HUGHES
NETWORK SYSTEMS
Subsidiary of
Hughes Aircraft Company
(Formerly M/A-COM Telecommunications)

# INTEGRATED PACKET NETWORK SYSTEM ARCHITECTURE D0020.6

## Technical Training Department

IPN™
Training Department

E-0555-1087L-40-4256

# INTEGRATED PACKET NETWORK SYSTEM ARCHITECTURE D0020.6

Revision 6.0
October 1987

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## NOTICE OF PROPRIETARY INFORMATION

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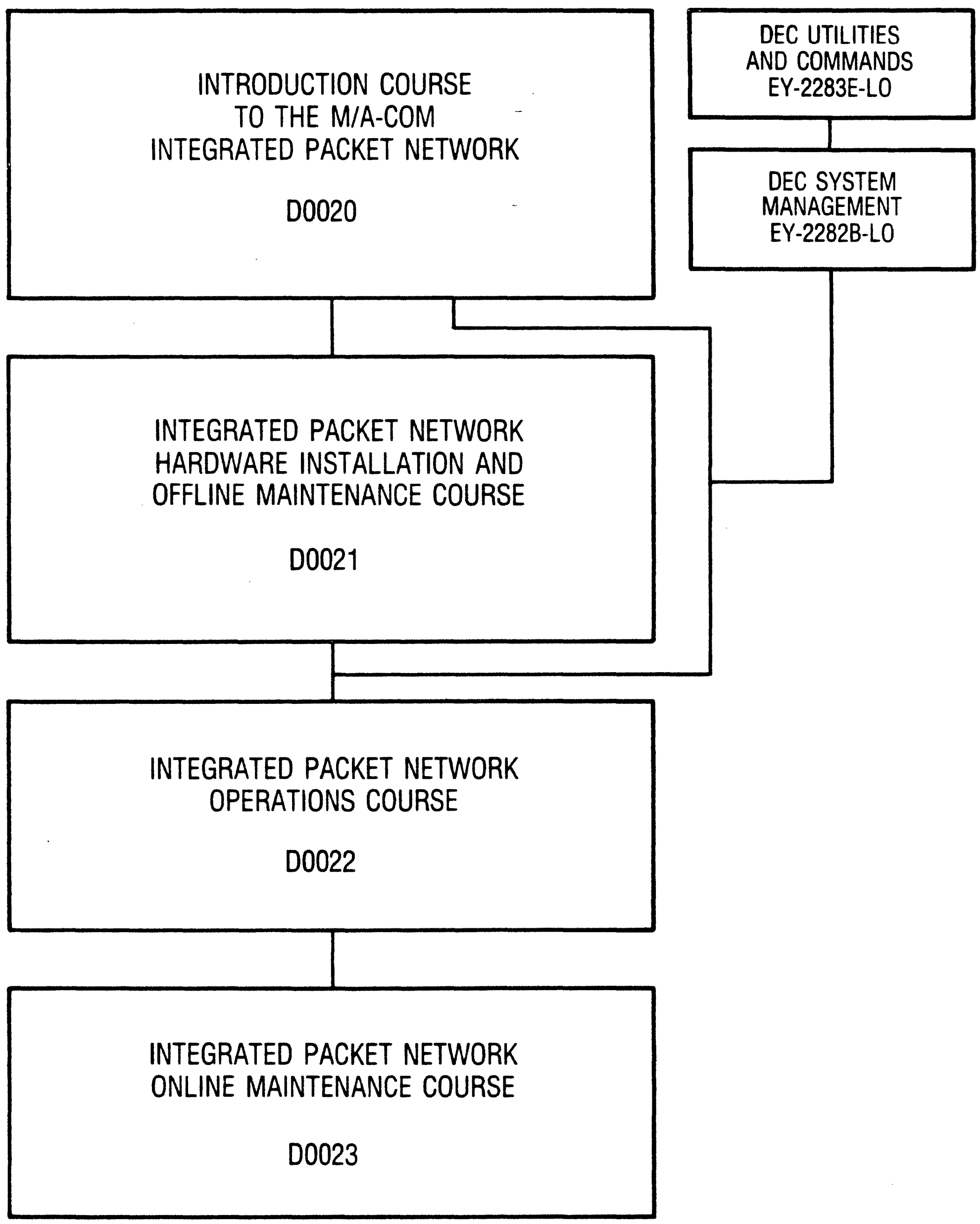
# RECOMMENDED SEQUENCE OF INTEGRATED PACKET NETWORK TRAINING COURSES

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# WHO SHOULD ATTEND IPN TRAINING PROFILE

| Function/ Classes | User/Manager (General) | Prog. Analyst (Cust. Staff Pos.) | Systems Prog. (Cust. Staff Pos.) | Systems Manager (TBD) (Cust. Staff Pos.) | Admin. Operator (General Operations) | Maint. Operator (System Troubleshooter) | Field Service Representative (Node Mod. Repair) |
|---|---|---|---|---|---|---|---|
| D0020 Introduction P.R. Familiar with Computer Switching & Telephony Systems | X | X | X | X | X | X | X |
| D0022 Admin. Ops. P.R. D0020.3 | X | X | X | X | X | X | |
| D0023 Online Maint. | | | | X | | X | |
| D0021 Offline Maint. P.R. D0020.3, D0022 | | | | | | X | X |
| Sys. Manager (TBD) | | X | X | X | | | |
| EY-2283E-LO VAX Utilities (P.R. for VAX Sys. Manager) | X | X | X | X | X | X | |
| EY-2282E-LO VAX Sys. Manager (P.R. for Admin. Ops.) | | X | X | X | X | X | |

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# INTRODUCTION COURSE ABSTRACT

| | |
|---|---|
| Title: | INTRODUCTION TO THE HNS INTEGRATED PACKET NETWORK (IPN) |
| Course No: | D0020.5 |
| Equipment: | Overhead Projector<br>White Board<br>Student Manuals |
| Duration: | 5 Days/30 Hours |
| Format: | 85% Lecture<br>7% Demonstration<br>8% Evaluation |
| Enrollment: | 10 Student Max, 5 Student Min* |
| Prerequisites: | A familiarity with Networks and X.25 Packet Switching is essential. |
| Description: | This course introduces all of the major functional and operational concepts of the IPN. System capabilities and their adaptability to suit specific needs are also addressed on an as-needed basis. |

*HNS reserves the right to cancel a course for insufficient enrollment.

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# INTRODUCTION COURSE OBJECTIVES

## On Completion of this Course the Student will be able to:

1. Draw the hierarchy structure of the system; list the functions of each of the blocks that comprise the system; state how each of these blocks are interfaced and related to each other.

2. State the minimum and maximum requirements of the NCP, ASP, NOC, and PSN.

3. List the Network Services provided and what Administrative functions are available; as well as explain how to access and control these services/functions.

4. State what interfaces are available; what access restrictions can be imposed; how a call is routed; what a logical channel is and what its limitations are; how cluster congestion is controlled.

5. State what data is downline loaded, what data is upline dumped; and explain the procedures for loading and dumping.

6. State the call establishment process including how the X.121 addressing scheme is used; what access restrictions are available; what the call records are and how they are retrieved; and what statistics are maintained by the system.

7. State what configuration capability and control are provided by the system; what events are and where they are sent; what System Control functions are in place in the system; what System Monitoring and Debug capabilities are provided by the system.

# INTRODUCTION COURSE SCOPE

This course is intended to present only those topics and concepts shown in the course outline that follows and not the topics listed below.

## Course Will NOT Cover:

- Engineering Concepts such as the detailed internal structure of system hardware and software
- Network Performance Analysis and System Optimization
- Network Management, System Administration, Route Optimization, and Network Topology Design practices
- VAX VMS, DCL, VAX System Management, CTOS, and HNS Software
- System Installation, Maintenance, Detailed Operations and Debugging

*The above concepts are addressed in follow-up courses, or through your HNS representative.

# INTRODUCTION COURSE OUTLINE

## ORIENTATION COURSE INTRODUCTION

1.0 INTRODUCTION - AN OVERVIEW
- 1.1 Packet Switching Network Concepts
- 1.2 HNS' Packet Switching History
- 1.3 System
  - 1.3.1 System Architecture
    - 1.3.1.1 System Software
  - 1.3.2 Integrated Packet Network Features and Functions
    - 1.3.2.1 System Components
    - 1.3.2.2 The User
    - 1.3.2.3 Network Services
    - 1.3.2.4 Network Administrative Functions
    - 1.3.2.5 Supervisory Network

2.0 SYSTEM COMPONENTS
- 2.1 Packet Switching Network Components
  - 2.1.1 PSN Physical Properties
  - 2.1.2 PSN Modules
  - 2.1.3 PSC Redundancy
  - 2.1.4 Configuration Rules Summary
  - 2.1.5 Offline Diagnostics Overview
- 2.2 Auxiliary Service Processor
- 2.3 Network Control Processor
  - 2.3.1 Network Control Processor Redundancy
- 2.4 Network Operators Console
  - 2.4.1 NOC Screens Overview
  - 2.4.2 Basic NOC Operations
    - 2.4.2.1 Getting Started
  - 2.4.3 Network Configuration

# INTRODUCTION
# COURSE OUTLINE (Cont.)

3.0 SYSTEM ARCHITECTURE
- 3.1 System Features
- 3.2 System Topology
- 3.3 Supervisory Network (Supernet)
- 3.4 Reconfiguration and Network Growth
- 3.5 IPN Capacity
- 3.6 IPN Accuracy

4.0 NETWORK SERVICES
- 4.1 General
- 4.2 Downline Loading
- 4.3 Upline Dump
- 4.4 Addressing and Access Restrictions
- 4.5 Call Records
- 4.6 Statistics

5.0 SYSTEM ADMINISTRATION AND MANAGEMENT
- 5.1 Debug Management
  - 5.1.1 Event Management
  - 5.1.2 Component Control
  - 5.1.3 Diagnostics
- 5.2 Configuration Management
- 5.3 Performance Monitoring
- 5.4 Report Management

# INTRODUCTION
# COURSE OUTLINE (Cont.)

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# INTRODUCTION COURSE TO THE HNS INTEGRATED PACKET NETWORK

## TYPICAL DAILY SCHEDULE

| | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 |
|---|---|---|---|---|---|
| | | | | | |
| 9:00 am | Course Introduction | (cont.) | (cont.) | (cont.) | Data Transfer |
| 10:00 am | Introduction an Overview | (cont.) | System Architecture | System Admin. & Management | (cont.) |
| 11:00 am | (cont.) | (cont.) | (cont.) | (cont.) | (cont.) |
| Noon | L | u | n | c | h |
| 1:00 pm | System Components | (cont.) | Network Services | (cont.) | (cont.) |
| 2:00 pm | (cont.) | (cont.) | (cont.) | (cont.) | Questions and Answers |
| 3:00 pm | (cont.) | (cont.) | (cont.) | System Interfaces | Final Exam |
| 3:45 | R e | v | i | e w | Adjourn |

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# REFERENCE DOCUMENTATION

| Code | Title | DOC # |
|---|---|---|
| NOC REF | Network Operator's Reference Manual | 8000809 |
| NOC PROC | Network Operator's Procedures Manual | 8000808 |
| NCP REF | Network Control Processor Operator's Reference Manual | 8000807 |
| NCP PROC | Network Control Processor Operator's Procedures Manual | 8000806 |
| SW INSTALL | Genesis System Software Installation Manual | 8000811 |
| DTM | CP9000 Series II Offline Diagnostics User's Manual | 8000812 |
| SSPEC | System Specification Document | 3422 |
| SDD | System Design Document | 3355 |
| CONFIG | Configuration Manual | 8000810 |
| TFRM | Tape Format Reference Manual | 8000813 |
| 9708 | 9708 Diagnostics Manual | 8000822 |

# IPN™ DOCUMENTATION
# READER'S COMMENT FORM

Date ___________

Document Title ______________________________ Document Number ____________ Revision ____

**Please use this form to make your comments and suggestions for this document only. Your comments and suggestions will help us in our continuous effort to improve the quality and usefulness of our publications. All comments and suggestions become the property of Hughes Network Systems, Inc.**

**Thank you for your assistance.**

Did you find this manual complete, accurate, well-organized and user-friendly?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Did you find errors in this publication? If so, please describe the problem and refer to the page number.

______________________________________________________________________

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What suggestions do you have to improve this manual?

______________________________________________________________________

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______________________________________________________________________

Please check the type of user you represent:

☐ Manager ☐ Engineer ☐ Technician

☐ Installer ☐ Operator

Name ______________________________ Title ______________________________

Organization ______________________________________________________

Street ______________________________________________________

City ______________________________ State ____________ Zip ____________

Phone (     ) ____________________

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# INTRODUCTION
# AN OVERVIEW
# 1.0

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# PACKET SWITCHING NETWORK CONCEPTS 1.1

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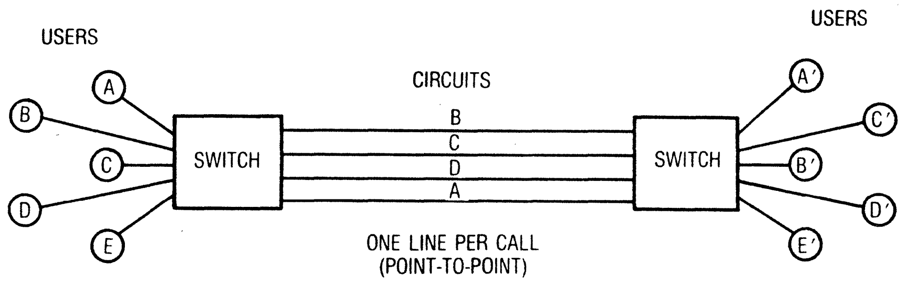
# SWITCHING TECHNOLOGY CHOICES

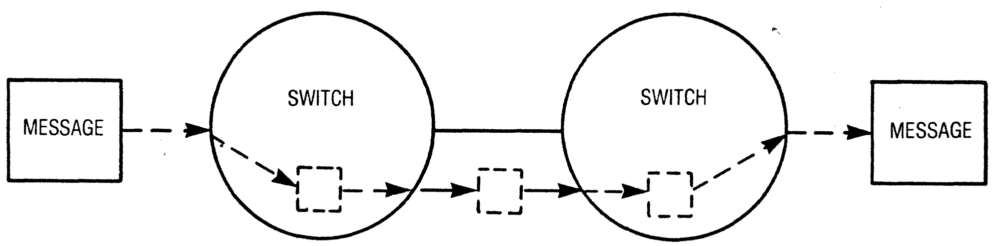
CIRCUIT SWITCHING
(TELEPHONE)



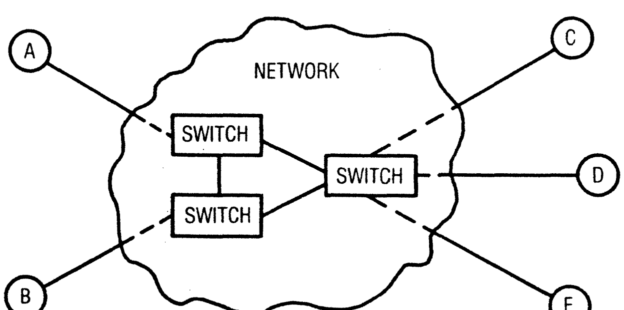

ONE LINE PER CALL
(POINT-TO-POINT)

*USETS E AND E' WOULD GET "BUSY" SIGNAL

MESSAGE SWITCHING
(TELEGRAM)




PACKET SWITCHING

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MULTIPLE CALLS PER LINE

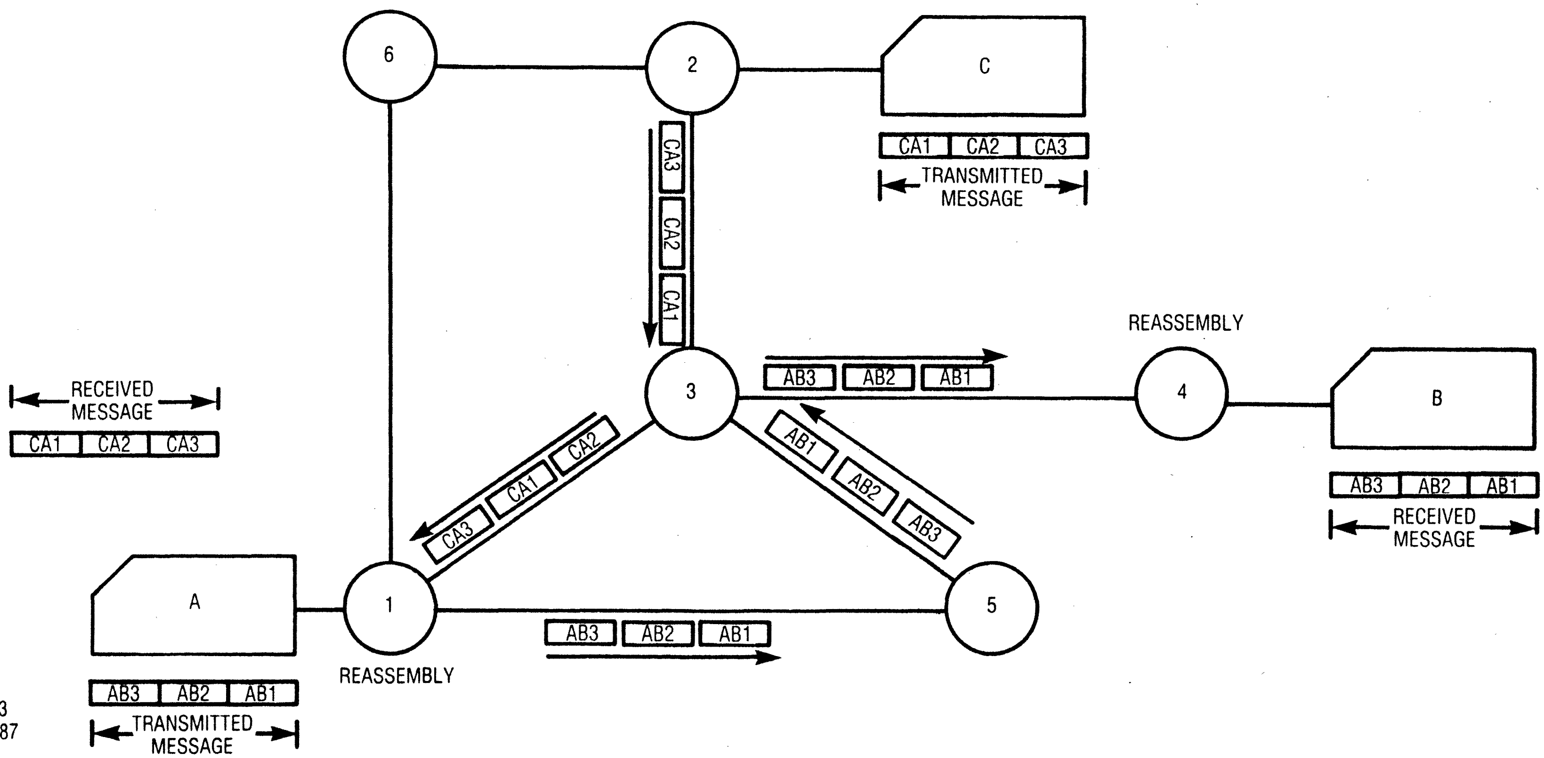
# PACKET SWITCHING CONCEPTS

## Operational Characteristics of Switching Techniques:

| Circuit | Message | Packet |
|---|---|---|
| Blocking | Storage | Queuing |
| One Line per Call | Delay Variance | Logical Multiplexing |
| Establishment Delay | | Packet Transit Delays |

# PACKET SWITCHING CONCEPTS

## *Basic Transmission Operation Concept*

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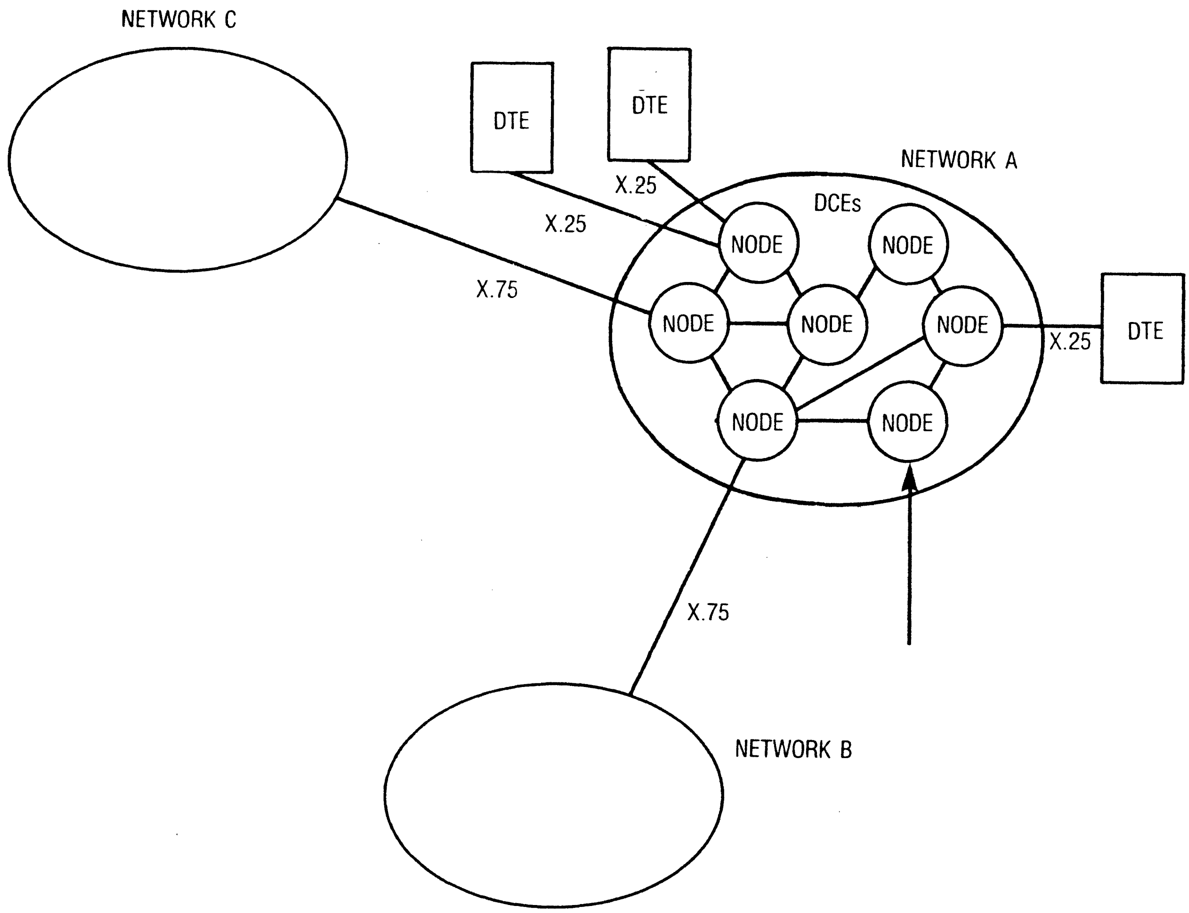
# PACKET SWITCHING CONCEPTS

## A Typical IPN




WHERE: IPN = INTEGRATED PACKET NETWORK
DTE = DATA TERMINAL EQUIPMENT
DCE = DATA CIRCUIT — TERMINATING EQUIPMENT
X.25 = CCITT RECOMMENDATION FOR DTE-DCE FORMATS/PROCEDURES
X.75 = CCITT RECOMMENDATION FOR INTERNETWORK CALLS

