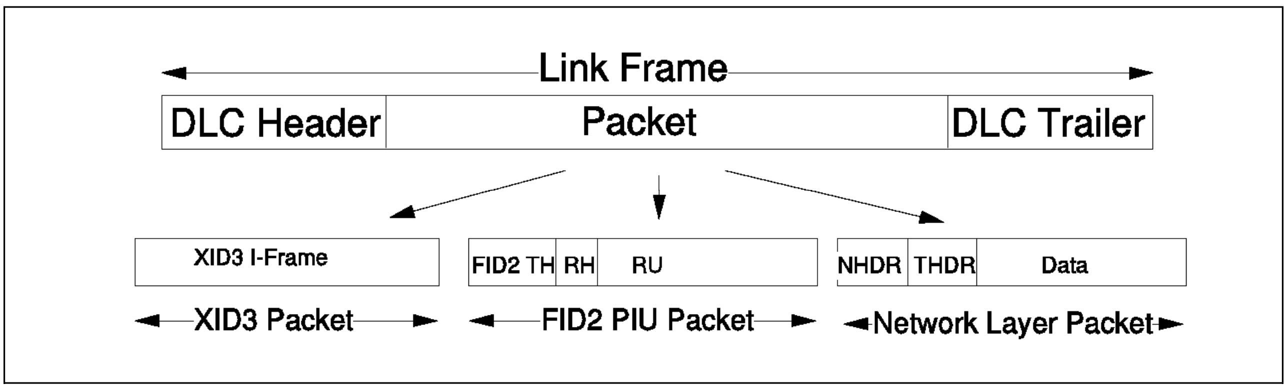


Figure 10. HPR Frame Formats

- The term Data Link Control (DLC) is used here to mean not only the traditional DLCs such as LAN LLC, but also the DLCs comprising whole networks, such as frame relay.
- HPR uses XID3 as defined in APPN, with the addition of a new control vector (CV61).
- FID2 PIUs contain a FID2 TH where the first 4 bits of the TH indicate the FID type. These 4 bits are used to distinguish FID2 PIUs from NLPs.
- Network Layer Packet
  - The NLP consists of the network layer header (NHDR) which contains ANR routing information (see Figure 11 on page 23).
  - The RTP transport layer header (THDR) which contains information used by the RTP (see Figure 12 on page 25).

– The data portion for CP-CP and LU-LU session traffic contains a new transmission header, the so-called FID5 TH, developed for HPR that contains an enhanced session address field (see Figure 13 on page 27).

- The DLC trailer contains the frame CRC field which is always present and provides data integrity checking, as it does in APPN.

  Note: This is the only integrity checking done in HPR so CRC is always required.

2.10.1 Network Layer Packet (NLP)

A network layer packet (NLP) is composed of the network layer header (NHDR) and the payload. The size of the packet is variable and no upper limit is specified. All implementations must be able to carry packets of at least 768 bytes. This ensures that the largest possible NHDR can be sent in one segment, as it cannot be segmented.

The length of a packet must not exceed the maximum packet size of any link over which the packet will flow. The minimum of the maximum packet sizes of the links on a connection path is obtained by the route setup protocol.

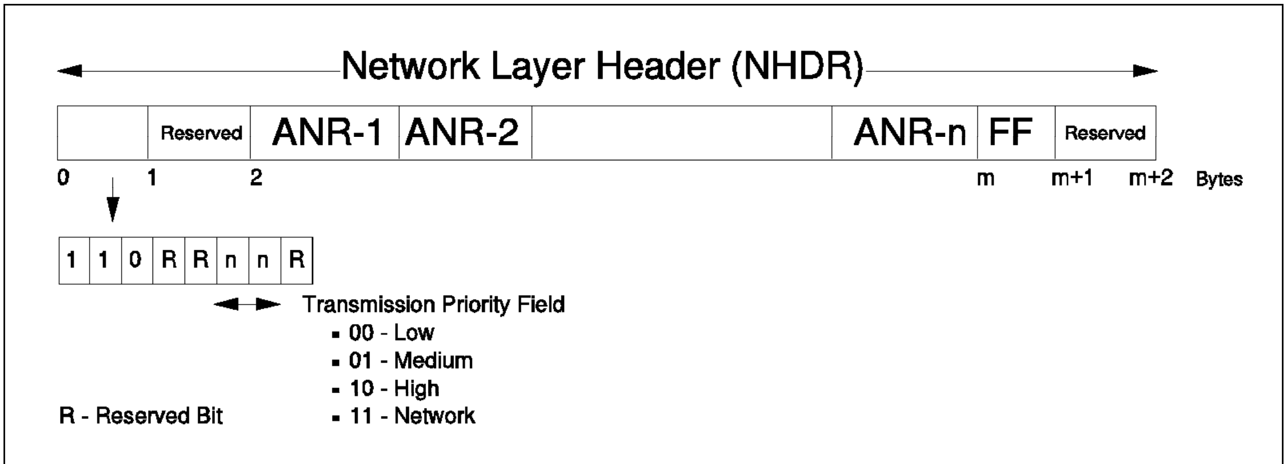


Figure 11. Network Layer Header (NHDR)

The network layer header is a field of variable length and has the structure shown. The first byte of the NLP indicates the routing mode ANR and the transmission priority. The transmission priority is the session priority as requested through the class of service. The routing field carries addressing information for how a packet should be routed through the network.

The network layer header of each packet contains a transmission priority field specifying one of four priorities: network, high, medium, and low. This priority function is implemented in intermediate nodes of the ANR path by means of priority queues. Products may use algorithms to ensure that lower priority traffic does eventually get transmitted. However, this is not architecturally defined.

2.10.1.1 ANR Labels

The ANR routing field is composed of a series of ANR labels identifying the packets′ path through the HPR network. The labels identify the intermediate links or TGs except for the last label which identifies the component receiving the packet inside the final node on the path.

The component receiving the packet is known as the network connection endpoint, or NCE. See 2.6.2, “Network Connection Endpoint (NCE)” on page 13. As the packet flows through the network each node examines the first ANR label to determine where to route the packet and removes the label prior to forwarding the packet. The packet decreases in size as it flows through the network due to the removing of these labels in the NHDR. The end of the ANR routing field is indicated with the delimiter of X′FF′. This means that no ANR label may contain a X′FF′.

There are two labels assigned with each link. When a link is activated, an ANR label is assigned by each node for its outbound direction. Each ANR label assigned within a node, be it for a link or for an internal component, is unique. If a node were to activate 25 links and has five network connection endpoints, it would assign 30 unique ANR labels.

The size of the ANR labels can vary from 1-8 bytes but should be kept as small as possible because of the space it uses in the NHDR and packet overall.

For FID2 links, NCP usually assigns a 2-byte long ANR label. However, when routing data between two FID2 TGs connected to the 3746-900, 5-byte long labels are used. For a HPR FID4 connection through the composite VTAM/NCP ANR node, NCP uses a 3-byte long ANR label.

2.10.2 RTP Transport Layer Header (THDR)

The length of the RTP transport layer header (THDR) is always an integer multiple of 4, to ensure alignment of any subsequent GDS variables on a “4-byte word” boundary. Variable length data is placed in control vectors or RTP optional header segments.

For control vectors, the length field counts the actual number of bytes, including the header and data fields. All control vectors and optional segments must begin on a “word” alignment point (multiple of 4). To achieve this, up to 3 bytes of non-significant padding X′00′ may be present after the control vector or segment.

The RTP transport layer header contains information necessary for creating and maintaining an RTP transport connection in the HPR network. The header may contain optional segments which carry additional state information about the connection.

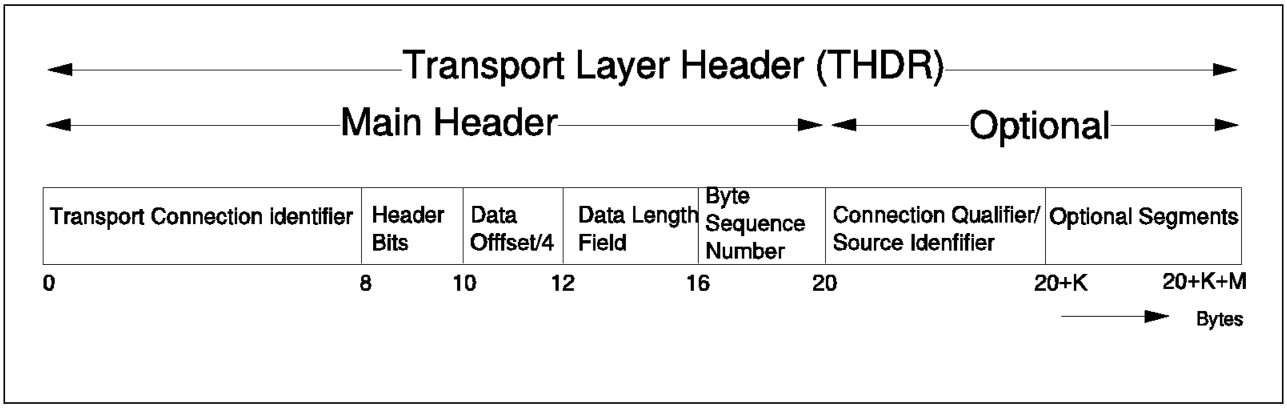


Figure 12. Transport Layer Header (THDR)

- The transport connection identifier (TCID) is a 63-bit field that, along with the connection qualifier and source identifier field, uniquely identifies a transport connection.
- The header bits (15 currently defined) specify the characteristics and the purpose of the RTP packet:
  - Setup packet
  - First, middle, last segment
  - Status request
  - Respond ASAP
  - Last message on this connection
- The data offset value must be multiplied by 4 to obtain the position of the user data relative to the beginning of the RTP header (must be a 4-byte boundary).
- The data length field (DLF) indicates the exact number of bytes of user data carried in this packet.
- The byte sequence number (BSN) field carries the sequence number of the first byte of the user data carried in this packet.

  Note: Each user message byte is assigned a sequence number.

2.10.2.1 RTP Optional Header Segments

Optional segments are used to carry connection control and management information. A packet may carry zero, one, or more optional segments. The intent of this design is that when long message streams are segmented into many packets, the vast majority of the packets carry no segments: just an RTP (main) header and the user data.

- The connection qualifier and source identifier (CQF) control vector (if present) contains the network identifier, node identifier (CP name), and NCE identifier. See 2.6.2, "Network Connection Endpoint (NCE)" on page 13 for more detail. The NCE is included here so that it can be used by the receiver of the message when a new route is obtained for path switch.
- The Connection Setup Segment must be carried in the first packet that flows from the sender to the receiver. It identifies the target transport user and the fact that ARB is used for flow control on this connection.
- The Connection Identifier Exchange Segment is used by the partner that was originally the receiver to provide its connection identifier to the sender.

- The Routing Information Segment is used to pass routing and other connection information from the sending to the receiving partner. This segment is included in the first packet of a connection to pass the ANR field for the return path of the network connection. It is also used in the path switch processing.
- The Adaptive Rate-Based (ARB) Segment is used to pass ARB information between the sending and receiving partner.
- The Client "Out of Band" Bits Segment is used to request deactivation of the connection and to carry replies to this request.
- The Status Segment is used to convey status information from one end of the logical connection to the other. The status information always includes a received sequence number which serves to acknowledge user data bytes received. It may be used to request retransmission of lost segments, when the receiver detects a "gap" in byte sequence numbers of the message stream.

  The retry indicator and Status Requested indicator (with its associated Status segment) are used by RTP to provide reliable SNA sessions.

  – The *Retry Indicator* is always set by the sending RTP endpoint to indicate that the sender will resend data if it is not successfully received by the partner.

  – The *Status Requested* indicator is set by the sender to request the receiver's status (acknowledgement of data successfully received). This allows the sender to find out what it can clear from its send buffer that it has been keeping in the event of a retransmission request. Data that was not received may be retransmitted.

    Status is not requested in every packet due to the overhead, so is only done when there is no more data to send, the data buffers are becoming depleted or an ARB request is included in the packet. See 2.7.2, "ARB Flow Control and Congestion Control" on page 16 for a description of ARB.

2.10.3 Enhanced Session Addressing

Although ANR provides the routing between ends of the RTP pipe we still need to identify individual sessions within the pipe. To do this we have to have some addressing structure. This structure does not need the level of detail in other FIDs, so a new FID5 was introduced.

An enhanced addressing algorithm has been developed for sessions flowing through HPR subnetworks. The new FID5 transmission header is used to transport the 8-byte session address. There are two addresses associated with each session. Each LU (or CP for CP-CP sessions) is assigned the address to be used on PIUs it receives. The PLU assigns an address and sends it to the SLU in the FID5 transmission header on the BIND request. The SLU, after having received the BIND, assigns its address and sends it in a new control vector included in the BIND response back to the PLU. Data flowing from the PLU to the SLU will then use the address assigned by the SLU, whereas data flowing from the SLU to the PLU will carry the address assigned by the PLU.

Since multiple sessions of the same COS can be multiplexed onto a single RTP connection, session addresses must be unique at least for each RTP connection in a node. This is necessary to allow connection endpoints to identify data flowing over the RTP connection based on RTP connection identifier and the individual session address.

Session addresses can be re-used, but this must be done with care to avoid problems during BIND/UNBIND races.

The new FID5 transmission header is very similar to the FID2 transmission header currently used in APPN. The main change is that the FID5 does not carry the ODAI, OAF′, and DAF′ fields, but a session address instead. This session address is unique per session and direction (PLU-to-SLU and SLU-to-PLU). Each side assigns the session address that has to be used by the session partner, when sending data, to address the session.

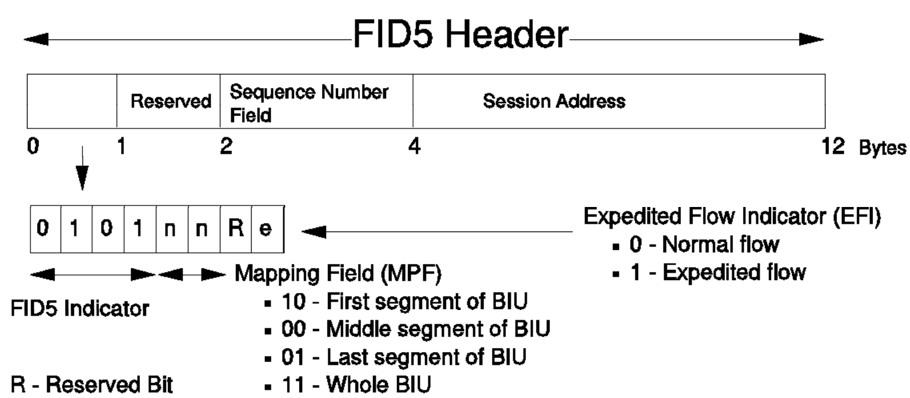


Figure 13. FID5 Transmission Header

2.11 HPR Summary

HPR augments current APPN (ISR) layer 3 and 4 transport and network functions with two new elements: Rapid Transport Protocol (RTP) and Automatic Network Routing (ANR), shifting the locus of APPN routing from layer 4 down to layer 2. HPR also includes an APPN/HPR boundary function to adapt an HPR-capable part of the network to an ISR-only part of the network, plugging one side of an ISR session connector into the end of an RTP transport-oriented logical link.

Because HPR is completely integrated into SNA and does not change APPN control functions at all, any node can be upgraded to the HPR level of function transparently, and continue to inter-operate with adjacent nodes still at the current APPN level of function. As soon as two or more adjacent nodes are HPR capable, benefits of HPR (non-disruptive path switch, adaptive rate-based congestion control, selective retransmission) start to be realized.

HPR provides a connection-oriented transport (RTP), end-to-end, over connectionless source routing (ANR), with minimal data link control. RTP acts as a “virtual link.” The amount of function that RTP demands of the underlying DLC depends on the quality of the transmission medium. On high quality links, the DLC is not asked to provide reliable delivery, sequence numbering, retransmission, or acknowledgment. It merely provides a frame check sequence, packets in error are simply discarded.

An HPR path can also include multi-link transmission groups (MLTGs). Benefits of MLTG include high availability (if one link of a multi-link group fails the MLTG remains operational) and bandwidth on demand (additional switched links can be dialed to increase the overall bandwidth of the MLTG). Long a feature of subarea SNA networking, MLTG can easily be added to HPR, without the performance and storage penalty of resequencing packets at each hop. Resequencing only needs to be performed at the endpoints of the RTP logical link, a task RTP was designed to accommodate.

RTP insulates the upper layers (the LU) and the user from any awareness of path switching, multi-path routing, network-related congestion control activities, retransmissions, acknowledgments, packet resequencing, multiplexing, and so forth. Thus a user's investment in existing SNA applications is completely preserved.

Chapter 3. HPR Implementations

This chapter covers HPR implementations in different IBM products and platforms currently supported. These products are VTAM Version 4 Release 3 for MVS/ESA, NCP Version 7 Release 3, Communication Manager/2 Version 1 Release 2, and OS/400 Version 3 Release 1.

The two main node types of the HPR are an Automatic Network Routing (ANR) node, which has not implemented HPR Transport Option or is not using it, and a Rapid-Transport Protocol (RTP) node, which has HPR Transport Option in addition to the HPR base. HPR base functions and transport options are an extension of APPN, so both of these HPR nodes can have full APPN support coexisting with the HPR capabilities they implement.

The advantages of the HPR for APPN sessions are:

- Sessions are carried in RTP connections which provides end-to-end error recovery, flow control, and congestion control.
- RTP connections can be dynamically rerouted without loss of sessions and data in the event of path failure.
- ANR routing provides faster and more efficient routing through intermediate nodes with the network than APPN intermediate session routing does.

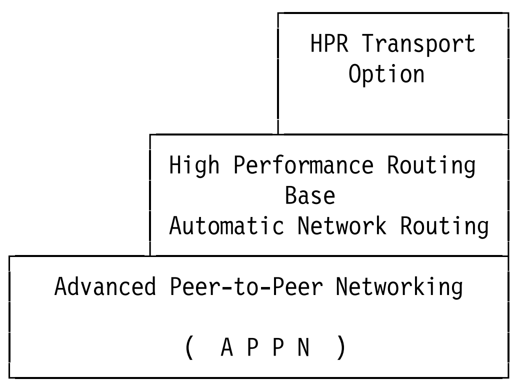


Figure 14. APPN Base and HPR Functions

The primary role of the HPR base function is to support Automatic Network Routing (ANR). Products that implement only the HPR base will act as intermediate ANR routing nodes for RTP connections. Products that implement the HPR transport option in addition to the HPR base can act as an endpoint of an RTP connection. RTP connections can only be established between nodes supporting the HPR transport option.

ANR is a low-level routing mechanism that minimizes cycles and storage requirements for routing packets through intermediate nodes, because it takes place at a lower layer than APPN intermediate session routing. Intermediate ANR nodes are not aware of the SNA sessions or RTP connections which are established across these nodes nor will they perform functions such like segmentation, flow control and congestion control.

3.1 VTAM Version 4.3 HPR Implementation

VTAM Version 4 release 3 for MVS/ESA is the first VTAM release, which has implemented HPR functions. It has both ANR and RTP capabilities, and depending on definitions it can be either of these two. See Table 1 below for VTAM roles.

However, even though these HPR capabilities are now included in VTAM, there are some limitations you should be aware of when you are planning how to use them. As an example, a composite network node (CNN), which consists of VTAM and subarea devices including NCPs, can only provide ANR support, and this only through the NCPs.

If you have not coded HPR support in the VTAM startup options, VTAM will automatically select whether it will act as a RTP or an ANR node (see Table 1 for default values). Depending on NODETYPE and HOSTSA definitions, VTAM will default to the highest supported level of HPR for that configuration. You will therefore need to code HPR in VTAM your startup options if you require a lower level of support.

3.1.1 VTAM Version 4.3 Node Roles

Because VTAM has implemented HPR base functions (ANR routing) and HPR transport options, it could act either as an ANR or a RTP node. Default values are shown in Table 1 below. These parameters are explained in *VTAM Version 4 Release 3 for MVS/ESA Resource Definition Reference (SC31-6552)* in Chapter 4. Start Options.

Table 1. VTAM Node Roles

Node Role	HOSTSA	NODETYPE	HPR Capability●
End Node	Not specified	=EN	RTP●
Network Node	Not specified	=NN	RTP● (default) ANR●
Migration Data Host	Specified	=EN	RTP●
Interchange Node (Composite Network Node)	Specified	=NN	ANR● (Through NCP)
Subarea Node	Specified	Not specified	Not available●

Notes:

1. By defining HPR=NONE in VTAM startup, it will be have no HPR support.
2. HPR connections are supported only over the AHHC and Local SNA.
3. HPR connections are not supported over AHHC nor Local SNA, ANR is only supported by NCP under the VTAM control.
4. If you do not code NODETYPE in VTAM startup, it will be pure subarea host without APPN and HPR support.

3.1.2 VTAM Version 4.3 HPR Base

As discussed previously, VTAM provides only HPR base functions in some configurations. These functions are needed to provide the ANR routing mechanism which is used by HPR transport option (refer to Figure 14 on page 29). These HPR base functions are now included in VTAM during VTAM startup (see Table 1 on page 30), unless HPR=NONE is specified or the APPN NODETYPE has not been specified.

However VTAM does not allow an end node (EN) or a migration data host to be an intermediate ANR node for RTP connections. As an EN or MDH, it is by definition the endpoint of an APPN route and cannot act as an intermediate node for APPN or HPR sessions. Both of these can be RTP endpoints and have HPR base and transport functions.

For VTAM to act as an intermediate ANR node and do ANR routing it has to be a network node (NN). A pure VTAM NN, which is an RTP node by default, can act as an endpoint for RTP connections, as well as an intermediate ANR node for other RTP connections. If it is defined as an ANR node, it could only be an intermediate ANR node for RTP connections and cannot itself be an RTP endpoint.

A composite network node, where VTAM has a NCP attached to it, can only be an ANR node, and only the NCP, under the control of the VTAM, provides ANR capable links.

VTAM DLCs supporting HPR in V4R3 are:

- APPN Host-to-Host Channel (AHHC)•
- Local SNA (Type 2.1 channel connection to NCP)•

•Current implementation does not support the ″no link-level error recovery″ option for these local DLCs.

These links support ANR and FID2 frames over the same link, allowing both APPN sessions, such as CP-CP sessions, and sessions over RTP connections to share the link. An example of this would be a channel link from an NCP in a CNN to an NN VTAM. This would have ANR traffic from RTP connections through the CNN but use FID2s for the sessions originating in the CNN such as LU-LU and the CP-CP session from the CNN to the NN.

Note also that VTAM does not have HPR support for External Communication Adapter (XCA), for example the 3172. And an interchange node VTAM does not support HPR links for any local DLCs.

VTAM HPR base functions supported in V4R3 are:

- Automatic Network Routing (ANR)
- Intermediate routing of network layer packets (NLPs) using ANR
- Support of ANR and FID2 routing over the same link
- Using FID2 routing for CP-CP sessions and route setup requests.
- Using FID2 routing for LU-LU sessions which use intermediate session routing.
- No link-level error recovery for NLPs using ANR through NCP and RTP connections.

3.1.3 VTAM Version 4.3 HPR Transport Option

VTAM has implemented HPR Transport Option in addition to HPR base for some configurations. This allows VTAM to be an endpoint for RTP connections. RTP connections can only be established between nodes which support the HPR transport options.

VTAM 4.3 HPR Transport Options supports:

- HPR base functions such like ANR routing
- Rapid-transport protocol (RTP)
- Nondisruptive path switch
- RTP end-to-end error recovery
- RTP segmentation and reassembly
- RTP resequencing
- APPN/HPR boundary function
- A single NCE for all LUs and APPN/HPR boundary function in VTAM node
- Adaptive rate-based (ARB) congestion control

3.1.3.1 RTP Connections

An RTP connection is established dynamically between two RTP endpoints for the Class of Service (COS) requested. The RTP connection is bi-directional, and all the LU-LU sessions using the same COS can share this RTP connection regardless of which side of this RTP connection they are started from.

However in certain circumstances, it is possible that between two RTP endpoints there are multiple RTP connections having the same COS characteristics, and they may also have different ANR routes (physical paths).

When the last session using an RTP connection ends and there are no pending requests or session initialization requests in process for this RTP connection, then that RTP connection will be taken down.

If two RTP endpoints attempt to establish an RTP connection at the same time, it is possible for two RTP connections to be made for the same COS.

Note: Whenever a new session is requesting this same COS, RTP endpoints will establish a new RTP connection, when there is a better route available between these two RTP endpoints than the current RTP connections have or there is no existing RTP connection for this COS.

3.1.3.2 RTP Segmentation and Reassembly

An RTP connection can be established over a series of HPR links and nodes. Each of these links can have different characteristics, such as speed and maximum BTU size. Because the size of the BTU depends on network definitions, this value also depends on the route the RTP connection traverses. Therefore the maximum BTU size is the smallest BTU supported by these links, over which the RTP connection is established, because NLPs can not be segmented between the RTP endpoints. Segmentation, when needed, is based on this value.

Note: If the path switch is performed for RTP connection, the smallest BTU size is also recalculated, and this new value is then used.

An RTP connection can carry several LU-LU sessions. A LU-LU session might use larger RU sizes than the maximum BTU size allowed for this RTP connection. To be able to deliver this RU over the RTP connection it must be segmented by the RTP. This means that the RTP, which receives a larger RU than it can forward, must segment this RU into smaller units (NLPs) and deliver them to the RTP at other end. Then the RTP receiving these NLPs reassembles the received packets and forwards it as a single RU to its destination.

VTAM Version 4.3 has implemented segmentation and reassembly into the HPR transport node functions. Segmentation and reassembly is also done for the LU-LU sessions not originating in VTAM RTP endpoints, such as like APPN sessions, which can use the RTP connections through the APPN/HPR boundary function.

RTP is designed to operate in a connection-oriented network, and so it expects the network to deliver data in sequence. However, if a packet arrives out of sequence, RTP will wait a short time to allow other packets to arrive before it will perform error recovery for the packet that is lost or out of sequence.

3.1.3.3 RTP End-to-End Error Recovery

In base APPN, error recovery is done on every link. This is no longer necessary in most cases because the reliability of links has increased and error rates are very low. As part of its RTP implementation VTAM Version 4.3 has implemented end-to-end error recovery for RTP connections. This enhances the performance across an HPR subnet, because many of these functions are now performed on an end-to-end basis, instead of the hop-by-hop basis as in APPN.

End-to-end error recovery in the RTP endpoint ensures that the data is delivered correctly between RTP endpoints. If the data arrives out of sequence or packets are lost, the end-to-end recovery can use selective retransmissions and resequencing of the data instead of retransmitting all data packets.

3.1.3.4 RTP Connections and Nondisruptive Path Switch

All RTP connections use ANR routing. VTAM calculates the best APPN route available and then activates an RTP connection, if one is possible, over the route. If part of the RTP connection route fails or a path switch is requested by the operator, VTAM will find an alternate HPR capable route, if available. The network server must also understand HPR and be able to select an HPR route from its topology database.

Between two RTP endpoints there may be several RTP connections having different physical paths between the two endpoints, depending on your physical network configuration. APPN routing establishes each path according to weighting of links for different classes of service.

If there are physical changes in your network such as the activation of a new HPR link providing a better route between these RTP endpoints, VTAM will start to use this new HPR link for new RTP connections. VTAM will also re-calculate the best ANR route between these RTP endpoints if requested by a VTAM operator command for a specific RTP.

If one of the HPR links between two RTP endpoints is lost (for example, a physical link fails), the endpoints will detect the loss of the link. The nondisruptive path switch function will automatically route RTP connections around the failed link or node, if an alternate path is available. The originating

VTAM RTP endpoint re-calculates the best route for the RTP connection and switches the RTP connection to that route. This is done on an individual RTP basis without losing the RTP connection or any of the LU-LU sessions on it. Any lost data is recovered without the LU sessions knowing.

3.1.3.5 APPN/HPR Boundary Function

VTAM Version 4.3 NN support has an APPN/HPR boundary function, which makes it possible to use an RTP connection within an HPR subnet for APPN LU-LU sessions not originating in HPR subnet. An APPN LU-LU session can then be established over an HPR subnet and it will use ANR routing in the HPR subnet. If the session crosses an HPR subnet, at the other end of the HPR subnet an APPN/HPR boundary function will forward the session into the APPN subnet. (APPN/HPR boundary function is explained in 9.2, "Network Flows" on page 86.)

3.1.3.6 Network Connection Endpoints

ANR requires a new form of address within an HPR transport node, called the NCE label. This NCE identifies the component within the node that is to process the received network layer packet. VTAM 4.3 has implemented one NCE for the entire VTAM node including all LUs and APPN/HPR boundary function. The value is X′F1′.

3.1.3.7 Adaptive Rate-Based Congestion Control

VTAM Version 4.3 has implemented a new algorithm for flow and congestion control called adaptive rate-based (ARB) congestion control algorithm, which is designed to make efficient use of network resources by avoiding congestion. A VTAM HPR transport node has end-to-end ARB control over the RTP connections. (ARB algorithm is explained in 2.7.2, "ARB Flow Control and Congestion Control" on page 16.)

3.2 VTAM Version 4.3 HPR New Parameters

VTAM Version 4 Release 3 has new parameters for HPR. These parameters will apply to VTAM startup, where you specify the level of high performance routing, and to APPN/HPR connections for other nodes. Between HPR nodes link level error recovery is now optional, but between APPN nodes you still have to use it.