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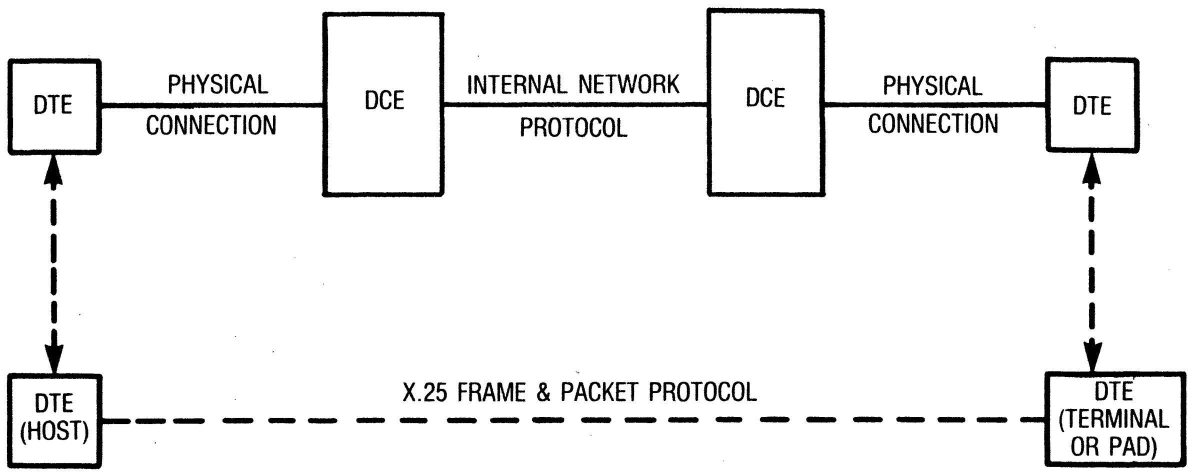
# PACKET SWITCHING CONCEPTS

## *Protocol Layering Concepts*

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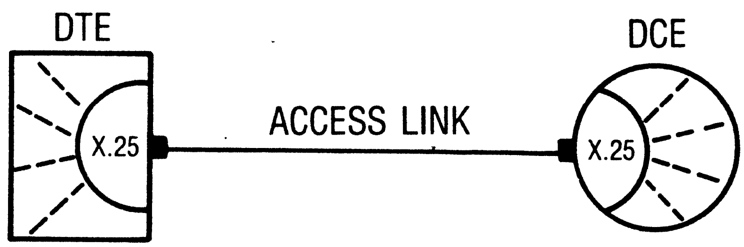
# PACKET SWITCHING CONCEPTS

## *CCITT Recommendation X.25*




**Access Link is Defined as a Path from a User to a Node**

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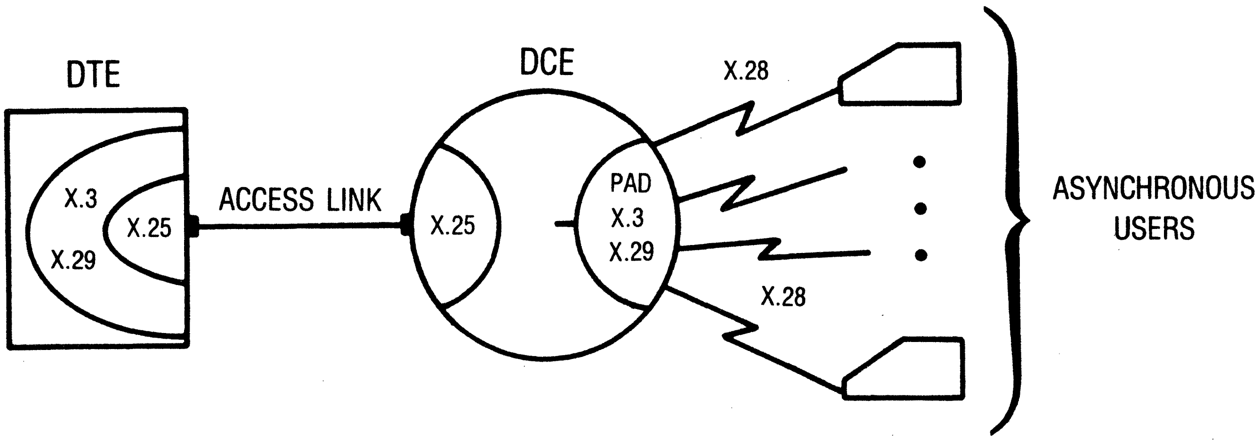
# PACKET SWITCHING CONCEPTS

## CCITT Recommendations X.3, X.28, X.29




WHERE:
PAD = PACKET ASSEMBLER/DISASSEMBLER
X.25 = PACKET MODE DTE TO DCE
X.28 = PAD COMMANDS AND MESSAGES
X.29 = PAD/PAD PROCEDURES
X.3 = PAD PARAMETERS

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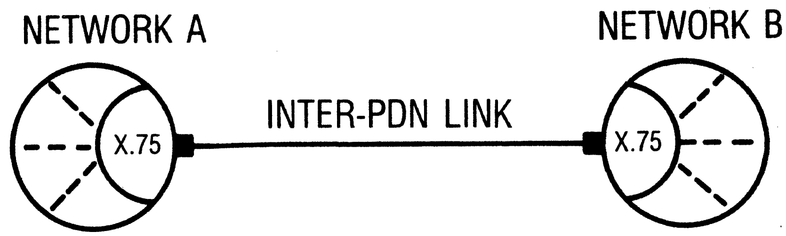
# PACKET SWITCHING CONCEPTS

## *CCITT Recommendation X.75*

- Defines Protocol for Interconnection Between Signaling Terminal Equipment (STEs) in Different Networks
- Defines Same Three Protocol Levels as X.25
- Additional Network Utilities to Specify PDN Characteristics

# PACKET SWITCHING CONCEPTS

## *CCITT Recommendation X.75*




NOTE: A & B MUST BOTH BE THE SAME TYPE
(i.e. PUBLIC OR PRIVATE)

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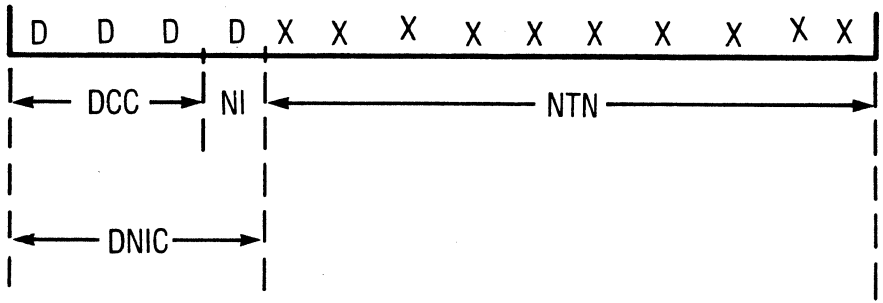
# PACKET SWITCHING CONCEPTS

## *CCITT Recommendation X.121*




DEFINES INTERNATIONAL NUMBERING PLAN FOR PUBLIC DATA NETWORK ADDRESSING:

DNIC = DATA NETWORK ID CODE
DCC = DATA COUNTRY CODE
NI = NETWORK IDENTIFIER
NTN = NETWORK TERMINAL NUMBER
DNIC + NTN = INTERNATIONAL ADDRESS

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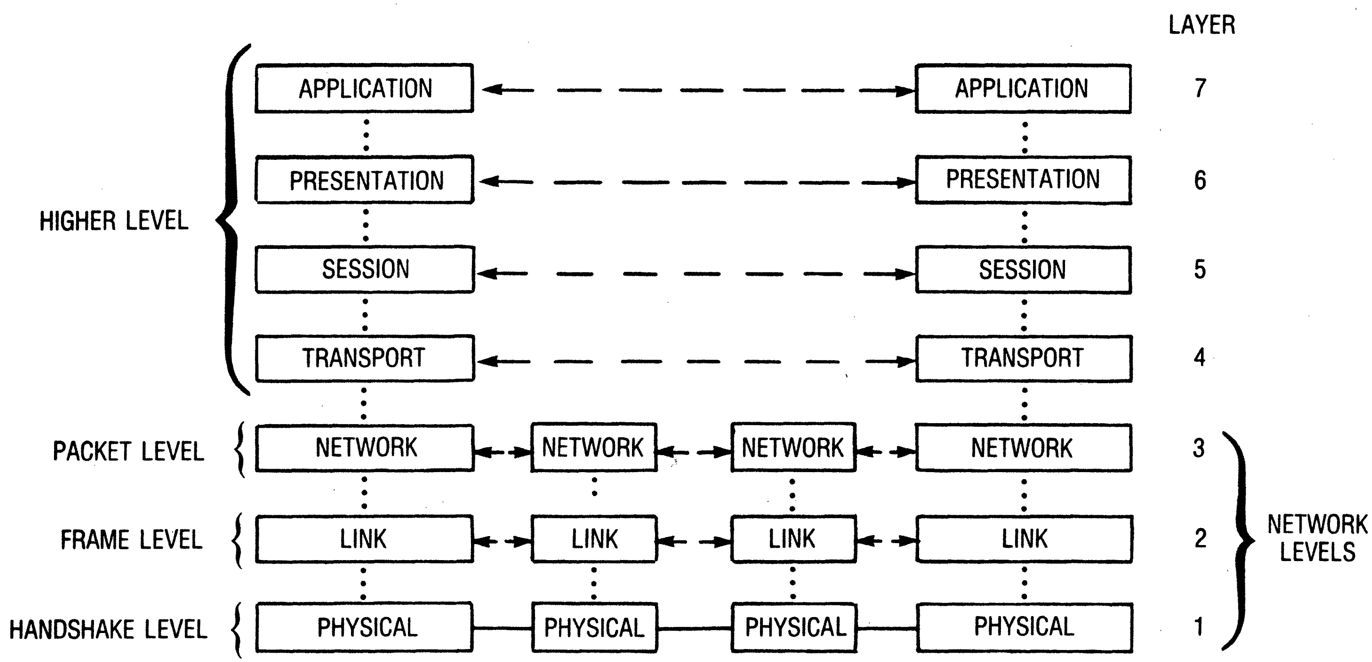
# PACKET SWITCHING CONCEPTS

## *Open Systems Interconnection (OSI) Layer Designation*

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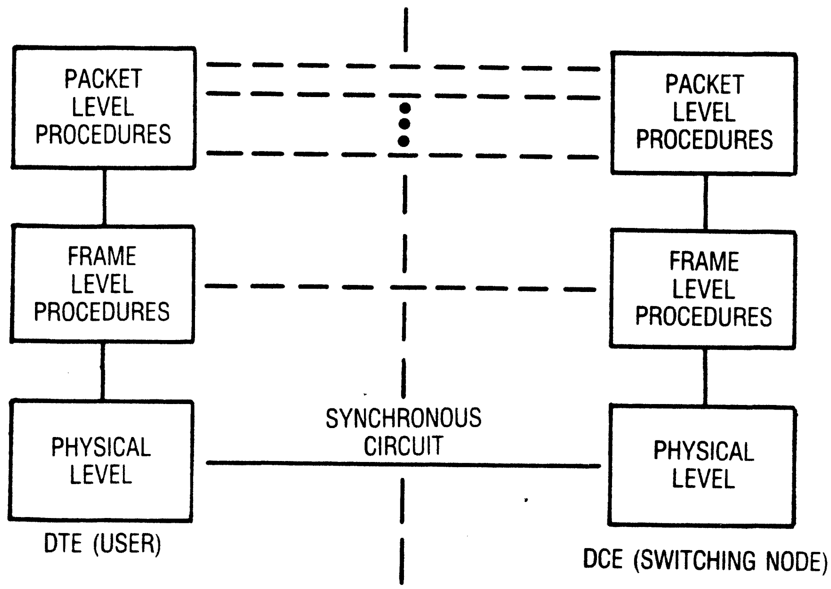
# PACKET SWITCHING CONCEPTS

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**DTE/DCE Electrical Interface**
- X.21 or X.21 bis (RS-232, V.35)
- Independent of Other Levels

**DTE/DCE Frame Level Interface**
- Link Access Procedures
- Does not Know about Virtual Calls

**DTE/DCE Packet Level Procedures**
- Virtual Call Procedures
  (Set-up, Maintain, Flow Control, Clear)
- May be End-to-End (DTE/DTE)

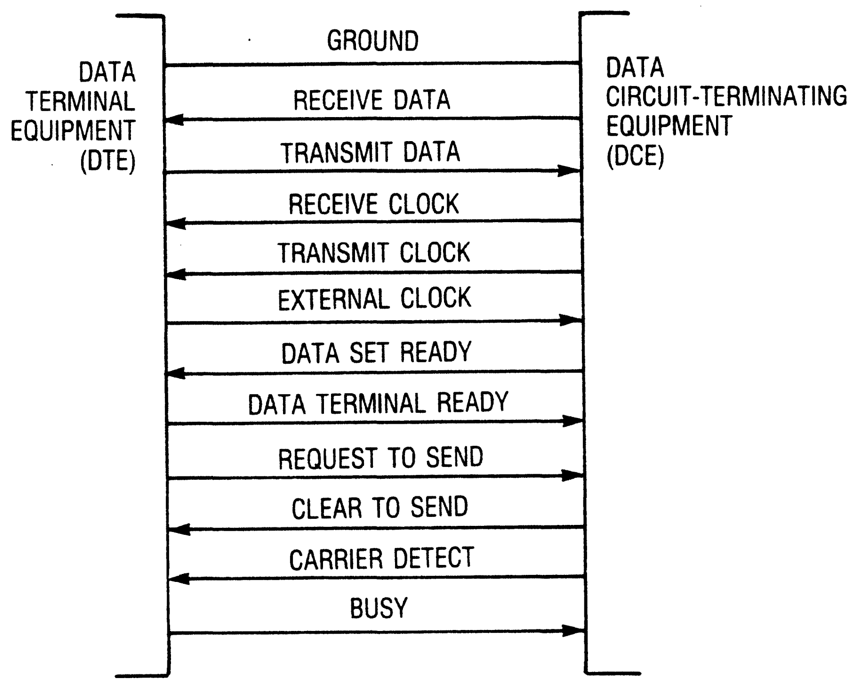
# PACKET SWITCHING CONCEPTS

## *DTE/DTE Higher Level Protocol*

- May Exist in PAD Software (X.3, X.28, X.29)
- Often a DTE Process to DTE Process Procedure
- Uses X.25 as a Framework
- May Use Data Qualified DATA Packets for Control Information

# PACKET SWITCHING CONCEPTS

## *Physical Level*

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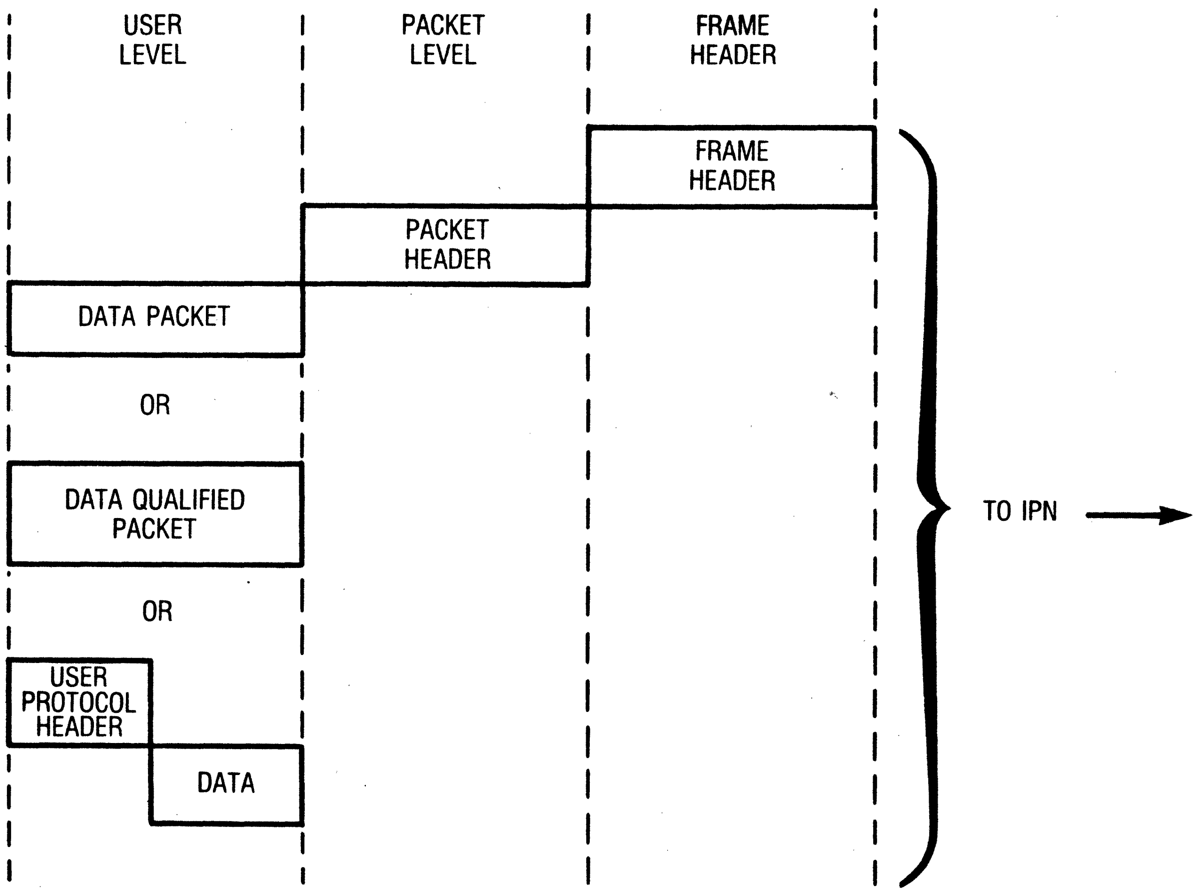
# PACKET SWITCHING CONCEPTS

## *Levels of Protocol Headers*

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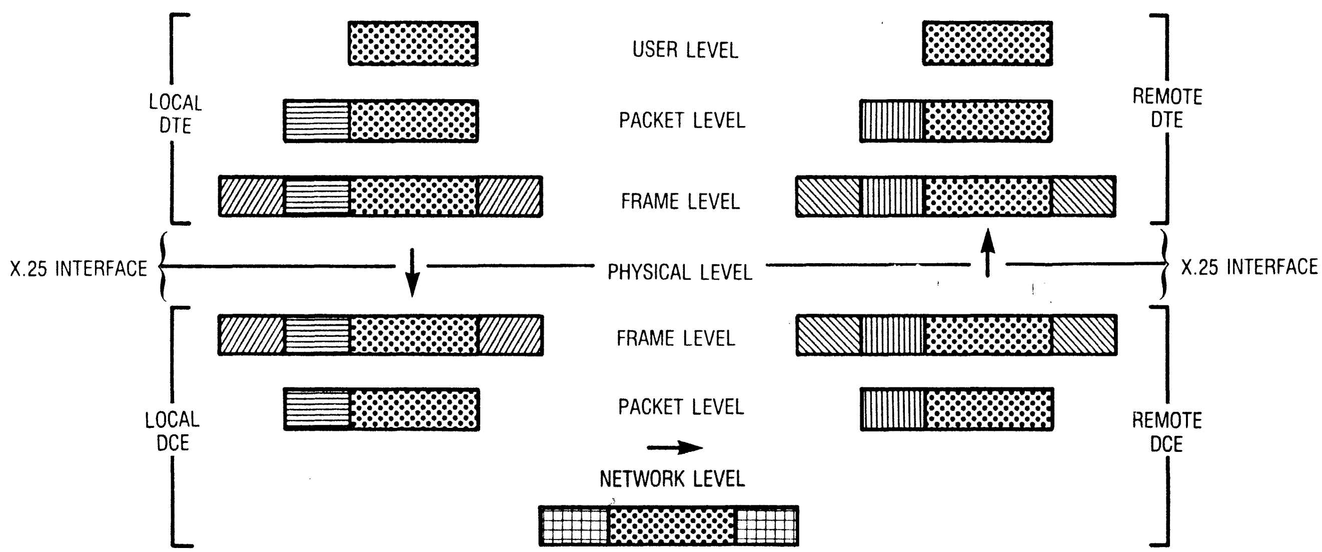
# PACKET SWITCHING CONCEPTS

## *Data Transfer Across a Packet Network*

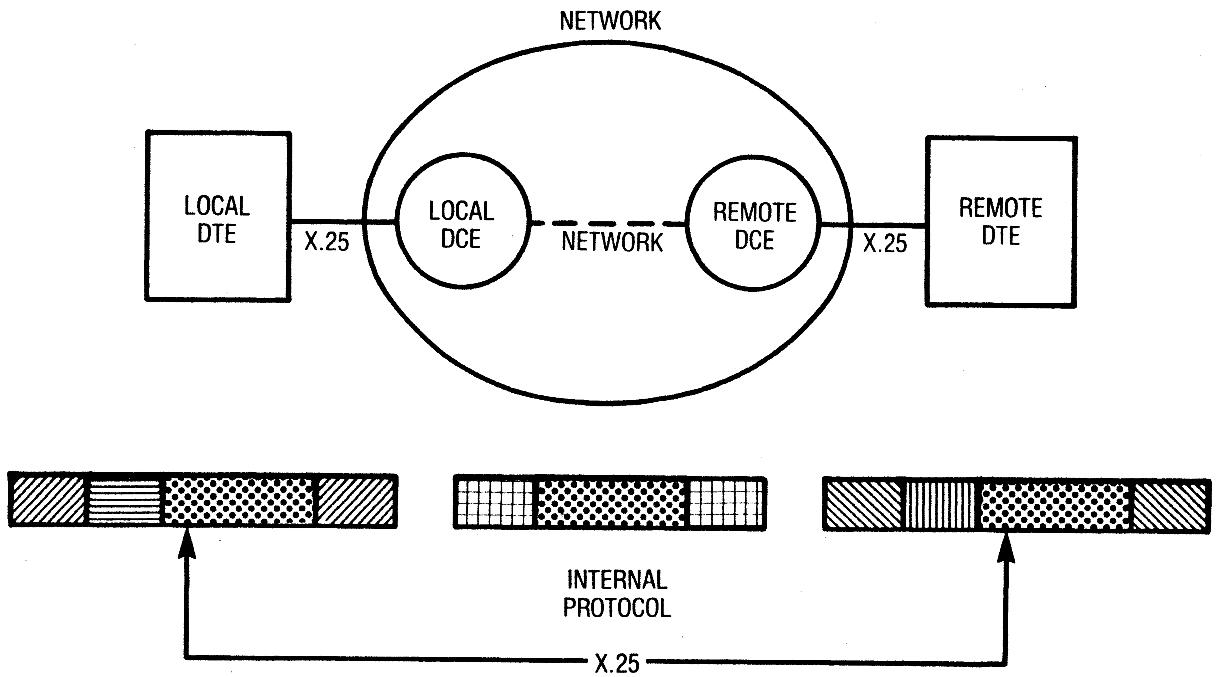



## Network Level Protocol

- **Intranetwork Protocol**
- **Transparent to End-User (DTE)**
- **May be Different in Each Network**

# PACKET SWITCHING CONCEPTS

## *Data Transfer Across a Network*

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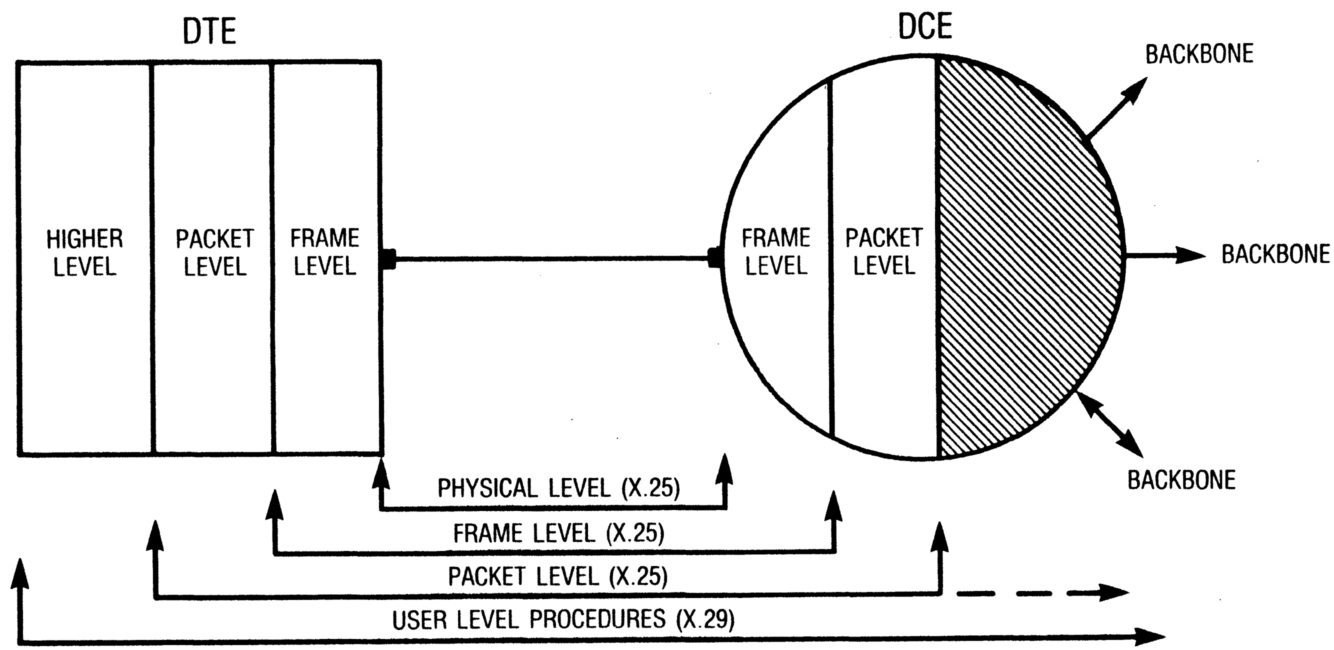
# PACKET SWITCHING CONCEPTS

## *Packet Mode DTE Layers of Protocol*

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# HNS' PACKET SWITCHING HISTORY 1.2

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# MAJOR PACKET SWITCHING CUSTOMERS

| Name | Date | $ | Application Features |
|---|---|---|---|
| GTE Telenet | 1976 | 35M | Public X.25 Network |
| City National Bank | 1978 | 1M | ATM Bank Network |
| Western Union | 1978 | 1M | Private Network |
| RCA Cyclix | 1979 | 12M | Public Data Network |
| Graphnet | 1981 | 8M | Nationwide Telex Service |
| U.S. Government | 1981 | 35M | Classified Private Data Network |
| U.S. Air Force | 1982 | 1M | Missile Warning Bypass |
| INMARSAT | 1983 | 3M | Ship to Shore Voice-Data-Telex |
| Uninet | 1983 | 8M | Public X.25 Network |
| KEL | 1985 | 1M | Private X.25 Commercial Network |
| Hewlett-Packard | 1985 | 4.5M | Private X.25 Corporate Network |
| Federal Express | 1986 | 45M | Integrated X.25 & Satellite Network |
| Ford Motor Co. | 1986 | 5M | CAD/CAM Supernode |
| Autex | 1987 | .5M | Private Network with Broadcast |
| MIGROS | 1987 | .6M | Retail Chain Network |
| 3M | 1987 | 1M | Multi Vendor 25 Corporate Network |
| MOOR | 1987 | .2M | IPN Distributor Support Network |

# HNS'
# PACKET SWITCHING HISTORY
# WHY THE IPN?

- Flexible System Size and Growth
- Local Storage Capability
- Processing and Switching Combined
- Distributed Memory
- Modular Growth
- Universal Card Types
- Fully Distributed Architecture
- High Reliability/Availability

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# THE SYSTEM
# 1.3

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# THE SYSTEM

The System (as Defined by HNS) is Composed of all Entities that are Transparent to the User. These Entities are:

- NETWORK CONTROL PROCESSOR
  NCP - One or Two (VAX)
- NETWORK OPER. CONSOLE
  NOCs - Minimum of 1; Up to 16 - WORKSTATIONS (CT)
- AUX. SERVICE PROCESSOR
  ASPs - Up to 2 per Node
- PACKET SWITCHING CLUSTER
  PSCs - as many as Required to Support Users and User Traffic
- BACK BONE LINK
  BBL - Typically no Less than 2 per Node

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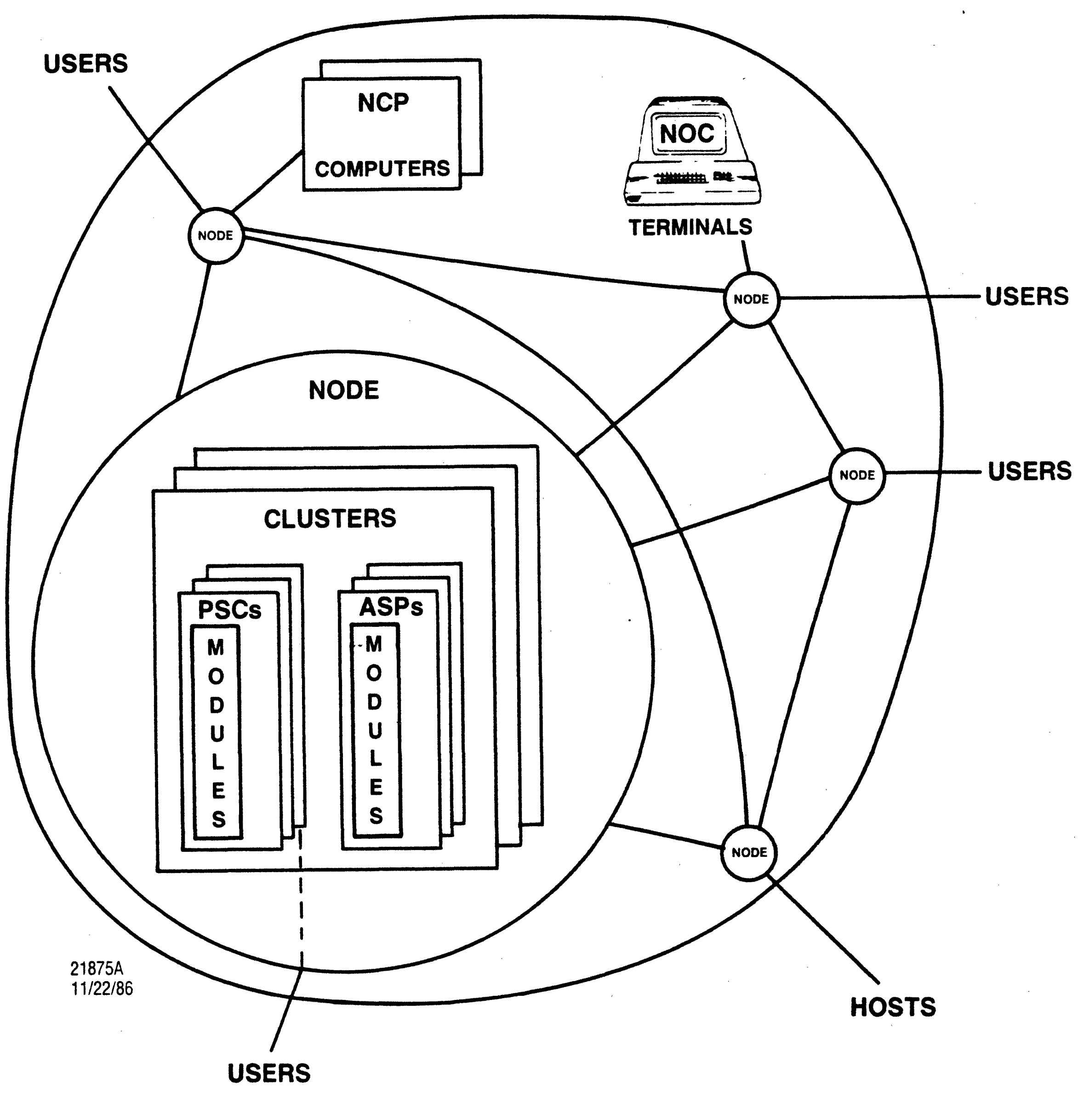
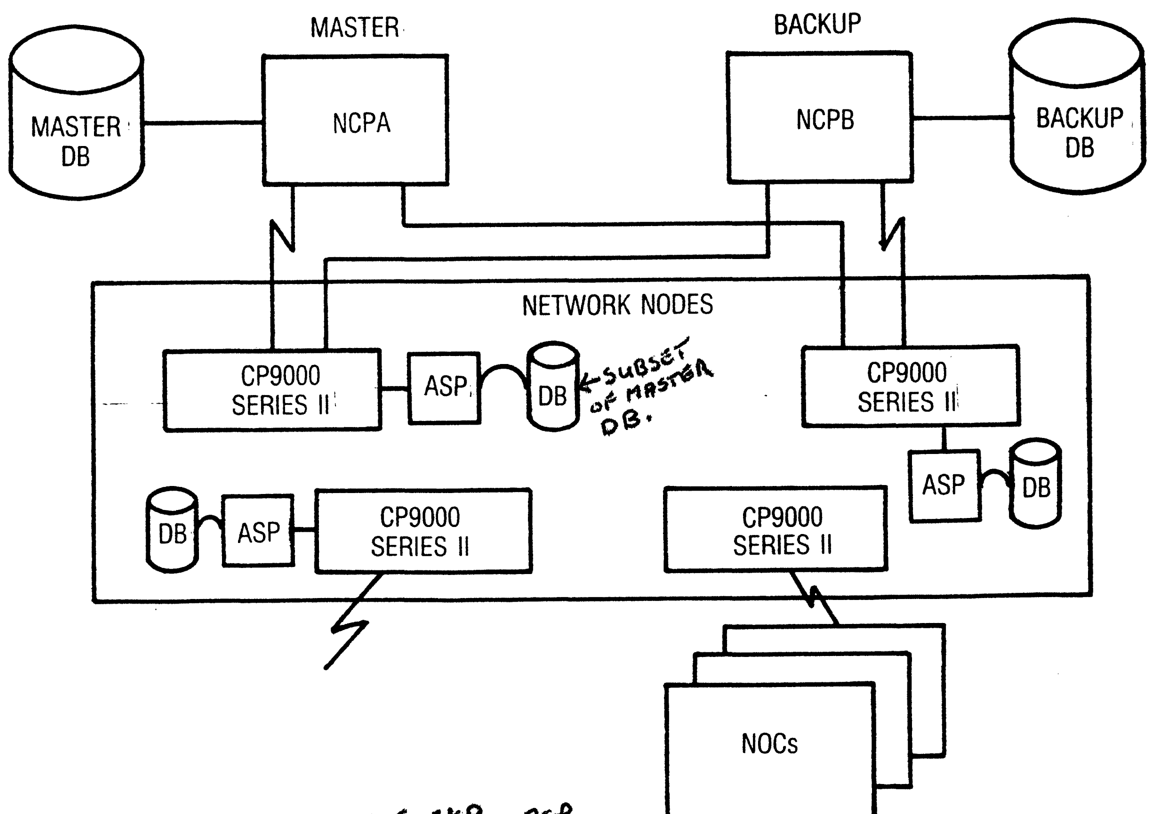
# SYSTEM ARCHITECTURE
# 1.3.1

# SYSTEM ARCHITECTURE BASIC SYSTEM COMPONENTS



# SYSTEM ARCHITECTURE BASIC NETWORK CONFIGURATION

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CONTROL SYSTEM = NOC, NCP + ASP
NETWORK = PSC

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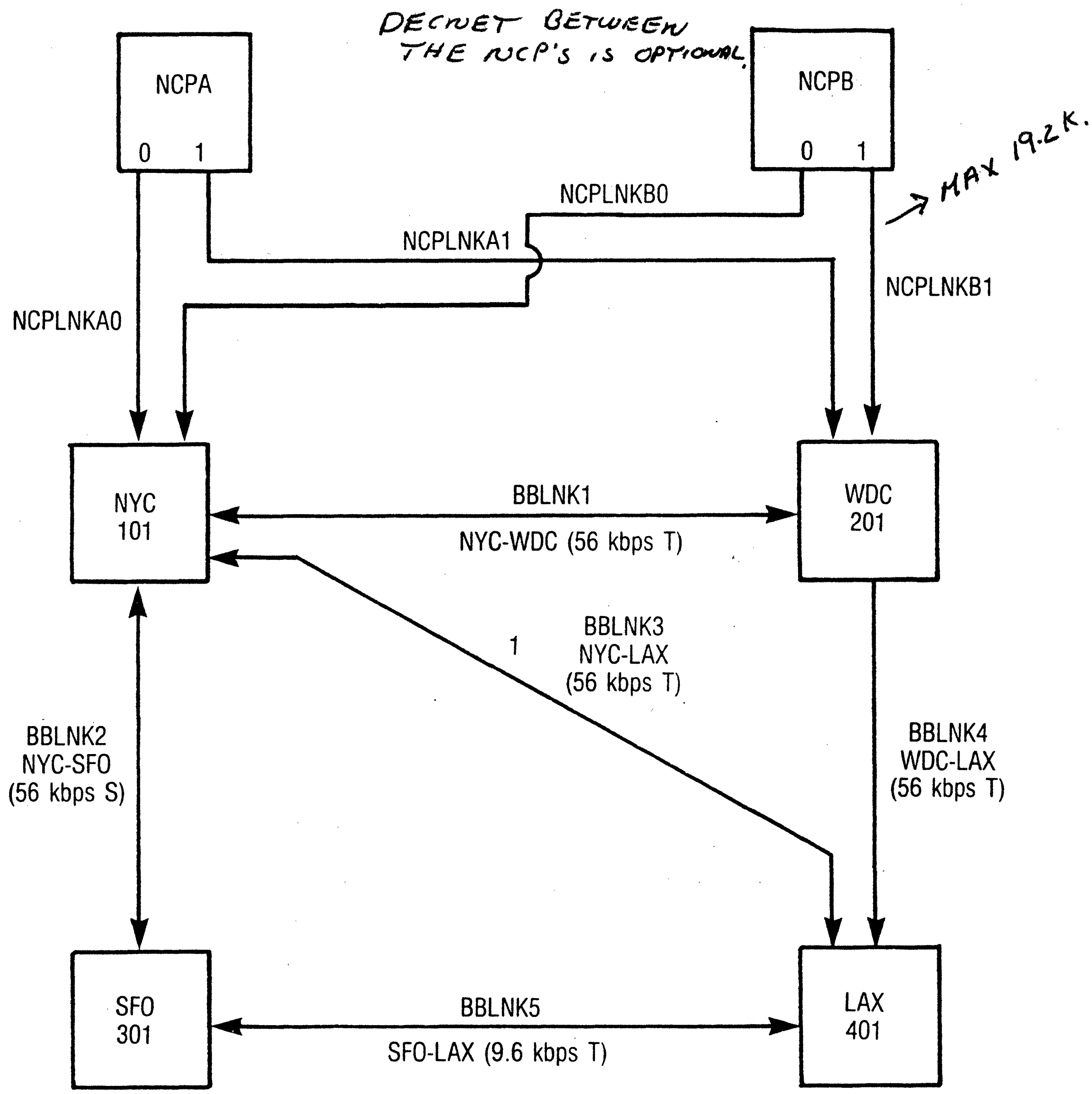
# SYSTEM ARCHITECTURE EXAMPLE NETWORK TOPOLOGY




T = TRUNK
S = SATELLITE

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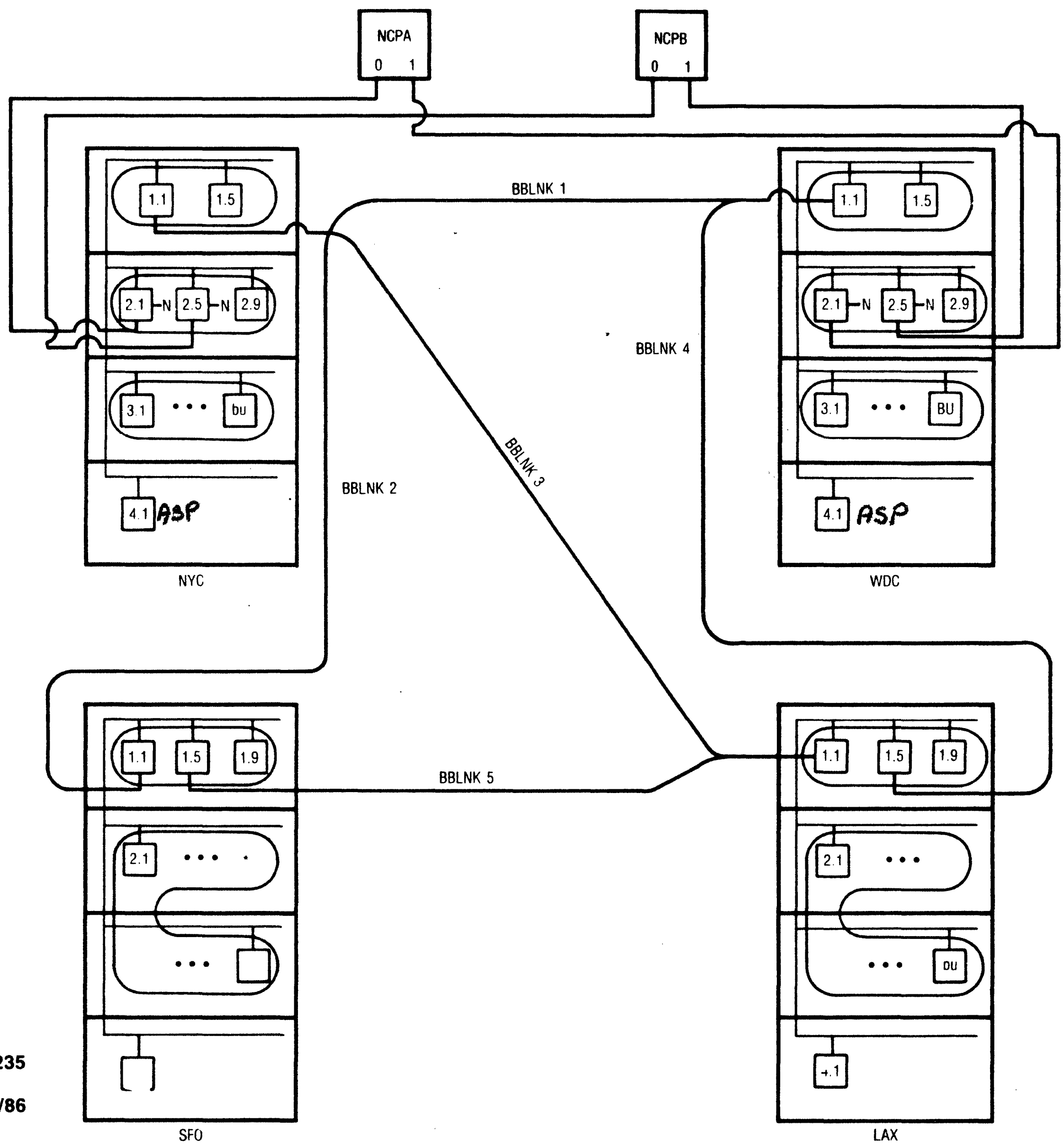
# SYSTEM ARCHITECTURE EXAMPLE NETWORK PHYSICAL CONNECTIVITY

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# SYSTEM SOFTWARE
# 1.3.1.1

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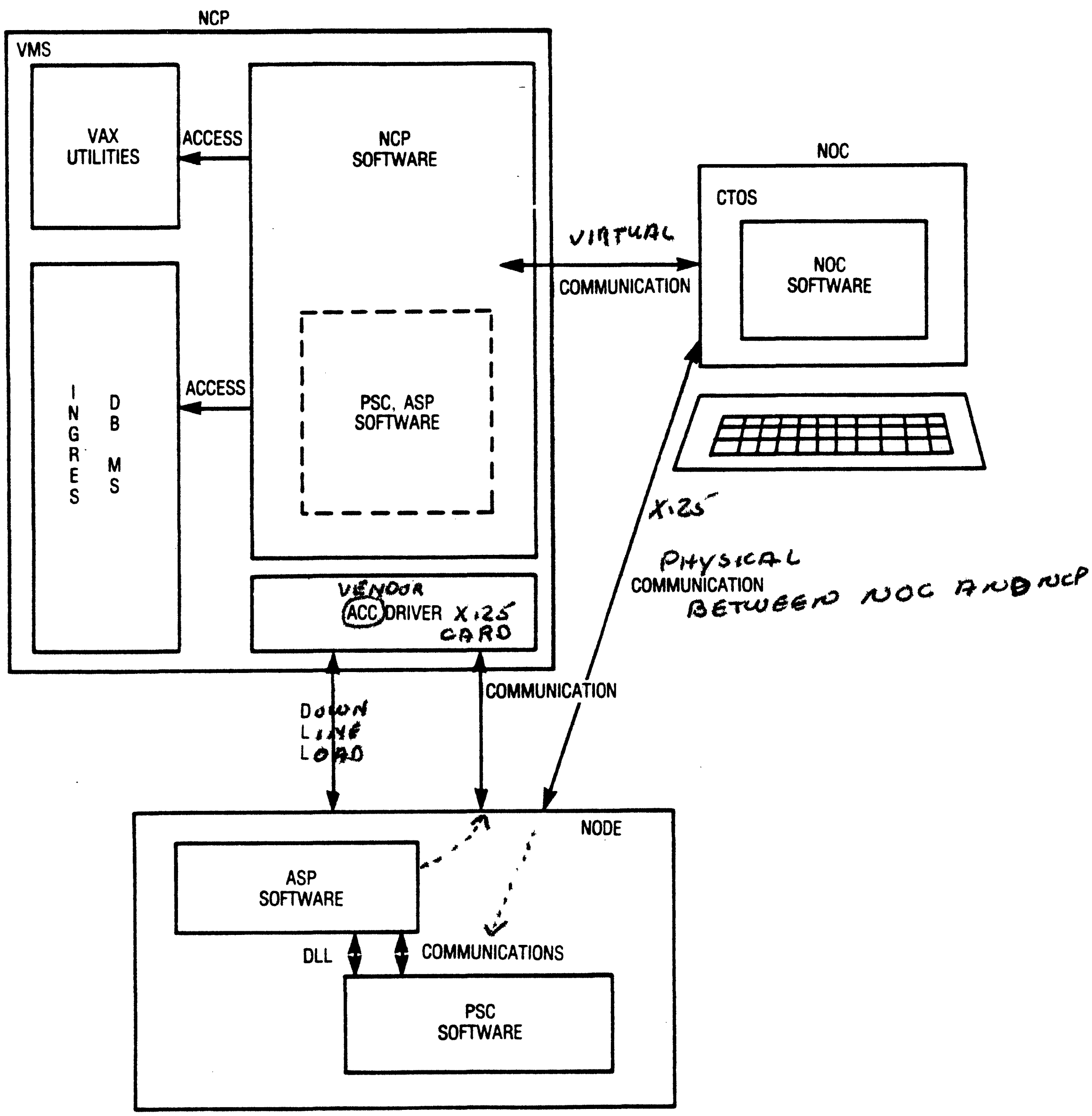
# SYSTEM SOFTWARE
# IPN SOFTWARE ORGANIZATION