3.2.1 Startup Parameters

VTAM Version 4 Release 3 has two new startup parameters for HPR. With these two new parameters you may define the level of high performance routing provided by VTAM, and how long the path switch can take for an RTP connection.

HPR Specifies the level of high performance routing (HPR) support provided by VTAM. See Table 1 on page 30 for default values.

If you do not code the NODETYPE parameter in VTAM startup this parameter is not meaningful.

For an end node, the default value is HPR=RTP. For a network node, the default value is HPR=RTP. For an interchange node (HOSTSA is coded), the default value is HPR=ANR. If you code HPR=ANR for a network node, then VTAM cannot be an RTP endpoint. All sessions to and from this VTAM can only use APPN routing instead of ANR routing. You must not code this for an end node, as it cannot act as an intermediate ANR node in an HPR subnet.

You can also code HPR=NONE if you do not need HPR support.

HPRPST The maximum time that VTAM tries a path switch before ending an RTP connection. This parameter is meaningful only for nodes which are RTP-capable.

The default value is 60 seconds for each transmission priority (HPRPST=(60s,60s,60s)). You can specify different time limits for low, medium, and high transmission priority connections, but there are no strict rules for coding HPRPST. If you code too short a time value, it may not allow enough time for a path switch attempt to succeed in finding a new route.

Possible ranges for each value are 5 secs - 24 hours. You can change the value of HPRPST with the MODIFY VTAMOPTS command while VTAM is running. 60 seconds appears to be a reasonable figure in most networks. If this value is too small then the path switch will fail before VTAM can reroute. If it is too large it will hold the connection and waste VTAM storage for connections which may never be recovered.

3.2.2 HPR Link Parameters

These new parameters are related to links to the APPN/HPR nodes (represented by PU statements), which have APPN/HPR connections with a VTAM HPR node. These parameters apply to local SNA major nodes, NCP major nodes, and switched major nodes, where you specify connections to other nodes.

HPR Specifies whether HPR support is enabled for an adjacent link station (ALS), where it may be HPR capable. The adjacent link station can be connected over a local SNA or through an NCP (to VTAM CNN). Peripheral HPR nodes, which are connected through an NCP token-ring, frame relay, or SDLC lines, are defined in switched major node with a default value of HPR=YES. HPR is also supported for VTAM HPR nodes connected through NCP channels to a CNN, when they are defined as APPN nodes.

HPR=YES indicates that this ALS provides HPR support.

HPR=NO indicates that this ALS does not provide HPR support.

Note: VTAM ICNs do not support HPR links for local SNA connections (AHHCs and Type 2.1 channel connections to NCP) and provide HPR-capable links only through the NCP. HPR links over external communication adapter are not supported, and they can only be APPN links.

LLERP Specifies the link level error recovery procedures (LLERP) preference for HPR connections. This parameter is meaningful only for nodes which are HPR-capable, because only HPR frames may be sent without link level error recovery procedure.

VTAM supports only ″link level error recovery″ for all its HPR links (LLERP=REQUIRED). NCP supports link level error recovery for all its HPR links, but only ″no link level error recovery″ for following link types:

- NTRI logical peripheral

- Frame relay logical peripheral
- Frame relay logical subarea•

• Frame relay subarea link between two NCPs supports the sending of the HPR_FID4s without link level error recovery, when both of these NCP subarea nodes are supporting HPR.

For NCP logical peripheral nodes, code the LLERP parameter in the VTAM switched major node. To override the NCP default value, you must code (LLERP=REQUIRED) in switched major node.

3.3 NCP Version 7.3 HPR Implementation

NCP Version 7 Release 3 is the first NCP release, which has implemented HPR functions, such as ANR capability under the control of a VTAM interchange node. The HPR support is built on top of the APPN support, so it is supported only for APPN-capable nodes.

When you build an HPR network, you can still have back-level NCPs in your composite network node between HPR-capable NCPs as the HPR NLPs are contained in FID4s. The VTAM ICN and its NCPs still appear as a single HPR node, so the NCPs do not appear in the APPN topology database.

The NCP receives the HPR frame and removes the ANR label associated with this ANR node. If the next destination can be reached from this NCP (the output link is in the same NCP) the frame is forwarded directly to that HPR link.

If the destination link is not in the same NCP, it prepares the HPR frame for BNN-BNN routing by creating a FID4 and encapsulates the HPR frame in it. The HPR_FID4 is routed similarly to non-HPR FID4s by using the INN routing mechanism. At the destination NCP, the FID4 containing the HPR frame is received and recognized as an HPR FID4 and the HPR frame (NLP) is created from the HPR data transported in the FID4. The HPR frame is then enqueued to the DLC for transmission to the next HPR node.

NCP has implemented ″no link level error recovery″ capability for the HPR links, which makes it possible for NCP to forward these NLPs without checking if the receiver is able to receive them correctly. This means that the NLPs are not re-transmitted on a link level basis, if the receiver does not receive frame correctly. The error recovery is performed on an end-to-end basis by RTPs. Without link level error recovery, throughput over an HPR network is better than in an APPN network, because routing needs less processing with no link level error recovery in intermediate nodes.

Note: A composite network node, where VTAM has an NCP attached to it, can only be an ANR node, and only the NCP provides HPR-capable links.

NCP DLCs supporting HPR links in V7R3 are:

- Parallel channels (Type 2.1 channel connection)•
- ESCON channels (Type 2.1 channel connection)•
- SDLC lines•
- Token-ring
- Frame relay

Note: •Currently LLERP is always used for these DLCs.

Lines in the 3746-900 are only supported through DLCs within the communication line processors (CLPs); however HPR support is provided by the NCP.

3.3.1 Link Level Error Recovery

NCP supports sending HPR data without link level error recovery only on frame relay logical subarea, frame relay logical peripheral, and NTRI logical peripheral connections. Link level ERP support for HPR is defined on the frame relay LMI PU, or on the token-ring physical PU for SNA (the one with NETWORK=SNA). The logical connections that map to the physical port will inherit the defined (or defaulted) support for LLERP. For the 3746 Model 900 token-ring LLERP=REQUIRED must be coded on the physical port definition.

Note: Lines in the 3746-900 are only supported through DLCs within the communication line processors (CLPs) and ″no link level error recovery″ is only supported for frame relay links by NCP.

You may override the LLERP definition for the physical port by defining LLERP support on the logical definitions as follows:

- **Frame relay logical subarea:** code LLERP on the logical subarea PU statement in the NCP major node.
- **Frame relay or token-ring logical peripheral:** code LLERP on the PU statement in the VTAM switched major node definition deck which represents the connection to the appropriate adjacent node.

Do not code LLERP on frame relay or token-ring logical peripheral stations in the NCP major node. Refer to the *VTAM Resource Definition Reference* for more information about coding PU statements in the switched major node.

3.4 AS/400 Implementation

OS/400 Version 3 Release 1 is the first release of the AS/400 operating system to provide HPR functions. This release only supports the base functions, so the AS/400 can only be an intermediate ANR node on an RTP connection.

3.4.1 Link Support

Unlike the PS/2 and 3745, the AS/400 has limited support for ANR on its adapters as DLC support on adapters such as the token-ring is held in ROM on the adapter and requires specific hardware features to ensure ANR support. Currently, support is provided for the following:

- Token-ring

  Feature card 2619
- Frame relay

  Feature card 2666
- Ethernet

  Feature card 2617
- FDDI

  Feature card 2618
- SDLC

  *** Not supported ***

3.4.2 HPR Parameters

As with other implementations, HPR support is provided as a default on links and is part of the base operating system. The only parameter to code is APPN/HPR capable - *YES or *NO on the APPC controller description.

LLERP is hard coded as NOT_ALLOWED in OS/400 and cannot be changed. This means that it can only use APPN to a 3746-900 token-ring adapter.

Note that if HPR is defined on an SDLC link then this will result in an error message. However, defining HPR on a lower-level card such as feature card 2626 for token-ring support will not produce any error message. On starting such a link, or using a supported link with a maximum frame size less than 768 bytes, no error message is seen and the link operates as APPN only.

3.5 Communications Manager/2 Implementation

The CM/2 implementation includes RTP support in its HPR implementation. Support is provided for token-ring, Ethernet and frame relay but not SDLC links. The code used during testing was Beta test code and no version or release level had been assigned.

3.5.1 HPR Parameters

Unlike other implementations the default when predefining links is for no HPR support. To enable HPR support on a link, the HPR support box must be selected on the Additional link parameters panel from the SNA connections option.

LLERP support is not allowed with the CM/2 implementation of HPR. This means that it can only use APPN to a 3746-900 token-ring adapter.

Chapter 4. APPN Host-to-Host Connection

As discussed earlier, HPR is an important evolution from APPN networks providing a number of benefits and positioning the user for future high-speed networking technologies.

This chapter demonstrates the basic concepts of RTP connections between RTP-capable nodes. The test scenario also demonstrates the limitations of VTAM in a composite network node environment.

4.1 Benefits

If we expand from a simple two-host scenario to a multi-host high availability complex, the ability to use RTP connections between hosts gives two benefits:

- The reduction in load at intermediate nodes
- The ability to reroute without loss of sessions

Hence in such a network we could lose an AHHC between two systems and dynamically switch paths through another VTAM without session loss and minimizing the loading on intermediate VTAMs.

4.2 Connecting two VTAMs Together

In this test scenario we have two VTAM 4.3 systems, one a pure network node and one an end node. These are connected via AHHC connections using MultiPath Channels (MPCs) to each other as a direct RTP-capable path and also via a third VTAM 4.3 system. This third system is an InterChange Node (ICN) forming a composite network node. As such, it cannot provide RTP capabilities and for ANR routing, the NCP only has ANR capability, not VTAM.

For the first test we enable the channel connections from each HPR VTAM system to the ICN node and demonstrate that while the links default to HPR=YES, the negotiation process results in simple APPN only links.

We then enable the channel connections directly between the two HPR VTAMs and these connections come up as RTP-capable. The results show the information available and the connections formed.

Later on we will see the use of the NCP in a CNN to provide the ANR capability but this test shows that we cannot use channel-to-channel links into ICN VTAMs if we require HPR routing facilities. In networks where we have multiple VTAMs, (multiple MVS VTAMS in a single VM system for example) we would need to channel connect HPR VTAMs to each other and link into the NCP via one or more channels as data hosts. We then have the capability to form RTP connections to other RTP capable nodes through the CNN network.

4.3 Description

We see in Figure 15 the configuration used in this test. The two VTAMs referred to as RAA and RAS are defined as pure APPN nodes, RAA is a network node and RAS an end node. RAB is an ICN and connects to an NCP, RA9NCPX, forming a CNN, although we do not use the NCP in this initial testing.

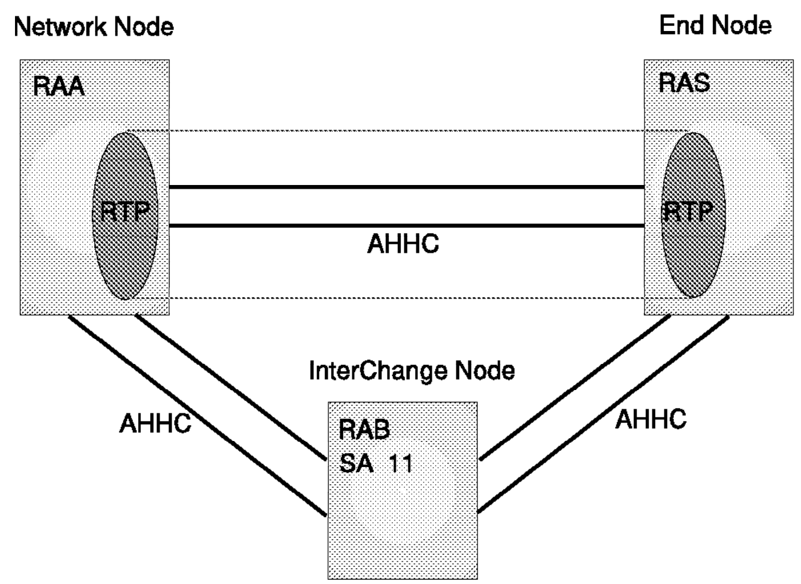


Figure 15. AHHC Test Network

In this test we activate the AHHC links RAA to RAB and RAB to RAS but although these are defined as HPR=YES on their PUs, the links are APPN only. This is shown by logging on to TSO in RAS (RASAT) and displaying the session.

We then activate the RAA-to-RAS connection with similar definitions and this time we get an RTP-capable link. Logging on again to RASAT gives us a session over an RTP connection and this is seen in the VTAM displays and messages. We can also demonstrate the setup of a separate RTP connection due to a new Class Of Service (COS) by using the new VTAM display and test function:

```
D NET,APING,ID=
```

We can APING VTAM in RAS from RAA which will set up a new RTP connection since it has a different COS from the TSO session.

When the last session over an RTP connection is closed, that pipe will be closed as can be seen during TSO logoff and at the end of the APING test.

4.3.1 Definitions

The test scenario is fairly simple in terms of definitions, as can be seen in Figure 16. This shows the AHHC and TRLE definitions for the channel from RAA to RAS. The definitions for the other links between RAA, RAS and RAB are similar and shown in Appendix A, “Test Scenario 1” on page 99.

```
*************************************************
* RAA PU FOR MPC LINK FROM RAA TO RAS           *
*************************************************
RAALCAS  VBUILD  TYPE=LOCAL
RAAPUAS  PU   TRLE=RAAMPCS,PUTYPE=2,XID=YES
 . . .
*************************************************
* TRLE FOR LINK FROM RAA TO RAS                 *
*************************************************
RAAAHHCS VBUILD  TYPE=TRL
RAAMPCS  TRLE   LNCTL=MPC,READ=(C09),WRITE=(C08)
```

Figure 16. AHHC and TRLE Definitions

Note that when defining multiple TRLEs you must have them in one single major node for inclusion at startup, or you will get an error message for subsequent TRLE startup members after the first. To add a new entry you must use the UPDATE=ADD on the vary activate.

4.4 Test Results

For the initial test we activate the RAA-to-RAB and RAB-to-RAS definitions in the three hosts. We then log on from a local 3270 screen on RAA (LU name RAAT420) to TSO in RAS (Application RASAT). If we display the cross domain resource in RAA for our TSO session as shown in Figure 17 on page 42, we see the adjacent link station is the PU for the link to RAB **1**.

```
D NET,ID=RASAT01,E
IST097I DISPLAY ACCEPTED
IST075I NAME = USIBMRA.RASAT01, TYPE = CDRSC 429
IST486I STATUS= ACT/S----Y, DESIRED STATE= ACTIV
IST1447I REGISTRATION TYPE = NO
IST977I MDLTAB=***NA*** ASLTAB=***NA***
IST1333I ADJLIST = ***NA***
IST861I MODETAB=***NA*** USSTAB=***NA*** LOGTAB=***NA***
IST934I DLOGMOD=***NA*** USS LANGTAB=***NA***
IST597I CAPABILITY-PLU ENABLED  ,SLU ENABLED  ,SESSION LIMIT NONE
IST231I CDRSC MAJOR NODE = ISTCDRDY
IST479I CDRM NAME = RAA, VERIFY OWNER = NO
IST1184I CPNAME = USIBMRA.RAS - NETSRVR = ***NA***
IST1044I ALSLIST = ISTAPNPU
IST082I DEVTYPE = INDEPENDENT LU / CDRSC
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST171I ACTIVE SESSIONS = 0000000001, SESSION REQUESTS = 0000000000
IST206I SESSIONS:
IST1081I ADJACENT LINK STATION = RAAPUAB      1
IST634I NAME     STATUS         SID          SEND RECV VR TP NETID
IST635I RAAT420  ACTIV-S    F627D164C62813E4 0008 0002  0  0 USIBMRA
IST924I -------------------------------------------------------------
IST075I NAME = USIBMRA.RASAT01, TYPE = DIRECTORY ENTRY
IST1186I DIRECTORY ENTRY = DYNAMIC LU
IST1184I CPNAME = USIBMRA.RAS - NETSRVR = USIBMRA.RAB
IST314I END
```

Figure 17. Display of TSO Session to RAS via RAB

Displaying the adjacent link station in Figure 18 shows the link as an APPN link, CONNECTION = NO, even though we specified HPR=YES **1**.

```
D NET,ID=RAAPUAB,E
IST097I DISPLAY ACCEPTED
IST075I NAME = RAAPUAB, TYPE = PU_T2.1 446
IST486I STATUS= ACTIV--L--, DESIRED STATE= ACTIV
IST1043I CP NAME = RAB, CP NETID = USIBMRA, DYNAMIC LU = YES
IST1105I RESOURCE STATUS TGN CP-CP TG CHARACTERISTICS
IST1106I RAAPUAB  AC/R    21 YES   988D0000000000000000017100808080
IST1482I HPR = YES - OVERRIDE = N/A - CONNECTION = NO   1
IST136I LOCAL SNA MAJOR NODE = RAALCAB
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST1314I TRLE = RAAMPCB   STATUS = ACTIV       CONTROL = MPC
IST355I LOGICAL UNITS:
IST080I RASAT01  ACT/S----Y RAB      ACT/S----Y W0517503 ACT/S----Y
IST314I END
```

Figure 18. Adjacent Link Station from RAA to RAB

We now log off from TSO in RAS and activate the AHHC from RAA to RAS. We see in Figure 19 on page 43 that a CP-CP session is established from RAA to RAS **1** but as VTAM 4.3 does not implement the control flows over RTP option, we do not see an RTP connection established.

We log onto TSO in RAS again and this time we will use the direct channel connection to RAS, as this has a lower weight.

We see an RTP connection established for the logon to TSO in RAS **2** followed by the inactivation of the RTP **3** and a new RTP connection **4**. This appears to be an anomaly in VTAM.

The TSO session is now established over the RTP connection to RAS. If additional users now log on they will use this RTP as long as they use the same APPN COS.

The RTP connection error recovery and failure messages **5** can occur during a normal closure of an RTP and should not be considered as an error indication.

Note also that this end of the RTP is the passive partner. The other end is the active partner and is responsible for RTP connection setup.

```
V NET,ACT,ID=RAALCAS
IST097I VARY ACCEPTED
IST093I RAALCAS ACTIVE
IST1086I APPN CONNECTION FOR USIBMRA.RAS IS ACTIVE - TGN = 21  1
IST093I RAAPUAS ACTIVE
log 'Now we logon to TSO in RAS from RAAT420'
IST1488I  ACTIVATION   FOR RTP CNR00001 AS PASSIVE PARTNER COMPLETED  2
IST1488I  INACTIVATION FOR RTP CNR00001 AS PASSIVE PARTNER COMPLETED  3
IST619I  ID = CNR00001 FAILED - RECOVERY IN PROGRESS
IST129I  UNRECOVERABLE OR FORCED ERROR ON NODE CNR00001 - VARY INACT
SCHED
IST1488I  ACTIVATION   FOR RTP CNR00002 AS PASSIVE PARTNER COMPLETED  4
IST619I  ID = CNR00001 FAILED - RECOVERY IN PROGRESS                  5
```

Figure 19. Route Activation RAA to RAS and TSO Logon

Displaying the TSO cross domain resource RASAT01 (Figure 20 on page 44) we can see that it is now flowing over an RTP connection **1**. This RTP connection is always shown as an adjacent link station in VTAM displays.

```
D NET,ID=RASAT01,E
IST097I DISPLAY ACCEPTED
IST075I NAME = USIBMRA.RASAT01, TYPE = CDRSC 471
IST486I STATUS= ACT/S----Y, DESIRED STATE= ACTIV
IST1447I REGISTRATION TYPE = NO
IST977I MDLTAB=***NA*** ASLTAB=***NA***
IST1333I ADJLIST = ***NA***
IST861I MODETAB=***NA*** USSTAB=***NA*** LOGTAB=***NA***
IST934I DLOGMOD=***NA*** USS LANGTAB=***NA***
IST597I CAPABILITY-PLU ENABLED  ,SLU ENABLED  ,SESSION LIMIT NONE
IST231I CDRSC MAJOR NODE = ISTCDRDY
IST479I CDRM NAME = RAA, VERIFY OWNER = NO
IST1184I CPNAME = USIBMRA.RAS - NETSRVR = ***NA***
IST1044I ALSLIST = ISTAPNPU
IST082I DEVTYPE = INDEPENDENT LU / CDRSC
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST171I ACTIVE SESSIONS = 0000000001, SESSION REQUESTS = 0000000000
IST206I SESSIONS:
IST1081I ADJACENT LINK STATION = CNR00002     1
IST634I NAME     STATUS         SID          SEND RECV VR TP NETID
IST635I RAAT420  ACTIV-S    F627D164C62813E9 0008 0002  0  0 USIBMRA
IST924I -------------------------------------------------------------
IST075I NAME = USIBMRA.RASAT01, TYPE = DIRECTORY ENTRY
IST1186I DIRECTORY ENTRY = DYNAMIC LU
IST1184I CPNAME = USIBMRA.RAS - NETSRVR = USIBMRA.RAB
IST314I END
```

Figure 20. Display of TSO Session to RAS Direct

If we now display this connection (Figure 21) we can see the details of this RTP connection. The connection is to RAS **1** and uses the Network Connection Endpoint (NCE) X′F1′.

Note that the VTAM implementation of HPR has only one NCE for all resources within a VTAM. This RTP connection is for COS #CONNECT **2** with one LU using it **3**.

```
D NET,ID=CNR00002,E
IST097I DISPLAY ACCEPTED
IST075I NAME = CNR00002, TYPE = PU_T2.1 477
IST486I STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I CP NAME = RAS, CP NETID = USIBMRA, DYNAMIC LU = YES
IST933I LOGMODE=***NA***, COS=#CONNECT            2
IST1476I TCID X′000000020000008B′ - REMOTE TCID X′000000020000006C′
IST1481I DESTINATION CP USIBMRA.RAS - NCE X′F1′    1
IST1477I DATA FLOW RATE = 2800 KBPS - INITIAL RATE = 3200 KBPS
IST1511I MAXIMUM NETWORK LAYER PACKET SIZE = 4063 BYTES
IST1478I NUMBER OF UNACKNOWLEDGED BUFFERS = 0
IST1479I RTP CONNECTION STATE = CONNECTED
IST1480I RTP END TO END ROUTE
IST1460I TGN  CPNAME             TG TYPE      HPR
IST1461I  21  USIBMRA.RAS        APPN         RTP
IST231I RTP MAJOR NODE = ISTRTPMN
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST355I LOGICAL UNITS:
IST080I RASAT01  ACT/S----Y    3
IST314I END
```

Figure 21. Display of RTP Connection to RAS for #CONNECT COS

Displaying the adjacent link station from RAA to RAS we can see in Figure 22 on page 45 that it is using HPR functions **1**. This time we can see that as both ends are RTP capable we get CONNECTION=YES and there are no sessions through it **2** as these are now shown on the RTP connection.

```
D NET,ID=RAAPUAS,E
IST097I DISPLAY ACCEPTED
IST075I NAME = RAAPUAS, TYPE = PU_T2.1 481
IST486I STATUS= ACTIV, DESIRED STATE= ACTIV
IST1043I CP NAME = RAS, CP NETID = USIBMRA, DYNAMIC LU = YES
IST1105I RESOURCE STATUS TGN CP-CP TG CHARACTERISTICS
IST1106I RAAPUAS  AC/R    21 YES   988D0000000000000000017100808080
IST1482I HPR = YES - OVERRIDE = N/A - CONNECTION = YES 1
IST1510I LLERP = REQUIRED - RECEIVED = REQUIRED
IST136I LOCAL SNA MAJOR NODE = RAALCAS
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST1314I TRLE = RAAMPCS   STATUS = ACTIV       CONTROL = MPC
IST172I NO LOGICAL UNITS EXIST     2
IST314I END
```

Figure 22. RAA to RAS Adjacent Link Station

The ADJCP display for RAS from RAA (Figure 23) shows the RTP connection for the TSO session currently in use.

The RTP count **1** shows the number of active RTPs currently to that adjacent CP.

```
D NET,ID=RAS,ADJCP,E
IST097I DISPLAY ACCEPTED
IST350I DISPLAY TYPE = ADJACENT CONTROL POINT 487
IST486I STATUS= ACTIV, DESIRED STATE= ACTIV
IST1197I ADJCP MAJOR NODE = ISTADJCP
IST1101I ADJCP DISPLAY SUMMARY FOR USIBMRA.RAS
IST1102I NODENAME          NODETYPE CONNECTIONS CP CONNECTIONS NATIVE
IST1103I USIBMRA.RAS        EN        1           1            *NA*
IST1104I CONNECTION SUMMARY FOR USIBMRA.RAS
IST1105I RESOURCE STATUS TGN CP-CP TG CHARACTERISTICS
IST1106I RAAPUAS  AC/R    21 YES   988D0000000000000000017100808080
IST1500I STATE TRACE = OFF
IST1493I RTP SUMMARY FOR USIBMRA.RAS COUNT = 1   1
IST1486I   RTP NAME   STATE             DESTINATION CP
IST1487I   CNR00002   CONNECTED         USIBMRA.RAS
IST314I END
```

Figure 23. Display of RAS Adjacent CP Entry in RAA

As a final test we issue a **D NET,APING,ID=RAS** which will set up a session to RAS and pass test data from RAA to RAS. Figure 24 on page 46 shows the APING display and the test results. Notice that the APING test uses #INTER COS **1** and so we see a new RTP connection established for this **2**.

The RTP connection uses an APPN link, TG 21, which is an RTP connection to the adjacent CP RAA **3**.

Note also that as the APING test drops its session the RTP connection closes **4** as it is the only remaining session on that RTP connection.

```
D NET,ID=RAS,APING
IST097I DISPLAY ACCEPTED
IST1488I  ACTIVATION   FOR RTP CNR00005 AS ACTIVE  PARTNER COMPLETED  2
IST1489I APING SESSION INFORMATION 509
IST1490I DLU=USIBMRA.RAS SID=F7FF6164B3F8EF96
IST933I LOGMODE=#INTER  , COS=*BLANK*
IST875I APPNCOS TOWARDS SLU = #INTER      1
IST1460I TGN  CPNAME             TG TYPE      HPR
IST1461I  21  USIBMRA.RAS        APPN         RTP  3
IST314I END
IST1457I VTAM APING VERSION 2R33 (PARTNER TP VERSION 2R33) 510
IST1490I DLU=USIBMRA.RAS SID=F7FF6164B3F8EF96
IST1462I ECHO IS ON
IST1463I ALLOCATION DURATION: 279 MILLISECONDS
IST1464I PROGRAM STARTUP AND VERSION EXCHANGE: 194 MILLISECONDS
IST1465I         DURATION      DATA SENT   DATA RATE   DATA RATE
IST1466I      (MILLISECONDS)    (BYTES)  (KBYTE/SEC)  (MBIT/SEC)
IST1467I              40           200          5           0
IST1467I              38           200          5           0
IST1468I TOTALS:      78           400          5           0
IST1469I DURATION STATISTICS:
IST1470I MINIMUM = 38 AVERAGE = 39 MAXIMUM = 40
IST314I END
IST1488I  INACTIVATION FOR RTP CNR00005 AS ACTIVE  PARTNER COMPLETED  4
```

Figure 24. Display APING to RAS from RAA

4.5 Hints and Tips

As can be seen in the testing above, the APING function is extremely valuable not only in proving connectivity to a remote node but also showing the path taken through a complex network.

However, you should be aware that the path taken will be the RTP connection currently active for the COS you specify (default LOGMODE=#INTER), otherwise it will open a new RTP using the best path currently available for that COS. If you are debugging a connectivity problem the path used may be different to the route attempted previously.

One other warning is to note the power of the APING transaction. The CM/2 and VTAM versions both have the options to specify what COS to use, how large a message and how many times. Consider the effect on the network of a token-ring attached user issuing an APING test to a remote system across a backbone for 20,000 iterations of a 32,000 byte message at high priority (#INTER). It would be advisable to consider installing only the APINGD receive transaction on PC user systems or even using password security.

When using ANR, there is a small additional storage requirement in the NCP for ANR code. The ANR code overhead in the sample NCP RA9NCPX is 20 kilobytes. As ANR needs no control blocks for sessions, unlike APPN intermediate session routing, this overhead is compensated by the storage savings even for a relatively small number of sessions using ANR.

Chapter 5. RTP Connection through a CNN

In any network we are likely to have a mixture of subarea and APPN capabilities due to factors such as multilink TG requirements and older-level software and hardware. Within VTAM 4.3 and the corresponding NCP 7.3 we have the capability to implement ANR routing across a subarea network. This provides an easier and staged migration to APPN and HPR networking.

Following on from the simple channel-to-channel RTP connection, we now consider the capabilities of a CNN network. In the previous chapter we demonstrated that VTAM, as an ICN, cannot provide ANR services itself. This is only available through the NCP which must be Version 7 Release 3. With a CNN as an intermediate node, we can establish an RTP connection through the CNN although we have no RTP capability in the CNN itself.

5.1 Benefits

With ANR support through a CNN we can have the benefits of HPR in a network whilst it is still migrating from a subarea basis. We will see later how a remote RTP-capable node such as CM/2 can form an RTP connection through the network to VTAM through a subarea network.

As a network moves towards an APPN base, the storage requirements and loading on the NCP will increase. With ANR routing, although there is some increase in storage, there is a reduction in control block requirements and 3745 load compared to an APPN-only environment.

5.2 Routing through a CNN

In this test scenario we have two VTAM 4.3 systems connected through a CNN network consisting of two NCPs and an ICN configured VTAM, the RAB system seen in the previous chapter. As we are now routing through the NCP rather than the ICN VTAM, we can establish an RTP connection over the network.