- **NCP Software** - REQUIRES A DEDICATED VAX.
  - VAX/VMS Operating System
  - INGRES DBMS
  - NCP Software
- **NOC Software**
  CONVERGENT TECH O.S.
  - CTOS Operating System - 286 PROC.
  - NOC Software
- **Node Software**
  - PSC Software
    - a) Switching
    - b) Control
  - ASP Software

# SYSTEM SOFTWARE RELATIONSHIPS



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# SYSTEM SOFTWARE
# NCP

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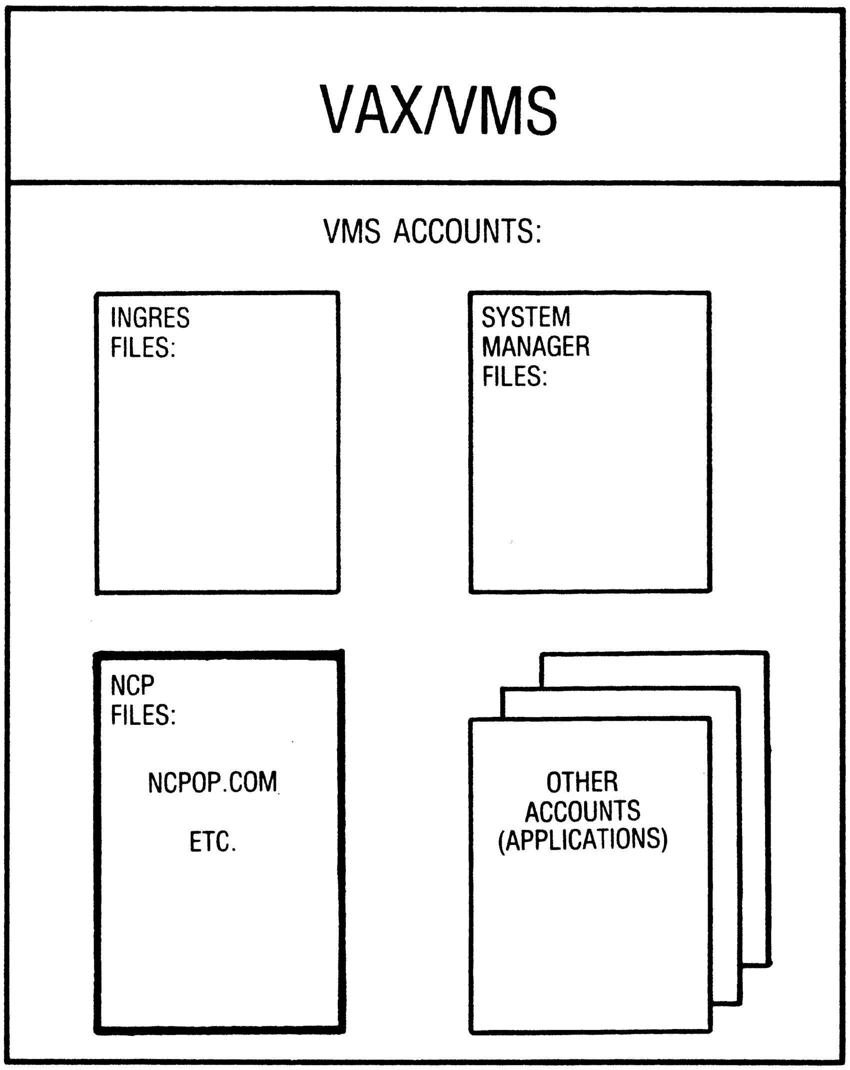
# SYSTEM SOFTWARE
# VAX/VMS OPERATING SYSTEM

- **Features:**
  - VMS - Virtual Memory System
  - Disk Resident
  - Byte Addressing Space
  - Process Priorities
  - Shared Data Images
  - Resource Locking
  - RMS File Management
  - Gen Parms
- **Functions:**
  - Virtual Memory Management
  - Process Creation/Deletion
  - Processor Scheduling
  - Interprocess Communication
  - Input/Output Services and Drivers
  - Error Logging and Recovery

# SYSTEM SOFTWARE
# VAX-NCP RELATIONSHIPS

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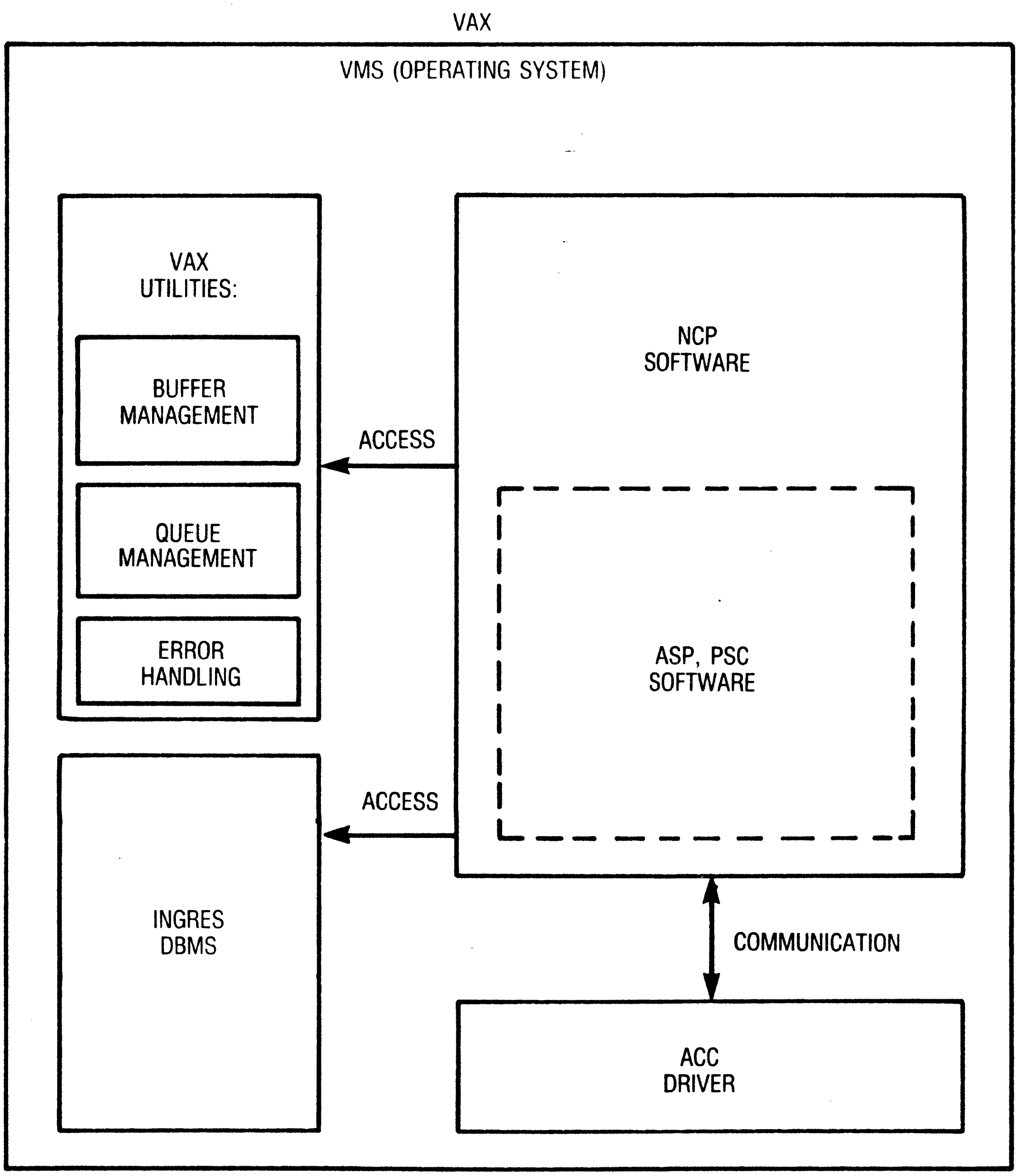
# SYSTEM SOFTWARE INGRES DATABASE MANAGEMENT SYSTEM

- Relational DBMS from Relational Technologies Inc.
- Installed with and Accessed by NCP Software
- Features Include:
  - Alterable Disk Storage and Indexing Structures
  - Query Optimizer
  - Report Generator
  - PASCAL Interface (Allows Quel Embedding in PASCAL Files)
  - Concurrent Multiple Process Data Access
  - VMS Locks
  - Transaction Management Facility
  - Terminal Monitor

# SYSTEM SOFTWARE
# NCP SOFTWARE RELATIONSHIPS

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# SYSTEM SOFTWARE
# NCP SOFTWARE FUNCTIONS

- Network Configuration Control
- Performance Monitoring
- Network Maintenance and Debugging
- Network Component Downline Load
- Network Statistics Gathering
- Call Setup Assistance
- Storage of Billing Information
- Network Operator Functions

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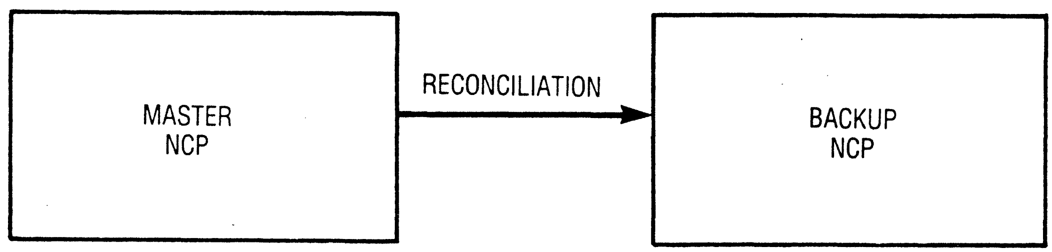
# SYSTEM SOFTWARE
# NCP MODES

- Master
- (SLAVE)
  Backup - All Network Services, Limited NOC Functions
- Reconciliation from Master to Backup Only




22171

- Mode is Set by NCP Operator
- Mode Conflicts Resolved by Demotion to Backup

# SYSTEM SOFTWARE
# NCP SOFTWARE STATES

- Local
  - NCP not Operational, VAX Running Under VMS
- Initialization
  - Initialization Processes in Execution
- Out-of-Service
  - NCP Software Loaded, NCP Disconnected from the Network
- In Service
  - Fully Operational and Connected to Network
- NCP Operator may Set/Modify NCP State from NCP Console

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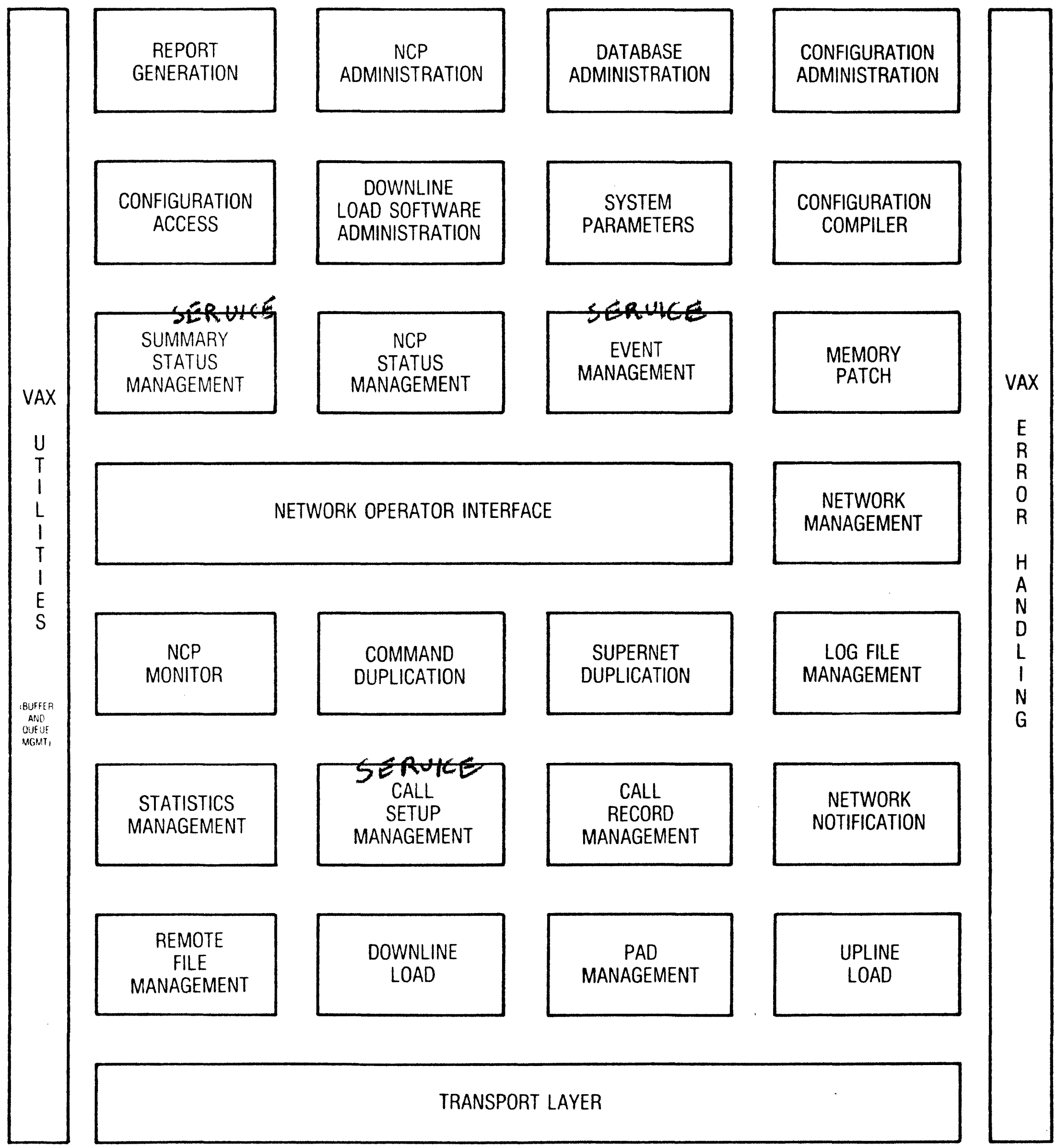
# SYSTEM SOFTWARE
# NCP SOFTWARE UNITS

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# SYSTEM SOFTWARE
# NOC

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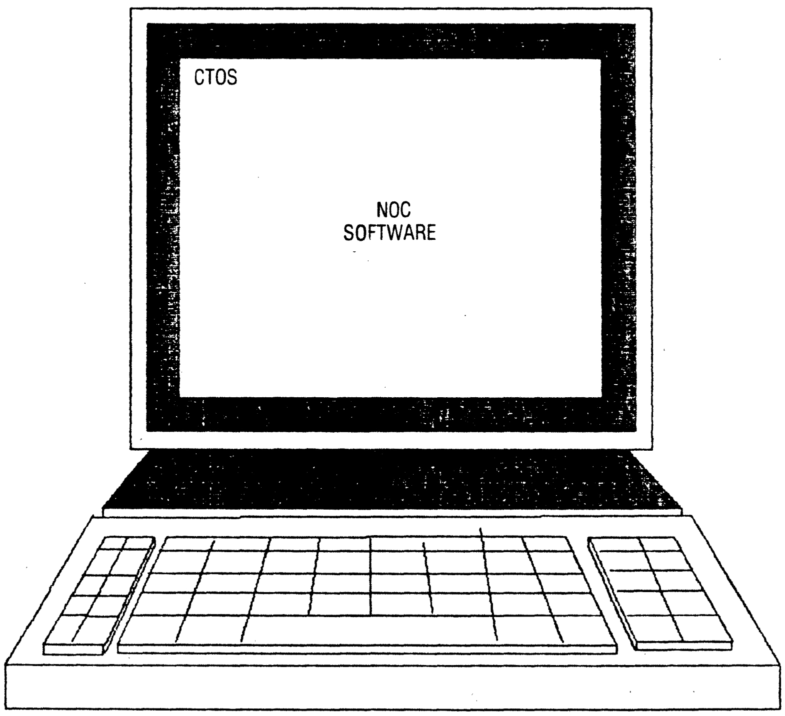
# SYSTEM SOFTWARE NOC




27496

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# SYSTEM SOFTWARE NOC-CTOS

- **Features:**
  - Real-Time Processing
  - Multi-Programming Environment
- **Functions:**
  - Event Driven Process Priority Scheduling
  - Interprocess Communication and Synchronization
  - Timer Management (Timeouts and TOD)
  - Virtual Code Segment Management
  - Printers Spooling
  - Memory Management

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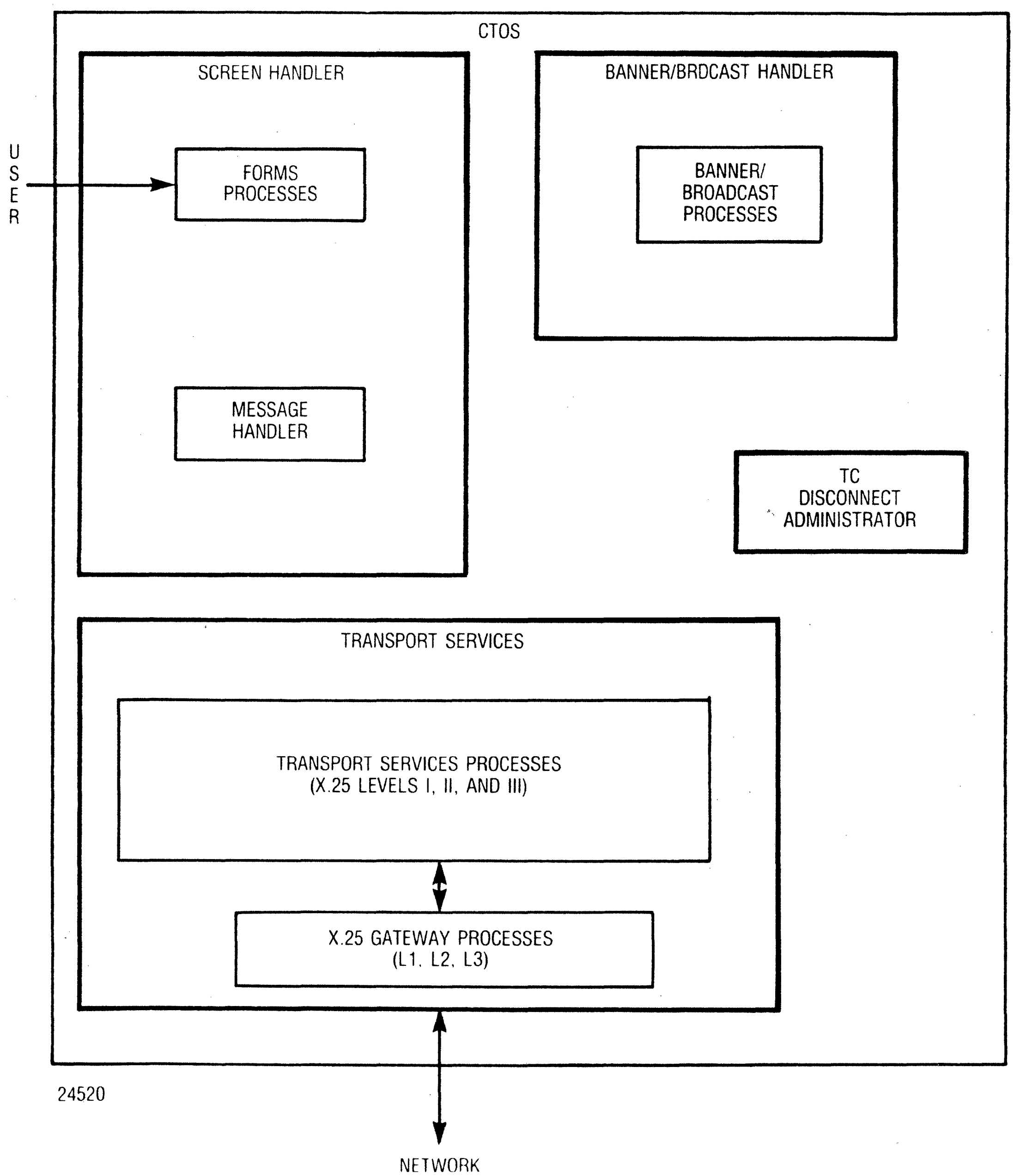
# SYSTEM SOFTWARE
# NOC SOFTWARE UNITS



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# SYSTEM SOFTWARE
# NOC OPERATOR INTERFACE

- Menu Driven
- Forms Based
- Tree Structured
- Soft Function Key Operation
- Local Data Validation
- X.25 Network Interface

# SYSTEM SOFTWARE
# NOC SOFTWARE FUNCTIONS

- Provides Operator to Network Communication
- Provides Operator Access to Complete Network via:
  - Operator Management
  - Configuration Definition
  - Database Management
  - Network Status Monitoring
  - Component State Control
  - Statistics Viewing
  - Debug Functions (Route Simulator, Call Records)
  - Report Generation

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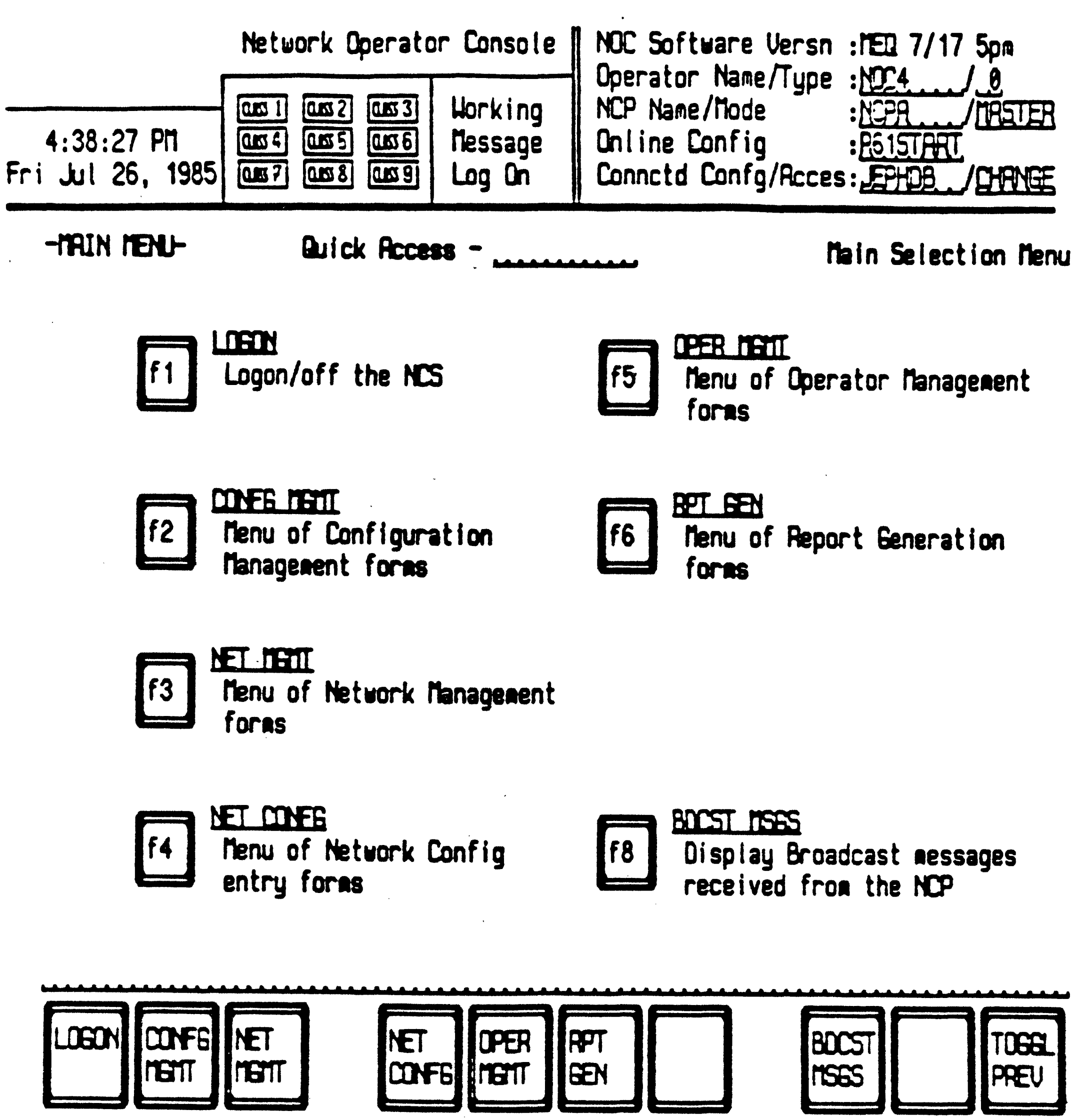
# SYSTEM SOFTWARE
# NOC FORMS EXAMPLE