The two NCPs are connected by a multimedia link TG which, as a subarea network, uses FID4s to transport the data between the NCPs. In defining the links we have APPN channel connections from the VTAM network nodes to the NCPs with HPR=YES coded for completeness as the default is HPR=YES.

This test is a more common scenario of multiple data hosts accessing a common network which may be in the process of migrating to an HPR environment.

In this test we have a simple connection across a CNN. In a more complex environment with multiple CNNs we would see the benefits of VR-TG across the subarea network.

5.3 Description

Figure 25 shows the configuration used in this test which is similar to the previous one. The two VTAMs referred to as RAA and RAS are defined as pure APPN nodes, both are network nodes. RAB is an ICN and connects to two NCPs, RA9NCPX and RA7NCPX, forming a CNN network.

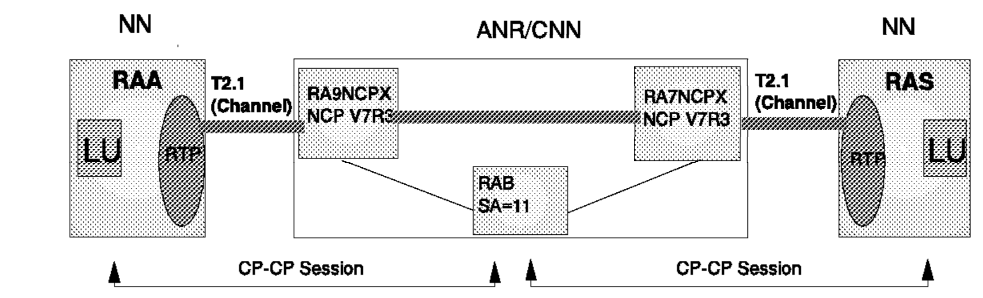


Figure 25. CNN Test Network

In this test we activate the APPN channels from RAA and RAS into RA9NCPX and RA7NCPX respectively. We see the links come active as ANR capable, and CP-CP sessions established to RAB.

We then log onto TSO in RAS from a local 3270 on RAA which gives us a session over an RTP connection and this is seen in the VTAM displays and messages. We can also view the session from NetView although there is limited information available on the path from NetView as it sees the RTP connection as a single link station to the remote system.

5.3.1 Definitions

Despite the increased complexity of the NCPs used in this test, the configuration is relatively simple. We have a SNA major node to define the APPN channel at each HPR-capable VTAM and the same VTAM ICN node shown in Figure 26.

```
**********************************************************************
*                                                                    *
*  APPN CHANNEL LINK FROM RAA TO NCP SA9                             *
*                                                                    *
**********************************************************************
RAACE2B  VBUILD TYPE=LOCAL
RAAPE2B  PU    CUADDR=E2B,PUTYPE=2,XID=YES,MAXBFRU=15,
               HPR=YES   (DEFAULT VALUE)
```

Figure 26. SNA Major Node

The two NCPs are channel attached to RAB and have a multimedia TG between themselves. Although the full definitions for the NCPs and other relevant major nodes in Appendix B, "Test Scenario 2" on page 107, the concept is relatively straightforward. We can consider the two NCPs and ICN VTAM as a single network node or composite network node to give it its correct definition. To RAA and RAS VTAMs, RAB appears as an ANR-capable network node as can be seen in the displays. They have no visibility of the NCPs as individual entities within the node.

5.4 Test Results

For this test we activate the RAA to RAB and RAB to RAS definitions in RAA and RAS. We then log on from a local 3270 screen on RAA (LU name RAAT420) to TSO in RAS (Application RASAT). We now display the RTP major node ISTRTPMN in RAA to see what RTP connections are active. Figure 27 shows two RTP connections have been activated, both of them to RAS **1**.

```
D NET,ID=ISTRTPMN,E
IST097I DISPLAY ACCEPTED
IST075I NAME = ISTRTPMN, TYPE = RTP MAJOR NODE 125
IST486I STATUS= ACTIV, DESIRED STATE= ACTIV
IST1486I   RTP NAME   STATE            DESTINATION CP
IST1487I   CNR00004   CONNECTED        USIBMRA.RAS  1
IST1487I   CNR00001   CONNECTED        USIBMRA.RAS
IST314I END
```

Figure 27. Display of RTP Major Node

Displaying CNR00004, Figure 28 shows that this connection is routed through RAB **1** which is ANR capable and then to RAS **2** which gives an RTP connection.

```
D NET,ID=CNR00004,E
IST097I DISPLAY ACCEPTED
IST075I NAME = CNR00004, TYPE = PU_T2.1 155
IST486I STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I CP NAME = RAS, CP NETID = USIBMRA, DYNAMIC LU = YES
IST933I LOGMODE=***NA***, COS=#CONNECT
IST1476I TCID X'0000000400000099' - REMOTE TCID X'0000000400000078'
IST1481I DESTINATION CP USIBMRA.RAS - NCE X'F1'
IST1477I DATA FLOW RATE = 1000 BPS - INITIAL RATE = 0 BPS
IST1511I MAXIMUM NETWORK LAYER PACKET SIZE = 2014 BYTES
IST1478I NUMBER OF UNACKNOWLEDGED BUFFERS = 0
IST1479I RTP CONNECTION STATE = CONNECTED
IST1480I RTP END TO END ROUTE
IST1460I TGN  CPNAME            TG TYPE      HPR
IST1461I  21  USIBMRA.RAB       APPN         ANR  1
IST1461I  21  USIBMRA.RAS       APPN         RTP  2
IST231I RTP MAJOR NODE = ISTRTPMN
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST355I LOGICAL UNITS:
IST080I RASAT02  ACT/S----Y RASAT01  ACT/S----Y
IST314I END
```

Figure 28. RTP Connection CNR00004 from RAA to RAS

If we now look at NetView on RAA we can see the session route in Figure 29 on page 50 as seen by NetView. Note that although we can see the session information such as Transmission Priority **1** and APPN COS **2**, we can only see the RTP connection as a PU connected to an ILU **3**.

```
NLDM.CON                  SESSION CONFIGURATION DATA                PAGE    1
-------------- PRIMARY ----------------+-------------- SECONDARY -------
NAME RASAT02   SA 00000001  EL 00A4    |   NAME RAAT420   SA 00000001  EL 006A
---------------------------------------+--------------------------------
DOMAIN RAAAN  C-C  PCID USIBMRA.RAS.F627D164C6C95D8C             DOMAIN RAAAN
               +-------------+                 +-------------+
*RAAT420       |   CP/SSCP   | ---         --- |             |
               | LOCAL DATA  |  APPN TP 01 [1] | SUBAREA PU  | ISTPUSA0(0000)
               +------+------+                 +------+------+
                      |                               |
               +------+------+                 +------+------+
CNR00004(00A3) |     PU      |                 |     CUA     | 0420
   [3]         +------+------+                 +------+------+
                      |       APPNCOS #CONNECT [2]    |
               +------+------+ SUBACOS N/A     +------+------+
RASAT02 (00A4) |     ILU     | LOGMODE M2BSCQ  |     LU      | RAAT420  (006A)
               +-------------+ PADJ CP RAS     +-------------+
                               SADJ CP N/A




SELECT PT, ST (PRI, SEC TRACE), RT (RESP TIME), P, AR, FC
CMD==>
```

Figure 29. NetView Display of TSO Session Configuration

We can also see the session on the other RTP connection. Figure 30 shows that a LU-LU session from RAA to RAS. Notice that this session is high priority **1**, and has an APPN COS of SNASVCMG **2**, used for session setup. Note also that this was not present in the previous channel to channel RTP connection as in that case there was a CP-CP session available for session setup.

```
NLDM.CON                  SESSION CONFIGURATION DATA                PAGE    1
-------------- PRIMARY ----------------+-------------- SECONDARY --------------
NAME RAS       SA 00000001  EL 009E    |   NAME RAA      SA 00000001  EL 0008
---------------------------------------+---------------------------------------
DOMAIN RAAAN  C-C  PCID USIBMRA.RAS.F627D164C6C95D7E             DOMAIN
              +-------------+                 +-------------+
RAA           |   CP/SSCP   | ---         --- |             |
              | LOCAL DATA  |  APPN TP 03 [1] | SUBAREA PU    | ISTPUSA0(0000)
              +------+------+                 +------+------+
                     |                               |
              +------+------+                 +------+------+
CNR00001(009D) |     PU      |                 |     LU      | RAA      (0008)
              +------+------+                 +-------------+
                     |       APPNCOS SNASVCMG [2]
              +------+------+ SUBACOS N/A
RAS     (009E) |     ILU     | LOGMODE SNASVCMG
              +-------------+ PADJ CP RAS
                              SADJ CP N/A




SELECT PT, ST (PRI, SEC TRACE), RT (RESP TIME), P, AR, FC
CMD==>
```

Figure 30. NetView Display of RAA-RAS Session

Finally we can also see the route from RAA to RAS, Figure 31 on page 51, used by this session as we can access the route setup details for the RTP. We can do the same APPN Route (AR) display for the TSO session which uses the same path but over a different RTP.

This display demonstrates the limitations in determining routes within the subarea network. To view the subarea network, you need to display the subarea network from the CNN VTAM. Even then, you can only see the network and not the route the RTP connection takes.

```
 NLDM.AR              APPN SESSION ROUTE CONFIGURATION               PAGE   1
 -- PRIMARY ---+-- SECONDARY --+--------------- PCID ---------------+- DOMAIN -
 NAME RAS      | NAME RAA      | USIBMRA.RAS.F627D164C6C95D7E       | RAAAN
 --------------+---------------+------------------------------------+----------

  +---------+
  |   CP    |
  |RAS      |
  +----+----+
 TG021 |
  +----+----+
  |   CP    |
  |RAB      |
  +----+----+
 TG021 |
  +----+----+
  |   CP    |
  |RAA      |
  +---------+


END OF DATA
SELECT PAR, SAR
CMD==>
```

Figure 31. NetView Display of RAA-RAS Session Route

5.5 Hints and Tips

As can be seen from the test results, NetView is a valuable tool in viewing the network from both APPN and subarea standpoints. Its capability to link to other NetViews simplifies the task of viewing the different parts of the network from a single point.

ARB data rate control can play an important role in network performance. In APPN networks the capacity of a link is used to calculate the route, so in simple networks where only single routes exist using the default values will not cause problems. For HPR networks these values will cause the initial data rate to be very low, restricting data flow.

During testing the defaults caused severe performance problems. For example, an APING of 100 messages of 8,000 bytes gave a data rate of 1 Kbps for the first block and took over 30 seconds to increase to full speed. Adding the CAPACITY keyword (VTAM only) to the NCP channels and specifying the HPRATT and HPRMLC keywords (NCP only) to the NCP definitions corrected the initial data rate problems. Beware also of specifying too small a value for the minimum packet size, HPRMPS, for the CNN subarea network.

These three parameters can be viewed and modified using NtuneMON with the NtuneNCP feature.

The topology display command is very effective in diagnosing configuration and capacity problems. The preceding problem was spotted using the display command D NET,TOPO,ORIG=xxx,TGN=yy to find the capacity details for the network. The second important display for performance information is for the RTP. This will show the initial rate and actual rate at the time of the display. This is the only way to see the ARB data flow rate.

Chapter 6. Non-Disruptive RTP Connection Recovery

One of the major benefits of HPR is the ability to switch paths without disrupting sessions using that connection. This has often been used as an argument for connectionless networks. With the implementation of HPR in VTAM, we have the ability to bypass a failing link or node in a network without losing sessions and then having to reestablish them.

In the event of a failure in the path taken by an RTP connection, a new route, if available, will be calculated and the RTP connection switched to that path without loss of the session and recovery of any data which may have been lost or discarded on the route.

This test scenario is designed to demonstrate this function and the information available to you on the RTP connections.

6.1 Benefits

The capability to switch routes non-disruptively is vital in high availability networks. With HPR, this switching facility can be extended as far as the end node in a network.

6.2 RTP Path Switching

In this test scenario we have the same configuration as in the previous test with the addition of an AHHC connection between RAA and RAS providing a second RTP-capable route between RAA and RAS. The normal APPN routing algorithms will use the AHHC connection for the initial RTP connection over the network as this has the lowest weight.

In the event of the first route failing, the second route from RAA to RAS through the CNN is RTP-capable and so RAA will establish a new path to RAS. As HPRs RTP Transport option provides for non-disruptive path switching we will see the RTP connections switched from the AHHC to the CNN route when the AHHC fails. We can reestablish this route later after recovering the AHHC connection

6.3 Description

Figure 32 on page 54 shows the configuration used in this test. This is identical to the configuration in the second scenario shown in Figure 25 on page 48 with the addition of an AHHC channel connection between RAA and RAS. This AHHC will have the lowest weight and so will be the preferred route for the RTP from RAA to RAS.

We also have another route whose physical path is:

RAA - RA9NCPX - RA7NCPX - RAS

This has a higher weight but is also RTP capable.

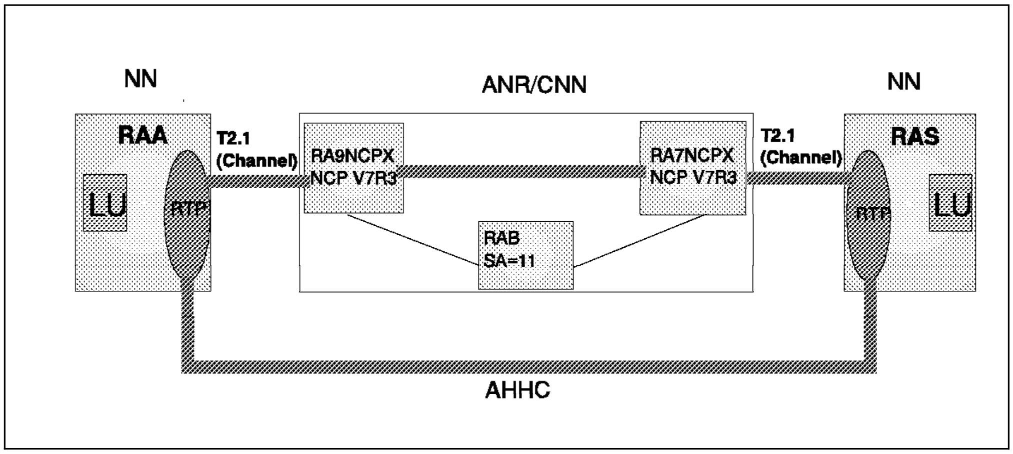


Figure 32. RTP Path Switching Network

For the first part of this test we activate the AHHC links between RAA and RAS and the APPN channels from RAA and RAS into RA9NCPX and RA7NCPX respectively as part of the startup of RAA and RAS. We see the links come active and CP-CP sessions established to RAB as ANR capable. Also activated are the APPN channel links to the NCPs which will form our backup path.

We then log onto TSO in RAS from a local 3270 on RAA which gives us a session over an RTP connection and this is seen in the VTAM displays and messages. This can be seen to flow over the AHHC channel connection.

Following this we inactivate the AHHC links. We see a path switch for the RTP connections and can display the new route through the CNN. When we test the TSO session it is still active.

We then reactivate the AHHC connection but note that the RTP connection will continue through the CNN until we issue a MODIFY to force a path switch which will find the AHHC as a better path and switch the RTP connection back to the AHHC route.

6.3.1 Definitions

The definitions for the network are found in Chapter 4, "APPN Host-to-Host Connection" on page 39 with the addition of the AHHC channel and TRLE definitions from Chapter 5, "RTP Connection through a CNN" on page 47. See also Appendix A, "Test Scenario 1" on page 99 and Appendix B, "Test Scenario 2" on page 107 for full definitions.

6.4 Test Results

The initial configuration activates both the AHHC from RAA to RAS and the APPN channel links to the CNN node as part of the VTAM startup members for RAA and RAS. We then log on from a local 3270 screen on RAA (LU name RAAT420) to TSO in RAS as we did in the previous test. We now display the RTP major node ISTRTPMN in RAA to see what RTP connections are active. Figure 33 on page 55 shows two RTP connections have been activated, both of them to RAS **1**. One is for COS SNASVCMG and the other #CONNECT for the TSO session.

```
D NET,ID=ISTRTPMN,E
IST097I DISPLAY ACCEPTED
IST075I NAME = ISTRTPMN, TYPE = RTP MAJOR NODE 125
IST486I STATUS= ACTIV, DESIRED STATE= ACTIV
IST1486I   RTP NAME   STATE            DESTINATION CP
IST1487I   CNR00004   CONNECTED        USIBMRA.RAS  1
IST1487I   CNR00001   CONNECTED        USIBMRA.RAS
IST314I END
```

Figure 33. Display of RTP Major Node

We can display the TSO session as we did in the first scenario and from that we find that we find that the RTP connection is CNR00004.

Displaying CNR00004 (Figure 34) shows that this connection is routed through the AHHC connection to RAS **1** using an RTP connection.

```
D NET,ID=CNR00004,E
IST097I DISPLAY ACCEPTED
IST075I NAME = CNR00004, TYPE = PU_T2.1 133
IST486I STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I CP NAME = RAS, CP NETID = USIBMRA, DYNAMIC LU = YES
IST933I LOGMODE=***NA***, COS=#CONNECT
IST1476I TCID X'0000000400000099' - REMOTE TCID X'0000000400000078'
IST1481I DESTINATION CP USIBMRA.RAS - NCE X'F1'
IST1477I DATA FLOW RATE = 3200 KBPS - INITIAL RATE = 3200 KBPS
IST1511I MAXIMUM NETWORK LAYER PACKET SIZE = 4063 BYTES
IST1478I NUMBER OF UNACKNOWLEDGED BUFFERS = 0
IST1479I RTP CONNECTION STATE = CONNECTED
IST1480I RTP END TO END ROUTE
IST1460I TGN  CPNAME            TG TYPE      HPR
IST1461I  21  USIBMRA.RAS       APPN         RTP  1
IST231I RTP MAJOR NODE = ISTRTPMN
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST355I LOGICAL UNITS:
IST080I RASAT02  ACT/S----Y RASAT01  ACT/S----Y
IST314I END
```

Figure 34. RTP Connection CNR00004 from RAA to RAS

We now inactivate the AHHC channel in RAA to kill the path to RAS (Figure 35 on page 56). Following the loss of the channel RAS is no longer adjacent to RAA so we lose the CP CP session from RAS to RAA **1**. This session does not recover.

However, with the RTP connections we see RAA attempting to reroute the RTP connections **2**.

```
V NET,INACT,I,ID=RAAPUAS
IST097I VARY ACCEPTED
IST1196I APPN CONNECTION FOR USIBMRA.RAS INACTIVE - TGN = 21
IST1097I CP-CP SESSION WITH USIBMRA.RAS TERMINATED 140  1
IST1280I SESSION TYPE = CONWINNER - SENSE = 08420001
IST314I END
IST1110I ACTIVATION OF CP-CP SESSION WITH USIBMRA.RAS FAILED 141
IST1280I SESSION TYPE = CONWINNER - SENSE = 08420001
IST314I END
IST1097I  CP-CP SESSION WITH USIBMRA.RAS       TERMINATED
IST105I RAAPUAS NODE NOW INACTIVE
IST1280I  SESSION TYPE = CONLOSER  - SENSE = 08420001
IST314I  END
IST1494I  PATH SWITCH STARTED   FOR RTP CNR00004  2
IST1494I  PATH SWITCH STARTED   FOR RTP CNR00001
```

Figure 35. Inactivating the AHHC Channel

If we now display the RTP connection used for our TSO session we see in Figure 36 that the session has successfully rerouted through CNN node RAB. The display shows that the link to the CNN is an ANR-only link **1** as the CNN can only perform ANR routing, but RAS is RTP-capable **2** so the RTP connection has been switched to this route.

On the TSO screen we are still working successfully.

```
D NET,ID=CNR00004,E
IST097I DISPLAY ACCEPTED
IST075I NAME = CNR00004, TYPE = PU_T2.1 155
IST486I STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I CP NAME = RAS, CP NETID = USIBMRA, DYNAMIC LU = YES
IST933I LOGMODE=***NA***, COS=#CONNECT
IST1476I TCID X'0000000400000099' - REMOTE TCID X'0000000400000078'
IST1481I DESTINATION CP USIBMRA.RAS - NCE X'F1'
IST1477I DATA FLOW RATE = 1000 BPS - INITIAL RATE = 0 BPS
IST1511I MAXIMUM NETWORK LAYER PACKET SIZE = 2014 BYTES
IST1478I NUMBER OF UNACKNOWLEDGED BUFFERS = 0
IST1479I RTP CONNECTION STATE = CONNECTED
IST1480I RTP END TO END ROUTE
IST1460I TGN  CPNAME            TG TYPE      HPR  .
IST1461I  21  USIBMRA.RAB       APPN         ANR   1
IST1461I  21  USIBMRA.RAS       APPN         RTP   2
IST231I RTP MAJOR NODE = ISTRTPMN
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST355I LOGICAL UNITS:
IST080I RASAT02  ACT/S----Y RASAT01  ACT/S----Y
IST314I END
```

Figure 36. Display of RTP Connection Following Path Switch

Now we can reactivate the AHHC connection and see our CP-CP session becomes active **1** in Figure 37 on page 57.

Having recovered the best route, we are still not using it as we must force VTAM to check for a better route for the RTP connection. This is done using a MODIFY command for a specific RTP connection **2**. If you wish to move all connections then you have to issue a MODIFY for each RTP.

Following the completion of the MODIFY we see that the RTP connection **3** has now been rerouted back to the AHHC link.

Note the rather odd order of the messages on path switching **4** and **5** in Figure 37.

```
V NET,ACT,ID=RAAPUAS
IST097I VARY ACCEPTED
IST1086I APPN CONNECTION FOR USIBMRA.RAS IS ACTIVE - TGN = 21
IST093I RAAPUAS ACTIVE
IST1096I CP-CP SESSIONS WITH USIBMRA.RAS ACTIVATED  1
LOG 'now get path switched back to direct route'
F NETA0,RTP,ID=CNR00004  2
IST097I MODIFY ACCEPTED
IST1494I PATH SWITCH COMPLETED FOR RTP CNR00004 169  4
IST1480I RTP END TO END ROUTE
IST1460I TGN  CPNAME             TG TYPE      HPR
IST1461I  21  USIBMRA.RAS        APPN         RTP  3
IST314I END
IST1494I  PATH SWITCH STARTED   FOR RTP CNR00004  5
```

Figure 37. Reactivate of AHHC and Forced Path Switch

Finally the display in Figure 38 of the RTP connection confirms the switch back to the AHHC connection and the TSO sessions are still active.

```
D NET,ID=CNR00004,E
IST097I DISPLAY ACCEPTED
IST075I NAME = CNR00004, TYPE = PU_T2.1 174
IST486I STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I CP NAME = RAS, CP NETID = USIBMRA, DYNAMIC LU = YES
IST933I LOGMODE=***NA***, COS=#CONNECT
IST1476I TCID X'0000000400000099' - REMOTE TCID X'0000000400000078'
IST1481I DESTINATION CP USIBMRA.RAS - NCE X'F1'
IST1477I DATA FLOW RATE = 3200 KBPS - INITIAL RATE = 3200 KBPS
IST1511I MAXIMUM NETWORK LAYER PACKET SIZE = 4063 BYTES
IST1478I NUMBER OF UNACKNOWLEDGED BUFFERS = 0
IST1479I RTP CONNECTION STATE = CONNECTED
IST1480I RTP END TO END ROUTE
IST1460I TGN  CPNAME             TG TYPE      HPR
IST1461I  21  USIBMRA.RAS        APPN         RTP   1
IST231I RTP MAJOR NODE = ISTRTPMN
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST355I LOGICAL UNITS:
IST080I RASAT02  ACT/S----Y RASAT01  ACT/S----Y
IST314I END
```

Figure 38. Display of RTP Connection Back on Original Path

The TSO session was still working following completion of the test and continued to do so despite a number of further path switches during further tests.

One other point noted during testing, but not shown here, is that there can be more than one RTP connection between two endpoints for the same class of service. In setting up a session the lowest weight route is found and then any suitable RTPs matching all or part of that route are used. In later testing a new TSO session was started after we had reactivated the AHHC from RAA to RAS and before switching the path back (as seen in Figure 37). In this case we established a new RTP connection from RAA to RAS and on forcing a path switch for the RTP through RAB we ended up with two RTPs both with COS #CONNECT from RAA to RAS.

6.5 Hints and Tips

Network design may be more critical with RTP-capable networks. Remember that once established, an RTP will remain in effect until the last session has closed. If a failure occurs in the network, a path switch will move all RTPs crossing the failing link to new routes, if available. APPN′s capability to find alternate routes may lead to paths which are not desirable.

One example experienced during testing was the routing of an APPN session from one VTAM to another through a PS/2 configured as an NN with links into each VTAM. If the CM/2 had been HPR-capable at that time then all RTPs over the original routes between the two VTAMs would have been switched through the PS/2.

Another example could be a CMC VTAM such as RAB being used as a route through the subarea. For our testing RAB had no paths from RA9NCPX through RAB to RA7NCPX. If there had been this would be used instead of the multilink TG.

As mentioned earlier, a route is first calculated and then mapped to RTPs which match all or part of that route. With changes in the network configuration or where parallel links of equal weight occur in the network you are most likely to get multiple RTPs with the same COS and endpoints. You should be aware of this when looking at session routes and testing routes with APING.

Chapter 7. APPN and HPR Interconnectivity

A major consideration of HPR design is its ability to be incorporated into an APPN network without changes to the APPN nodes. This requires sessions to be made up of both APPN and RTP links in the overall end-to-end setup. The HPR nodes must therefore add their new functions without affecting the APPN parts of the network.

When a session is requested between two endpoints, APPN routing services finds the lowest weight path and this is then mapped into a set of APPN and RTP connections to form the overall route.

This scenario not only demonstrates this mixed environment but also demonstrates some of the other capabilities of HPR and some the points to be aware of.

7.1 Benefits

The mixed environment capabilities allow APPN nodes to be migrated to HPR as they become HPR-capable with no disruption to the rest of the network.

HPR can be introduced in a staged manner into the network to provide high availability in critical areas.

7.2 Mixed APPN and HPR Networks

In this scenario we use the same configuration as in the RTP path switching test. Whereas the previous test showed a terminal on RAA connecting to RAS through RAB, an RTP route, we now have a terminal on RAB connection through RAA to RAS. The path RAB to RAA is an APPN connection, as RAB is a CNN, while the RAA-to-RAS AHHC will provide an RTP connection, so the overall path is a mixture of both.

This configuration appears relatively simple but we will see that with ANR capability in the network, routes can change unexpectedly and without NetView session services knowing this.

We also see the network maintaining sessions over odd routes where a pure APPN network would have dropped the session.

7.3 Description

Figure 39 on page 60 shows the configuration for this test. As before we have an AHHC link from RAA to RAS and APPN links into NCPs RA9NCPX and RA7NCPX from RAA and RAS respectively. The NCPs and RAB VTAM form a CNN shown as RAB in the displays.

For the initial part of the test we activate the SNA link from RAA to NCP RA9NCPX giving us RAA to RAB, and the AHHC.

The path we are testing is:

RAB --> (APPN) --> RAA --> (RTP) --> RAS

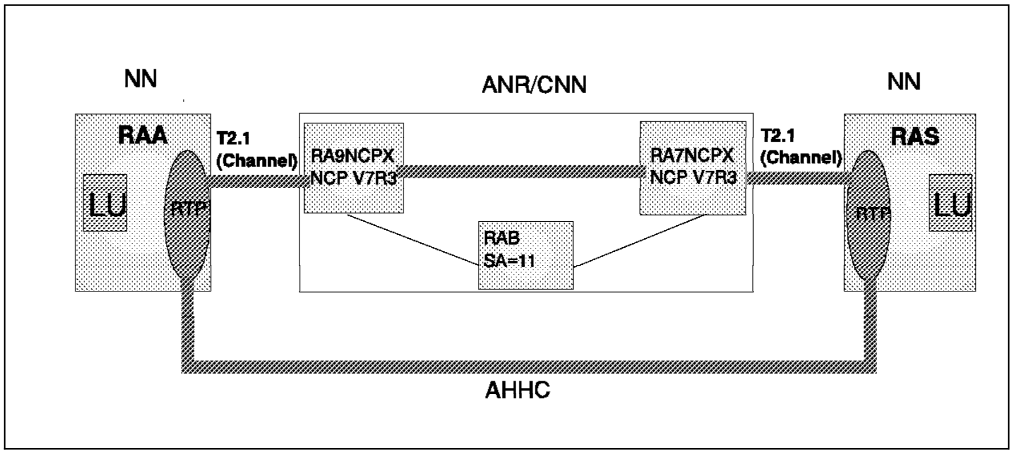


Figure 39. APPN/HPR Mixed Network

From a terminal, RABT421, on RAB we log onto TSO in RAS forming a session which is APPN to RAA and over an RTP connection to RAS. We can see this session from the NetView session displays.

We now activate the APPN channel for RAS to RA7NCPX getting a CP-CP session RAS to RAB. We then inactivate the AHHC from RAA to RAS which in a pure APPN network would result in the loss of the session. In the HPR environment we see what at first appears to be an impossible change. The RTP connection attempts to reroute as its path has failed and in this case it can see an alternate route RAA-RAB-RAS as we have seen before.