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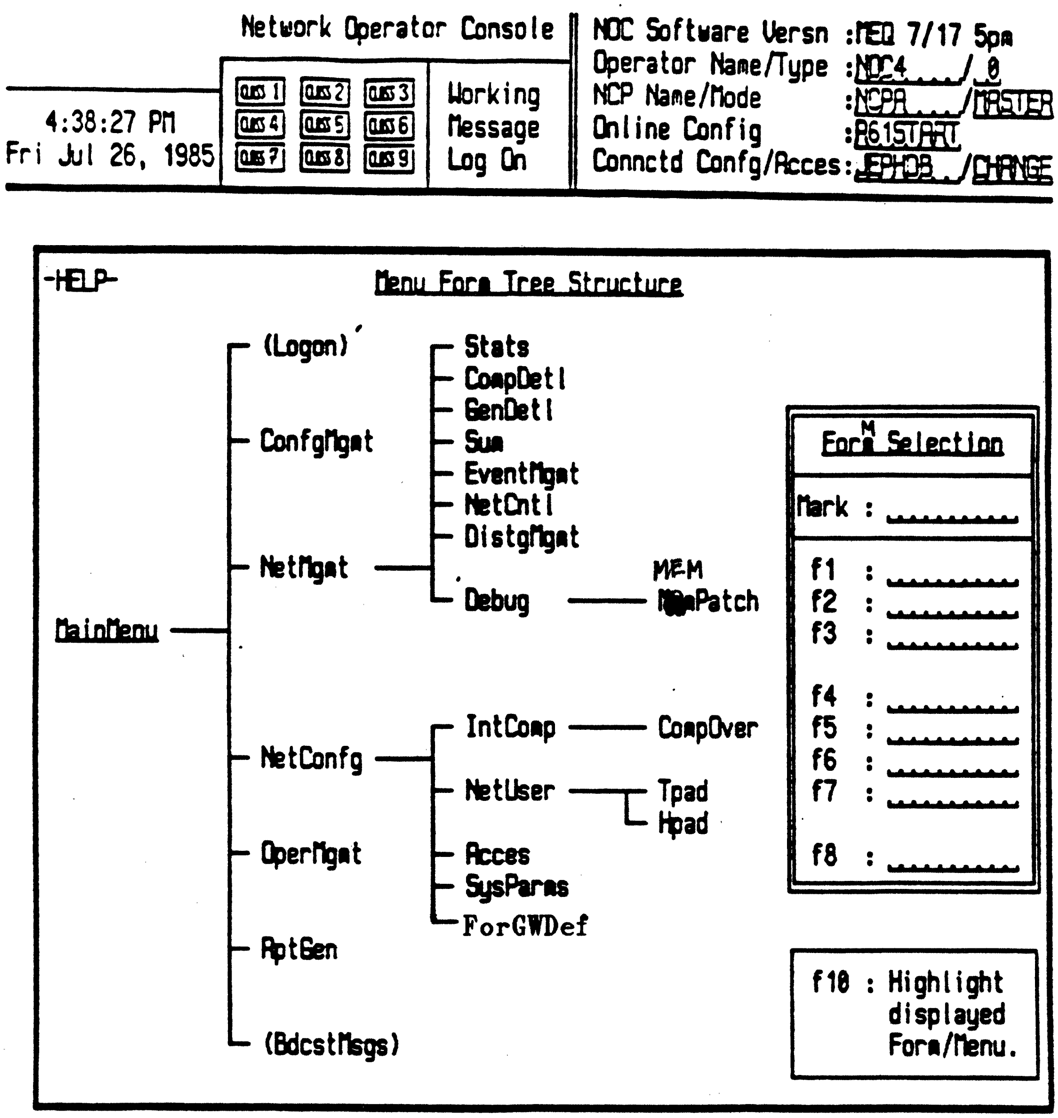
# SYSTEM SOFTWARE
# NOC TREE STRUCTURE




24522

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# SYSTEM SOFTWARE
# PSN

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# SYSTEM SOFTWARE
# PSN SOFTWARE

- ASP Software
- PSC Software
  - Switching
  - Network management DTE
- Downline Loaded from NCS

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# SYSTEM SOFTWARE
# ASP FUNCTIONS

- Downline Load of Operational Software and Configuration Data for PSCs
  - Fast Local Load - 2 to 3 MINUTES
  - Remote Downline Load
- Upline Dump of PSC Memory
- Call Setup Address Resolution
- Retention of Call Records/Stats/Events

  PROGRAMMABLE MIN = 90 MIN
  MAX = ?
- Access Restriction Mechanisms

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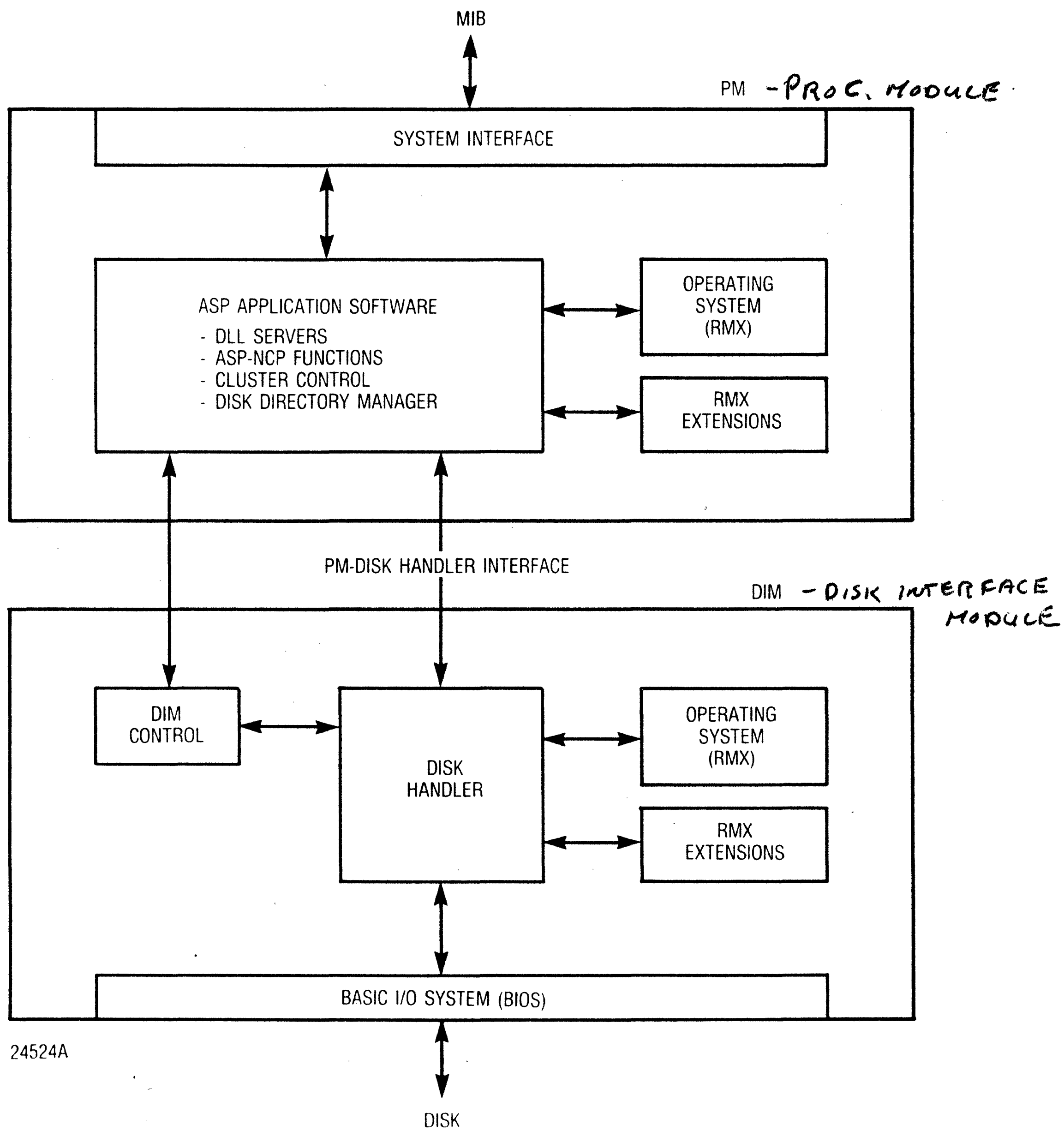
# SYSTEM SOFTWARE
# ASP SOFTWARE UNITS



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# SYSTEM SOFTWARE PSC FUNCTIONS

- Packet Switching and Routing
- Call Establishment
- Call Reconnection and Rerouting
- Call Recording
- Performance Recording
- Network User Interfacing
- Redundant, Fail-Safe Operation

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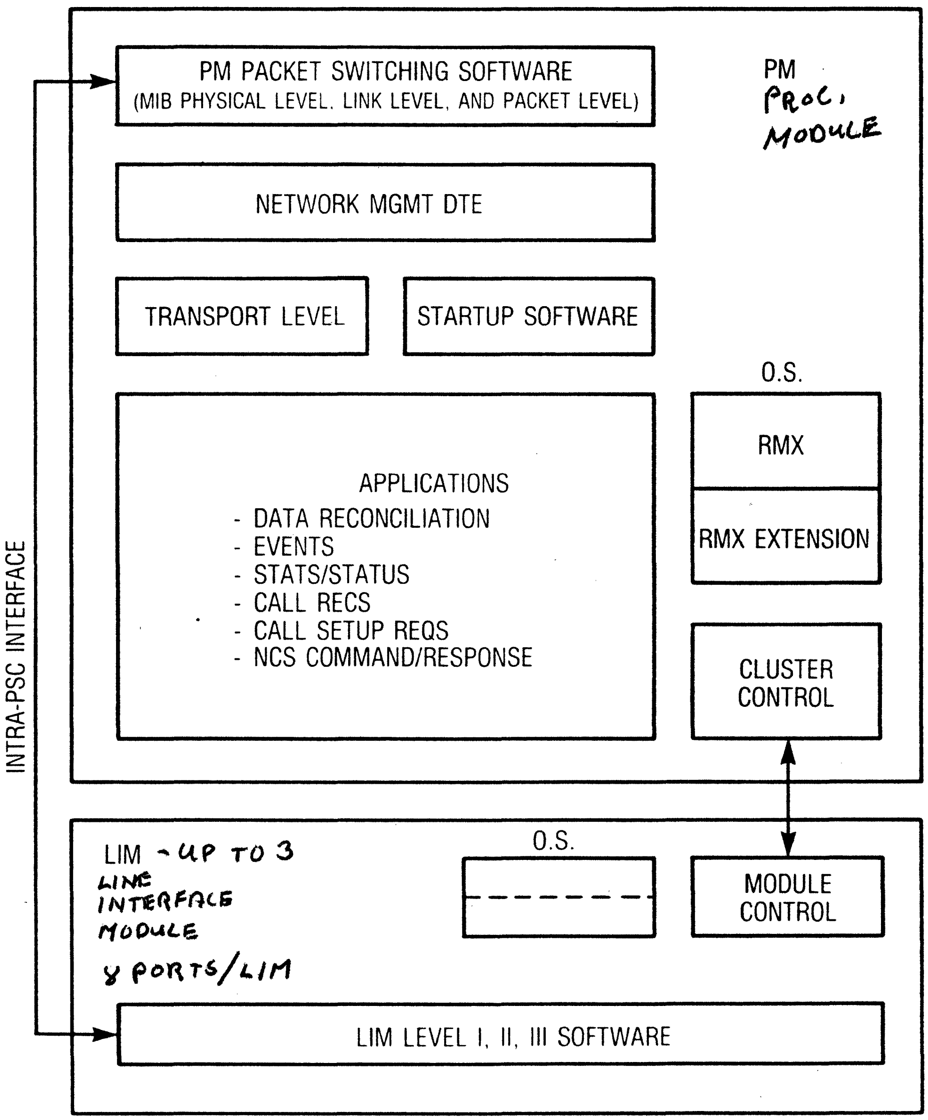
# SYSTEM SOFTWARE
# PSC SOFTWARE UNITS

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64KBPS THRUPUT

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# INTEGRATED PACKET SWITCHING NETWORK SYSTEM FEATURES AND FUNCTIONS 1.3.2

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# IPN GENERAL FEATURES

- Network Control Provided via NCS
- Powerful 16-Bit CPU Processors
- Distributed Memory Microprocessor Architecture
- High Data Throughput and Switching Capacity
  - 200 DPPS per PSC - BASED ON 65 BYTE PACKETS
  - 10 Call Setups/sec per ASP/NCP
- Multiple Protocol Support
- Online Maintenance and Debugging Facilities
- Redundant Fail-Safe Operation
- Cost Effective Modular Expansion and Sparing Capability
- Centralized or Distributed Network Control

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# SYSTEM COMPONENTS
# 1.3.2.1

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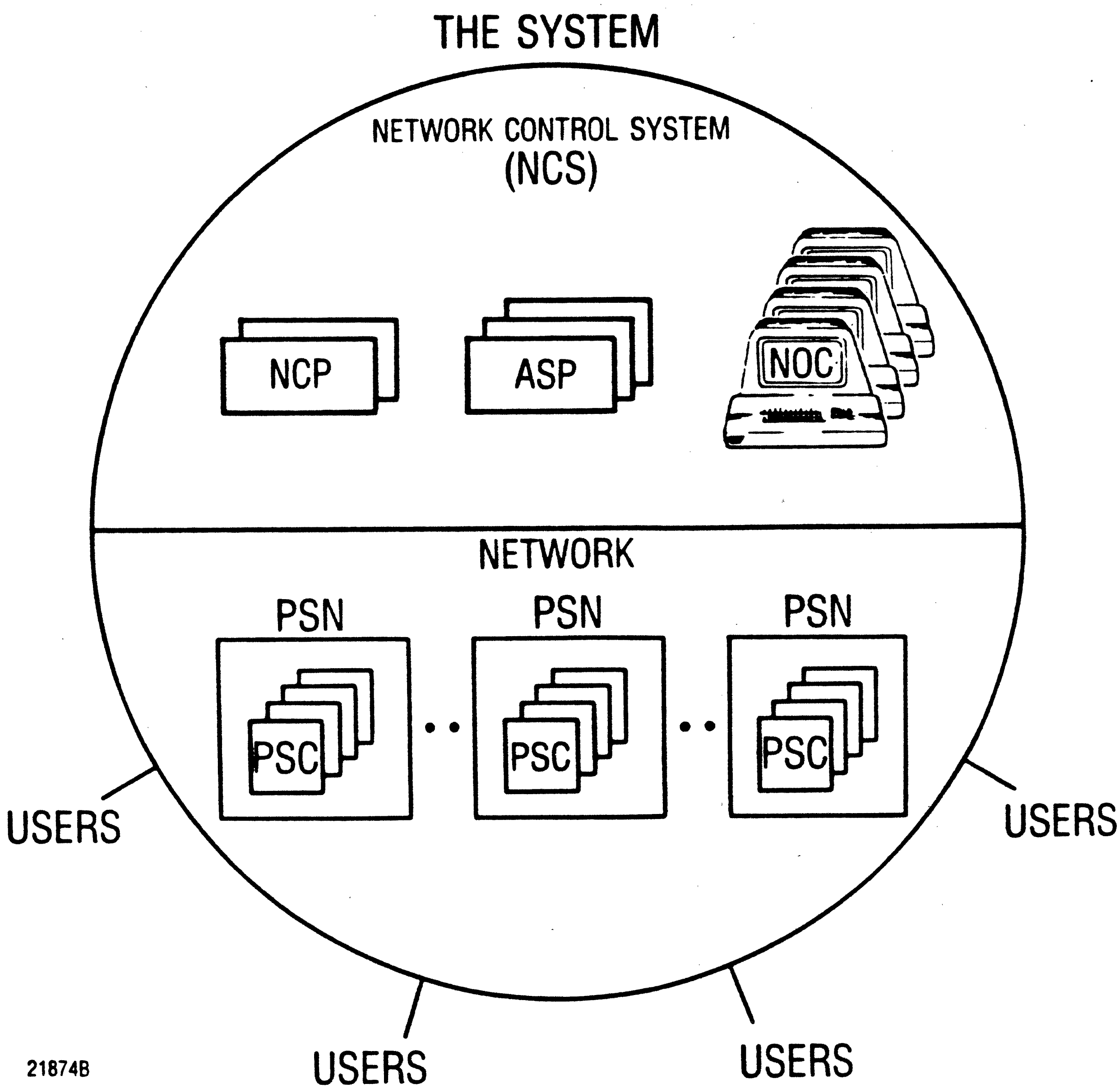
# SYSTEM COMPONENTS
# SYSTEM ORGANIZATION



# SYSTEM COMPONENTS
# PSC FUNCTIONS

- Packet Switching and Routing
- Call Establishment
- Call Reconnection and Rerouting
- Call Records
- Statistics
- Network User Interfacing
- 1-for-N Redundancy

# SYSTEM COMPONENTS
# NCS FUNCTIONS

- Network Configuration Control
- Performance Monitoring
- Network Maintenance and Debugging
- Network Component Downline Load
- Network Statistics Gathering
- Call Setup Assistance
- Storage of Billing Information
- Network Operator Functions

# SYSTEM COMPONENTS
# NOC FUNCTIONS

- Provides Network Operators with Network Configuration and Control Capabilities
- Menu Driven
- Soft Key Operation
- Local Data Validation, Detects Most Operator Errors
- Provides Summary Information
- Treated as Network Users, Therefore They can be Distributed Throughout the Network

# SYSTEM COMPONENTS
# ASP FUNCTIONS

- Downline Load of Operational Software and Configuration Data for PSCs
  - Fast Local Load
  - Remote Downline Load
- Can Provide Upline Dump of PSC Memory to NCP Upon NOC Command
- Provides Supervisory Network Services to Lower Hierarchical System Components
  - Address Translation*
  - Access Restrictions*
  - CREC/STATS/EVENTS Spooling*

* Enhanced Mode Only

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# THE USER
# 1.3.2.2

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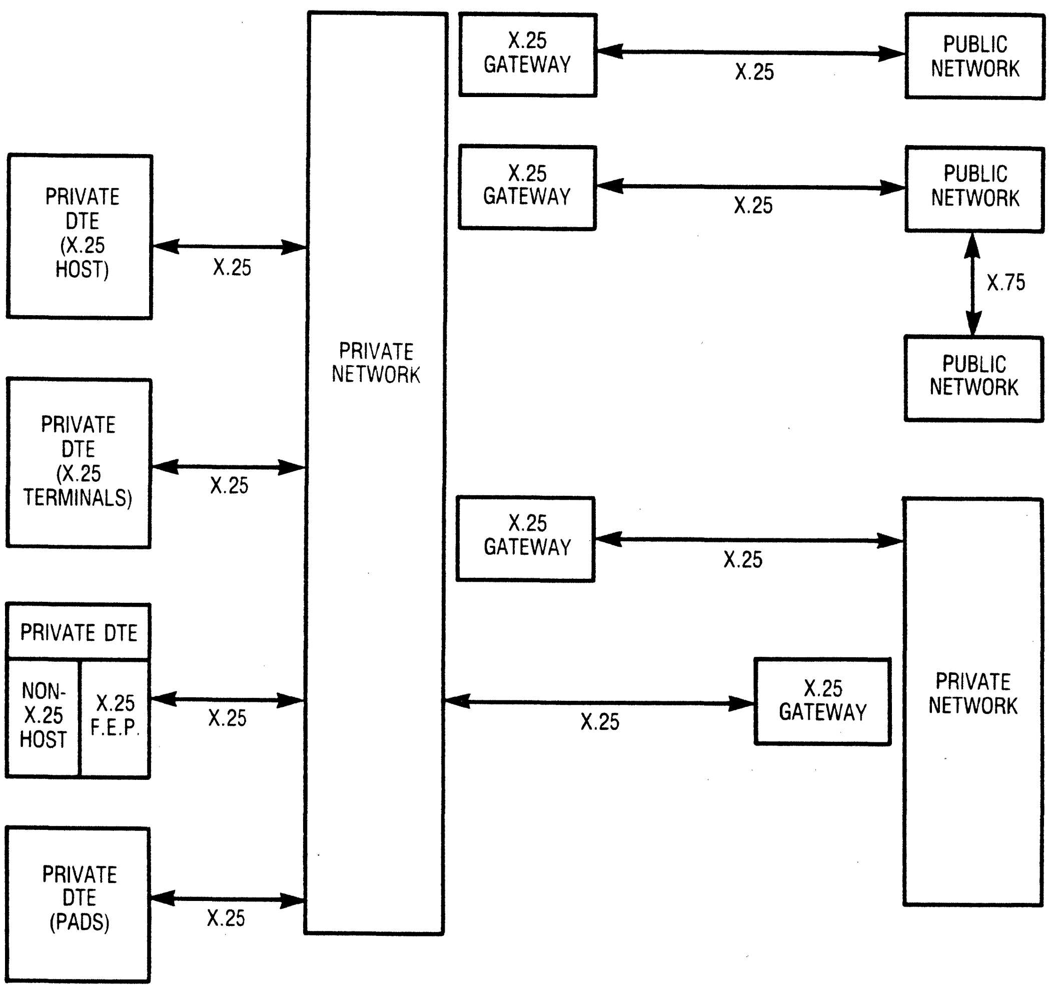
# THE USER SYSTEM INTERFACES

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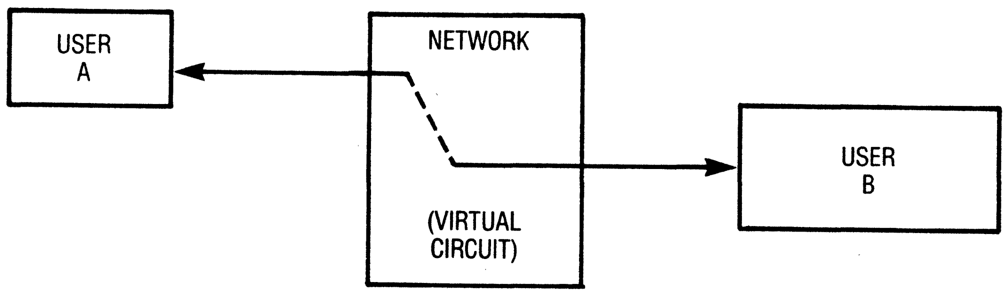
# THE USER SYSTEM INTERFACES

Interface Standards Supported are:

- X.25 (CCITT 1980)
  - A. Physical Level
    1. RS-232C/V.24
    2. V.35
    3. RS-449 - Both RS-422 and RS-423 Electrical Levels
  - B. Link Level
    1. LAPB, SLP, Modulo 8/128
  - C. Packet Level
- X.75
  - A. Physical Level
    1. RS-232C/V.24
    2. V.35
    3. RS-449 - Both RS-422 and RS-423 Electrical Levels
  - B. Link Level
  - C. Packet Level

# THE USER VIRTUAL CIRCUIT

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## Two Types:

- Switched Virtual Circuit (SVC)
- Permanent Virtual Circuit (PVC)

# THE USER ROUTING

- Utilizes "Shortest Path First" Concept
- Routes Optimized According To . . .

  Data Link Capacity - "Remaining Capacity"
  Propagation Delay - "Relative Length"
  Data Link Class (e.g., Satellite) Classes 1-16 Cost
- Fixed Routing Achieved by Adjusting Route Parameters via the NOC
- Determined by PSC on Which Call Originates (Source Routing)

# THE USER ADDRESSING

- **CCITT X.121 Formats (DTE-to-DTE)**
  1) DNIC - NPA - NXX - YYZZ
     or
  2) DCC - N - NPA - NXX - YYZZ

- **Format Key**
  - DNIC = Data Network Identification Code
  - DCC = Data Country Code
  - N = National Number
  - NPA = Area Code
  - NXX = Exchange
  - YY = Extension
  - ZZ = Optional Subaddress

- **Optional Mnemonic Addressing**
  - 8 Character Mnemonic "Access Code"
  - Optional "User ID"
  - Inserted into Called Address of Call Request Packet

# THE USER LOGICAL ADDRESSING

## Address Translation Table

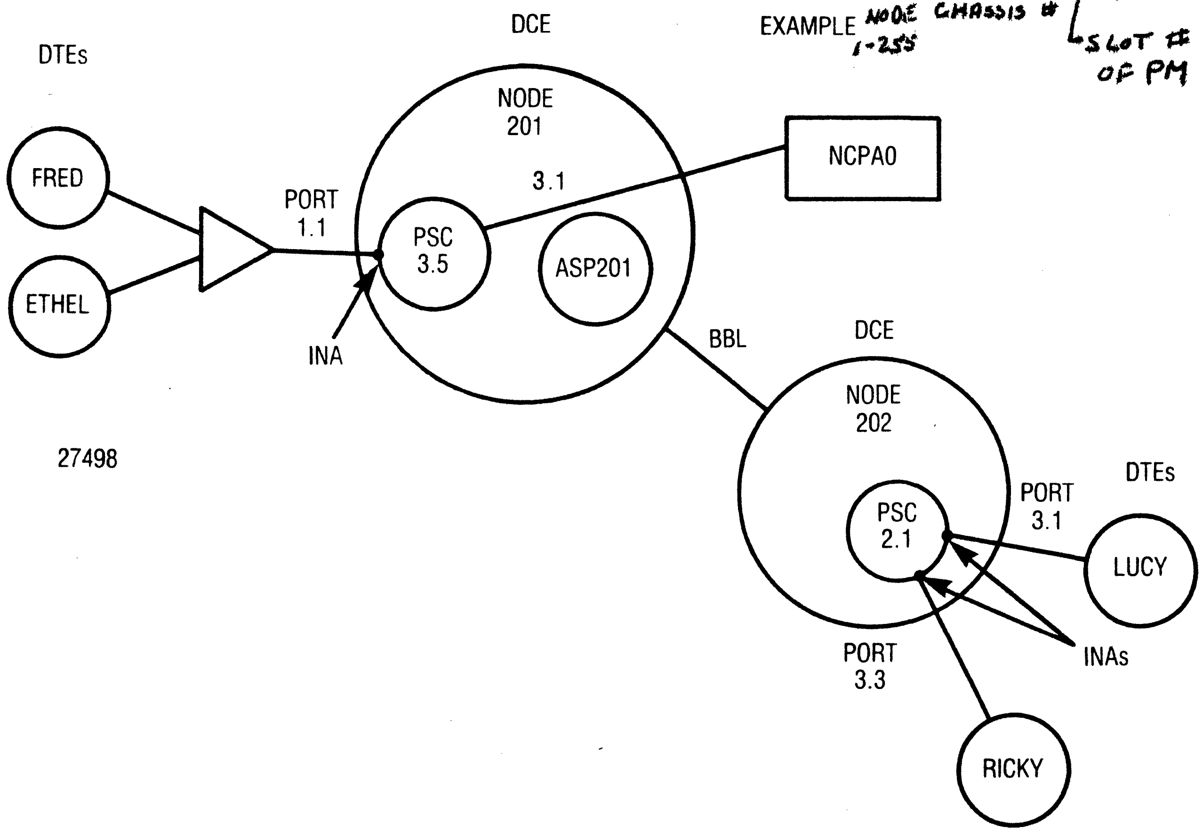
| Access Code | Logical Address (X.121) | Physical Address (INA) |
|---|---|---|
| FRED | 3999 303 424 8800 | 201 3.5 1.1 |
| ETHEL | 3999 303 424 8801 | 201 3.5 1.1 |
| LUCY | 3999 303 424 71XX | 202 2.1 3.1 |
| RICKY | 3999 303 424 72XX | 202 2.1 3.3 |
| ASP 201 | 3999 303 200 0001 | 201 4.1 0.0 |
| NCPA0 | 3999 303 100 0001 | 201 3.5 3.1 |

NET MGT DTE CALL

LIM/DM # & PORT #

EXAMPLE NODE 1-255 CHASSIS #

SLOT # OF PM




27498

# THE USER
# WHAT CAN BE CALLED ?

Port Users can Call the Following Entities :

- Individual X.25, PAD, or X.75 User Ports; (Foreign Network)
- Load Leveling Groups of X.25, PAD, or X.75 User Ports.
- X.25 Gateway to Foreign Network User or for Transit of Foreign Network

Note: It is not Possible for the User to Place Calls to Entities such as Nodes, MIB's or Backbone Links, Although User Calls do Pass Through These Facilities. Network Management DTEs may Establish Such Calls for Monitoring/Troubleshooting Purposes.

# THE USER CALL ESTABLISHMENT

- The Network Connects a User Call After the NCS Validates:
  - Mnemonic Address (Access Code)
  - User ID
  - Access Restrictions (Source, Destination)
  - Subscription Parameters (Reverse Charge Acceptance, Fast Select)

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# NETWORK SERVICES
# 1.3.2.3

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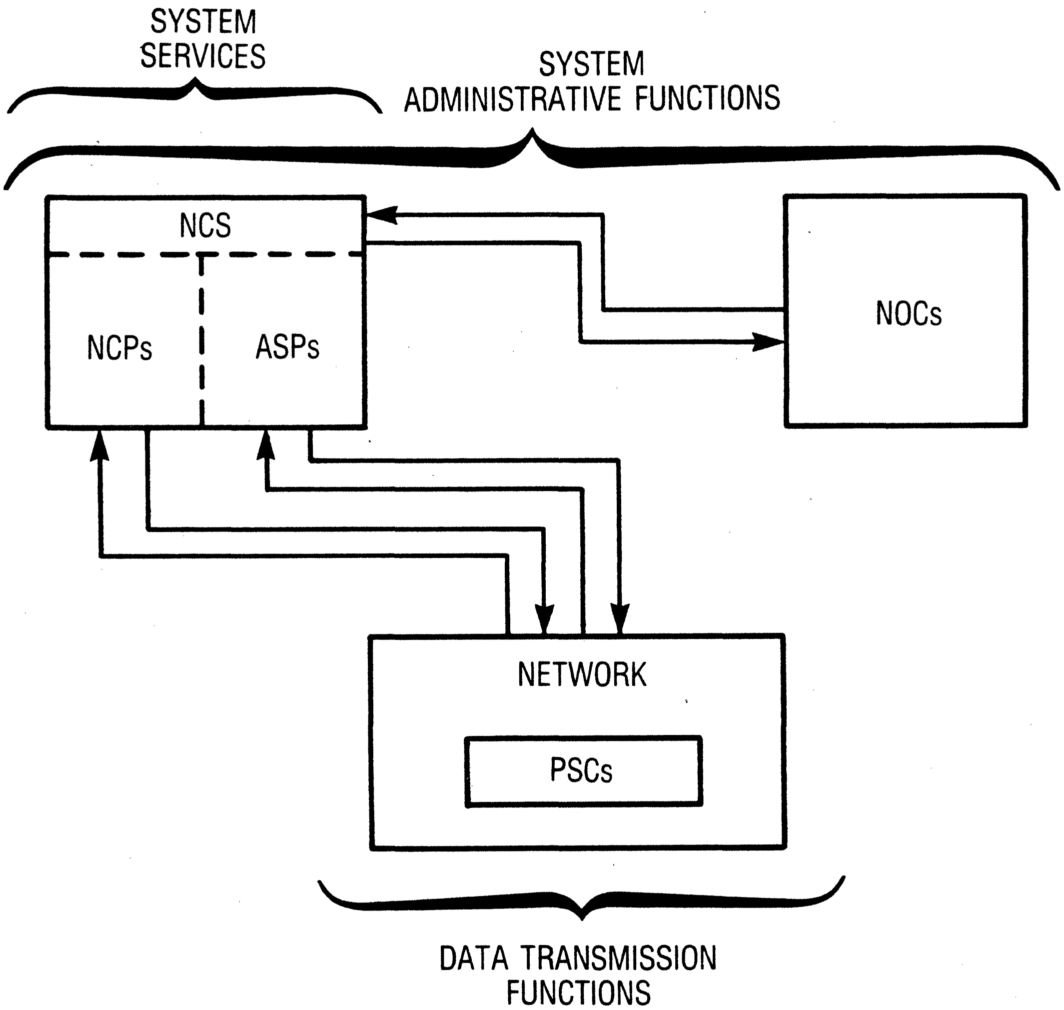
# SYSTEM SERVICES
# SYSTEM FUNCTIONS

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# NETWORK SERVICES

- Network Services Provided Within Network Control Include:
  - Call Setup Assistance ~~and~~ FOR Call Establishment
  - Call Records for Billing Purposes - SEND TO NCP BY PSC's
  - Statistics Collection for Performance Monitoring - SENT TO NCP ON CONFIGURABLE INTERVAL
  - Network Downline Loading via the (Supernet) SUPERVISORY NETWORK (Transparent to the User)
  - Network Upline Dumping of ASP or PSC Memory Images Provided for Debugging Purposes.

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# NETWORK ADMINISTRATIVE FUNCTIONS 1.3.2.4

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# NETWORK ADMINISTRATIVE FUNCTIONS

- Provided by Combination of ASP, NCP Processes, NOCs and the Supernet.
- NOC Initiated
- These Functions Include:
  - Configuration Definition and Management
  - Event and Alarm Signaling
  - Network Status
  - Network Component Control (Reset, Restart, and State Control)
  - Network Maintenance
  - Reports

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# SUPERVISORY NETWORK 1.3.2.5

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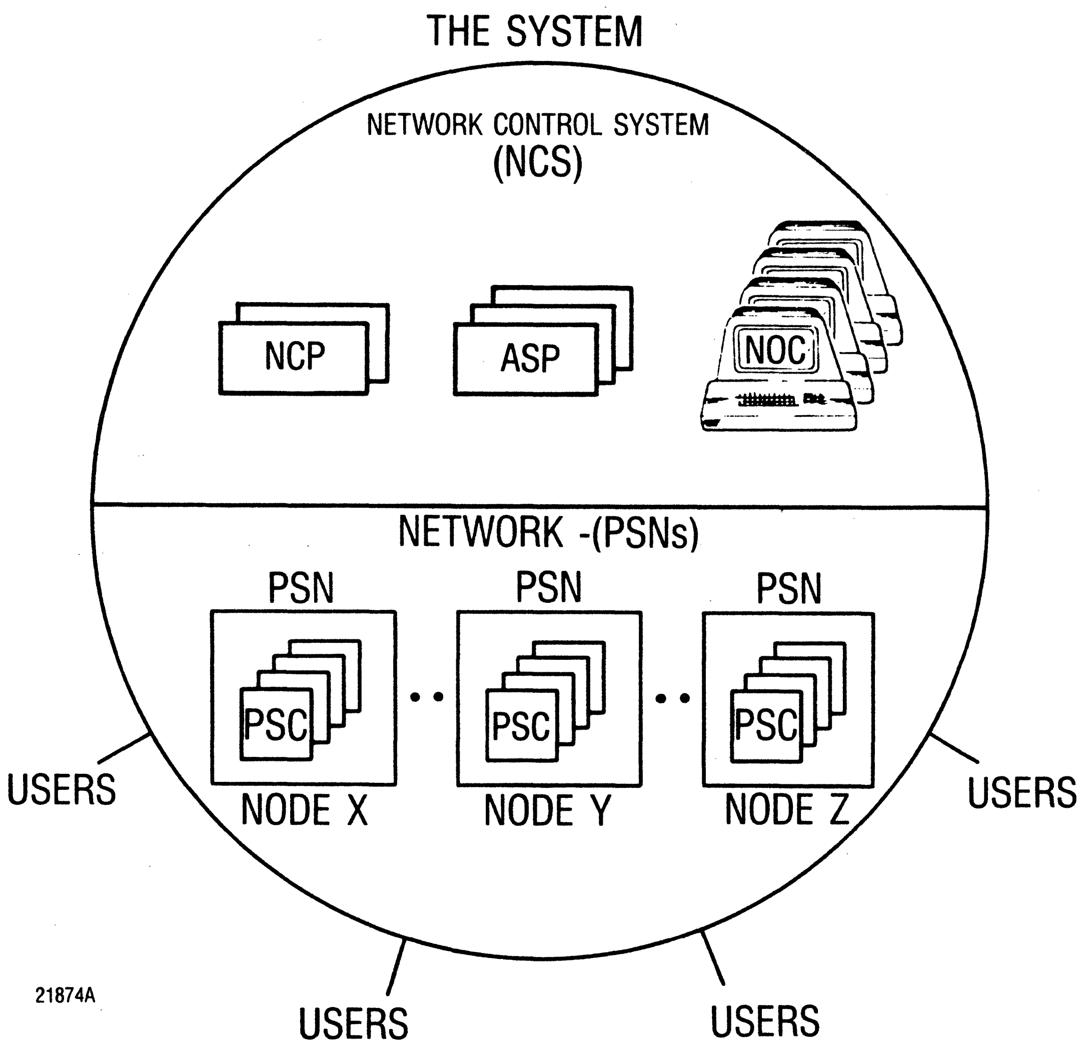
# SUPERVISORY NETWORK SYSTEM ORGANIZATION

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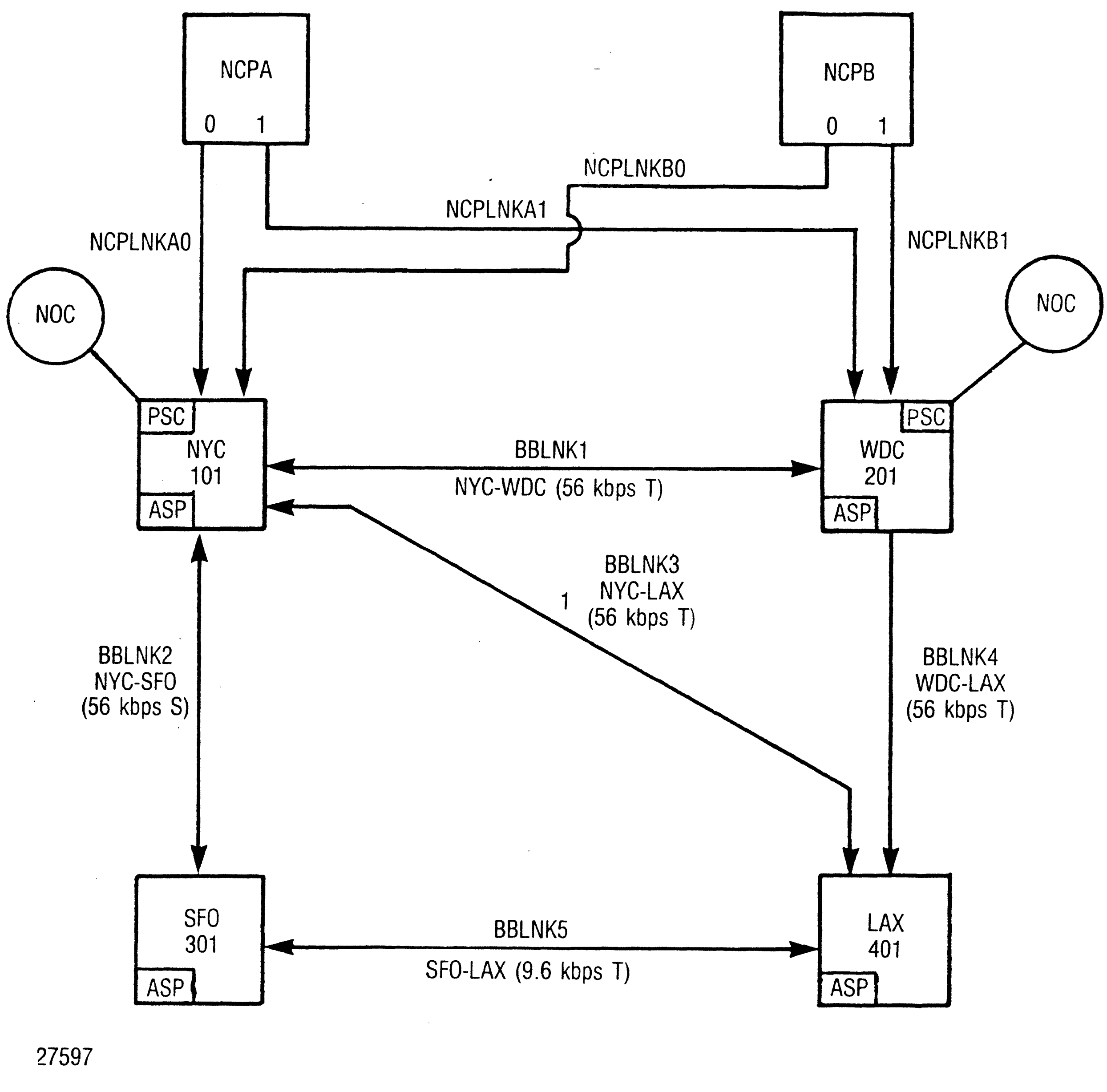
# SUPERVISORY NETWORK EXAMPLE NETWORK TOPOLOGY

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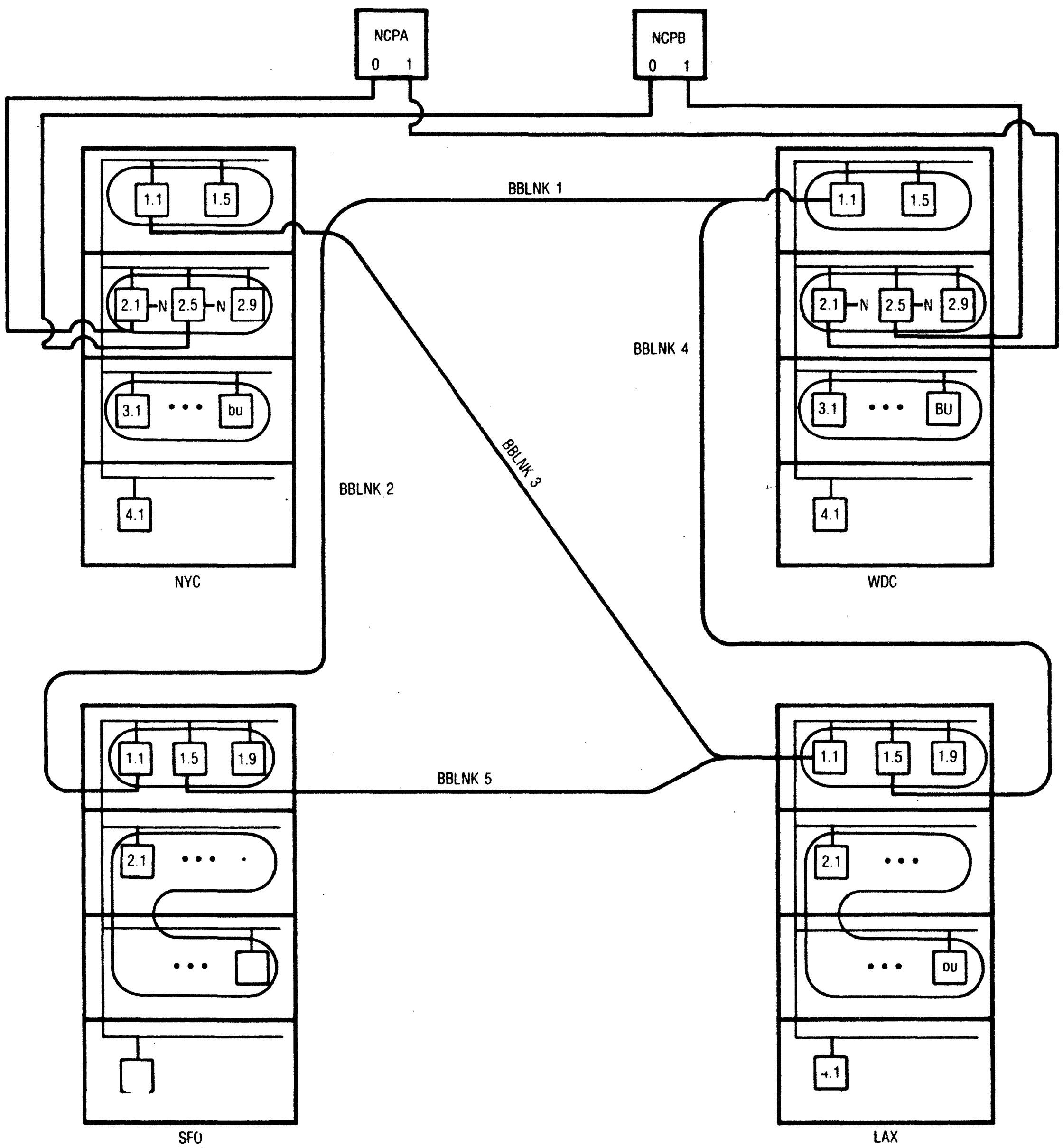
# SUPERVISORY NETWORK EXAMPLE NETWORK PHYSICAL CONNECTIVITY

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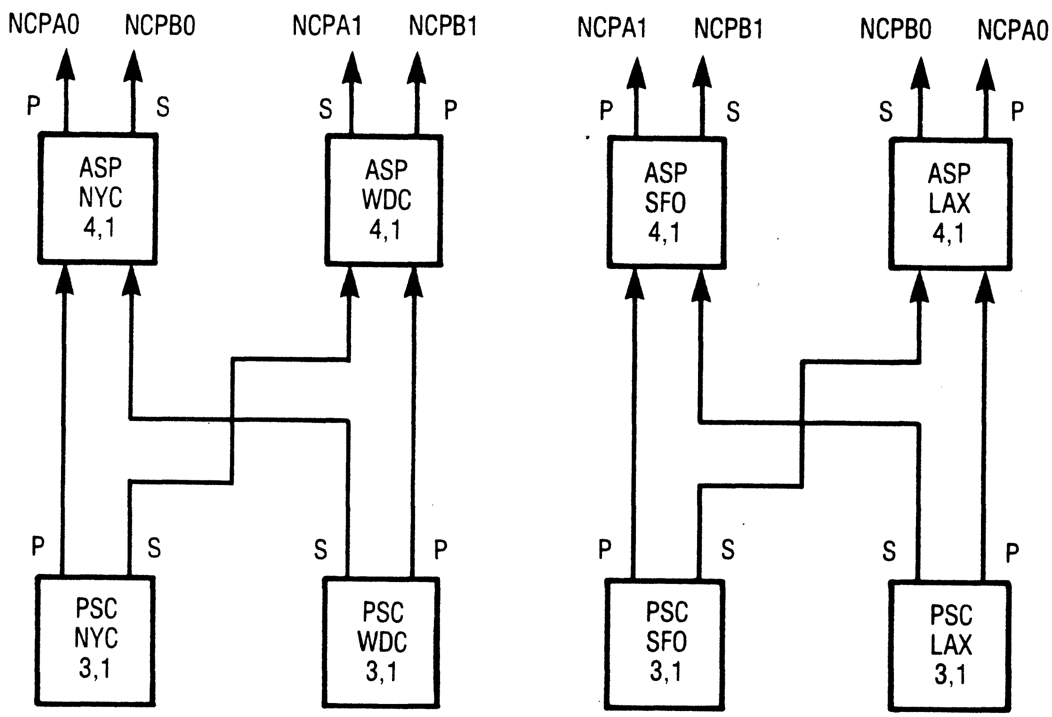
# SUPERVISORY NETWORK LOGICAL CONNECTIVITY