At first sight this appears impossible as the overall route for the session, which is still working, is RAB-RAA-RAB-RAS. When we consider this more carefully we see that the first part RAA-RAB is an APPN link which is still intact. The route from RAA to RAB is not APPN but ANR routing hence RAB knows nothing of the sessions over it and knows only of RAA and RAS sending NLPs through it. So we see that this is a valid configuration.

This test demonstrates three important points. First, RTP has kept a session up despite a link failure. Secondly, we are using a single link for both ANR and APPN traffic showing the capability to share traffic. Thirdly, we will see that while we have session information in NetView on APPN and RTP connections, the switching capability makes this information out of date as it is not updated when paths switch.

7.3.1 Definitions

The definitions for the network are identical to those used in Chapter 6, “Non-Disruptive RTP Connection Recovery” on page 53. The main difference is the use of RAB as an APPN node rather than as an ANR intermediate node.

7.4 Test Results

For the first part of the test we have the AHHC from RAA to RAS and the local SNA channel from RAA to RA9NCPX active. We therefore have CP-CP sessions RAA-RAS and RAA-RAB active. From a 3270 terminal RABT421 on RAB, we log onto TSO in RAS. We can now see the session seen by NetView in Figure 40 on page 61.

```
NLDM.SESS                                                                 PAGE    1
                                 SESSION LIST
NAME: RABT421                                                         DOMAIN: RASAN
-------------------------------------------------------------------------------
      ***** PRIMARY *****  **** SECONDARY ****
 SEL#   NAME   TYPE  DOM     NAME   TYPE  DOM     START TIME       END TIME
 ( 1) RASAT01  LU   RASAN  RABT421  ILU   C-C   05/10 13:29:31  *** ACTIVE ***
 ( 2) RASAT02  LU   RASAN  RABT421  ILU   C-C   05/10 11:33:04  05/10 13:19:48















END OF DATA
ENTER SEL# (CONFIG), SEL# AND CT (CONN. TEST), SEL# AND STR (TERM REASON)
CMD==> 1
```

Figure 40. RABT421 Screen Session to RAS TSO

We can see in Figure 41 that the session as seen in RAS is from RAS to RAA to RAB, an ILU (or CDRSC). It is confusing in that it shows the RTP connection as apparently from RAA to RAB **1**.

```
NLDM.CON                  SESSION CONFIGURATION DATA                      PAGE    1
-------------- PRIMARY ---------------+-------------- SECONDARY --------------
NAME RASAT01   SA 00000001  EL 000A   |   NAME RABT421   SA 00000001  EL 0083
--------------------------------------+---------------------------------------
DOMAIN RASAN       PCID USIBMRA.RAS.F627D164C7EEAA89        C-C DOMAIN RASAN
               +-------------+                 +-------------+
RAS            |   CP/SSCP   | ---         ---  |   CP/SSCP   |  RAA
ISTPUS28(0000) | SUBAREA PU  |  APPN TP 01      | LOCAL DATA  |
               +------+------+                 +------+------+
                      |                               |
               +------+------+                 +------+------+
RASAT01 (000A) |     LU      |                 |     PU      | CNR00015(0086)
               +-------------+                 +------+------+     1
                              APPNCOS #CONNECT        |
                              SUBACOS N/A      +------+------+
                              LOGMODE M2BSCNQ  |     ILU     | RABT421 (0083)
                              PADJ CP N/A      +-------------+
                              SADJ CP RAA





SELECT PT, ST (PRI, SEC TRACE), RT (RESP TIME), P, AR, FC
CMD==> AR
```

Figure 41. Session Detail of RABT421 to RAS TSO

Displaying the session APPN route configuration, we see in Figure 42 on page 62 that the route is RAS-RAA-RAB. This information is gathered from the

RSCV produced. Note that there is no RTP information in the RSCV so we cannot see the RTP other than as a PU on the previous display.

```
NLDM.AR              APPN SESSION ROUTE CONFIGURATION               PAGE   1
-- PRIMARY ---+-- SECONDARY --+--------------- PCID ---------------+- DOMAIN -
NAME RASAT01  | NAME RABT421  | USIBMRA.RAS.F627D164C7EEAA89       | RASAN
--------------+---------------+------------------------------------+----------

 +---------+
 |   CP    |
 |RAS      |
 +----+----+
TG021 |
 +----+----+
 |   CP    |
 |RAA      |
 +----+----+
TG021 |
 +----+----+
 |   CP    |
 |RAB      |
 +---------+


END OF DATA
SELECT PAR, SAR
CMD==>
```

Figure 42. APPN Route Information

If we go to RAA we can see more clearly on the NetView session display (Figure 43) that the session is over an RTP connection from RAA to RASAT01 LU. Note that the RTP connection has a different PU name **1** at this end from the name at the RAS end which was CNR00015.

```
NLDM.CON                  SESSION CONFIGURATION DATA                  PAGE    1
-------------- PRIMARY ---------------+-------------- SECONDARY --------------
NAME RASAT01   SA 00000001  EL 00B3   |   NAME RABT421   SA 00000001  EL 00B4
--------------------------------------+---------------------------------------
DOMAIN RAAAN  C-C  PCID USIBMRA.RAS.F627D164C7EEAA89         C-C DOMAIN RAAAN
               +-------------+                  +-------------+
-RABT421       |   CP/SSCP   | ---          --- |   CP/SSCP   | RAA
               | LOCAL DATA  |  APPN TP 01      | SUBAREA PU  | ISTPUSA0(0000)
               +------+------+                  +------+------+
                      |                                |
               +------+------+                  +------+------+
CNR00019(00B7) |     PU      |                  |     CUA     | 0E2B
    1          +------+------+                  +------+------+
                      |       APPNCOS #CONNECT         |
               +------+------+ SUBACOS N/A      +------+------+
RASAT01 (00B3) |     ILU     | LOGMODE M2BSCNQ  |     PU      | RAAPE2B (0067)
               +-------------+ PADJ CP RAS      +------+------+
                               SADJ CP RAB             |
                                                +------+------+
                                                |     ILU     | RABT421 (00B4)
                                                +-------------+

SELECT PT, ST (PRI, SEC TRACE), RT (RESP TIME), P, AR, FC
CMD==> AR
```

Figure 43. Session Display from RAA NetView

We display the path and see the same configuration as from RAS NetView (Figure 44 on page 63).

Again we have no visibility of the RTP connection other than its name. For detailed information on the RTP we have to issue a VTAM display of the RTP.

```
 NLDM.AR               APPN SESSION ROUTE CONFIGURATION                PAGE   1
 -- PRIMARY ---+-- SECONDARY --+--------------- PCID ---------------+- DOMAIN -
 NAME RASAT01  | NAME RABT421  | USIBMRA.RAS.F627D164C7EEAA89       | RAAAN
 --------------+---------------+------------------------------------+----------

  +---------+
  |   CP    |
  |RAS      |
  +----+----+
 TG021 |
  +----+----+
  |   CP    |
  |RAA      |
  +----+----+
 TG021 |
  +----+----+
  | CP(ICN) |
  |RAB      |
  +---------+


END OF DATA
SELECT PAR, SAR
CMD==>
```

Figure 44. Route Display

Our next step is to activate the path from RAB to RAS and then deactivate the AHHC from RAA to RAS. We see the NetView display for this in Figure 45 and the CP-CP session to RAB becoming active and the RAS session inactive.

We now have links from RAA to RAB and RAB to RAS. In the system log we would see a path switch for the RTP from RAA to RAS, CNR00019.

```
* RASAN    ACT RASCRA7
C RASAN    VARY NET,ACT,ID=RASCRA7
  RASAN    IST097I  VARY     ACCEPTED
  RASAN    IST093I  RASCRA7  ACTIVE
  RASAN    IST1086I  APPN CONNECTION FOR USIBMRA.RAB       IS ACTIVE - TGN =
           21
  RASAN    IST093I  RASP925  ACTIVE

* RASAN    INACT RASLCAA
C RASAN    VARY NET,INACT,ID=RASLCAA,I
  RASAN    IST097I  VARY     ACCEPTED
  RASAN    IST1196I  APPN CONNECTION FOR USIBMRA.RAA       INACTIVE - TGN =  21
  RASAN    IST105I  RASPUSA  NODE NOW INACTIVE
  RASAN    IST105I  RASLCAA  NODE NOW INACTIVE
```

Figure 45. AHHC Dropped and RAB Linked

At this point in an APPN-only scenario the TSO session would be lost, but we can still enter TSO commands so it is still working. We display the RTP connection in Figure 46 on page 64 and see that the RTP connection has switched paths so that it now runs from RAA to RAB and on to RAS. This means we have FID2 frames on the link from RAB to RAA and then they are converted to NLPs by the boundary function in RAA and sent over the RTP connection to RAS, through RAB, using ANR routing. Although we are passing through node RAB twice we are only using APPN flows once so we do not violate any architectural rules.

Our path is now RAB --> (APPN) --> RAA --> (ANR) --> RAB --> (ANR) --> RAS

The RTP PU names are dynamically defined and use the address from the TCID for their name at each end of the connection.

```
NCCF                      N E T V I E W    RAAAN TTHOMAS  05/10/95 13:56:39
* RAAAN    D NET,ID=CNR00019
  RAAAN    IST097I  DISPLAY  ACCEPTED
' RAAAN
IST075I  NAME = CNR00019         , TYPE = PU_T2.1
IST486I  STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I  CP NAME = RAS     , CP NETID = USIBMRA , DYNAMIC LU = YES
IST933I  LOGMODE=***NA***, COS=#CONNECT
IST1476I  TCID X'00000019000000B7' - REMOTE TCID X'0000001500000086'
IST1481I  DESTINATION CP USIBMRA.RAS       - NCE X'F1              '
IST1477I  ALLOWED DATA FLOW RATE =   1000  BITS/SEC
IST1516I  INITIAL DATA FLOW RATE =   1000  BITS/SEC
IST1511I  MAXIMUM NETWORK LAYER PACKET SIZE =   1970 BYTES
IST1478I  NUMBER OF UNACKNOWLEDGED BUFFERS =     0
IST1479I  RTP CONNECTION STATE = CONNECTED
IST1480I  RTP END TO END ROUTE
IST1460I  TGN  CPNAME            TG TYPE      HPR
IST1461I   21  USIBMRA.RAB       APPN         ANR
IST1461I   21  USIBMRA.RAS       APPN         RTP
IST231I  RTP      MAJOR NODE = ISTRTPMN
IST654I  I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I  STATE TRACE = OFF
??? ***
```

Figure 46. Path Switched via RAB

Finally we look to NetView to see if we can see the new path (Figure 47 on page 65). This display gives no indication so we look to the APPN routing.

```
NLDM.CON                   SESSION CONFIGURATION DATA                  PAGE    1
--------------- PRIMARY ---------------+-------------- SECONDARY --------------
NAME RASAT01   SA 00000001  EL 00B3    |   NAME RABT421   SA 00000001  EL 00B4
---------------------------------------+---------------------------------------
DOMAIN RAAAN  C-C  PCID USIBMRA.RAS.F627D164C7EEAA89         C-C DOMAIN RAAAN
               +-------------+                  +-------------+
-RABT421       |   CP/SSCP   | ---          ---  |   CP/SSCP   | RAA
               | LOCAL DATA  |  APPN TP 01       | SUBAREA PU  | ISTPUSA0(0000)
               +------+------+                  +------+------+
                      |                                |
               +------+------+                  +------+------+
CNR00019(00B7) |     PU      |                  |     CUA     | 0E2B
               +------+------+                  +------+------+
                      |       APPNCOS #CONNECT         |
               +------+------+ SUBACOS N/A      +------+------+
RASAT01 (00B3) |     ILU     | LOGMODE M2BSCNQ  |     PU      | RAAPE2B (0067)
               +-------------+ PADJ CP RAS      +------+------+
                               SADJ CP RAB             |
                                                +------+------+
                                                |     ILU     | RABT421 (00B4)
                                                +-------------+
AAU070I TRACE IS NOT ACTIVE FOR SPECIFIED RESOURCE
SELECT PT, ST (PRI, SEC TRACE), RT (RESP TIME), P, AR, FC
CMD==> PT
```

Figure 47. Session Display from RAA NetView

We see no change in the path despite the RTP path switch (Figure 48).

The reason for this is that there is no mechanism for NetView to see the path switch. The routing data is collected at the start of a session and, in APPN networks, never changes until the session ends.

```
NLDM.AR                APPN SESSION ROUTE CONFIGURATION                 PAGE   1
-- PRIMARY ---+-- SECONDARY --+--------------- PCID ---------------+- DOMAIN -
NAME RASAT01  | NAME RABT421  | USIBMRA.RAS.F627D164C7EEAA89       | RAAAN
--------------+---------------+------------------------------------+----------


 +---------+
 |   CP    |
 |RAS      |
 +----+----+
TG021 |
 +----+----+
 |   CP    |
 |RAA      |
 +----+----+
TG021 |
 +----+----+
 | CP(ICN) |
 |RAB      |
 +---------+


END OF DATA
SELECT PAR, SAR
CMD==>
```

Figure 48. Route Display

7.5 Hints and Tips

The NetView session information, particularly the APPN route display, are invaluable in finding the original route of a session. Be aware that you should also check any RTPs shown in the route, especially if path switches have occurred.

Where there are a large number of RTPs in a network, use the NetView session displays at either end of an RTP or the TCIDs to get the correct names at each end of an RTP connection.

While NetView can show the configuration and APPN route information, it has difficulty interpreting RTP connections, as seen in Figure 41 on page 61. You need to understand clearly your network topology and display the RTPs to get an accurate view.

Chapter 8. Multi-Platform Implementation

HPR, as an enhancement to APPN, is being implemented across the major IBM platforms. Currently it is implemented on VTAM, NCP, AS/400 and CM/2 and the intention of this test is to demonstrate multiple platforms working together. This test was set up using VTAM, NCP and CM/2 test systems to show their interoperation, together with the information available to help understand the network.

Following this test, the intermediate node CM/2 was replaced by an AS/400 and the testing repeated.

8.1 Benefits

All major APPN platforms have either implemented or made a statement of intent to implement HPR routing. HPR will provide a base for future high-speed networking technologies, hence migrating your network to HPR will help position you for the future.

8.2 Multi-Platform Environment

Having demonstrated all the elements of HPR routing in the previous scenarios, we are now looking at the information we can see across multiple platforms and demonstrating AS/400 and CM/2 capabilities. Here we have an RTP-capable VTAM linked through an NCP in a CNN to a CM/2 network node which in turn links to another CM/2 system.

Having already seen the information available at the host end, we now look further into the network to see the remote CM/2 system acting as both an RTP endpoint and an intermediate router.

As a final test, we replace the intermediate node CM/2 by an AS/400 to see its operation and the information available.

8.3 Description

In this test we are building on the previous test scenarios, adding CM/2 systems for both HPR and intermediate routes. Figure 49 on page 68 shows the configuration for this test.

As before RAA is an RTP-capable VTAM connected by a local SNA channel connection to NCP RA9NCPX in CNN RAB. CM/2 system RAXSERV attaches via a token-ring to the NCP as a network node and in turn attaches via another token-ring to RAXWKSTN, another CM/2 RTP-capable system.

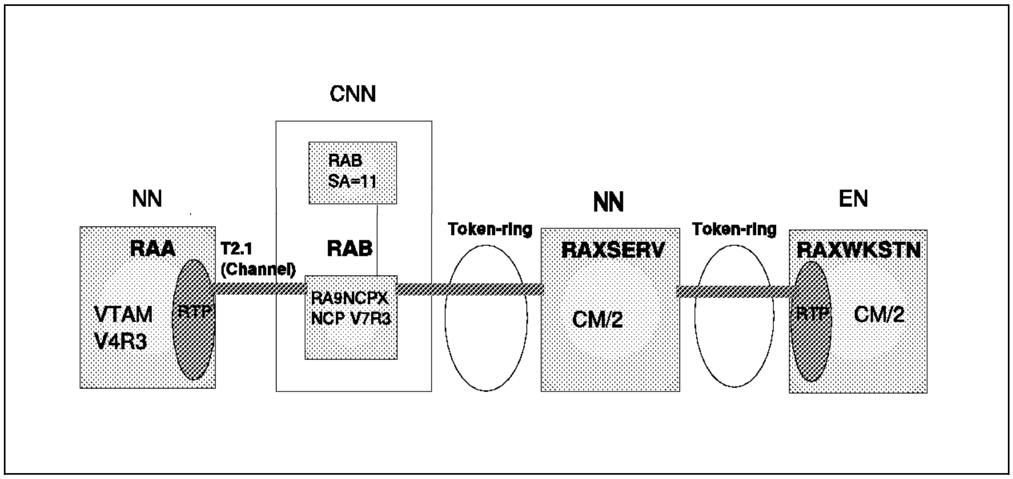


Figure 49. Multi-platform Network

We use APING from RAA to both RAXSERV and RAXWKSTN which form RTP connections between the ends. As CM/2 holds the sessions up after completion of the APINGs, we can see the RTP connections still in place and view the information from the host and from the CM/2 systems. In addition we APING from RAXWKSTN to RAB which now produces an RTP connection from RAXWKSTN to RAXSERV, which then routes the session to RAB over an APPN link as RAB is not RTP capable. We can now see the boundary function in effect in CM/2 and we also note that there is no visibility of the RAA-RAXWKSTN RTP connection as such in RAXSERV.

We then replace RAXSERV with an AS/400 to verify we can use an AS/400 as an ANR node and review the information available.

8.3.1 Definitions

The definitions for RAA and RA9NCPX are the same as used previously and can be seen in Appendix A, "Test Scenario 1" on page 99 and Appendix B, "Test Scenario 2" on page 107.

The definitions for the CM/2 systems are shown in Appendix C, "Test Scenario 5" on page 123.

There are no definitions for the AS/400 shown as the default for the controller definition is for APPN/HPR capability is yes. The controllers for the links to RAB and RAXWKSTN are defined as you would for normal APPN links.

8.4 Test Results

Until now we have been viewing the network solely through VTAMs perspective of the world. We now can see both VTAM and CM/2 views of the network.

8.4.1 VTAM Network Information

In order to set up sessions and hence RTPs to the CM/2 systems, we use APING to RAXSERV and RAXWKSTN as seen in Figure 50 on page 69.

```
 D NET,APING,ID=RAXSERV
 IST097I DISPLAY ACCEPTED
 IST1457I VTAM APING VERSION 2R33 (PARTNER TP VERSION 2R43) 387
 IST1490I DLU=USIBMRA.RAXSERV SID=F09F7CFE9A2F2E48
 IST1462I ECHO IS ON
 IST1463I ALLOCATION DURATION: 283 MILLISECONDS
 IST1464I PROGRAM STARTUP AND VERSION EXCHANGE: 2140 MILLISECONDS
 IST1465I         DURATION      DATA SENT   DATA RATE   DATA RATE
 IST1466I      (MILLISECONDS)    (BYTES)  (KBYTE/SEC)  (MBIT/SEC)
 IST1467I               81           200          2           0
 IST1467I               50           200          4           0
 IST1468I TOTALS:      131           400          3           0
 IST1469I DURATION STATISTICS:
 IST1470I MINIMUM = 50 AVERAGE = 65 MAXIMUM = 81
 IST314I END
D NET,APING,ID=RAXWKSTN
IST097I DISPLAY ACCEPTED
IST1457I VTAM APING VERSION 2R33 (PARTNER TP VERSION 2R43) 390
IST1490I DLU=USIBMRA.RAXWKSTN SID=E92F62B494BDDE2B
IST1462I ECHO IS ON
IST1463I ALLOCATION DURATION: 59 MILLISECONDS
IST1464I PROGRAM STARTUP AND VERSION EXCHANGE: 2414 MILLISECONDS
IST1465I         DURATION      DATA SENT   DATA RATE   DATA RATE
IST1466I      (MILLISECONDS)    (BYTES)  (KBYTE/SEC)  (MBIT/SEC)
IST1467I               50           200          4           0
IST1467I               48           200          4           0
IST1468I TOTALS:       98           400          4           0
IST1469I DURATION STATISTICS:
IST1470I MINIMUM = 48 AVERAGE = 49 MAXIMUM = 50
IST314I END
```

Figure 50. APING Displays

As these RTPs had been set up by earlier tests, we find the RTP connection by displaying the session information with a display sessions command. Figure 51 on page 70 shows the RTP for this session which runs through RAB to RAXSERV **1**.

```
D NET,ID=CNR00060,E
IST097I DISPLAY ACCEPTED
IST075I NAME = CNR00060, TYPE = PU_T2.1 403
IST486I STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I CP NAME = RAXSERV, CP NETID = USIBMRA, DYNAMIC LU = YES
IST933I LOGMODE=***NA***, COS=#INTER
IST1476I TCID X'000000600000008A' - REMOTE TCID X'00000000131224C0'
IST1481I DESTINATION CP USIBMRA.RAXSERV - NCE X'80'
IST1477I ALLOWED DATA FLOW RATE = 58 KBITS/SEC
IST1516I INITIAL DATA FLOW RATE = 58 KBITS/SEC
IST1511I MAXIMUM NETWORK LAYER PACKET SIZE = 1929 BYTES
IST1478I NUMBER OF UNACKNOWLEDGED BUFFERS = 0
IST1479I RTP CONNECTION STATE = CONNECTED
IST1480I RTP END TO END ROUTE
IST1460I TGN  CPNAME             TG TYPE      HPR
IST1461I  21  USIBMRA.RAB        APPN         ANR  1
IST1461I  21  USIBMRA.RAXSERV    APPN         RTP
IST231I RTP MAJOR NODE = ISTRTPMN
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST355I LOGICAL UNITS:
IST080I RAXSERV  ACT/S----Y
IST314I END
```

Figure 51. RAA to RAXSERV RTP Connection

Similarly, having displayed the RAXWKSTN session, we can see the RTP connection for RAXWKSTN from RAA (Figure 52), and the route it takes **1** through RAB and RAXSERV.

```
D NET,ID=CNR00062,E
IST097I DISPLAY ACCEPTED
IST075I NAME = CNR00062, TYPE = PU_T2.1 406
IST486I STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I CP NAME = RAXWKSTN, CP NETID = USIBMRA, DYNAMIC LU = YES
IST933I LOGMODE=***NA***, COS=#INTER
IST1476I TCID X'00000062000000A7' - REMOTE TCID X'00000000137C2468'
IST1481I DESTINATION CP USIBMRA.RAXWKSTN - NCE X'80'
IST1477I ALLOWED DATA FLOW RATE = 58 KBITS/SEC
IST1516I INITIAL DATA FLOW RATE = 58 KBITS/SEC
IST1511I MAXIMUM NETWORK LAYER PACKET SIZE = 1929 BYTES
IST1478I NUMBER OF UNACKNOWLEDGED BUFFERS = 0
IST1479I RTP CONNECTION STATE = CONNECTED
IST1480I RTP END TO END ROUTE
IST1460I TGN  CPNAME             TG TYPE      HPR
IST1461I  21  USIBMRA.RAB        APPN         ANR  1
IST1461I  21  USIBMRA.RAXSERV    APPN         RTP
IST1461I  21  USIBMRA.RAXWKSTN   APPN         RTP
IST231I RTP MAJOR NODE = ISTRTPMN
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST355I LOGICAL UNITS:
IST080I RAXWKSTN ACT/S----Y
IST314I END
```

Figure 52. RAA to RAXWKSTN RTP Connection

We can also look at the APPN topology information for RAXSERV (Figure 53 on page 71) which shows RAXSERV with CP sessions to RAB and RAXWKSTN **1**.

We also see RAXWKSTN has a CP session to only RAXSERV **2**.

```
D NET,TOPO,ID=RAXSERV,LIST=ALL
IST097I DISPLAY ACCEPTED
IST350I DISPLAY TYPE = TOPOLOGY 412
IST1295I CP NAME           NODETYPE ROUTERES CONGESTION  CP-CP WEIGHT
IST1296I USIBMRA.RAXSERV   NN       128      NONE        NO    *NA*
IST1297I                   ICN/MDH  CDSERVR  RSN         HPR
IST1298I                   NO       NO       14          RTP
IST1223I                   BN       NATIVE
IST1224I                   NO       YES
IST1299I TRANSMISSION GROUPS ORIGINATING AT CP USIBMRA.RAXSERV    1
IST1357I                                                 CPCP
IST1300I DESTINATION CP    TGN      STATUS   TGTYPE      VALUE WEIGHT
IST1301I USIBMRA.RAB       21       OPER     INTERM      YES   *NA*
IST1301I USIBMRA.RAXWKSTN  21       OPER     INTERM      YES   *NA*
IST314I END
D NET,TOPO,ID=RAXWKSTN,LIST=ALL
IST097I DISPLAY ACCEPTED
IST350I DISPLAY TYPE = TOPOLOGY 516
IST1295I CP NAME           NODETYPE ROUTERES CONGESTION  CP-CP WEIGHT
IST1296I USIBMRA.RAXWKSTN  NN       128      NONE        NO    *NA*
IST1297I                   ICN/MDH  CDSERVR  RSN         HPR
IST1298I                   NO       NO       34          RTP
IST1223I                   BN       NATIVE
IST1224I                   NO       YES
IST1299I TRANSMISSION GROUPS ORIGINATING AT CP USIBMRA.RAXWKSTN   2
IST1357I                                                 CPCP
IST1300I DESTINATION CP    TGN      STATUS   TGTYPE      VALUE WEIGHT
IST1301I USIBMRA.RAXSERV   21       OPER     INTERM      YES   *NA*
IST314I END
```

Figure 53. RAXSERV Topology Display

However, if we now display RAXWKSTN using the adjacent CP display command we can see in Figure 54 that it is adjacent to RAA due to the RTP connection, even though there is no CP session.

```
D NET,ADJCP,ID=RAXWKSTN,E
IST097I DISPLAY ACCEPTED
IST350I DISPLAY TYPE = ADJACENT CONTROL POINT 513
IST486I STATUS= ACTIV, DESIRED STATE= ACTIV
IST1197I ADJCP MAJOR NODE = ISTADJCP
IST1101I ADJCP DISPLAY SUMMARY FOR USIBMRA.RAXWKSTN
IST1102I NODENAME          NODETYPE CONNECTIONS CP CONNECTIONS NATIVE
IST1103I USIBMRA.RAXWKSTN  *NA*       3           0            *NA*
IST1104I CONNECTION SUMMARY FOR USIBMRA.RAXWKSTN
IST172I NO CONNECTIONS FOUND
IST1500I STATE TRACE = OFF
IST1493I RTP SUMMARY FOR USIBMRA.RAXWKSTN COUNT = 2
IST1486I   RTP NAME   STATE             DESTINATION CP
IST1487I   CNR00062   CONNECTED         USIBMRA.RAXWKSTN
IST1487I   CNR00061   CONNECTED         USIBMRA.RAXWKSTN
IST314I END
```

Figure 54. ADJCP Display of RAXWKSTN

8.4.2 CM/2 Network Information

Here we have two nodes to look at: RAXSERV as the intermediate network node and RAXWKSTN connected to it as another network node. To capture the information from the testing we used the CM/2 command DISPLAY >DISPLAY.OUT to print the CM/2 information into a file. For normal use PMDSPLAY will show this information in a more structured form.