**The Supervisory Network Configuration below has a Good Balance of Connections (and Possibly Traffic) Between NCPs, Among NCP Ports, and Among ASPs.**

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# SYSTEM COMPONENTS
# 2.0

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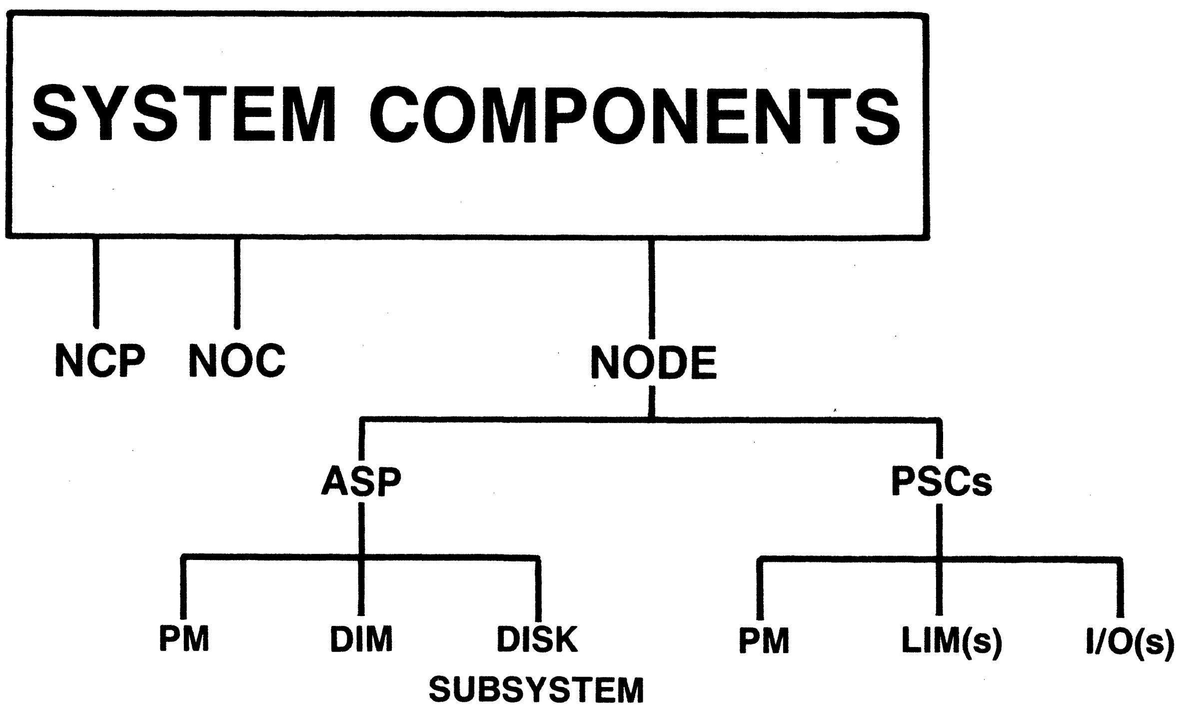
# SYSTEM COMPONENTS

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# SYSTEM COMPONENTS

PSN(s)

- RACK(s)
- CHASSIS
  - STANDARD -PSC
  - STORAGE - ASP
- PSCs
  - PM
  - LIM(s)
  - I/Os
- 24 PORTS
  9724(s)
  - PM
  - 1-3 LIMs
  - I/Os
- 8 PORT
  9708(s)
  - SELF-CONTAINED UNIT
  RS232 ONLY

ASP(s)

- CHASSIS
  - STORAGE
- ASP CLUSTER
  - PM
  - DIM
  - SASI
  1 cd
  - CONTROLLER
  - 20 MBYTE DISK DRIVE

NCP(s)

- VAX 8600
  VAX 8800
  VAX 11/750
  VAX 11/780
  VAX 11/785
  MICROVAX
- I/O BOARDS
  - DMF 32
  - ACC BOARDS
- PERIPHERALS
  - HARD COPY TERMINAL
  - CRT CONSOLE
  - EVENT PRINTER
  - REPORT PRINTER
  - DISK SUBSYSTEM
  - TAPE SUBSYSTEM

NOC(s)

- IWS
  - INTELLIGENCE UNIT
    - DISPLAY
    - MEMORY
    - 8086
    - I/O
  - TOWER UNIT
    - 10 MBYTE
    - POWER SUPPLY
    - 8'' FLOPPY
- NGEN
  - DISPLAY
  - 1 MB MEMORY
  - 80286
  - 24 MB HARD/FLOPPY
  - POWER SUPPLY -2

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# PSN COMPONENTS
# 2.1

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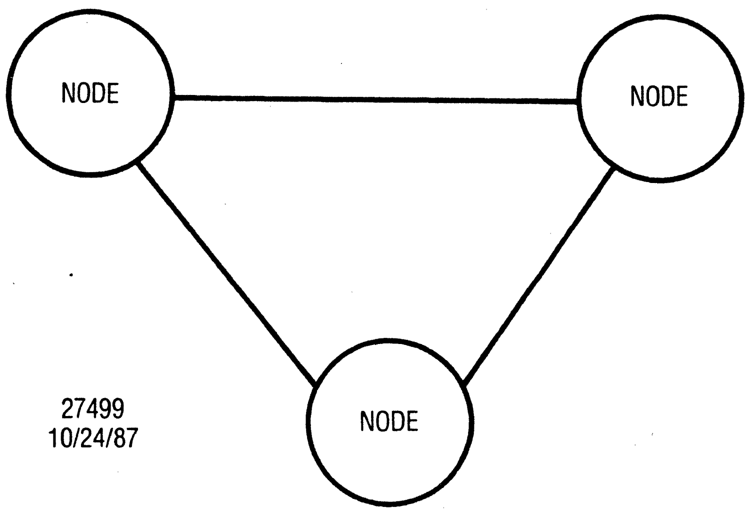
# PSN COMPONENTS

## WHAT IS A PACKET SWITCHING NODE?

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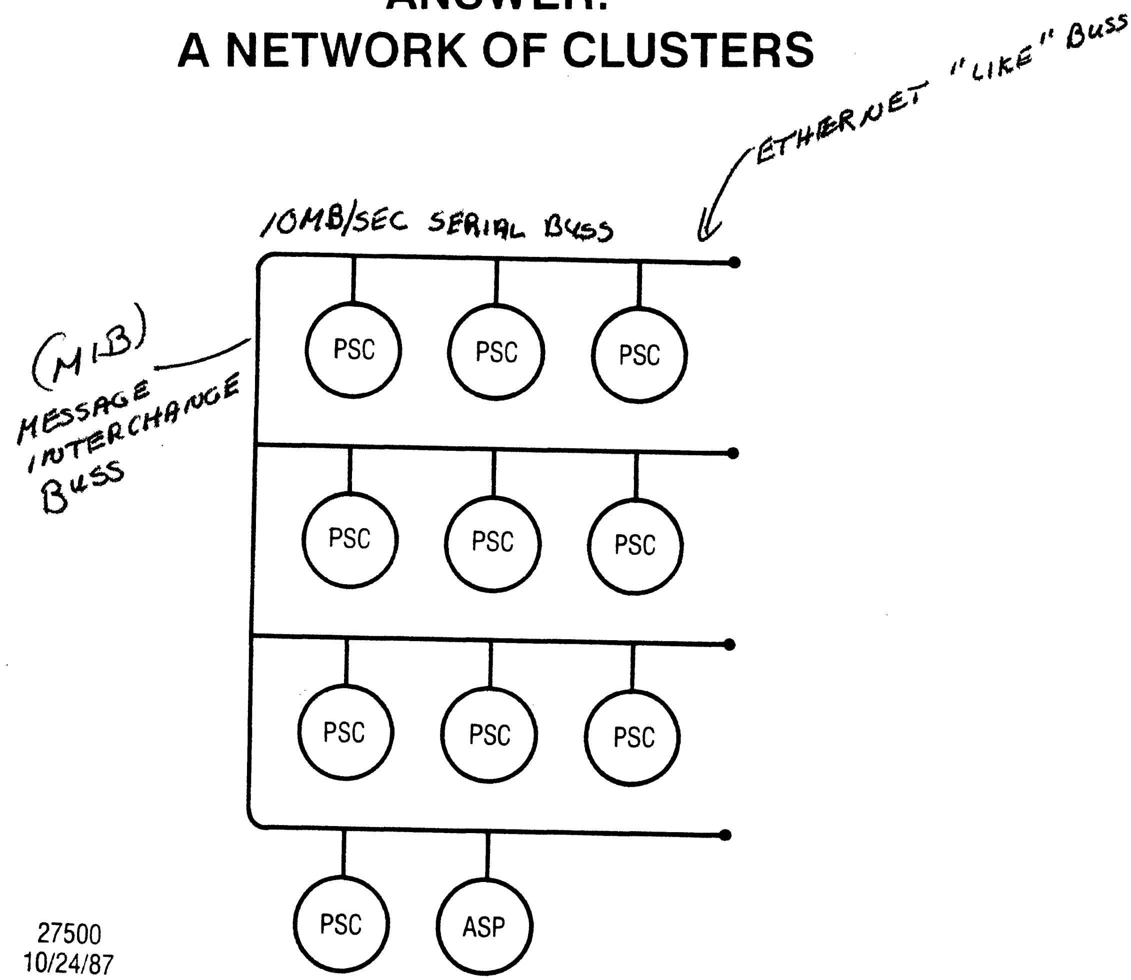
# PSN COMPONENTS

## ANSWER:
## A NETWORK OF CLUSTERS




27500
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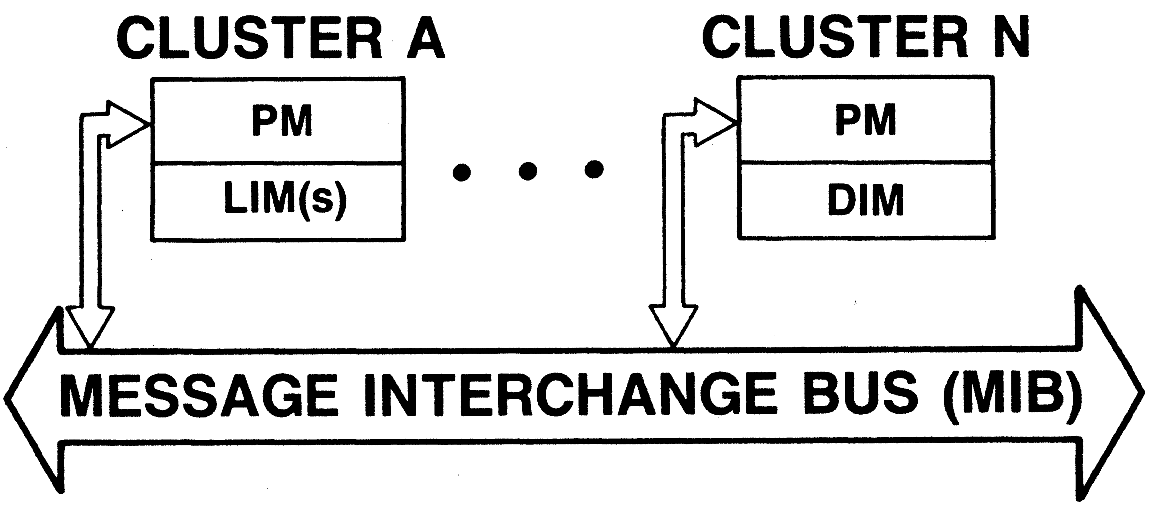
# PSN COMPONENTS

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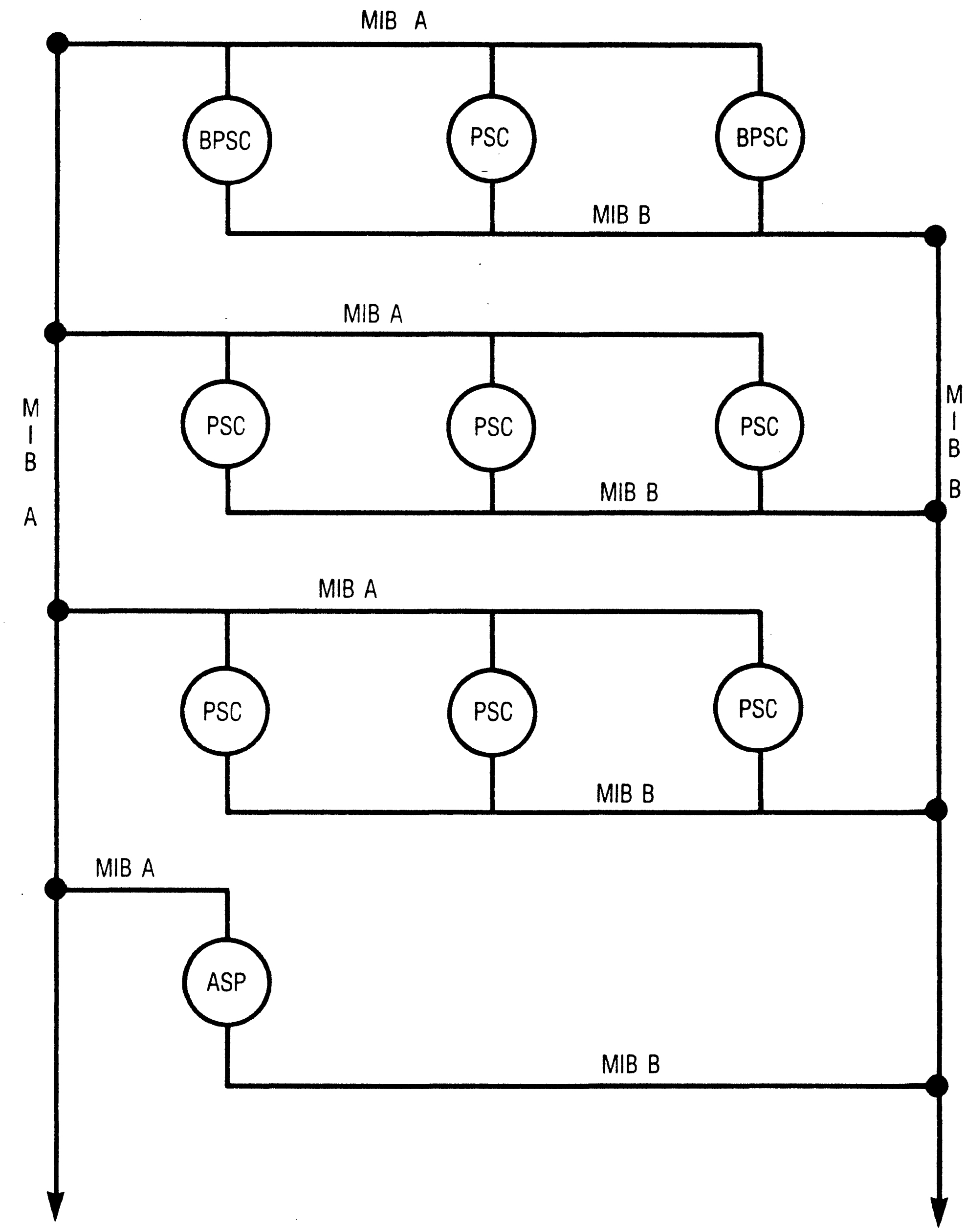
# PSN COMPONENTS
# "A NETWORK OF CLUSTERS"

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11/23/86

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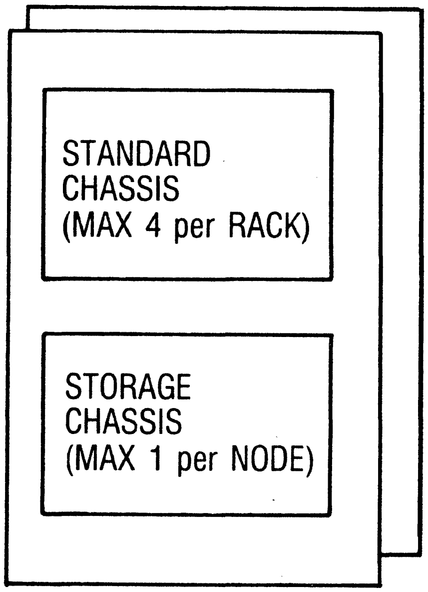
# PSN COMPONENTS WHAT ARE THE PHYSICAL BOUNDARIES OF A NODE?

- A Node is Comprised of 1 to 2 Racks of up to 4 Chassis Each
- All Clusters in the Chassis can Communicate Over a Common High Speed (10 Mbps) Serial Bus Called the MIB (MESSAGE INTERCHANGE BUS)
- There are Two MIBs, A and B
- A Node is a Single Geographical Location/Site
- If a Node Initially Configured as a Single Rack Node with X Chassis, it can Easily be Expanded to a 2 Rack Node with X + 4 Chassis

# PSN COMPONENTS WHAT ELEMENTS COMPRISE A NODE?




RACK (MAX 2 per NODE)

## STANDARD CHASSIS

MMB - MULTI MASTER BUSS

- Power Supplies (4 per Chassis)
- Processor Modules (1 per Cluster)
- LIM (1-3 per PSC)
- I/O Modules (1 per ~~PM~~, LIM, DIM)
- MMB Jumpers (1 per LIM)
- MMB Terminators (2 per Cluster)
- 1:N Redundancy Cables (Cluster Sparing, Max. 1 for 11)
- BRCs (2 per Chassis)

USS EPEATER ARD

## STORAGE CHASSIS

- Standard Power Supplies (2 per Chassis)
- Storage Power Supplies (Max. 2 per Chassis)
- PM (1 per Disk Cluster-ASP)
- DIM (1 per ASP)
- I/O Modules (1 per DIM)
- MMB Jumpers (1 per DIM)
- MMB Terminators (2 per Chassis)
- BRCs (2 per Chassis)
- Disk Controller (Max. 2 per Chassis)
- Disk Units (Max. 2 per Chassis, 20 MBytes Ea.)

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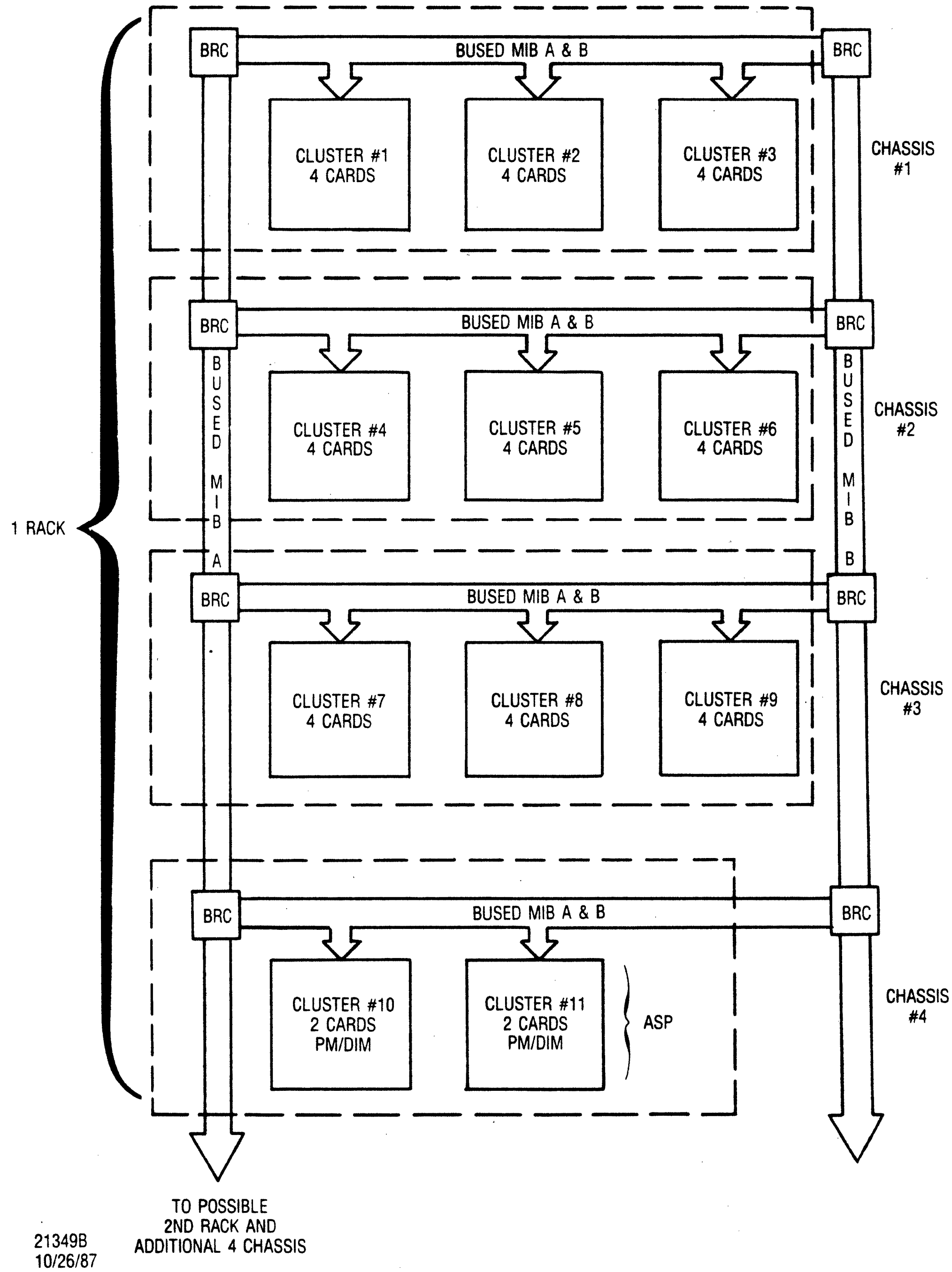
# PSN COMPONENTS
# TYPICAL NODE CONFIGURATION






MIB SWITCHOVER IS MANUAL

# PSN COMPONENTS
# WHAT IS A CLUSTER?

- A Cluster is a Group of Intelligent Modules (PM, LIMs, or PM, DIM) and Their Associated I/O Modules that Communicate with Each Other Within the Cluster over a 1 M Byte Sec. Parallel Bus. This Bus is Called the MMB (Multimaster Bus) whose "Length" is Configurable via MMB Jumpers and MMB Terminators