8.4.2.1 RAXWKSTN Network Node

THe following section shows the network view from the remote workstation. Having used APING to RAA, RAB and RAXSERV, we can see the type 6.2 LUs still active in Figure 55.

```
**************************************
*    Logical Unit 6.2 Information    *
**************************************
Number of logical units (LUs)              1

1>LU name                                  RAXWKSTN
  LU alias                                 RAXWKSTN
  Fully-qualified LU name                  USIBMRA.RAXWKSTN
  Default LU                               Yes
  LU local address                         Independent
  Configured sessions limit                65535
  Transaction programs limit               No limit
  LU type                                  6.2
  Number of partner LUs (PLUs)             3

1.1>Partner LU alias                       RAXSERV
    Partner LU uninterpreted name          RAXSERV
    Partner LU name                        USIBMRA.RAXSERV
       . . . .

1.1.2>Mode name                            #INTER
      Max RU size, lower limit             256
      Max RU size, upper limit             1920

1.2>Partner LU alias                       RAB
    Partner LU uninterpreted name          RAB
    Partner LU name                        USIBMRA.RAB
       . . . .

1.2.1>Mode name                            #INTER
      Max RU size, lower limit             256
      Max RU size, upper limit             1920
       . . . .

1.3>Partner LU alias                       RAA
    Partner LU uninterpreted name          RAA
    Partner LU name                        USIBMRA.RAA
       . . . .

1.3.1>Mode name                            #INTER
      Max RU size, lower limit             256
      Max RU size, upper limit             1920
       . . . .
```

Figure 55. RAXWKSTN LU Type 6.2 Information

If we now look at the session information, we see two which are of interest to us in Figure 56 on page 73. These show sessions to RAA and RAB which are both on link "overHPR" **1**, which will be RTP connections. We will see the RAB session in RAXSERV later in this chapter.

```
**************************************
*        Session Information         *
**************************************
6>Session ID                                  X'E92F62B492BDDE2B'
  Conversation ID                             X'00000000'
  LU alias                                    RAXWKSTN
  Partner LU alias                            RAB
  Mode name                                   #INTER
  Send maximum RU size                        1920
  Receive maximum RU size                     1792
  Send pacing window                          1
  Receive pacing window                       8
  Link name                                   overHPR    1
  Outbound destination address (DAF)          X'04'
  Outbound origin address (OAF)               X'02'
  OAF-DAF assignor indicator (ODAI)           B'1'
  Session type                                LU-LU session
  Connection type                             Peer
  Session security                            None
  Procedure correlator ID (PCID)              X'E92F62B492BDDE2B'
  PCID generator CP name                      USIBMRA.RAXWKSTN
  Conversation group ID                       X'8357F65B'
  LU name                                     USIBMRA.RAXWKSTN
  Partner LU name                             USIBMRA.RAB
       . . . .

8>Session ID                                  X'E92F62B494BDDE2B'
  Conversation ID                             X'00000000'
  LU alias                                    RAXWKSTN
  Partner LU alias                            RAA
  Mode name                                   #INTER
  Send maximum RU size                        1920
  Receive maximum RU size                     1920
  Send pacing window                          1
  Receive pacing window                       7
  Link name                                   overHPR    1
  Outbound destination address (DAF)          X'06'
  Outbound origin address (OAF)               X'02'
  OAF-DAF assignor indicator (ODAI)           B'1'
  Session type                                LU-LU session
  Connection type                             Peer
  Session security                            None
  Procedure correlator ID (PCID)              X'E92F62B494BDDE2B'
  PCID generator CP name                      USIBMRA.RAXWKSTN
  Conversation group ID                       X'9557F65B'
  LU name                                     USIBMRA.RAXWKSTN
  Partner LU name                             USIBMRA.RAA
       . . . .
```

Figure 56. RAXWKSTN LU Type 6.2 Sessions

The active links display (Figure 57 on page 74) shows the single link to RAXSERV. Note the link HPR information **1**, giving the ANR labels and RTP capability to RAXSERV. Note also the HPR SAP value of X′C8′.

```
**************************************
*      Active Links Information      *
**************************************
Number of active links                       1

1>Link name                                  LINK$NNS
  DLC name                                   IBMTRNET
  Adapter number                             0
  Destination DLC address                    X'40000003331704'
  Link activated                             Remotely
  Link state                                 Active
  Deactivating link                          No
  Active and activating sessions             8
  Max frame data (BTU) size                  1929
  Adjacent node CP name                      USIBMRA.RAXSERV
  Adjacent node type                         Network node
  CP-CP session support                      Yes
  Connection type                            Peer
  Link station role                          Secondary
  Line type                                  Switched
  Transmission group number                  21
  Effective capacity                         4000000 bits per second
  Cost per connect time                      0
  Cost per byte                              0
  Propagation delay                          384.00 microseconds
  User defined parameter 1                   128
  User defined parameter 2                   128
  User defined parameter 3                   128
  Security                                   Nonsecure
  Physical unit (PU) name                    RAXWKSTN
  HPR enabled                                Yes        1
  Inbound ANR label                          X'800A'
  Outbound ANR label                         X'8012'
  HPR SAP                                    X'C8'
  Adjacent node HPR level                    RTP
```

Figure 57. RAXWKSTN Active Links

Viewing the topology database, we see a large number of nodes, but we are interested in only our four. These are shown in Figure 58 on page 75. We can build the route RAA-RAB-RAXSERV-RAXWKSTN from this data. Also of interest is the HPR capability **1** for each node. RAB as a CNN is ANR only while the rest are RTP capable.

```
*************************************
*        Topology Information       *
*************************************
Number of network nodes                    52

27>Network node CP name                    USIBMRA.RAA
       . . . .
   Node HPR level                          RTP  1
   Number of TGs                           1

27.1>TG partner CP name                    USIBMRA.RAB
     Transmission group number             21
       . . . .
     HPR enabled                           Yes

28>Network node CP name                    USIBMRA.RAB
       . . . .
   Node HPR level                          ANR  1
   Number of TGs                           10

28.10>TG partner CP name                   USIBMRA.RAXSERV
      Transmission group number            21
       . . . .
      HPR enabled                          Yes

29>Network node CP name                    USIBMRA.RAXWKSTN
       . . . .
   Node HPR level                          RTP  1
   Number of TGs                           1

29.1>TG partner CP name                    USIBMRA.RAXSERV
     Transmission group number             21
       . . . .
     HPR enabled                           Yes

50>Network node CP name                    USIBMRA.RAXSERV
       . . . .
   Node HPR level                          RTP  1
   Number of TGs                           2

50.1>TG partner CP name                    USIBMRA.RAB
     Transmission group number             21
       . . . .
     HPR enabled                           Yes

50.2>TG partner CP name                    USIBMRA.RAXWKSTN
     Transmission group number             21
       . . . .
     HPR enabled                           Yes
```

Figure 58. RAXWKSTN Topology

Finally, the system defaults show us the HPR timers in CM/2 and the default for link HPR support (Figure 59 on page 76).

```
*************************************
*     System Default Information     *
*************************************
Default mode name
Default local LU name                        RAXWKSTN
       . . . .
Implicit link HPR support                    No
Retry count                                  6
Alive timer                                  60
Path switch timer (Low)                      600
Path switch timer (Medium)                   600
Path switch timer (High)                     60
```

Figure 59. RAXWKSTN System Defaults

8.4.2.2 RAXSERV Network Node

Having seen the view of the network from RAXWKSTN, we now look at the information in RAXSERV. Figure 60 on page 77 shows the active type 6.2 LUs in RAXSERV and as we would expect, we have in RAA, RAB and RAXWKSTN due to the earlier APINGs.

```
*************************************
*    Logical Unit 6.2 Information    *
*************************************
Number of logical units (LUs)               1

1>LU name                                   RAXSERV
  LU alias                                  RAXSERV
  Fully-qualified LU name                   USIBMRA.RAXSERV
  Default LU                                Yes
  LU local address                          Independent
  Configured sessions limit                 65535
  Transaction programs limit                No limit
  LU type                                   6.2
  Number of partner LUs (PLUs)              4

1.1>Partner LU alias                        RAB
    Partner LU uninterpreted name           RAB
    Partner LU name                         USIBMRA.RAB
       . . . .

1.1.2>Mode name                             #INTER
      Max RU size, lower limit              256
      Max RU size, upper limit              1920
       . . . .

1.2>Partner LU alias                        RAXWKSTN
    Partner LU uninterpreted name           RAXWKSTN
    Partner LU name                         USIBMRA.RAXWKSTN
       . . . .

1.2.3>Mode name                             #INTER
      Max RU size, lower limit              256
      Max RU size, upper limit              16371
    Partner LU name                         USIBMRA.RAXWKSTN

1.3>Partner LU alias                        RAA
    Partner LU uninterpreted name           RAA
    Partner LU name                         USIBMRA.RAA
       . . . .

1.3.1>Mode name                             #INTER
      Max RU size, lower limit              256
      Max RU size, upper limit              1920
       . . . .
```

Figure 60. RAXSERV Type 6.2 LUs

The session information (Figure 61 on page 78) shows HPR sessions to RAA and RAXWKSTN **1** which will be RTPs and a session to RAB which is APPN only **2**.

```
**************************************
*        Session Information         *
**************************************
Number of sessions                             12

6>Session ID                                   X'E92F62B490BDDE2B'
  Conversation ID                              X'00000000'
  LU alias                                     RAXSERV
  Partner LU alias                             RAXWKSTN
  Mode name                                    #INTER
  Send maximum RU size                         1920
  Receive maximum RU size                      1920
  Send pacing window                           1
  Receive pacing window                        7
  Link name                                    overHPR   1
  Outbound destination address (DAF)           X'02'
  Outbound origin address (OAF)                X'02'
  OAF-DAF assignor indicator (ODAI)            B'0'
  Session type                                 LU-LU session
  Connection type                              Peer
  Session security                             None
  Procedure correlator ID (PCID)               X'E92F62B490BDDE2B'
  PCID generator CP name                       USIBMRA.RAXWKSTN
  Conversation group ID                        X'EAA3EC5B'
  LU name                                      USIBMRA.RAXSERV
  Partner LU name                              USIBMRA.RAXWKSTN

8>Session ID                                   X'F09F7CFE982F2E48'
  Conversation ID                              X'00000000'
  LU alias                                     RAXSERV
  Partner LU alias                             RAB
  Mode name                                    #INTER
  Send maximum RU size                         1920
  Receive maximum RU size                      1920
  Send pacing window                           1
  Receive pacing window                        7
  Link name                                    HOST$RAB   2
  Outbound destination address (DAF)           X'03'
  Outbound origin address (OAF)                X'02'
  OAF-DAF assignor indicator (ODAI)            B'1'
  Session type                                 LU-LU session
  Connection type                              Peer
  Session security                             None
  Procedure correlator ID (PCID)               X'F09F7CFE982F2E48'
  PCID generator CP name                       USIBMRA.RAXSERV
  Conversation group ID                        X'09A4EC5B'
  LU name                                      USIBMRA.RAXSERV
  Partner LU name                              USIBMRA.RAB
```

Figure 61 (Part 1 of 2). RAXSERV Type 6.2 LU Sessions

```
10>Session ID                                  X'F09F7CFE9A2F2E48'
   Conversation ID                             X'00000000'
   LU alias                                    RAXSERV
   Partner LU alias                            RAA
   Mode name                                   #INTER
   Send maximum RU size                        1920
   Receive maximum RU size                     1920
   Send pacing window                          1
   Receive pacing window                       7
   Link name                                   overHPR   1
   Outbound destination address (DAF)          X'02'
   Outbound origin address (OAF)               X'02'
   OAF-DAF assignor indicator (ODAI)           B'1'
   Session type                                LU-LU session
   Connection type                             Peer
   Session security                            None
   Procedure correlator ID (PCID)              X'F09F7CFE9A2F2E48'
   PCID generator CP name                      USIBMRA.RAXSERV
   Conversation group ID                       X'22A4EC5B'
   LU name                                     USIBMRA.RAXSERV
   Partner LU name                             USIBMRA.RAA
```

Figure 61 (Part 2 of 2). RAXSERV Type 6.2 LU Sessions

If we now look at the active links (Figure 62 on page 80) we see an APPN link to RAB **1** which is HPR capable and supports ANR routing **2**. This means sessions terminating in RAB must be APPN from RAXSERV.

We also have a link to RAXWKSTN **3** which is HPR capable and supports RTP connections **4**. This leads to the conclusion that the session from RAXWKSTN to RAB seen earlier (Figure 56 on page 73) will be over an RTP connection to RAXSERV and is then routed through the boundary function for onward routing to RAB over an APPN only link.

```
*************************************
*      Active Links Information     *
*************************************
Number of active links                       2

1>Link name                                  HOST$RAB  1
  DLC name                                   IBMTRNET
  Adapter number                             0
  Destination DLC address                    X'40000109000104'
  Link activated                             Locally
  Link state                                 Active
  Deactivating link                          No
  Active and activating sessions             10
  Max frame data (BTU) size                  1929
  Adjacent node CP name                      USIBMRA.RAB
  Adjacent node type                         Network node
  CP-CP session support                      Yes
  Connection type                            Peer
  Link station role                          Secondary
  Line type                                  Switched
  Transmission group number                  21
  Effective capacity                         4000000 bits per second
  Cost per connect time                      0
  Cost per byte                              0
  Propagation delay                          384.00 microseconds
  User defined parameter 1                   128
  User defined parameter 2                   128
  User defined parameter 3                   128
  Security                                   Nonsecure
  Physical unit (PU) name                    RAXSERV
  HPR enabled                                Yes         2
  Inbound ANR label                          X'8010'
  Outbound ANR label                         X'C00086'
  HPR SAP                                    X'C8'
  Adjacent node HPR level                    ANR
```

Figure 62 (Part 1 of 2). RAXSERV Active Links

```
2>Link name                              EN$WKSTN     3
  DLC name                               IBMTRNET
  Adapter number                         0
  Destination DLC address                X'40005200522104'
  Link activated                         Locally
  Link state                             Active
  Deactivating link                      No
  Active and activating sessions         7
  Max frame data (BTU) size              1929
  Adjacent node CP name                  USIBMRA.RAXWKSTN
  Adjacent node type                     Network node
  CP-CP session support                  Yes
  Connection type                        Peer
  Link station role                      Primary
  Line type                              Switched
  Transmission group number              21
  Effective capacity                     4000000 bits per second
  Cost per connect time                  0
  Cost per byte                          0
  Propagation delay                      384.00 microseconds
  User defined parameter 1               128
  User defined parameter 2               128
  User defined parameter 3               128
  Security                               Nonsecure
  Physical unit (PU) name                RAXSERV
  HPR enabled                            Yes          4
  Inbound ANR label                      X'8012'
  Outbound ANR label                     X'800A'
  HPR SAP                                X'C8'
  Adjacent node HPR level                RTP
```

Figure 62 (Part 2 of 2). RAXSERV Active Links

We now look at the intermediate sessions. In Figure 63 on page 82, we see that there are two sessions from RAXWKSTN to RAB being routed as a hybrid route of APPN/RTP connections. One is for session negotiation (SNASVCMG) and one is COS #INTER opened for the APING.

One final point to note is that, as expected, there is no sign of the RAXWKSTN session to RAA as this is an RTP connection and invisible to this node.

```
************************************
* Intermediate Sessions Information  *
************************************
Number of intermediate sessions              2

1>Primary side adjacent CP name
  Secondary side adjacent CP name            USIBMRA.RAB
  Primary side link name                     overHPR
  Secondary side link name                   HOST$RAB
  Procedure correlator ID (PCID)             X'E92F62B491BDDE2B'
  PCID generator CP name                     USIBMRA.RAXWKSTN
  Primary LU name                            USIBMRA.RAXWKSTN
  Secondary LU name                          USIBMRA.RAB
       . . . .

2>Primary side adjacent CP name
  Secondary side adjacent CP name            USIBMRA.RAB
  Primary side link name                     overHPR
  Secondary side link name                   HOST$RAB
  Procedure correlator ID (PCID)             X'E92F62B492BDDE2B'
  PCID generator CP name                     USIBMRA.RAXWKSTN
  Primary LU name                            USIBMRA.RAXWKSTN
  Secondary LU name                          USIBMRA.RAB
       . . . .
```

Figure 63. RAXSERV Intermediate Sessions

8.4.3 AS/400 Intermediate Node

Having tested out the network with a CM/2 intermediate network node, RAXSERV was replaced by an AS/400. The definition of the link to RAB used the network defaults which included "APPN/HPR capable *YES." The definition for RAXWKSTN was autocreated when it contacted the AS/400.

Initially a token-ring card (feature 2626) was tested but failed to establish an HPR capability as this is not a supported card. This was then replaced by a feature 2619 card which established an HPR capable link.

RAXWKSTN was APING from RAA and an RTP connection was established which was a similar route to that seen in Figure 52 on page 70, except that the AS/400 HPR capability is ANR instead of RTP as seen for RAXSERV.

Finally RAB is APING from RAXWKSTN and the intermediate session information displayed (DSPAPPNINF). As with the RAXSERV displays, there is no view of the RTP connection. The only session seen is the one formed by the APING from RAXWKSTN to the RAB which is APPN only.

8.5 Hints and Tips

CM/2 can provide a great deal of useful information on its RTP connections. Use PMDSPLAY particularly for:

- Sessions
- Topology
- Active links

For intermediate nodes, the intermediate sessions display shows the APPN connections for HPR/APPN hybrid routes.

With RTP connections, intermediate nodes show nothing of the RTP connections or sessions through them. The only useful information available are the ANR labels.

The LAPS default buffer size is too small for HPR which needs a minimum of 768 bytes. If this is not changed then the links will always use APPN routing.

AS/400 adapters must be the correct feature code as the HPR support is provided by the card, unlike NCP and CM/2. If back-level adapters are used, no error message is given and the links operate only as APPN links.

Chapter 9. VTAM Diagnosis

This chapter covers the new and changed diagnostics with VTAM V4R3 from a VTAM viewpoint, with examples. The main changes are the inclusion of HPR support into the VTAM internal trace. ACF/TAP is also discussed briefly for line traces. This subject is covered in more detail in *NCP V7R3 New Functions*.

Also included is an introduction to the network flows showing route setup for APPN and CNN nodes, connection setup and data flow.

More details on all of these areas is available in *VTAM V4R3 for MVS/ESA Diagnosis*.

9.1 Common Problems

This is not intended to be an exhaustive list, but a brief example of the types of problems found during testing.

9.1.1 Configuration Problems

- Session sets up using intermediate session routing with no RTPs.
  - RTP->Base->Base configuration. There must be an RTP-enabled node at each end.
  - First TG could be an inter-cluster link which does not support RTP.
  - All nodes on path refuse to perform RTP function. This error returns Route_Setup reply with BACKOUT sense (′08550020′X).
- RTP connection is not established over the entire session path.
  - Link in path is not HPR-capable.
  - Link in path activated as HPR=NO.
- An attempt to activate a PU in an MPC member as HPR-capable in an ICN fails.

  This is not supported.

9.1.2 Miscellaneous Symptoms

- Path switch via operator command fails.

  If an F VTAM,RTP,ID=rtp is issued but no alternate path exists, message IST1495I is issued indicating no alternate path exists.
- Inactivation of the RTP major node (ISTRTPMN) fails.

  This node cannot be deactivated.
- Inactivation of the RTP connection with VARY INACT,IMMED fails.

  Only the FORCE is supported.

9.2 Network Flows

This section covers the basic flows for route setup over APPN and CNN networks together with connection setup and data flow examples. These are not intended to be exhaustive or detailed, but to illustrate the unique HPR-related points.

9.2.1 Route Setup Flow

The request to establish an LU-LU session is the catalyst for performing route setup, which creates the RTP connection. Therefore, prior to these flows, the network node server of the origin LU has located the resource. Let′s see what happens in the flows shown in Figure 64.

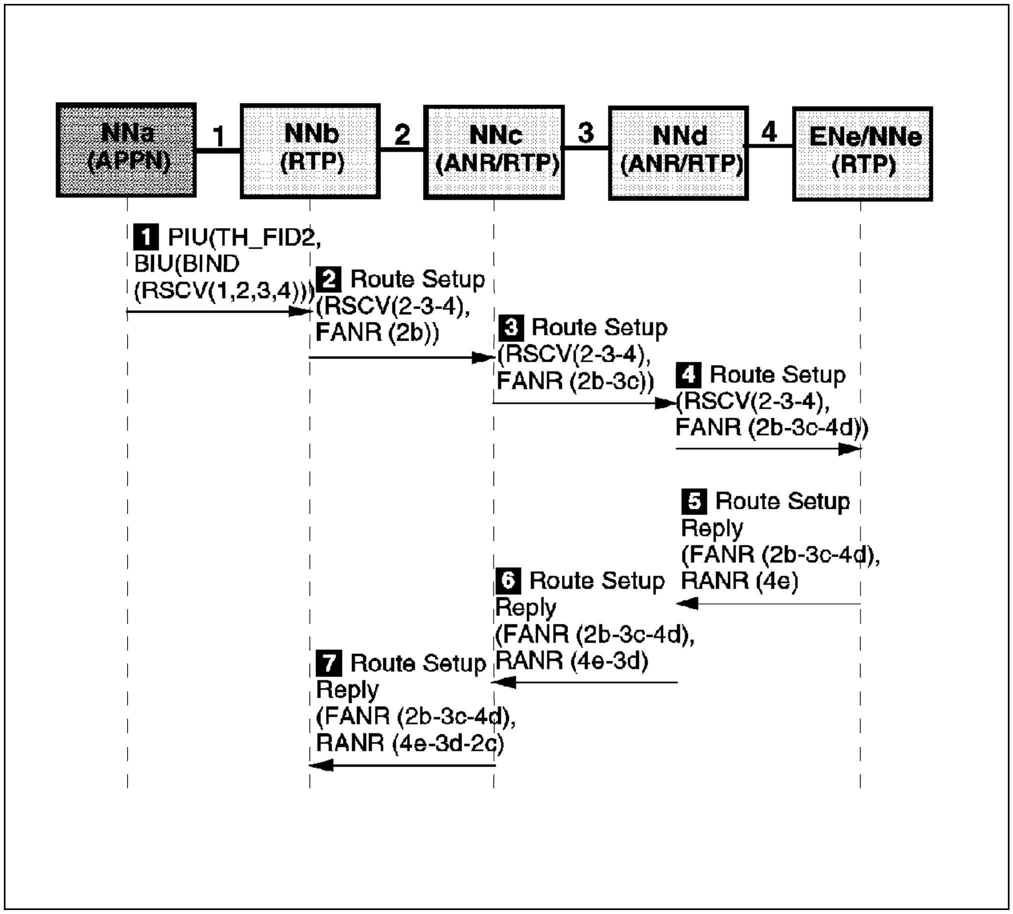


Figure 64. Route setup Flow

Assumptions:

- The TGs in this diagram have unique ANR (automatic network routing) labels. For each TG, the ANR label is the TG number and the suffix of the node it originates in this diagram for display purposes. For example, TG2 connects NNb and NNc. The ANR label in NNb is 2b; in NNc, it is 2c.
- NNc and NNd do not have to provide the RTP function; they may provide the ANR function only.
- NNe may be either an end node or a network node; it must, however, provide the RTP function.

1. The session request is originating at an LU in the domain of a pure APPN network node. This network node is unaware of the HPR subnetwork; it only sees the nodes as APPN nodes. NNa computes the route for the session and provides it to the PLU in the BIND. The BIND is sent along the first hop of the route via a FID2 PIU.

   Note that no preferential treatment is given to HPR-capable routes. If there are two potential routes for the session, the one that best matches the APPN class of service is used, regardless of HPR capability.

2. NNb receives the FID2 PIU. Since NNb is an RTP node, it checks to see if an RTP connection is a possibility and if an existing pipe can be used for the RTP connection. If one exists, processing continues with step 3 on page 88. If there is no available pipe, NNb builds a Route_Setup request. NNb begins to create the forward ANR field (FANR) by inserting its ANR label for TG2. NNb then sends the Route Setup request, which is in a FID2 PIU, to NNc.

3. NNc receives the Route_Setup request. It refers to the RSCV to determine the next hop for the RTP connection, adds its FANR information, and sends the data to NNd.

4. NNd receives the Route_Setup, adds its FANR information and sends the request to NNe.

5. NNe returns a Route_Setup Reply. The reply contains all the necessary information about the forwarded path. NNe begins building the reverse ANR field (RANR).

6. NNd receives the Route_Setup Reply, adds its RANR information and sends the reply to NNc.

7. NNc receives the Route_Setup Reply, adds its RANR information and sends the reply to NNb. This completes the RANR.

9.2.2 Connection Setup Flow

Once the route has been established, the RTP connection can be activated. Let′s see how that works.

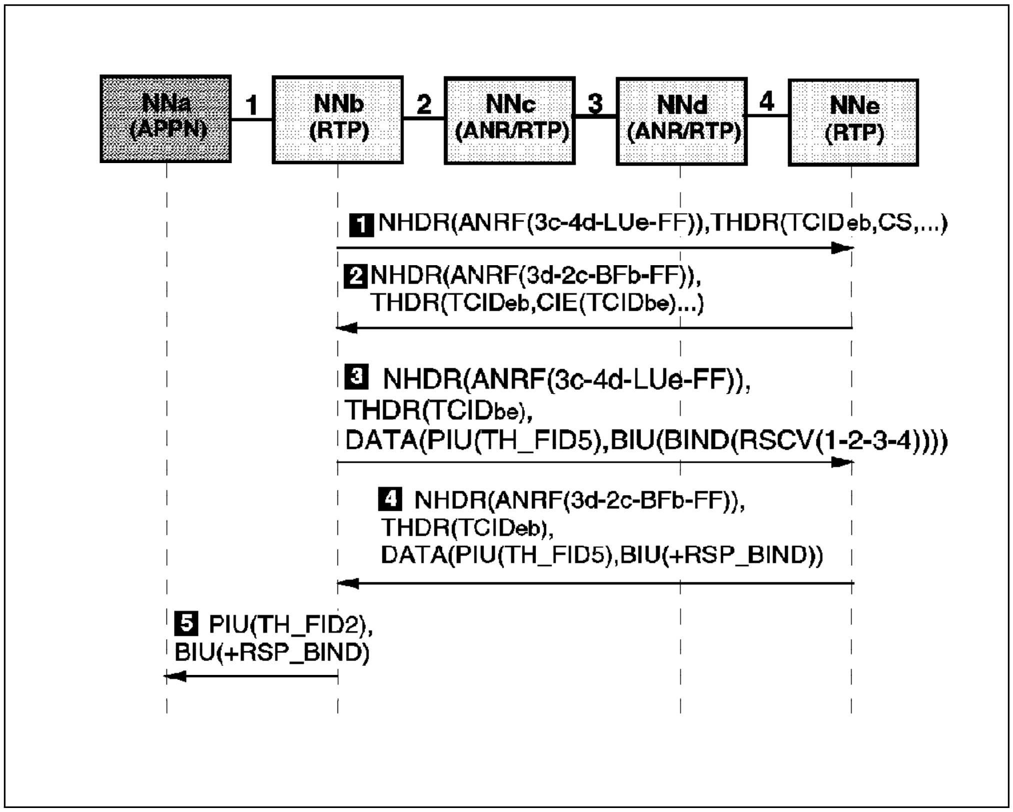


Figure 65. Connection Setup Flow

1. NNb activates a new RTP connection to NNe by sending a packet that contains the Connection Setup (CS) segment in the THDR. The NHDR ANR field (ANRF) contains the forward route, ending with the ANR label for the LU. The THDR contains the reverse ANR, ending with the ANR label for the boundary function of the node. The THDR also contains a TCID to be used for data sent from NNe to NNa over the connection.

2. NNe responds with a packet containing a Connection ID Exchange (CIE) in the THDR. The CIE identifies a TCID to be used for data sent from NNa to NNe over this RTP connection.

3. Once the connection is established, NNb packages the BIND into a NLP, which contains a FID5 PIU, and sends to the other end of the connection. The NLP contains the ANR field to indicate the route to take. If the destination had been in a non-HPR node, the NLP would have been converted back into a FID2 PIU for forwarding to the APPN-only node.

4. NNe takes the BIND response from the LU and packages it in an NLP. The reverse ANR is used for the route.

5. NNb converts the NLP into a FID2 PIU and sends the BIND response to NNa, which sends it to the PLU.

9.2.3 Route Setup Flow with One CNN

The Route Setup flow has additional flows when one or more of the intermediate nodes is a composite network node. Let′s look at that flow in Figure 66 on page 89.

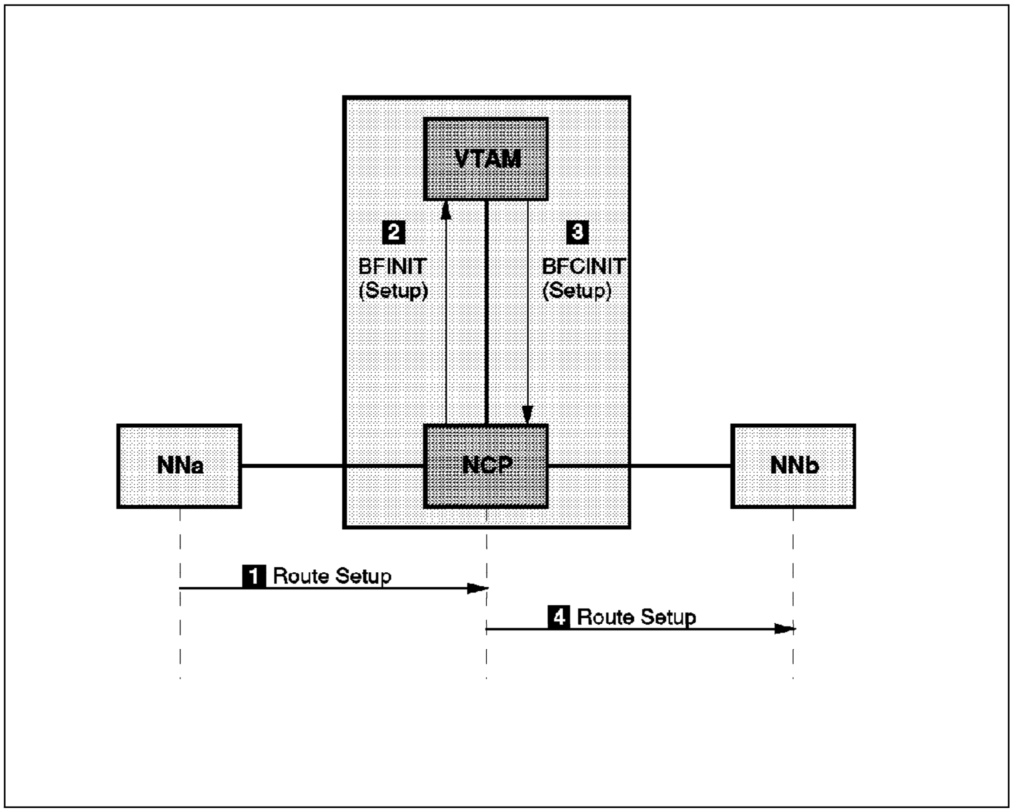


Figure 66. Route Setup with one CNN

1. The Route Setup FID2 PIU is sent to the NCP in the composite network node. Keep in mind that in a composite network node, the HPR link must be to the NCP; there can be no HPR link to the VTAM.

2. The NCP doesn′t know how to get to NNb so it sends a BFINIT(Setup) to VTAM to find out how to get to the link station for NNb. The BFINIT(Setup) RU is sent from the NCP to VTAM to request information that identifies the inbound and outbound PU element address along with the VR list, which is used internally by the NCP.

   VTAM uses the APPNCOS provided in the BFINIT and the APPNTOSA table to determine the subarea COS. The subarea COS provides the VR list, which contains the PU element address pair.

3. VTAM determines the location of NNb and provides this information back to the NCP in a BFCINIT(Setup). The BFCINIT(Setup) RU is sent in response to the BFINIT(Setup) by VTAM to NCP when the destination PU is found. The BFCINIT contains a list of VRs which map to the destination subarea along with the PU address pair.

   Instead of a BFCINIT, VTAM may return a BFCLEANUP to the NCP under the following conditions:

   - When VTAM cannot find the destination HPR node
   - When the destination node is not HPR-capable
   - When the TG is not HPR-capable

4. The NCP then determines the ANR label for the RTP connection and forwards the Route Setup to NNb.

9.2.4 Route Setup Flow with Two CNNs

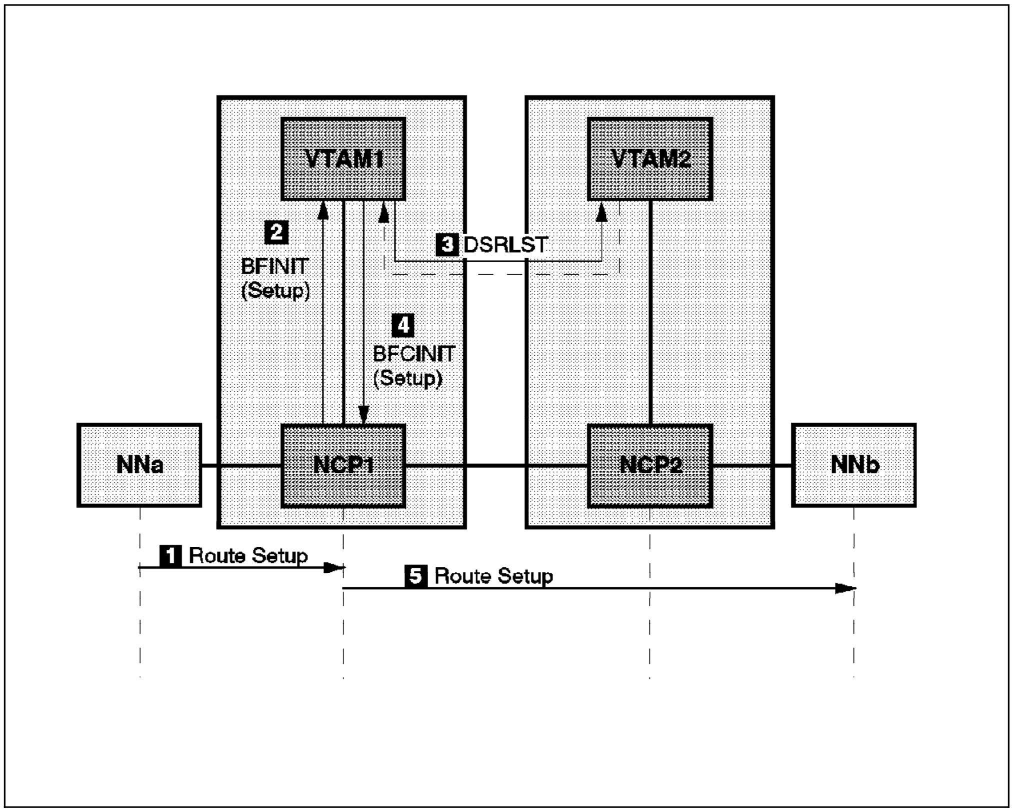


Figure 67. Route Setup with two CNNs

1. The Route Setup comes into NCP1.
2. NCP1 doesn't know how to get to NNb so it sends a BFINIT(Setup) to VTAM1 to find out how to get to the link station for NNb.
3. VTAM1 realizes that there is another composite network node which is connected to the destination. These two composite network nodes are connected via a VR/TG. Since VTAM1 and VTAM2 have an SSCP-SSCP session, VTAM1 sends a DSRLST to VTAM2 to determine the PU element address of the outbound HPR NCP. VTAM2 provides this information in the DSRLST response.
4. VTAM1 sends the PU element address of NNb back to NCP1 in a BFCINIT(Setup). BFCLEANUP would have been sent instead if necessary.
5. NCP1 builds the ANR label and sends the Route Setup to NNb.

Note that if the connection between the two composite network nodes was not a VR/TG, each NCP would have sent the BFINIT(Setup) to its owning VTAM.

9.2.5 End-to-End Data Flow

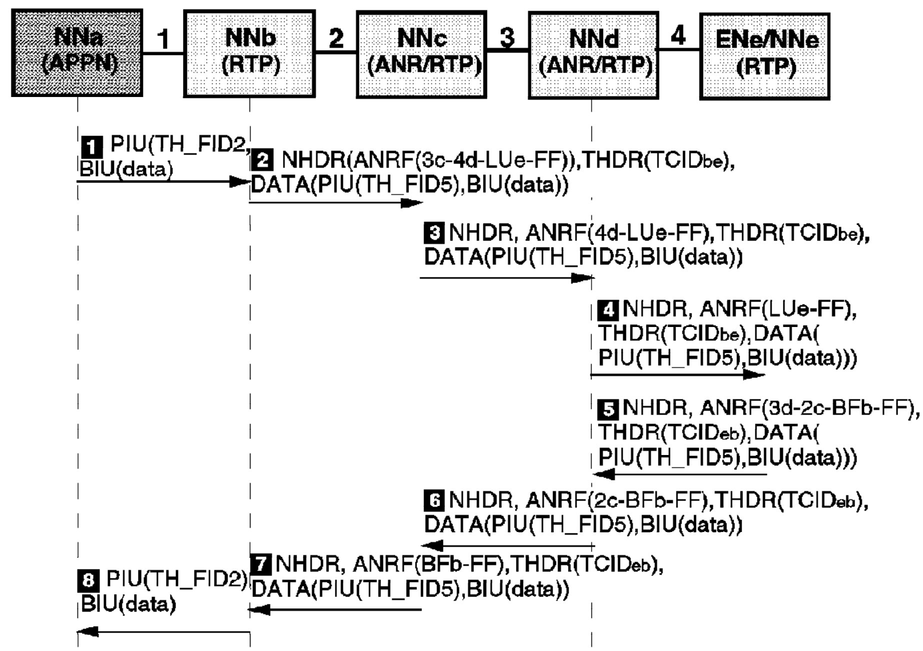


Figure 68. End-to-End Data Flow

This diagram shows the data flow in both directions. Note that the RTP connection endpoint is responsible for converting the data from a FID2 PIU to an NLP and vice versa. The RTP connection endpoints are also responsible for building the NLPs. All the intermediate nodes must do is forward the information along the connection using the ANR field.

This diagram also depicts the fact that the ANR field gets smaller as it goes through the pipe. As a node receives an NLP, it takes its ANR label out of the ANRF and forwards the packet on. This way, the first label in a received packet indicates where it should go next.

9.3 VTAM Internal Trace

There are 12 new entries to assist in debugging problems.

9.3.1 New Trace Entries

ARB Records adaptive rate-based statistics. An ARB VIT entry is cut by the RTP component when data is sent to the partner node. This entry is a summary of the statistical information being sent.

HCLK Records HPR clock state change. This occurs approximately once a second.

HPR Records when the HPRCTL macro is issued. Is followed by one HPR2 entry and sometimes one or more HPR3 entries. This entry indicates the type of lookup being performed, the return code for that operation, and the addresses of the parameters involved.

HPR2 Records additional information for the HPR entry.

HPR3 Records additional information for the HPR entry.

HPRT Records when the HPRTIMER macro is issued.

NLP Records when a network layer packet is sent or received. Is followed by one or more NLP2 entries. This VIT entry is created each time a network layer packet (NLP) is sent or received at the DLC layer. The entry provides inbound/outbound information about the NLPs, including NLH and THDR information, and the FID5 PIU. The NLP record will be 32 bytes in length.

NLP2 Extension of the NLP entry. Up to 31 additional NLP2 continuation records, and 32 bytes in length, can occur following an NLP.

RCM Records the dispatch of the RTP context manager. An RCM VIT entry is created by the RTP context manager during each dispatch to summarize the activities that occurred during that dispatch.

RTP Records when an RTP PAB is dispatched. The entry contains RTP state and ARB information.

RTPE This VIT entry is created whenever RTP detects an error condition (including protocol violations).

RTS This VIT entry is created each time a FID2 Route Setup record is sent or received at the DLC layer. It will provide inbound/outbound information about the FID2 RTP Route Setup signal when it is detected at the DLC. Is followed by one or more RTS2 entries.

RTS2 Extension of the RTS entry.

9.3.2 Examples

The following JCL taken from *VTAM V4R3 Diagnosis* was used to format the examples following it. In this case the VIT trace was written to an external data set so the VITEXT DD defines this data set. Note the LRECL must be that of the data set or 284, whichever is smaller.

```
TTHOMASX JOB A-144268,MSGLEVEL=1,MSGCLASS=O,NOTIFY=TTHOMAS,CLASS=I
//S1 EXEC PGM=ISTRAFT1
//STEPLIB DD DSN=SYS1.SISTDBUG,DISP=SHR
//SUMMARY    DD SYSOUT=O,DCB=(RECFM=V,LRECL=84)
//DETAILS    DD SYSOUT=O,DCB=(RECFM=V,LRECL=84)
//LOG        DD SYSOUT=O,DCB=(RECFM=V,LRECL=124)
//OUTSTAN    DD SYSOUT=O,DCB=(RECFM=V,LRECL=124)
//VITEXT     DD SYSOUT=O,DCB=(RECFM=V,LRECL=284)
//PARM       DD DSN=(MCLI.TEST.JCL(VITPARM)),DISP=SHR
//TRACE      DD DSN=(MCLI.TRACE),DCB=(RECFM=VB,LRECL=23472),DISP=SHR
/*
```

Figure 69. VIT Analysis Tool JCL

```
VITEXT ALL
FORMAT
```

Figure 70. VITPARM Parameters

The following figure shows sample output from the VIT analysis tool. The entries are described in detail in *VTAM V4R3 Diagnosis*.

```
VTAM V4     Trace Analysis       Summary           95.137 05/17 11:51:07 LOC

Wrapped:     No
Formatting:  Yes
Interval:    None
Start time:  Beginning of trace
Stop time:   End of trace
SMS:         No
RU:          No
VITEXT:      Yes
       ALL

********************************************************************************
Observations

182 GTF VIT records were extracted and written to VITEXT.

********************************************************************************
Trace Statistics

First GTF Timestamp: 95.135 05/15 15:13:59.923 LOC (AB1290D2 CD1ACF01)
First VIT Timestamp: 95.135 05/15 15:13:59.923 LOC (AB1290D2 CD1ACF01)

Last VIT Timestamp:  95.135 05/15 15:20:09.764 LOC (AB129233 8287F301)
Last GTF Timestamp:  95.135 05/15 15:20:09.764 LOC (AB129233 8287F301)

Summary of GTF Record Types

                   2 Timestamp control records
                 182 VIT records
                 279 Other trace records
                     -----------------
                 463 Total GTF records

Count of VIT Entry and Option Occurrences

     VIT Entry Occurrences
                   7 ARB              81 HCLK
                  25 HPR              15 HPRT
                  25 HPR2              6 HPR3
                  10 NLPI             14 NLPO
                  69 NLP2              5 RCM
                  22 RTP               1 RTSI
                   1 RTSO             13 RTS2

     VIT Option Occurrences
                 294 HPR
                     -----
                 294 Total
```

Figure 71. VIT Analysis Tool Output Summary

```
VTAM V4     Trace Analysis       VIT Selections     95.137 05/17 11:51:07 LOC


95.135 05/15 15:13:59.923 LOC (AB1290D2 CD1ACF01) (record 26)
RCM             ASID 16   CONNST  00     NAME RCCAL     SIGNAL    ÙRAL             SENSE   FF000001
                          RUPE    04160FC0              RPNCBA    00000000         RPH     03ADF810

95.135 05/15 15:18:49.522 LOC (AB1291E6 FBF53C01) (record 285)
HPR             ASID 16   TYPE   R          FUNC   F          RETCD     04              NAME  RCCPV
                          INSTANCE  83      RTPA   00000000   COS       #INTER          RPH   03AE1010
HPR2            FLAG1 00       FLAG2 80   CPNAME   NCE   80000000 00000000 TGNUM 00
HPR3            DATA 2B2B0200 16461480 150BE4E2 C9C2D4D9 C14BD9C1 C2200000 00091346
HPR3            DATA 11801508 D9C1E7E6 D2E2E3D5 21800000 09000000 00000000 00000000

95.135 05/15 15:18:49.530 LOC (AB1291E6 FE0FBE01) (record 289)
RTSO            ASID 16   TSCBFL1 00        TSCBFL2  00        TSCBFL3  00         TSCBFL4 00       TSCBFL5  00
                          CBID    99        NAME     TSCWS     TSCB     03B131F0   NLPLGTH 009A     RPH      03AA1288
RTS2            DATA 2D000000 00002B00 0010008C 12CE0002 20000000 00000000 0000130E
RTS2            DATA F3E4E2C9 C2D4D9C1 4BD9C1E7 E6D2E2E3 D52D2B02 01164614 80150BE4
RTS2            DATA E2C9C2D4 D9C14BD9 C1C22000 00000913 46118015 08D9C1E7 E6D2E2E3
RTS2            DATA D5218000 00090A2C 02067BC9 D5E3C5D9 16600000 00000000 00010BE4
RTS2            DATA E2C9C2D4 D9C14BD9 C1C11C80 00000000 10CE0000 00240000 7D000000
RTS2            DATA 00000867 06008002 00670000 00000000 00000000 00000000 00000000

95.135 05/15 15:18:49.694 LOC (AB1291E7 261E4D01) (record 290)
RTSI            ASID 16   TSCBFL1 00        TSCBFL2  00        TSCBFL3  00         TSCBFL4 00       TSCBFL5  00
                          CBID    99        NAME     TSCAR     TSCB     03B13010   NLPLGTH 00BE     RPH      03AA1288
RTS2            DATA 2D000000 00002B00 001000B4 12CE8002 A0000000 EA600000 00000A2C
RTS2            DATA 02067BC9 D5E3C5D9 16600000 00000000 00010BE4 E2C9C2D4 D9C14BD9
RTS2            DATA C1C12180 00000000 07890000 06EC0000 024C0000 00000D67 06008002
RTS2            DATA 00670500 C2008613 0EF4E4E2 C9C2D4D9 C14BD9C1 E7E6D2E2 E3D50326
RTS2            DATA 8006392F B79F7F28 2B020016 46148015 0BE4E2C9 C2D4D9C1 4BD9C1C2
RTS2            DATA 20000000 000E460C 801503D9 C1C16180 0000091F 80800000 00078900
RTS2            DATA 00047700 0004BE00 0000000B 67040080 080500C2 00A80000 00000000

95.135 05/15 15:18:49.763 LOC (AB1291E7 36E14901) (record 298)
RTP             ASID 16   SWITCH  00  FLAGS   00       SEQSENT   00000000  SEQRCVD 00000000         CONNST    14
                          TIMERS  80  RETRANS 0000     SNDBYTS   00000000  RPNCBA  03A1CAB8         RPH 03AE1810

95.135 05/15 15:18:49.772 LOC (AB1291E7 39081001) (record 299)
HPRT            ASID 16   TIMRTYP S         TIMRFNC S         TIMRDUR   000003E8       FLAGS 60
                          TIMRCBS 04441020  INSTANCE  88      NAME      RPCRS          RPH   03AE1810

95.135 05/15 15:18:49.776 LOC (AB1291E7 3A07DE01) (record 300)
HCLK            ASID 16   OLDST     S       NEWST  R          TIMSTMP   AB12C78C 3A01E501 TOTTIMR 00000000
                          LIVTIMR   00000000                  LATEQ     00000000         RPH     04316808


95.135 05/15 15:18:49.776 LOC (AB1291E7 3A137D01) (record 301)
NLPO            ASID 16   TSCBFL1      00   TSCBFL2  00        TSCBFL3   00      TSCBFL4 00   TSCBFL5   00
                          CBID 99 NAME TSCWS    TSCB 03B13010  THDOFST   0008  PIUOFST 00D4   NLPLGTH 00D8 RPH 03AA1288
NLP2            DATA C408C200 8680FF00 80000001 00000088 4C0C0033 00000000 00000000
NLP2            DATA 22058000 0903E4E2 C9C2D4D9 C1000000 0500D9C1 C1000000 0326F100
NLP2            DATA 0639AB12 58F50000 0E0D0101 98000000 0D28800A 2C02067B C9D5E3C5
NLP2            DATA D9000000 0903E4E2 C9C2D4D9 C1000000 0A00D9C1 E7E6D2E2 E3D50000
NLP2            DATA 06392FB7 9F7F0000 12140000 1B832800 00000789 0000EA60 000000B4
NLP2            DATA 0B670400 80080500 C200A800 28850002 16461480 150BE4E2 C9C2D4D9
NLP2            DATA C14BD9C1 C2200000 00000E46 0C801503 D9C1C161 80000009 05220000

95.135 05/15 15:18:49.776 LOC (AB1291E7 3A159F01) (record 302)
NLP2            DATA 000036B0 00021728 000004BE 001170D8 00000000 00000000 00000000

95.135 05/15 15:18:49.796 LOC (AB1291E7 3EF5B001) (record 303)
HPR             ASID 16   TYPE   L          FUNC   C          RETCD     00              NAME  TSCSB
                          INSTANCE  84      SESCT  00000001                             RPH   03AE1810
HPR2            FLAG1 10       FLAG2 40   LUNAME USIBMRA.RAXWKSTN   NCE   00000000 00000000

95.135 05/15 15:18:49.796 LOC (AB1291E7 3EFF1701) (record 304)
RTP             ASID 16   SWITCH  11  FLAGS   00       SEQSENT   00000000  SEQRCVD 00000000         CONNST    1E
                          TIMERS  80  RETRANS 0000     SNDBYTS   00000000  RPNCBA  03A1CAB8         RPH 03AE1810

95.135 05/15 15:18:50.145 LOC (AB1291E7 944C3901) (record 305)
NLPI            ASID 16   TSCBFL1      00   TSCBFL2  00        TSCBFL3   00      TSCBFL4 00   TSCBFL5   00
                          CBID 99 NAME TSCAR    TSCB 03B131F0  THDOFST   0005  PIUOFST 0039   NLPLGTH 0039 RPH 03AA1288
NLP2            DATA C400F1FF 00000000 01000000 88000400 0D000000 00000000 00050E00
NLP2            DATA 00000100 00000000 00000000 00000000 00031000 00800000 0011B901
NLP2            DATA 90000000 00000000 00000000 00000000 00000000 00000000 00000000

95.135 05/15 15:18:50.174 LOC (AB1291E7 9B381601) (record 310)
ARB             ASID 16   INSTANCE  A       SNDRATE 00001C52  BURST     0000001D      BYTSSNT 000000D4
                                            SNDBYTS 00000F25  PKTSIZE   000000D4      RPH     03AE1010


95.135 05/15 15:18:50.768 LOC (AB1291E8 2C41F601) (record 330)
HCLK            ASID 16   OLDST     R       NEWST  R          TIMSTMP   AB12C78D 2C3CFA01 TOTTIMR 00000001
                          LIVTIMR   00000001                  LATEQ     00000000         RPH     04316808
```

Figure 72. VIT Analysis Tool Output Detail

9.4 ACF/TAP

ACF/TAP has been changed to support the ANR routing capability of NCP V7R3. The line trace, SNA summary and detail for SDLC, frame relay and token-ring have been modified to format HPR information. Details provided include the NLP header and ANR labels.

Detailed information and examples are contained in *NCP SSP EP Trace Analysis Handbook*.

9.5 Displays

In this section we are briefly discussing the displays new to VTAM V4R3 which relate to HPR functions. The three new displays are for the RTP connection major node, an individual RTP connection, and a new route test facility referred to as APING.

9.5.1 APING Display

This new function provides the capability to send test messages to a remote APPN node which can return the messages if it supports the APING facility. This application has been available for some time as a separate facility and has now been incorporated into VTAM as a display command. The results of the APING test are displayed by VTAM as shown in Figure 73 on page 96.

All APING tests will, if successful, provide information on the time taken to perform the testing as shown following **1**. In this case we can see that it took 812 milliseconds to set up the path and then we get the statistics on the transactions. If desired, it is possible to specify the size of the message (default 100 bytes), iterations (default 2) and logmode to use (default #INTER).

When VTAM uses an APPN-only route or the RTP is not set up then VTAM uses the RSCV information to display the route details **2**. Here we see information on the COS used, the VTAM nodes and HPR capability **3**. We do not see non-VTAM network nodes here. As this is an ICN node we also get the subarea routing information to the NCP (subarea 9). When VTAM already has an RTP connection, the session ID is shown in the display **6**. Displaying the session will show the RTP connection used as the adjacent link station (ALSNAME).

```
D NET,APING,ID=RAA
IST097I DISPLAY ACCEPTED
IST1489I APING SESSION INFORMATION 103
IST1490I DLU=USIBMRA.RAA SID=F7EFD164D221BB21       6
IST933I LOGMODE=#INTER  , COS=*BLANK*               2
IST875I APPNCOS TOWARDS SLU = #INTER
IST1458I ORIGIN   ADJSUB    VR       TP       ER      REVERSE ER
IST1459I    11        9      0        0        0           1
IST1460I TGN  CPNAME             TG TYPE      HPR
IST1461I  21  USIBMRA.RAA        APPN         RTP   3
IST314I END
IST1457I VTAM APING VERSION 2R33 (PARTNER TP VERSION 2R33) 104  1
IST1490I DLU=USIBMRA.RAA SID=F7EFD164D221BB21
IST1462I ECHO IS ON
IST1463I ALLOCATION DURATION: 812 MILLISECONDS
IST1464I PROGRAM STARTUP AND VERSION EXCHANGE: 219 MILLISECONDS
IST1465I         DURATION      DATA SENT   DATA RATE   DATA RATE
IST1466I      (MILLISECONDS)    (BYTES)  (KBYTE/SEC)  (MBIT/SEC)
IST1467I              83           200          2          0
IST1467I              46           200          4          0
IST1468I TOTALS:     129           400          3          0
IST1469I DURATION STATISTICS:
IST1470I MINIMUM = 46 AVERAGE = 64 MAXIMUM = 83
IST314I END
```

Figure 73. APING Display

9.5.2 RTP Major Node

ISTRTPMN is the major node used for all RTP connections. RTPs are shown in this major node (Figure 74) with their destination CP, status and name. To see the detail of individual RTPs we need to display the individual RTP.

```
D NET,ID=ISTRTPMN,E
IST097I DISPLAY ACCEPTED
IST075I NAME = ISTRTPMN, TYPE = RTP MAJOR NODE 292
IST486I STATUS= ACTIV, DESIRED STATE= ACTIV
IST1486I   RTP NAME   STATE            DESTINATION CP
IST1487I   CNR00007   CONNECTED        USIBMRA.RAXWKSTN
IST1487I   CNR00005   CONNECTED        USIBMRA.RAXWKSTN
IST1487I   CNR00004   CONNECTED        USIBMRA.RAXWKSTN
IST1487I   CNR00002   CONNECTED        USIBMRA.RAXWKSTN
IST314I END
```

Figure 74. RTP Major Node Display

9.5.3 RTP Connection Display

To see the details of an RTP connection we display the RTP name seen in the RTP major node display. The RTP is a dynamically defined PU. Figure 75 on page 97 shows a typical RTP connection running to our CM/2 workstation. This RTP has a COS of #INTER **1** and the destination is RAXWKSTN. Note that in CM/2s case the NCE is X′80′ **2** as opposed to VTAM which is X′F1′.

The route **3** for this RTP is from this VTAM (RAA), through the CNN RAB to RAXWKSTN. The route is also RTP end to end **4**. Also provided is the data rate both allowed and actual **5** over this RTP connection.

```
D NET,ID=CNR00007,E
IST097I DISPLAY ACCEPTED
IST075I NAME = CNR00007, TYPE = PU_T2.1 298
IST486I STATUS= ACTIV--LX-, DESIRED STATE= ACTIV
IST1043I CP NAME = RAXWKSTN, CP NETID = USIBMRA, DYNAMIC LU = YES
IST933I LOGMODE=***NA***, COS=#INTER     1
IST1476I TCID X'000000070000008A' - REMOTE TCID X'0000000011B91A68'
IST1481I DESTINATION CP USIBMRA.RAXWKSTN - NCE X'80'   2
IST1477I ALLOWED DATA FLOW RATE = 58 KBITS/SEC    5
IST1516I INITIAL DATA FLOW RATE = 58 KBITS/SEC
IST1511I MAXIMUM NETWORK LAYER PACKET SIZE = 1929 BYTES
IST1478I NUMBER OF UNACKNOWLEDGED BUFFERS = 0
IST1479I RTP CONNECTION STATE = CONNECTED
IST1480I RTP END TO END ROUTE      4
IST1460I TGN  CPNAME             TG TYPE      HPR    3
IST1461I  21  USIBMRA.RAB        APPN         ANR
IST1461I  21  USIBMRA.RAXWKSTN   APPN         RTP
IST231I RTP MAJOR NODE = ISTRTPMN
IST654I I/O TRACE = OFF, BUFFER TRACE = OFF
IST1500I STATE TRACE = OFF
IST355I LOGICAL UNITS:
IST080I RAXWKSTN ACT/S----Y
IST314I END
```

Figure 75. RTP Connection Display

Appendix A. Test Scenario 1

We have three VTAM hosts in this scenario: RAA, RAS, and RAB. All three VTAMs are connected together using APPN Host-to-Host Connection (AHHC) between RAA and RAB, RAA and RAS, and RAB and RAS.

RAA and RAS are pure network nodes having HPR RTP transport capability. Both of these VTAMs act as RTP endpoints in this scenario. Between RAA and RAS, the AHHC provides an HPR-capable link over which we see RTP connections.

RAB forms a CNN node which has only HPR base capability, which is to say ANR only. The ICN VTAM in a CNN has no ANR capability so the only possible role of the links from RAB to RAA and RAS is as APPN links. This allows RAB to have CP-CP sessions with both RAA and RAS, but no ANR connectivity and hence no RTP connection from RAA to RAS through RAB.

Note: RAA and RAS are the only RTP endpoints in this scenario.

A.1 VTAM RAA Definitions

RAA is a pure network node (NN). RAA has AHHC channels to RAB and to RAS.

A.1.1 Startup Definitions

ATCSTRA0

```
********************************************************************
*                                                                  *
* VTAM STARTUP OPTIONS FOR RAA                                     *
* THIS IS AN APPN NN NODE                                          *
*                                                                  *
********************************************************************
SSCPID=99,
CONFIG=AH,
SUPP=NOSUP,
NETID=USIBMRA,
HOSTPU=ISTPUSA0,
SSCPNAME=RAA,
NOTRACE,TYPE=VTAM,IOINT=0,
CSALIMIT=0,
NODETYPE=NN,
DYNLU=YES,
HPR=RTP,
CPCP=YES,
XNETALS=YES,
TNSTAT,CNSL
```

Note: HPR=RTP is the default value for node type NN. To be a pure NN it must not have HOSTSA specified.

ATCCONAH

```
MODELS,
RAABTSO,                    RAA TSO APPLICATION DEFINITIONS
RAABAPP,                    RAA NJE APPLICATION DEFINITIONS
RAABNSYS,                   RAA NETVIEW APPLICATION DEFINITIONS
RAABKAM,                    LU 6.2 REQUESTOR SERVER
RAAAHHCS,                   MPC AHHC DEFINITIONS RAA TO RAS
RAALCAS,                    APPN MPC LINK FROM RAA TO RAS
RAAAHHCB,                   MPC AHHC DEFINITIONS RAA TO RAB
RAALCAB,                    APPN MPC LINK FROM RAA TO RAB
RAAQ42                      LOCAL 3277 SNA TERMINAL DEFINITIONS
```

Note: Because this VTAM is an NN, there is no requirement for a CDRM major node or PATH definitions.

A.1.2 AHHC Definitions from RAA to RAS

To define an AHHC link, you need to define both a transport resource list major node and a local major node. Each entry (TRLE) defines a multipath channel (MPC) that can be used as an APPN connection.

RAAAHHCS

```
********************************************************************
* RTP * TRLE FOR LINK FROM RAA TO RAS                              *
********************************************************************
RAAAHHCS VBUILD  TYPE=TRL
RAAMPCS  TRLE   LNCTL=MPC,READ=(C14),WRITE=(C12)
```

RAALCAS

```
********************************************************************
* RTP * MPC LINK FROM RAA TO RAS                                   *
********************************************************************
RAALCAS  VBUILD  TYPE=LOCAL
* RTP * MPC LINK FROM RAA TO RAS
RAAPUAS  PU   TRLE=RAAMPCS,PUTYPE=2,XID=YES
```

Note: HPR=YES is the default value on the PU. Because RAS also has HPR support, this AHHC link is established as an HPR link.

A.1.3 AHHC Definitions from RAA to RAB

RAAAHHCB

```
********************************************************************
* RTP * TRLE FOR LINK FROM RAA TO RAB                              *
********************************************************************
RAAAHHCB VBUILD  TYPE=TRL
RAAMPCB  TRLE   LNCTL=MPC,READ=(C11),WRITE=(C10)
```

RAALCAB

```
********************************************************************
* RTP * MPC LINK FROM RAA TO RAB                                   *
********************************************************************
RAALCAB  VBUILD  TYPE=LOCAL
RAAPUAB  PU   TRLE=RAAMPCB,PUTYPE=2,XID=YES
```

Note: HPR=YES is the default value on the PU but, as RAB VTAM is an ICN, the AHHC link comes up without HPR support. It can only use FID2 routing between these two hosts.

A.2 VTAM RAB Definitions

We run RAB as an interchange node, because this VTAM owns subarea nodes like NCPs, forming a CNN. The CNN node is therefore defined as an ANR node, which is the only allowed value for CNN. RAB has AHHC channels to RAA and to RAS, which are both non HPR-capable links.

A.2.1 Startup Definitions

ATCSTRB0

```
*******************************************************************
*                                                                 *
* VTAM STARTUP OPTIONS FOR RAB AS AN ICN                          *
* THIS IS COMPOSITE NETWORK NODE (CNN)                            *
*                                                                 *
*******************************************************************
SSCPID=11,
CONFIG=B0,SUPP=NOSUP,CMPVTAM=0,
CPCP=YES,
VRTG=YES,
NODETYPE=NN,
INITDB=NONE,
NETID=USIBMRA,
HOSTPU=ISTPUS11,
HOSTSA=11,
SSCPNAME=RAB,
GWSSCP=NO,DYNASSCP=YES,XNETALS=YES,
SSCPDYN=YES,SSCPORD=PRIORITY,DYNLU=YES,
NOTRACE,TYPE=VTAM,IOINT=0,
CSALIMIT=0,
TNSTAT,CNSL,IOPURGE=5M,
PPOLOG=YES,
ASYDE=TERM
*******************************************************************
```

Note: HPR=ANR is the default value for node type NN when HOSTSA is coded, as in our case.

ATCCONB0

```
RABBOSYS,RABBNSYS,ADJSSCP,NGMFPS2S,RABAHHC,RABLCAK,
RABQ42,RABBTSO,RABBAPP,RA$BVMD,RABBTCP,RABBCICS,
RA$RCICS,RABAPPC,RABB4700,RALNM11,MODELS,RABEOA,
RA$WRA,RA$WMK,RA$WSC1,RA$RRAP,RA$RRA3,RA$RSC,RA$RRAI,
RAB3172,LORETTA,RABAP1,FNMSYRN1,RABAP621,
RABCRAK,LABLNM,RA2RS6KY,CWSMSAA,
RA7NCPX,
RABAHHCA,                    MPC AHHC DEFINITIONS RAB TO RAA
RABLCAA,                     APPN MPC LINK FROM RAB TO RAA
RABAHHCS,                    MPC AHHC DEFINITIONS RAB TO RAS
RABLCAS                      APPN MPC LINK FROM RAB TO RAS
```

Note: The last four lines (which have comments) were added to ATCCONB0 to include the AHHC definitions we need in our test scenario.

A.2.2 AHHC Definitions from RAB to RAA

RABAHHCA

```
*********************************************************************
* RTP * TRLE FOR LINK FROM RAB TO RAA                               *
*********************************************************************
RABAHHCA VBUILD  TYPE=TRL
RABMPCA  TRLE   LNCTL=MPC,READ=(C10),WRITE=(C11)
```

RABLCAA

```
*********************************************************************
* RTP * MPC LINK FROM RAB TO RAA                                    *
*********************************************************************
RABLCAA  VBUILD  TYPE=LOCAL
* APPN MPC LINK FROM RAB TO RAA
RAAPUBA  PU   TRLE=RABMPCA,PUTYPE=2,XID=YES
```

Note: This link does not come up as an HPR link because the ICN VTAM in the CNN has no ANR capability for local SNA major nodes.

A.2.3 AHHC Definitions from RAB to RAS

RABAHHCS

```
*********************************************************************
* RTP * TRLE FOR LINK FROM RAB TO RAS                               *
*********************************************************************
RABAHHCS VBUILD  TYPE=TRL
RABMPCS  TRLE   LNCTL=MPC,READ=(C09),WRITE=(C08)
```

RABLCAS

```
*********************************************************************
* RTP * MPC LINK FROM RAB TO RAS                                    *
*********************************************************************
RABLCAS  VBUILD  TYPE=LOCAL
RABPU89  PU   TRLE=RABMPCS,PUTYPE=2,XID=YES
```

Note: This link does not come up as an HPR link, because the ICN VTAM in the CNN has no ANR capability for local SNA major nodes.

A.3 VTAM RAS Definitions

We run RAS as a pure network node (NN). RAS has AHHC channels to RAB and to RAA.

A.3.1 Startup Definitions

ATCSTRSH

```
******************************************************************
*                                                                *
* VTAM STARTUP OPTIONS FOR RAS                                   *
* THIS IS APPN NN NODE                                           *
*                                                                *
******************************************************************
CONFIG=SH,
CONNTYPE=APPN,
CPCP=YES,
CSALIMIT=0,
DYNADJCP=YES,
DYNLU=YES,
HOSTPU=ISTPUS28,
NCPBUFSZ=2048,
NETID=USIBMRA,
SSCPNAME=RAS,
NODETYPE=NN,
NOTRACE,TYPE=VTAM,IOINT=0,
PPOLOG=YES,
SORDER=APPN,
SSCPID=28,
SUPP=NOSUP,
HPR=RTP,
XNETALS=YES
```

Note: HPR=RTP is the default value for node type NN when HOSTSA is not coded, as in our case.

ATCCONSH

```
RASBTSO,                     RAS TSO APPLICATION DEFINITIONS
RASBAPP,                     RAS NJE APPL DEFS
RASBNSYS,                    RAS NETVIEW APPL DEFS
RASAPPC,                     APPC APPLICATION DEFINITIONS
RASP42,                      LOCAL 3277 SNA TERMINAL DEFINITIONS
RASAHHCA,                    MPC AHHC DEFINITIONS RAS TO RAA
RASLCAA,                     APPN MPC LINK FROM RAS TO RAA
RASAHHCB,                    MPC AHHC DEFINITIONS RAS TO RAB
RASLCAB,                     APPN MPC LINK FROM RAS TO RAB
MODELS
```

Note: Because this VTAM is an NN, there is no requirement for a CDRM major node or PATH definitions.

A.3.2 AHHC Definitions from RAS to RAA

RASAHHCA

```
*******************************************************************
* RTP * TRLE FOR LINK FROM RAS TO RAA                             *
*******************************************************************
RASAHHCA VBUILD  TYPE=TRL
RASMPCA  TRLE   LNCTL=MPC,READ=(C12),WRITE=(C14)
```

RASLCAA

```
*******************************************************************
* RTP * MPC LINK FROM RAS TO RAA                                  *
*******************************************************************
RASLCAA  VBUILD  TYPE=LOCAL
RASPUSA  PU   TRLE=RASMPCA,PUTYPE=2,XID=YES
```

Note: HPR=YES is the default value on the PU. Because RAS also has HPR support, this AHHC link is established as an HPR link.

A.3.3 AHHC Definitions from RAS to RAB

RASAHHCB

```
*******************************************************************
* RTP * TRLE FOR LINK FROM RAS TO RAB                             *
*******************************************************************
RASAHHCB VBUILD  TYPE=TRL
RASMPCB  TRLE   LNCTL=MPC,READ=(C08),WRITE=(C09)
```

RASLCAB

```
*******************************************************************
* RTP * MPC LINK FROM RAS TO RAB                                  *
*******************************************************************
RASLCAB  VBUILD  TYPE=LOCAL
RASPUSB  PU   TRLE=RASMPCB,PUTYPE=2,XID=YES
```

Note: HPR=YES is the default value on the PU but, as RAB VTAM is an ICN, the AHHC link comes up without HPR support. It can only use FID2 routing between these two hosts.

Appendix B. Test Scenario 2

We have three VTAM hosts in this scenario: RAA, RAS, and RAB. RAA and RAS are connected together using APPN host-to-host connection (AHHC) between them.

RAA and RAS, as pure network nodes, have HPR transport capability. Both these VTAMs act as RTP endpoints in this scenario. Between RAA and RAS the AHHC provides an HPR-capable link over which we can have RTP connections. As a CNN node, RAB has HPR base functions and provides ANR routing over NCPs. An RTP connection can also be established between RAA and RAS over this CNN node RAB.

RAB and the NCPs form a CNN node which has ANR routing capability. In this scenario we have local channel links from RAA to RA9NCPX (subarea 9) and from RAS to RA7NCPX (subarea 7). These NCPs, which are connected to each other over a MLTG, are activated from RAB. This allows RAB to have CP-CP sessions with both RAA and RAS, and ANR routing is now supported by NCPs under the control of ICN VTAM RAB in addition to FID2 routing.

Note: RAA and RAS are the only RTP endpoints in this scenario. And VTAM ICN node RAB with NCPs attached to it forms, in this scenario, an single ANR capable node. An RTP connection between endpoints RAA and RAS, can use either AHHC link between them, or they can also establish an RTP connection through the CNN node RAB, which is ANR capable.

B.1 VTAM RAA Definitions

RAA is a pure network node (NN). RAA has an AHHC link to RAS and local channel attachment to ICN RAB through the NCP RA9NCPX, which are now both HPR-capable links.

B.1.1 Startup Definitions

ATCSTRAI

```
*******************************************************************
*                                                                 *
* VTAM STARTUP OPTIONS FOR RAA                                     *
* THIS IS APPN NN NODE                                            *
*                                                                 *
*******************************************************************
SSCPID=99,
CONFIG=AI,
SUPP=NOSUP,
NETID=USIBMRA,
HOSTPU=ISTPUSA0,
SSCPNAME=RAA,
NOTRACE,TYPE=VTAM,IOINT=0,
CSALIMIT=0,
NODETYPE=NN,
DYNLU=YES,
HPR=RTP,
CPCP=YES,
XNETALS=YES,
TNSTAT,CNSL
```

ATCCONAI

```
MODELS,
RAABTSO,                     RAA TSO APPLICATION DEFINITIONS
RAABAPP,                     RAA NJE APPLICATION DEFINITIONS
RAABNSYS,                    RAA NETVIEW APPLICATION DEFINITIONS
RAABKAM,                     LU 6.2 REQUESTOR SERVER
RAAAHHCS,                    MPC AHHC DEFINITIONS RAA TO RAS
RAALCAS,                     APPN MPC LINK FROM RAA TO RAS
RAACRA9,                     APPN CHANNEL TO RAB VIA NCP SA 9
RAAQ42                       LOCAL 3277 SNA TERMINAL DEFINITIONS
* RAAAHHCB                   MPC AHHC DEFINITIONS RAA TO RAB
* RAALCAB                    APPN MPC LINK FROM RAA TO RAB
```

Note: RAACRA9 defines a connection to RAB through NCP. The AHHC is not used in this scenario between RAA and RAB.

B.1.2 AHHC Definitions from RAA to RAS

This is the AHHC link between RAA and RAS. (Refer to A.1.2, AHHC Definitions from RAA to RAS which are covered in Appendix A, "Test Scenario 1" on page 101.)

RAAAHHCS

```
********************************************************************
* RTP * TRLE FOR LINK FROM RAA TO RAS                              *
********************************************************************
RAAAHHCS VBUILD  TYPE=TRL
* RTP * MPC LINK FROM RAA TO RAS
RAAMPCS  TRLE   LNCTL=MPC,READ=(C14),WRITE=(C12)
```

RAALCAS

```
********************************************************************
* RTP * MPC LINK FROM RAA TO RAS                                   *
********************************************************************
RAALCAS  VBUILD  TYPE=LOCAL
* RTP * MPC LINK FROM RAA TO RAS
RAAPUAS  PU   TRLE=RAAMPCS,PUTYPE=2,XID=YES
```

Note: HPR=YES is a default value for PU. Because the RAS also has HPR support, this AHHC link will established as an HPR link.

B.1.3 Local Channel Definitions RAA to RA9NCPX

RAACRA9

```
**********************************************************************
*                                                                    *
*  APPN CHANNEL LINK FROM RAA TO NCP SA9 (RA9NCPX)                   *
*                                                                    *
**********************************************************************
RAACE2B  VBUILD TYPE=LOCAL
RAAPE2B  PU    CUADDR=E2B,PUTYPE=2,XID=YES,MAXBFRU=15,
               HPR=YES   (DEFAULT VALUE)
```

Note: HPR=YES is a default value for PU. NCP subarea 9 (RA9NCPX) is HPR-capable, so this link supports ANR routing for HPR connections and FID2 routing for APPN sessions originating in the CNN such as the LU-LU and the CP-CP sessions.

B.2 VTAM RAB Definitions

RAB is an ICN and it has two HPR-capable NCPs RA7NCPX and RA9NCPX. These NCPs under the control of ICN VTAM form a CNN called RAB, which supports ANR routing. RAA has a channel link to RA9NCPX and RAS to RA7NCPX.

B.2.1 Startup Definitions

ATCSTRB0

```
*******************************************************************
*                                                                 *
* VTAM STARTUP OPTIONS FOR RAB                                    *
* THIS IS COMPOSITE NETWORK NODE (CNN)                            *
*                                                                 *
*******************************************************************
SSCPID=11,
CONFIG=B0,SUPP=NOSUP,CMPVTAM=0,
CPCP=YES,
VRTG=YES,
NODETYPE=NN,
INITDB=NONE,
NETID=USIBMRA,
HOSTPU=ISTPUS11,
HOSTSA=11,
SSCPNAME=RAB,
GWSSCP=NO,DYNASSCP=YES,XNETALS=YES,
SSCPDYN=YES,SSCPORD=PRIORITY,DYNLU=YES,
NOTRACE,TYPE=VTAM,IOINT=0,
CSALIMIT=0,
TNSTAT,CNSL,IOPURGE=5M,
PPOLOG=YES,
ASYDE=TERM
*******************************************************************
```

Note: HPR=ANR is a default value for node type NN, when HOSTSA is coded, as in our case.

ATCCONB0

```
RABBOSYS,RABBNSYS,ADJSSCP,NGMFPS2S,RABAHHC,RABLCAK,
RABQ42,RABBTSO,RABBAPP,RA$BVMD,RABBTCP,RABBCICS,
RA$RCICS,RABAPPC,RABB4700,RALNM11,MODELS,RABEOA,
RA$WRA,RA$WMK,RA$WSC1,RA$RRAP,RA$RRA3,RA$RSC,RA$RRAI,
RAB3172,LORETTA,RABAP1,FNMSYRN1,RABAP621,
RABCRAK,LABLNM,RA2RS6KY,CWSMSAA,
RA7NCPX,                     NCP SUBAREA 7 (HPR CAPABLE)
RA9NCPX,                     NCP SUBAREA 9 (HPR CAPABLE)
* RABAHHCA                   MPC AHHC DEFINITIONS RAB TO RAA
* RABLCAA                    APPN MPC LINK FROM RAB TO RAA
* RABAHHCS                   MPC AHHC DEFINITIONS RAB TO RAS
* RABLCAS                    APPN MPC LINK FROM RAB TO RAS
```

Note: In this test scenario, we only use the NCP HPR support under the control of the VTAM RAB. These NCPs are RA7NCPX and RA9NCPX.

B.2.2 NCP RA7NCPX Definitions

```
NCPOPT   OPTIONS NEWDEFN=(YES,ECHO,NOSUPP),USERGEN=FNMNDFGN
*--------------------------------------------------------------------*
*       PCCU     RAB (BCCA)                                          *
*--------------------------------------------------------------------*
VTAMV311 PCCU CUADDR=E2A,                                             *
               AUTODMP=NO,        ONLY ONE AUTODMP-HOST IF TWINTAIL   *
               AUTOIPL=NO,        ONLY ONE AUTOIPL-HOST IF TWINTAIL   *
               AUTOSYN=YES,       USE THE ALREADY LOADED NCP IF OK    *
               BACKUP=YES,        RESOURCE TAKEOVER PERMITTED         *
               CHANCON=COND,      CONDITIONAL CONTACT REQ. TO NCP SENT*
               DUMPDS=NCPDUMP,    DUMP DATASET                        *
               MDUMPDS=NCPDMOSS,  MOSS DUMP DATASET                   *
               CDUMPDS=NCPDCSP,   SCANNER DUMP DATASET                *
               MAXDATA=5000,                                          *
               OWNER=RAB,                                             *
               VFYLM=YES,         VERIFY LMOD WHEN LOADING            *
               SUBAREA=11
**********************************************************************
*       BUILD MACRO SPECIFICATIONS                                   *
**********************************************************************
NCPBUILD BUILD BFRS=(240),        NCP BUFFER SIZE                     *
               ERLIMIT=16,                                       *AK  *
               DSABLTO=6.5,                                           *
               DYNPOOL=25,        ALLOW FOR DYNAMIC EXPANSIONS        *
               ENABLTO=6.5,       IBM 386X REQUIRE 6.5 AS MINIMUM     *
               HPR=YES,           HPR CAPABLE                       7.3*
               HPRMPS=2000,       MAXIMUM PACKET SIZE ACROSS SNA    7.3*
               LTRACE=4,          SIT FOR 4 LINES                     *
               ADDSESS=300,       PU2.1 SUPPORT                       *
               AUXADDR=300,       PU2.1 SUPPORT                       *
               LOADLIB=NCPLOAD,   NCP LOAD MODULE LIBRARY             *
               MAXSESS=5000,      MAX NUMBER SESSIONS FOR ILU         *
               MAXSSCP=8,                                             *
               MODEL=3745-61A,    3745 COMMUNICATION CONTROLLER       *
               NAMTAB=50,         MAX NUMBER NETWORKS,SSCP,CP T2.1    *
               NETID=USIBMRA,     REQUIRED                            *
               NEWNAME=RA7NCPX,   NAME OF THIS LOAD MODULE            *
               NUMHSAS=6,         6 HOSTS MAY COMMUNICATE CONCURRENTLY*
               PATHEXT=20,        DYNAMIC PATHES                      *
               PUNAME=RA7NCPX,    NAME OF THIS PU                     *
               SUBAREA=07,        SUBAREA ADDRESS = 07                *
               TYPGEN=NCP,        NCP ONLY                            *
               TYPSYS=MVS,        MVS OPERATING SYSTEM                *
               USGTIER=5-TD,      NCP USAGE TIER                      *
               VERSION=V7R3F,     NCP V7.3, WITH 3746-900 SUPPORT     *
               T1TIMER=(1.5,1.5)
*
**********************************************************************
*       SYSCNTRL MACRO SPECIFICATIONS                                *
**********************************************************************
NCPSYSC  SYSCNTRL OPTIONS=(STORDSP)
*
**********************************************************************
```

```
*      HOST MACRO SPECIFICATIONS - VTAM ONLY                          *
**********************************************************************
MO7RAB   HOST MAXBFRU=34,          UP TO 34 VTAM BUFFERS SHIPPED       *
               UNITSZ=384,         VTAM IO BUFFERS SIZE                *
               BFRPAD=0,           BUFFER PAD                          *
               SUBAREA=11          CHANNEL ATTACHED HOSTSA
*
**********************************************************************
*        DYNAMIC RECONFIGURATION POOL SPACE                           *
**********************************************************************
*
DRPOOLPU PUDRPOOL NUMBER=16,       CAN ADD 16 PUS                      *
               FRSEDRPU=8          OF WHICH 8 FRSE
*
DRPOOLLU LUDRPOOL NUMTYP1=10,      RESERVE 10 LUS ON PU.T1 PUS         *
               NUMTYP2=500,        RESERVE  500  LUS ON PU.T2 PUS      *
               NUMILU=50           RESERVE 50 INDEPENDANT LUS
**********************************************************************
* NCP PATH DEFINITIONS FOR RA7NCPX                                    *
**********************************************************************
         PATH DESTSA=9,                                                *
               ER0=(9,1,5000,5000,5000,20000),                         *
               VR1=0,ER6=(9,1),VR6=6,                                  *
               VRPWS10=(1,30),VRPWS11=(1,30),VRPWS12=(1,30)
         PATH DESTSA=11,                                               *
               ER0=(25,1),ER1=(11,1),                                  *
               VR0=1,                                                  *
               VRPWS00=(1,30),VRPWS01=(1,30),VRPWS02=(1,30),           *
               VR1=0,                                                  *
               VRPWS10=(3,90),VRPWS11=(3,90),VRPWS12=(3,90)
**********************************************************************
*        SDLCST STATEMENTS FOR CONFIGURABLE LINK STATIONS             *
**********************************************************************
SDL07PRI SDLCST GROUP=G07XPRI,                                         *
               MODE=PRI,                                               *
               RETRIES=(7,3,5),                                        *
               MAXOUT=127,                                             *
               PASSLIM=254
*
SDL07SEC SDLCST GROUP=G07XSEC,                                         *
               MODE=SEC,                                               *
               RETRIES=(7),                                            *
               MAXOUT=127,                                             *
               PASSLIM=254
*
**********************************************************************
*        GROUP DEFINITION FOR SDLC SELECTION TABLE ENTRY              *
**********************************************************************
G07XPRI  GROUP LNCTL=SDLC,                                             *
               MODE=PRI,                                               *
               REPLYTO=3,                                              *
               ACTIVTO=180,                                            *
               DIAL=NO,                                                *
               RETRIES=(7,4,5),                                        *
               TYPE=NCP
G07XSEC  GROUP LNCTL=SDLC,                                             *
               MODE=SEC,                                               *
               ACTIVTO=180,                                            *
               DIAL=NO,                                                *
```

```
              RETRIES=(7,0,0),                                        *
              TYPE=NCP
*
**********************************************************************
*        NON-SWITCHED POINT-TO-POINT INN LINKS                       *
*        RA7/RA9  ( 272 <-> 080 )                                    *
**********************************************************************
G07NSINN GROUP LNCTL=SDLC,                                            *
              DIAL=NO,                                                *
              REPLYTO=1,                                              *
              NPATP=YES,                                              *
              TYPE=NCP
*
L07272   LINE ADDRESS=(272,FULL),   LINE ADDRESS                      *
              CLOCKNG=EXT,        MODEM PROVIDES CLOCK ####           *
              DUPLEX=FULL,        MODEM STRAPPING IS FULL             *
              IPL=YES,            LOADING OVER THIS LINK CAN BE DONE  *
              LPDATS=LPDA2,       SUPPORT LPDA-2 FUNCTIONS            *
              MONLINK=YES,        MONITOR LINK FOR ACTPU              *
              NRZI=YES,                                               *
              PAUSE=(0.2,2.8),    DEFAULT                             *
              SDLCST=(SDL07PRI,SDL07SEC),                             *
              RETRIES=(7,7,17),   TIME OUT OCCURS AFTER 4 MINUTES     *
              SERVLIM=254,                                            *
              SPEED=9600,         9.6KBPS                             *
              SRT=(,64),                                              *
              ISTATUS=ACTIVE      INITIAL STATUS
*
P07272   PU MAXOUT=127,           MAX PIU'S SENT BEFORE RESP REQ      *
              MODULO=128,                                             *
              PUTYPE=4,           PHYSICAL UNIT TYPE 3745             *
              ISTATUS=ACTIVE,     INITIAL STATUS                      *
              TGN=1,              TRANSMISSION GROUP 1                *
              ANS=CONTINUE        DON'T BREAK THE X-DOMAIN SESSIONS
*
**********************************************************************
*        PARALLEL CHANNEL ADAPTER LINKS                              *
**********************************************************************
G07CA    GROUP LNCTL=CA,                                              *
              ISTATUS=INACTIVE    STOP VTAM ACTIVATING CHANNEL LINK
*
**********************************************************************
*       CHANNEL ADAPTER LINK FOR SUBAREA 11 (CONNECTION NETWORK NODE) *
**********************************************************************
L07CA5   LINE ADDRESS=00,         1ST CA PHYSICAL POSITION            *
              ISTATUS=ACTIVE,                                         *
              CA=TYPE6,           CHANNEL ADAPTER TYPE 6              *
              CASDL=120,                                              *
              DELAY=0.0,          CHAN ATTNDELAY                      *
              DYNADMP=NONE,                                           *
              NCPCA=ACTIVE,       NATIVE SUBCHANNEL (NSC) ACTIVE      *
              TIMEOUT=120         INTERVAL BEFORE CHANNEL DISCONTACT
*
P07CA5   PU PUTYPE=5,            INTERMEDIATE SUBAREA FUNCTION        *
              TGN=1               MUST BE ONE FOR PU TYPE 5
*
**********************************************************************
*       CHANNEL ADAPTER LINK FOR APPN                                *
```

```
*********************************************************************
L07CA6   LINE ADDRESS=01,         2ND CA PHYSICAL POSITION          *
               ISTATUS=ACTIVE,    8825 CHANNEL ADAPTER TYPE         *
               CA=TYPE6,          8825 CHANNEL ADAPTER TYPE         *
               CASDL=120,         INTERNAL BEFORE CHANNEL SLOWDOWN  *
               DELAY=0.0,         CHAN ATTNDELAY                    *
               ANS=CONT,                                            *
               HPR=YES,           (THIS IS THE DEFAULT)             *
               DYNADMP=NONE,                                        *
               NCPCA=ACTIVE,      NATIVE SUBCHANNEL (NSC) ACTIVE    *
               TIMEOUT=120        INTERVAL BEFORE CHANNEL DISCONTACT
*
P07CA6   PU PUTYPE=2,             APPN CHANNEL LINK                 *
               HPR=YES,           THIS IS A VTAM KEYWORD FOR HPR    *
               HPRQLIM=0,         THIS CAN BE DEFINED IN PU BASES   *
               XID=YES
*
*********************************************************************
         GENEND INIT=ECLINIT,                                       *
               TMRTICK=ECLTICK,                                     *
               UGLOBAL=ECLUGBL
```

Notes:

1. NCP BUILD macro has new keywords related to HPR.
2. HPR=YES is default for PUs.
3. Channel link definition for RAS is L07CA6 (at the end of this NCP generation deck).

B.2.3 NCP RA9NCPX Definitions

```
NCPOPT   OPTIONS NEWDEFN=(YES,ECHO,NOSUPP),USERGEN=(FNMNDFGN)
*---------------------------------------------------------------------*
*       PCCU     RAB                                                  *
*---------------------------------------------------------------------*
VTAMV323 PCCU CUADDR=E23,         CHANNEL ADDRESS                      *
               AUTODMP=NO,        ONLY ONE AUTODMP-HOST IF TWINTAIL    *
               AUTOIPL=NO,        ONLY ONE AUTOIPL-HOST IF TWINTAIL    *
               AUTOSYN=YES,       USE THE ALREADY LOADED NCP IF OK     *
               BACKUP=YES,        RESOURCE TAKEOVER PERMITTED          *
               DUMPDS=NCPDUMP,    DUMP DATASET                         *
               MDUMPDS=NCPDMOSS,  MOSS DUMP DATASET                    *
               CDUMPDS=NCPDCSP,   SCANNER DUMP DATASET                 *
               CHANCON=COND,      CONDITIONAL CONTACT REQ. TO NCP SENT*
               MAXDATA=5000,                                           *
               OWNER=RAB,                                              *
               VFYLM=YES,         VERIFY LMOD WHEN LOADING             *
               SUBAREA=11
*
**********************************************************************
*       BUILD MACRO - NCP/CONTROLLER INFORMATION                      *
**********************************************************************
         BUILD BFRS=(240),                  NCP BUFFER SIZE            *
               AUXADDR=50,                                             *
               MEMSIZE=4M,                  4 MEGABYTES                *
               CWALL=26,          RNR LIMIT FOR INN TRAFFIC            *
               DSABLTO=6.5,                                            *
               DYNPOOL=10,        ALLOW FOR DYNAMIC EXPANSIONS         *
               ENABLTO=6.5,       IBM 386X REQUIRE 6.5 AS MINIMUM      *
               ERLIMIT=16,        NCP SUPPORTS 16 EXPLICIT ROUTES      *
               LTRACE=4,          SIT FOR 4 LINES                      *
               LOADLIB=NCPLOAD,   NCP LOAD MODULE LIBRARY              *
               MAXSSCP=8,         8 SSCP'S CAN ACTIVATE THIS NCP       *
               MODEL=3745-170,    3745-170 COMMUNICATION CONTROLLER    *
               NETID=USIBMRA,     REQUIRED                             *
               NEWNAME=RA9NCPX,   NAME OF THIS LOAD MODULE             *
               NPA=NO,                                                 *
               NUMHSAS=6,         6 HOSTS MAY COMMUNICATE CONCURRENTLY*
               PUNAME=RA9NCPX,    NAME OF THIS PU                      *
               SUBAREA=09,        SUBAREA ADDRESS = 09                 *
               TRACE=(YES,64),    64 ADDRESS-TRACE ENTRIES             *
               TYPGEN=NCP,        CHANNEL ATTACHED  NCP                *
               TYPSYS=MVS,        MVS OPERATING SYSTEM                 *
               USGTIER=3,         NCP USAGE TIER                       *
               VERSION=V7R3       NDF VERSION INDICATOR
*
**********************************************************************
*       SYSCNTRL MACRO SPECIFICATIONS                                 *
**********************************************************************
NCPSYSC  SYSCNTRL OPTIONS=(STORDSP)
**********************************************************************
*       HOST MACRO - CHANNEL ATTACHED HOST DEFINITION                 *
**********************************************************************
M09RAB   HOST INBFRS=10,          NCP BUFFERS ALLOCATION               *
               MAXBFRU=34,        UP TO 34 VTAM BUFFERS SHIPPED        *
               UNITSZ=152,        VTAM IOBUFFER SIZE                   *
               BFRPAD=0,          BUFFER PAD                           *
```

```
               SUBAREA=11          CHANNEL ATTACHED HOST SUBAREA
*
***********************************************************************
*        DYNAMIC RECONFIGURATION POOL SPACE                           *
***********************************************************************
*
DRPOOLPU PUDRPOOL NUMBER=50        CAN ADD 8 PUS
*
DRPOOLLU LUDRPOOL NUMILU=32,                                            *
               NUMTYP1=10,                                              *
               NUMTYP2=250         RESERVE 250 LUS ON PU.T2 PUS
***********************************************************************
* PATH DEFINITIONS FOR RA9NCPX                                        *
***********************************************************************
* RA9NCP   NCPPATH    NETID=USIBMRA
         PATH DESTSA=7,                                                 *
               ER0=(7,1,5000,5000,5000,20000),                          *
               VR1=0,ER6=(7,1),VR6=6,                                   *
               VRPWS10=(1,30),VRPWS11=(1,30),VRPWS12=(1,30)
         PATH DESTSA=11,                                                *
               ER0=(18,1),ER1=(11,1),                                   *
               VR0=1,                                                   *
               VRPWS00=(1,30),VRPWS01=(1,30),VRPWS02=(1,30),            *
               VR1=0,                                                   *
               VRPWS10=(3,90),VRPWS11=(3,90),VRPWS12=(3,90)
*
***********************************************************************
*        SDLCST STATEMENTS FOR SDLC                                   *
***********************************************************************
SDL09PRI SDLCST GROUP=G09XPRI,                                          *
               MODE=PRI,                                                *
               RETRIES=(7,3,5),                                         *
               MAXOUT=7,                                                *
               PASSLIM=254
SDL09SEC SDLCST GROUP=G09XSEC,                                          *
               MODE=SEC,                                                *
               RETRIES=(7),                                             *
               MAXOUT=7,                                                *
               PASSLIM=254
*
***********************************************************************
*        GROUP DEFINITION FOR SDLC SELECTION TABLE ENTRY              *
***********************************************************************
G09XPRI  GROUP LNCTL=SDLC,                                              *
               MODE=PRI,                                                *
               REPLYTO=3,                                               *
               ACTIVTO=180,                                             *
               DIAL=NO,                                                 *
               RETRIES=(7,4,5),                                         *
               TYPE=NCP
G09XSEC  GROUP LNCTL=SDLC,                                              *
               MODE=SEC,                                                *
               ACTIVTO=180,                                             *
               DIAL=NO,                                                 *
               RETRIES=(7,0,0),                                         *
               TYPE=NCP
*
***********************************************************************
*        SDLC INN CONNECTIONS                                         *
```

```
*        9.6 KBPS  (INN LINK) --> SA=07                                 *
***********************************************************************
G09NSINN GROUP LNCTL=SDLC,                                              *
               DIAL=NO,                                                 *
               REPLYTO=60,                                              *
               TYPE=NCP
*
L09080   LINE ADDRESS=(080,FULL),  LINE ADDRESS                         *
               CLOCKNG=EXT,        EXTERNAL CLOCKING                    *
               DUPLEX=FULL,        MODEM STRAPPING IS FULL              *
               IPL=YES,            LOADING OVER THIS LINK CAN BE DONE   *
               MLTGPRI=32,                                              *
               MONLINK=YES,        MONITOR LINK FOR ACTPU               *
               NRZI=YES,                                                *
               PAUSE=(0.2,2.8),    DEFAULT                              *
               SDLCST=(SDL09PRI,SDL09SEC),                              *
               RETRIES=(7,7,17),   TIME OUT OCCURS AFTER 4 MINUTES      *
               SERVLIM=254,                                             *
               SPEED=9600,         LINE SPEED                           *
               SRT=(,64),                                               *
               ISTATUS=ACTIVE      INITIAL STATUS
*
P09080   PU MAXOUT=127,            MAX PIU'S SENT BEFORE RESP REQ       *
               MAXDATA=2044,                                            *
               MODULO=128,                                              *
               PUTYPE=4,           PHYSICAL UNIT TYPE REMOTE 3725       *
               ISTATUS=ACTIVE,     INITIAL STATUS                       *
               TGCONF=MULTI,                                            *
               TGN=1,              TRANSMISSION GROUP 1                 *
               ANS=CONTINUE        DON'T BREAK THE X-DOMAIN SESSIONS
*
***********************************************************************
* NTRI PHYSICAL DEFINITIONS
***********************************************************************
G09089PT GROUP ECLTYPE=(PHYSICAL,ANY),                                  *
               ADAPTER=TIC2,                                            *
               TYPE=NCP,                                                *
               DIAL=NO,                                                 *
               LNCTL=SDLC,                                              *
               LEVEL2=ECLNARL2,                                         *
               LEVEL3=ECLNARL3,                                         *
               LEVEL5=NCP,                                              *
               TIMER=(ECLNART1,,ECLNART2,ECLNART3),                     *
               XIO=(ECLNARXL,ECLNARXS,ECLNARXI,ECLNARXK),               *
               USERID=(5668854,ECLRBDT,NORECMS,,ECLNMVT),               *
               SPEED=9600,                                              *
               NPACOLL=NO,                                              *
               PUTYPE=1,                                                *
               PUDR=NO,                                                 *
               COMPTAD=YES,                                             *
               COMPSWP=YES,                                             *
               COMPOWN=YES
*
L09089PT LINE ADDRESS=(1089,FULL),                                      *
               PORTADD=1,                                               *
               LOCADD=400001090001,                                     *
               TRSPEED=4,                                               *
               RCVBUFC=8192,                                            *
               MAXTSL=4060,                                             *
```

```
               SPEED=9600,                                                *
               UACB=(X$P2AX,X$P2AR)
*
P09089PT PU ADDR=01,                                                      *
               INNPORT=YES,                                               *
               ANS=CONTINUE
*
***********************************************************************
G09089LP GROUP ECLTYPE=LOGICAL,                                           *
               AUTOGEN=13,                                                *
               CALL=INOUT,                                                *
               PHYPORT=1,                                                 *
               TYPE=NCP,                                                  *
               DIAL=YES,                                                  *
               LNCTL=SDLC,                                                *
               LEVEL2=ECLNAVL2,                                           *
               LEVEL3=ECLNAVL3,                                           *
               LEVEL5=NCP,                                                *
               XIO=(ECLNAVXL,ECLNAVXS,ECLNAVXI,ECLNAVXK),                 *
               USERID=(5668854,ECLFTDT,NORECMS,,ECLNMVT),                 *
               LINEADD=NONE,                                              *
               LINEAUT=YES,                                               *
               NPACOLL=NO,                                                *
               PUTYPE=2,                                                  *
               XMITDLY=NONE,                                              *
               COMPOWN=YES,                                               *
               RETRIES=(6,0,0,6)
*
***********************************************************************
         IGNORE     * LINES BETWEEN IGNORE/NOIGNORE WILL BE REGENERATED
* GENERATED BY NDF
J0009001 LINE UACB=X$L2A
* GENERATED BY NDF
J0009002 PU
* GENERATED BY NDF
J0009003 LINE UACB=X$L3A
* GENERATED BY NDF
J0009004 PU
* GENERATED BY NDF
*        :
*        :
*        :
J0009019 LINE UACB=X$L14A
* GENERATED BY NDF
J000901A PU
         NOIGNORE   * LINES BETWEEN IGNORE/NOIGNORE WILL BE REGENERATED
***********************************************************************
*       CHANNEL ADAPTER LINKS SECTION                                 *
* ------------------------------------------------------------------- *
*        PORT    LINE     PU        CA POS.     DESCRIPTION           *
*        ----    -------  --------  -------     -----------------     *
*         01     L09CA11  P09CA11      6        CUA E23 RAB SA11      *
*         01     L09CAXX  P09CAXX      7        APPN LINK             *
***********************************************************************
G09CA    GROUP LNCTL=CA,                                                  *
               ISTATUS=INACTIVE    STOP VTAM ACTIVATING CHANNEL LINK
*
L09CA11  LINE ADDRESS=P6,          1ST CA PHYSICAL POSITION 6             *
               ISTATUS=ACTIVE,     8825 CHANNEL ADAPTER TYPE              *
```

```
              CA=TYPE6,          8825 CHANNEL ADAPTER TYPE          *
              CASDL=120,         INTERNAL BEFORE CHANNEL SLOWDOWN   *
              DELAY=0.0,         CHAN ATTNDELAY                     *
              DYNADMP=NONE,                                         *
              NCPCA=ACTIVE,      NATIVE SUBCHANNEL (NSC) ACTIVE     *
              TIMEOUT=120        INTERVAL BEFORE CHANNEL DISCONTACT
*
P09CA11  PU PUTYPE=5,           INTERMEDIATE SUBAREA FUNCTION       *
              TGN=1              MUST BE ONE FOR PU TYPE 5
*
*********************************************************************
*       CHANNEL ADAPTER LINK FOR APPN                               *
*********************************************************************
L09CA10  LINE ADDRESS=P5,        2ND CA PHYSICAL POSITION 5         *
              ISTATUS=ACTIVE,    8825 CHANNEL ADAPTER TYPE          *
              CA=TYPE6,          8825 CHANNEL ADAPTER TYPE          *
              CASDL=120,         INTERNAL BEFORE CHANNEL SLOWDOWN   *
              DELAY=0.0,         CHAN ATTNDELAY                     *
              ANS=CONT,                                             *
              HPR=YES,           (THIS IS THE DEFAULT)              *
              DYNADMP=NONE,                                         *
              NCPCA=ACTIVE,      NATIVE SUBCHANNEL (NSC) ACTIVE     *
              TIMEOUT=120        INTERVAL BEFORE CHANNEL DISCONTACT
*
P09CA10  PU PUTYPE=2,            APPN CHANNEL LINK                  *
              HPR=YES,           THIS IS A VTAM KEYWORD FOR HPR     *
              HPRQLIM=0,         THIS CAN BE DEFINED IN PU BASES    *
              XID=YES
*
*********************************************************************
*       NCP GENEND MACRO                                            *
*********************************************************************
         GENEND INIT=ECLINIT,                                       *
              TMRTICK=ECLTICK,                                      *
              UGLOBAL=ECLUGBL
```

Notes:

1. NCP BUILD macro has new keywords related to HPR.
2. HPR=YES is default for PUs.
3. Channel link definition for RAS is L09CA10 (at the end of this NCP generation deck).
4. Token-ring logical lines are also HPR-capable, although not used in this scenario.

B.3 VTAM RAS Definitions

RAS is a pure network node (NN). RAS has an AHHC link to RAA and local channel attachment to ICN RAB through the NCP RA7NCPX, which are now both HPR-capable links.

B.3.1 Startup Definitions

ATCSTRSH

```
*******************************************************************
*                                                                 *
* VTAM STARTUP OPTIONS FOR RAS                                    *
* THIS IS APPN NN NODE                                            *
*                                                                 *
*******************************************************************
CONFIG=SI,
CONNTYPE=APPN,
CPCP=YES,
CSALIMIT=0,
DYNADJCP=YES,
DYNLU=YES,
HOSTPU=ISTPUS28,
NCPBUFSZ=2048,
NETID=USIBMRA,
SSCPNAME=RAS,
NODETYPE=NN,
NOTRACE,TYPE=VTAM,IOINT=0,
PPOLOG=YES,
SORDER=APPN,
SSCPID=28,
SUPP=NOSUP,
HPR=RTP,
XNETALS=YES
```

Note: HPR=RTP is a default value for node type NN, when HOSTSA is not coded, as in our case.

ATCCONSH

```
RASBTSO,                      RAS TSO APPLICATION DEFINITIONS
RASBAPP,                      RAS NJE APPL DEFS
RASBNSYS,                     RAS NETVIEW APPL DEFS
RASAPPC,                      APPC APPLICATION DEFINITIONS
RASP42,                       LOCAL 3277 SNA TERMINAL DEFINITIONS
RASCRA7,                      APPN CHANNEL TO RAB VIA NCP SA 7
RASAHHCA,                     MPC AHHC DEFINITIONS RAS TO RAA
RASLCAA,                      APPN MPC LINK FROM RAS TO RAA
MODELS
* RASAHHCB                    MPC AHHC DEFINITIONS RAS TO RAB
* RASLCAB                     APPN MPC LINK FROM RAS TO RAB
```

Note: RAACRA7 defines a connection to RAB through NCP. The AHHC is not used in this scenario between RAS and RAB.

B.3.2 AHHC Definitions from RAS to RAA

RASAHHCA

```
*********************************************************************
* RTP * TRLE FOR LINK FROM RAS TO RAA                               *
*********************************************************************
RASAHHCA VBUILD  TYPE=TRL
* RTP * MPC LINK FROM RAS TO RAA
RASMPCA  TRLE   LNCTL=MPC,READ=(C12),WRITE=(C14)
```

RASLCAA

```
*********************************************************************
* RTP * MPC LINK FROM RAS TO RAA                                    *
*********************************************************************
RASLCAA  VBUILD  TYPE=LOCAL
* RTP * MPC LINK FROM RAA TO RAA
RASPUSA  PU   TRLE=RASMPCA,PUTYPE=2,XID=YES
```

Note: HPR=YES is a default value for PU. Because the RAS also has HPR support, this link will become as a HPR link.

B.3.3 Local Channel Definitions RAS to RA7NCPX

RASCRA7

```
**********************************************************************
*                                                                    *
*  APPN CHANNEL LINK FROM RAS TO NCP SA7 (RA7NCPX)                   *
*                                                                    *
**********************************************************************
RASC925  VBUILD TYPE=LOCAL
RASP925  PU    CUADDR=925,PUTYPE=2,XID=YES,MAXBFRU=15,
               HPR=YES   (DEFAULT VALUE)
```

Note: HPR=YES is a default value for PU. NCP subarea 9 (RA9NCPX) is HPR-capable, so this link supports ANR routing for HPR connections and FID2 routing for APPN sessions originating in the CNN such as the LU-LU and the CP-CP sessions.

Appendix C. Test Scenario 5

We have three VTAM hosts in this scenario: RAA, RAS, and RAB. These three VTAM host definitions are the same we used in previous scenarios. (Refer to Appendix B, Test Scenario 2.) In addition to these VTAM network nodes, we have in this scenario two Communication Mangager/2 network nodes: RAXSERV and RAXWKSTN.

RAB and NCP RA9NCPX form a CNN node which has ANR routing capability. An RTP connection can also be established between any two RTP endpoints we have over this CNN node. In this scenario we now have, in addition to the previous scenarios, peripheral HPR nodes attached through NCP RA9NCPX to CNN RAB.

RAA and RAS, as pure VTAM network nodes, have HPR transport capability. RAXSERV and RAXWKSTN, as CM/2 network nodes, also have HPR transport capability. All these nodes act as RTP endpoints in this scenario.

C.1 CM/2 RAXSERV Definitions

RAXSERV is a pure network node. It has two HPR links, HOST$RAB to ANR node RAB, and EN$WKSTN to RTP node RAXWKSTN (NN).

```
DEFINE_LOCAL_CP  FQ_CP_NAME(USIBMRA.RAXSERV  )
                 DESCRIPTION(Local node def's)
                 CP_ALIAS(RAXSERV )
                 NAU_ADDRESS(INDEPENDENT_LU)
                 NODE_TYPE(NN)
                 NODE_ID(X'05D33317')
                 NW_FP_SUPPORT(NONE)
                 HOST_FP_SUPPORT(YES)
                 FREE_UNUSED_SESSIONS(NO)
                 FREE_UNUSED_SESSIONS_TIME(10)
                 MAX_COMP_LEVEL(NONE)
                 MAX_COMP_TOKENS(0);

DEFINE_LOGICAL_LINK  LINK_NAME(HOST$RAB)
                     DESCRIPTION(Only HPR no sscp-pu)
                     ADJACENT_NODE_TYPE(NN)
                     PREFERRED_NN_SERVER(NO)
                     DLC_NAME(IBMTRNET)
                     ADAPTER_NUMBER(0)
                     DESTINATION_ADDRESS(X'400001090001O4')
                     ETHERNET_FORMAT(NO)
                     CP_CP_SESSION_SUPPORT(YES)
                     SOLICIT_SSCP_SESSION(NO)
                     MAX_ACTIVATION_ATTEMPTS(USE_ADAPTER_DEFINITION)
                     USE_PUNAME_AS_CPNAME(NO)
                     ACTIVATE_AT_STARTUP(YES)
                     LIMITED_RESOURCE(NO)
                     LINK_STATION_ROLE(USE_ADAPTER_DEFINITION)
                     EFFECTIVE_CAPACITY(USE_ADAPTER_DEFINITION)
                     COST_PER_CONNECT_TIME(USE_ADAPTER_DEFINITION)
                     COST_PER_BYTE(USE_ADAPTER_DEFINITION)
                     SECURITY(USE_ADAPTER_DEFINITION)
                     PROPAGATION_DELAY(USE_ADAPTER_DEFINITION)
                     HPR_SUPPORT(YES)
                     AUTO_REACTIVATE(NO_RETRY)
                     USER_DEFINED_1(USE_ADAPTER_DEFINITION)
                     USER_DEFINED_2(USE_ADAPTER_DEFINITION)
                     USER_DEFINED_3(USE_ADAPTER_DEFINITION);
```

Figure 76 (Part 1 of 3). NDF File

```
DEFINE_LOGICAL_LINK  LINK_NAME(EN$WKSTN)
                     DESCRIPTION(Link to RAXWKSTN hpr=yes)
                     ADJACENT_NODE_TYPE(LEARN)
                     DLC_NAME(IBMTRNET)
                     ADAPTER_NUMBER(0)
                     DESTINATION_ADDRESS(X'40005200522104')
                     ETHERNET_FORMAT(NO)
                     CP_CP_SESSION_SUPPORT(YES)
                     SOLICIT_SSCP_SESSION(NO)
                     MAX_ACTIVATION_ATTEMPTS(USE_ADAPTER_DEFINITION)
                     USE_PUNAME_AS_CPNAME(NO)
                     ACTIVATE_AT_STARTUP(NO)
                     LIMITED_RESOURCE(NO)
                     LINK_STATION_ROLE(USE_ADAPTER_DEFINITION)
                     EFFECTIVE_CAPACITY(USE_ADAPTER_DEFINITION)
                     COST_PER_CONNECT_TIME(USE_ADAPTER_DEFINITION)
                     COST_PER_BYTE(USE_ADAPTER_DEFINITION)
                     SECURITY(USE_ADAPTER_DEFINITION)
                     PROPAGATION_DELAY(USE_ADAPTER_DEFINITION)
                     HPR_SUPPORT(YES)
                     AUTO_REACTIVATE(NO_RETRY)
                     USER_DEFINED_1(USE_ADAPTER_DEFINITION)
                     USER_DEFINED_2(USE_ADAPTER_DEFINITION)
                     USER_DEFINED_3(USE_ADAPTER_DEFINITION);

DEFINE_PARTNER_LU  FQ_PARTNER_LU_NAME(USIBMRA.RAA      )
                   DESCRIPTION(RAA VTAM RTP node)
                   PARTNER_LU_ALIAS(RAA)
                   PARTNER_LU_UNINTERPRETED_NAME(RAA     )
                   MAX_MC_LL_SEND_SIZE(32767)
                   CONV_SECURITY_VERIFICATION(NO)
                   PARALLEL_SESSION_SUPPORT(YES);

DEFINE_PARTNER_LU  FQ_PARTNER_LU_NAME(USIBMRA.RAS      )
                   DESCRIPTION(RAS VTAM RTP node)
                   PARTNER_LU_ALIAS(RAS)
                   PARTNER_LU_UNINTERPRETED_NAME(RAS     )
                   MAX_MC_LL_SEND_SIZE(32767)
                   CONV_SECURITY_VERIFICATION(YES)
                   PARALLEL_SESSION_SUPPORT(YES);

DEFINE_PARTNER_LU  FQ_PARTNER_LU_NAME(USIBMRA.RAB      )
                   DESCRIPTION(RAB VTAM ANR node)
                   PARTNER_LU_ALIAS(RAB)
                   PARTNER_LU_UNINTERPRETED_NAME(RAB     )
                   MAX_MC_LL_SEND_SIZE(32767)
                   CONV_SECURITY_VERIFICATION(NO)
                   PARALLEL_SESSION_SUPPORT(YES);

DEFINE_PARTNER_LU  FQ_PARTNER_LU_NAME(USIBMRA.RAXWKSTN )
                   DESCRIPTION(Workstation)
                   PARTNER_LU_ALIAS(RAXWKSTN)
                   PARTNER_LU_UNINTERPRETED_NAME(RAXWKSTN)
                   MAX_MC_LL_SEND_SIZE(32767)
                   CONV_SECURITY_VERIFICATION(NO)
                   PARALLEL_SESSION_SUPPORT(YES);
```

Figure 76 (Part 2 of 3). NDF File

```
DEFINE_DEFAULTS  IMPLICIT_INBOUND_PLU_SUPPORT(YES)
                 DEFAULT_MODE_NAME(BLANK)
                 MAX_MC_LL_SEND_SIZE(32767)
                 DIRECTORY_FOR_INBOUND_ATTACHES(*)
                 DEFAULT_TP_OPERATION(NONQUEUED_AM_STARTED)
                 DEFAULT_TP_PROGRAM_TYPE(BACKGROUND)
                 DEFAULT_TP_CONV_SECURITY_RQD(NO)
                 MAX_HELD_ALERTS(10)
                 IMPLICIT_LINK_HPR_SUPPORT(NO)
                 RETRY_COUNT(6)
                 ALIVE_TIMER(60)
                 PATH_SWITCH_TIMER_LOW(600)
                 PATH_SWITCH_TIMER_MEDIUM(600)
                 PATH_SWITCH_TIMER_HIGH(60);

DEFINE_TP  TP_NAME(APINGD)
           PIP_ALLOWED(NO)
           FILESPEC(C:\os2utils\apingd.exe)
           CONVERSATION_TYPE(ANY_TYPE)
           CONV_SECURITY_RQD(NO)
           SYNC_LEVEL(EITHER)
           TP_OPERATION(NONQUEUED_AM_STARTED)
           PROGRAM_TYPE(FULL_SCREEN)
           RECEIVE_ALLOCATE_TIMEOUT(INFINITE);

START_ATTACH_MANAGER;

SET_DISCOVERY_SERVER  ADAPTER_NUMBER(0)
                      GROUP_NAMES(IROUTSNA)
                      ROUTING_CAPABILITIES(NN);
```

Figure 76 (Part 3 of 3). NDF File

Some of the keywords and parameters are highlighted, because they are important in this scenario.

New keywords are:

- **HPR_SUPPORT(***Yes/No***)** in DEFINE_LOGICAL_LINK.
- **ALIVE_TIMER(60)** in DEFINE_DEFAULTS.
- **PATH_SWITCH_TIMER_LOW(600)** in DEFINE_DEFAULTS.
- **PATH_SWITCH_TIMER_MEDIUM(600)** in DEFINE_DEFAULTS.
- **PATH_SWITCH_TIMER_HIGH(60)** in DEFINE_DEFAULTS.

New statement is:

- **SET_DISCOVERY_SERVER**

Note: You have to define receive and transmit buffer sizes in the LAN Adapter and Protocol Support (LAPS) large enough to allow the CM/2 use frame sizes of at least 768 bytes (under adapter profile). Under the CM/2 DLC definitions, you must define a maximum I-field size large enough to support a frame size of at least 768 bytes. In our tests, we use 2040 bytes for buffer sizes and 1929 for I-field size.

HPR uses token-ring SAP X′C8′ for NLPs and x′04′ for FID2s.

C.2 CM/2 RAXWKSTN Definitions

RAXWKSTN is a pure network node. It has only one HPR link LINK$NNS to RTP node RAXSERV (NN).

```
DEFINE_LOCAL_CP  FQ_CP_NAME(USIBMRA.RAXWKSTN )
                 DESCRIPTION(Local node defs)
                 CP_ALIAS(RAXWKSTN)
                 NAU_ADDRESS(INDEPENDENT_LU)
                 NODE_TYPE(NN)
                 NODE_ID(X'05D05221')
                 NW_FP_SUPPORT(NONE)
                 HOST_FP_SUPPORT(YES)
                 FREE_UNUSED_SESSIONS(NO)
                 FREE_UNUSED_SESSIONS_TIME(10)
                 MAX_COMP_LEVEL(NONE)
                 MAX_COMP_TOKENS(0);

DEFINE_LOGICAL_LINK  LINK_NAME(LINK$NNS)
                     DESCRIPTION(Link to RAXSERV)
                     ADJACENT_NODE_TYPE(NN)
                     PREFERRED_NN_SERVER(NO)
                     DLC_NAME(IBMTRNET)
                     ADAPTER_NUMBER(0)
                     DESTINATION_ADDRESS(X'400000003331704')
                     ETHERNET_FORMAT(NO)
                     CP_CP_SESSION_SUPPORT(YES)
                     SOLICIT_SSCP_SESSION(NO)
                     MAX_ACTIVATION_ATTEMPTS(USE_ADAPTER_DEFINITION)
                     USE_PUNAME_AS_CPNAME(NO)
                     ACTIVATE_AT_STARTUP(YES)
                     LIMITED_RESOURCE(NO)
                     LINK_STATION_ROLE(USE_ADAPTER_DEFINITION)
                     EFFECTIVE_CAPACITY(USE_ADAPTER_DEFINITION)
                     COST_PER_CONNECT_TIME(USE_ADAPTER_DEFINITION)
                     COST_PER_BYTE(USE_ADAPTER_DEFINITION)
                     SECURITY(USE_ADAPTER_DEFINITION)
                     PROPAGATION_DELAY(USE_ADAPTER_DEFINITION)
                     HPR_SUPPORT(YES)
                     AUTO_REACTIVATE(NO_RETRY)
                     USER_DEFINED_1(USE_ADAPTER_DEFINITION)
                     USER_DEFINED_2(USE_ADAPTER_DEFINITION)
                     USER_DEFINED_3(USE_ADAPTER_DEFINITION);

DEFINE_PARTNER_LU  FQ_PARTNER_LU_NAME(USIBMRA.RAA      )
                   DESCRIPTION(RAA VTAM RTP node)
                   PARTNER_LU_ALIAS(RAA)
                   PARTNER_LU_UNINTERPRETED_NAME(RAA     )
                   MAX_MC_LL_SEND_SIZE(32767)
                   CONV_SECURITY_VERIFICATION(NO)
                   PARALLEL_SESSION_SUPPORT(YES);
```

Figure 77 (Part 1 of 2). NDF File

```
DEFINE_PARTNER_LU  FQ_PARTNER_LU_NAME(USIBMRA.RAB      )
                   DESCRIPTION(RAB VTAM ANR node)
                   PARTNER_LU_ALIAS(RAB)
                   PARTNER_LU_UNINTERPRETED_NAME(RAB      )
                   MAX_MC_LL_SEND_SIZE(32767)
                   CONV_SECURITY_VERIFICATION(NO)
                   PARALLEL_SESSION_SUPPORT(YES);

DEFINE_PARTNER_LU  FQ_PARTNER_LU_NAME(USIBMRA.RAS      )
                   DESCRIPTION(RAS VTAM RTP node)
                   PARTNER_LU_ALIAS(RAS)
                   PARTNER_LU_UNINTERPRETED_NAME(RAS      )
                   MAX_MC_LL_SEND_SIZE(32767)
                   CONV_SECURITY_VERIFICATION(NO)
                   PARALLEL_SESSION_SUPPORT(YES);

DEFINE_PARTNER_LU  FQ_PARTNER_LU_NAME(USIBMRA.RAXSERV  )
                   DESCRIPTION(RAX SERVER NN)
                   PARTNER_LU_ALIAS(RAXSERV)
                   PARTNER_LU_UNINTERPRETED_NAME(RAXSERV )
                   MAX_MC_LL_SEND_SIZE(32767)
                   CONV_SECURITY_VERIFICATION(NO)
                   PARALLEL_SESSION_SUPPORT(YES);

DEFINE_DEFAULTS  IMPLICIT_INBOUND_PLU_SUPPORT(YES)
                 DEFAULT_MODE_NAME(BLANK)
                 MAX_MC_LL_SEND_SIZE(32767)
                 DIRECTORY_FOR_INBOUND_ATTACHES(*)
                 DEFAULT_TP_OPERATION(NONQUEUED_AM_STARTED)
                 DEFAULT_TP_PROGRAM_TYPE(BACKGROUND)
                 DEFAULT_TP_CONV_SECURITY_RQD(NO)
                 MAX_HELD_ALERTS(10)
                 IMPLICIT_LINK_HPR_SUPPORT(NO)
                 RETRY_COUNT(6)
                 ALIVE_TIMER(60)
                 PATH_SWITCH_TIMER_LOW(600)
                 PATH_SWITCH_TIMER_MEDIUM(600)
                 PATH_SWITCH_TIMER_HIGH(60);

DEFINE_TP  TP_NAME(APINGD)
           DESCRIPTION(APING RESPONSES)
           PIP_ALLOWED(NO)
           FILESPEC(C:\OS2UTILS\APINGD.EXE)
           CONVERSATION_TYPE(ANY_TYPE)
           CONV_SECURITY_RQD(NO)
           SYNC_LEVEL(EITHER)
           TP_OPERATION(NONQUEUED_AM_STARTED)
           PROGRAM_TYPE(FULL_SCREEN)
           RECEIVE_ALLOCATE_TIMEOUT(INFINITE);

START_ATTACH_MANAGER;
```

Figure 77 (Part 2 of 2). NDF File

Index

Special Characters

Numerics

A

B

C

D

W

X

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Early User Experiences
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