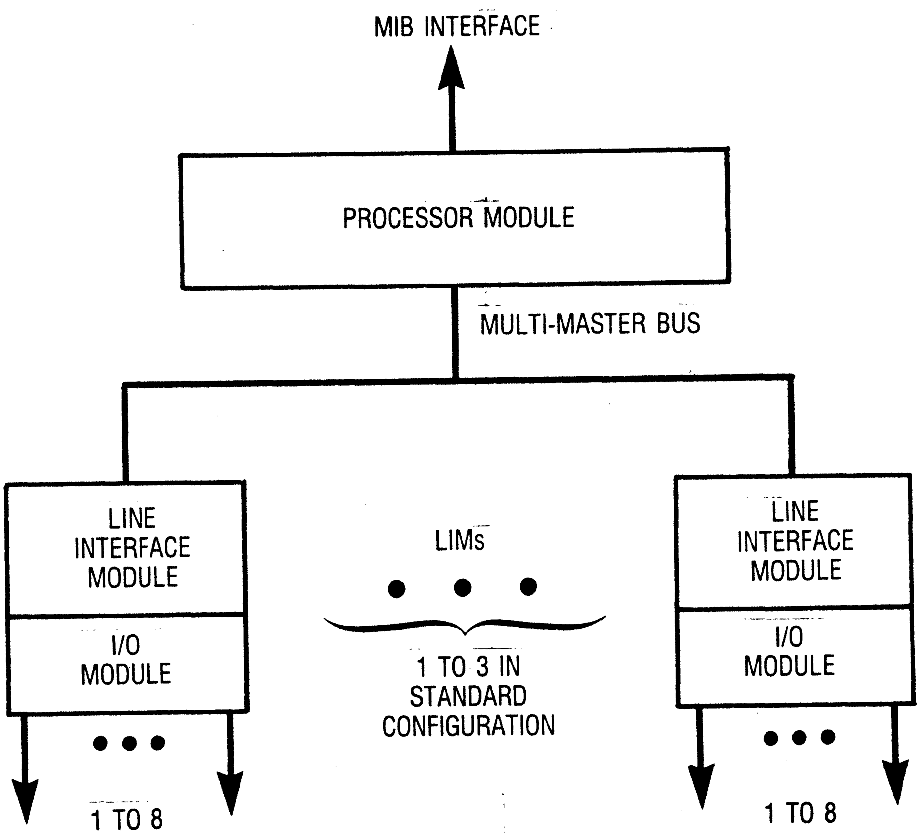
- There are Two Cluster Types: PSCs and ASPs

- Cluster Configurations are Flexible and Customer/Application Dependent

- A Minimum PSC Configuration is 2 Modules (1 PM and LIM), Whereas a Standard PSC Configuration is 4 Modules (1 PM and 3 LIMs)

- There Must Always be a PM in a Cluster Because it is the Cluster Master. LIMs and DIMs are not Supported Within the same Cluster

# PSN COMPONENTS
# PSC




RS232 - 8 PORTS
V. 35 - 2 PORTS
RS449 - 4 PORTS

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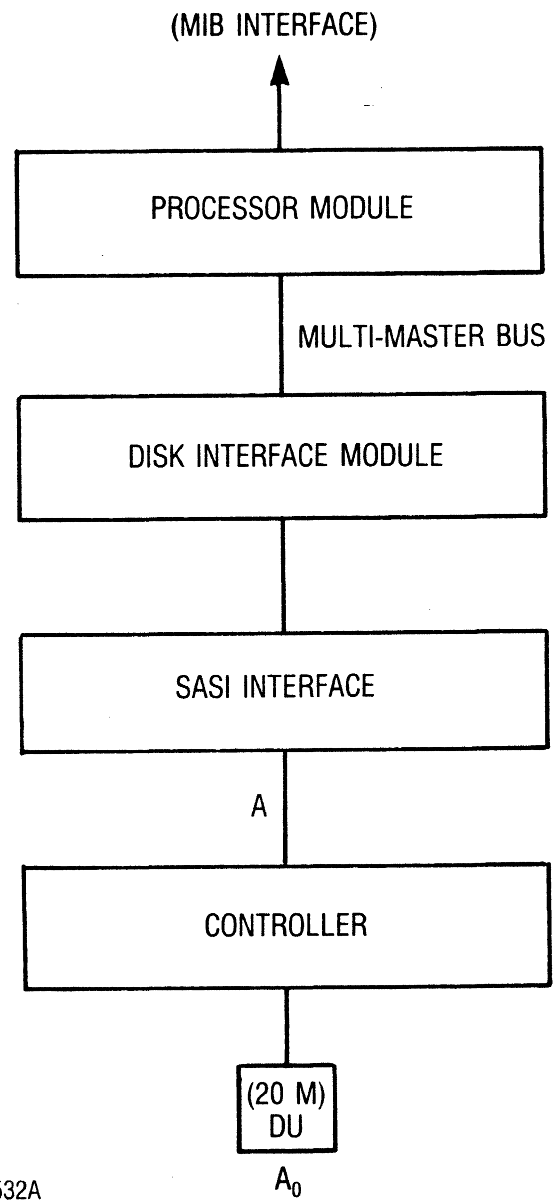
# PSN COMPONENTS ASP

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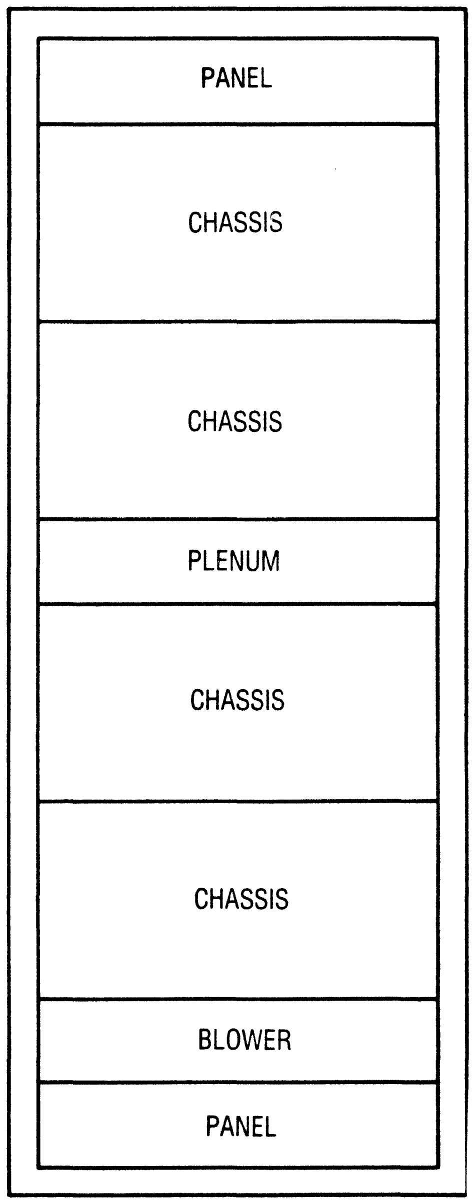
# PSN
# PHYSICAL PROPERTIES
# (CP9000 SERIES II HARDWARE)
# 2.1.1

2-15E4256
30-OCT-87

# PSN PROPERTIES EQUIPMENT RACK

- Standard 19" EIA
- Contains Power Distribution and Cooling
- Supports Up to 288 Lines Maximum (4 Standard Chassis)
- Dimensions - Height: 84" (213.4 cm), Width: 25" (61 cm), Depth: 36" (91.4 cm)
- Approximately 1000 lbs Fully Loaded Weight - 225 lbs (102.3 kg) Empty
- Power - 115 Vac Nominal Single Phase or 220 Vac Nominal Single Phase

# PSN PROPERTIES SINGLE STANDARD RACK NODE LAYOUT FRONT VIEW

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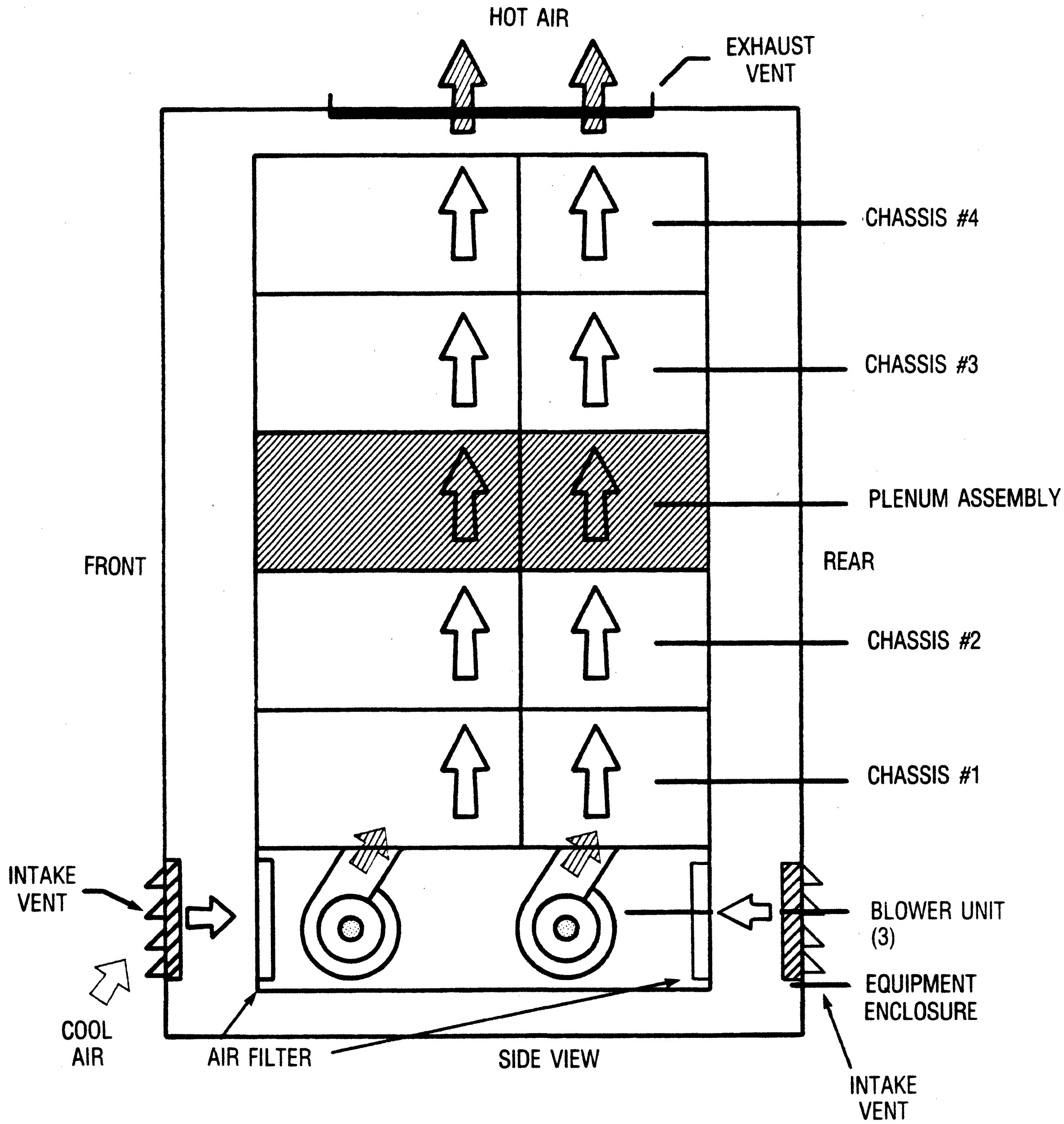
# PSN PROPERTIES
# COOLING SUBSYSTEM

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11/22/86

# PSN PROPERTIES
# STANDARD CHASSIS

- Supports up to 12 CP9000 Series II Modules
  - PM, LIM
  - With I/O Modules
- Four Modular Power Supplies (Standard)
- Accommodates Up to 72 Lines Maximum (Using 8 Port RS-232C I/O Modules)
- Up to 4 Chassis Per Rack
- Dimensions - Height: 14" (35.6 cm), Width: 19" (48.3 cm), Depth: 26" (66 cm)
- Weight (Maximum) - Approximately 200 lbs (91 kg) Loaded

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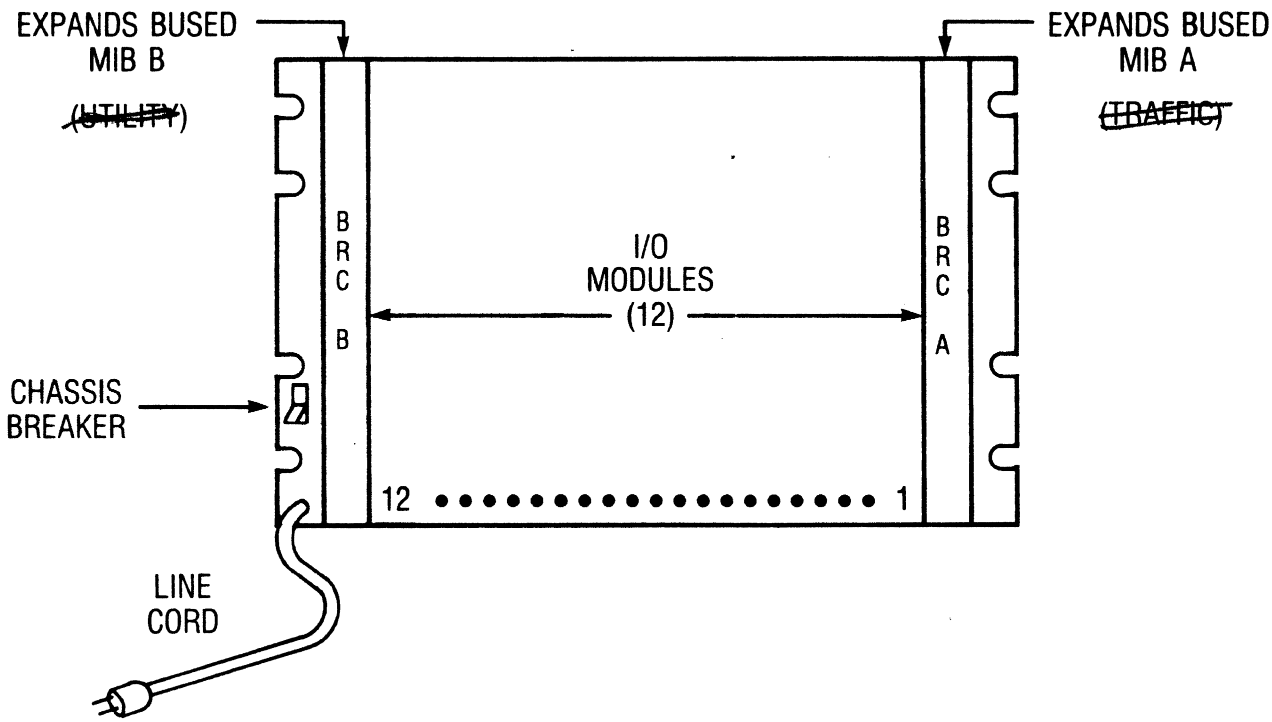
# PSN PROPERTIES
# STANDARD CHASSIS

<table>
<tr><td>MODULE POWER SUPPLY</td><td rowspan="2">MODULE 1</td><td rowspan="2">MODULE 2</td><td rowspan="2">MODULE 3</td><td rowspan="2">MODULE 4</td><td rowspan="2">MODULE 5</td><td rowspan="2">MODULE 6</td><td rowspan="2">MODULE 7</td><td rowspan="2">MODULE 8</td><td rowspan="2">MODULE 9</td><td rowspan="2">MODULE 10</td><td rowspan="2">MODULE 11</td><td rowspan="2">MODULE 12</td><td>MODULE POWER SUPPLY</td></tr>
<tr><td>MODULE POWER SUPPLY</td><td>MODULE POWER SUPPLY</td></tr>
</table>

13413W2
16P156
08/30/85

# PSN PROPERTIES STANDARD CHASSIS LAYOUT (REAR VIEW)

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# PSN PROPERTIES
# STANDARD CHASSIS MODULE PLACEMENT

| | |
|---|---|
| | |
| BUS REPEATER CARD | B |
| I/O MODULE 12 | |
| I/O MODULE 11 | |
| I/O MODULE 10 | |
| I/O MODULE 9 | |
| I/O MODULE 8 | |
| I/O MODULE 7 | |
| I/O MODULE 6 | |
| I/O MODULE 5 | |
| I/O MODULE 4 | |
| I/O MODULE 3 | |
| I/O MODULE 2 | |
| I/O MODULE 1 | |
| BUS REPEATER CARD | A |
| | |

REAR VIEW
RIGHT SIDE

| | |
|---|---|
| POWER SUPPLY MODULE | POWER SUPPLY MODULE |
| PM, LIM OR DIM MODULE 1 | |
| PM, LIM OR DIM MODULE 2 | |
| PM, LIM OR DIM MODULE 3 | |
| PM, LIM OR DIM MODULE 4 | |
| PM, LIM OR DIM MODULE 5 | |
| PM, LIM OR DIM MODULE 6 | |
| PM, LIM OR DIM MODULE 7 | |
| PM, LIM OR DIM MODULE 8 | |
| PM, LIM OR DIM MODULE 9 | |
| PM, LIM OR DIM MODULE 10 | |
| PM, LIM OR DIM MODULE 11 | |
| PM, LIM OR DIM MODULE 12 | |
| POWER SUPPLY MODULE | POWER SUPPLY MODULE |

FRONT VIEW
RIGHT SIDE

105P224
01/24/86

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# PSN PROPERTIES
# EXAMPLE - 2, 3, 4 CARD CLUSTERS

PM ARE ADDRESSED BY CHASSIS #
& SLOT #

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHASSIS SLOT # | 1 PM | 2 LIM | 3 LIM | 4 LIM | 5 PM | 6 LIM | 7 LIM | 8 | 9 PM | 10 LIM | 11 PM | 12 LIM |
| CLUSTER SLOT # (MMB ID) | 0 | 1 | 2 | 3 | 0 | 1 | 2 | | 0 | 1 | 0 | 1 |

SET BY DIP SWITCH ON EACH LIM.

19477A
10/26/87

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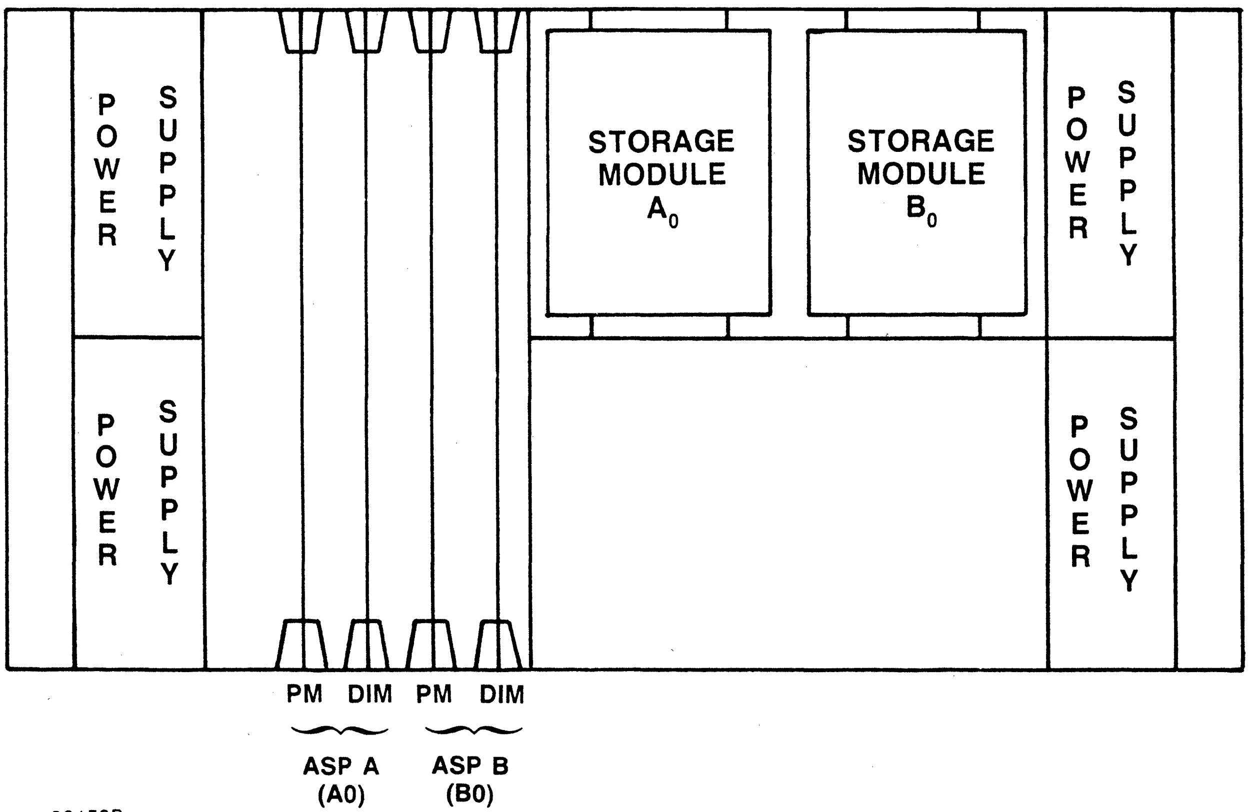
# PSN PROPERTIES STORAGE CHASSIS (FRONT VIEW)

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10/26/87

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30-OCT-87

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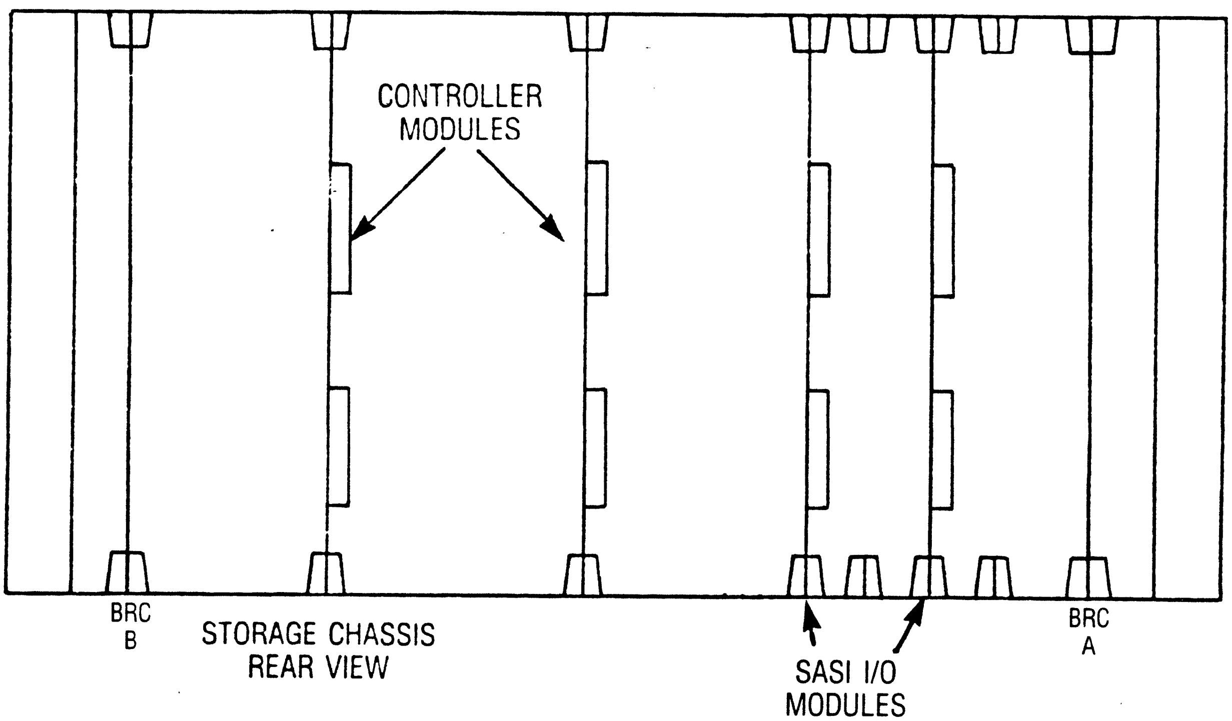
# PSN PROPERTIES STORAGE CHASSIS (REAR VIEW)




**102P235**
17740A
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# MODULE DESCRIPTIONS 2.1.2

2-26E4256
30-OCT-87

# PSN MODULES
# CP9000 SERIES II
# INTELLIGENT MODULES

- PM - Processor Module
- LIM - Line Interface Module
- DIM - Disk Interface Module
- PSC = PM + LIM + . . . + LIM
- ASP = PM + DIM

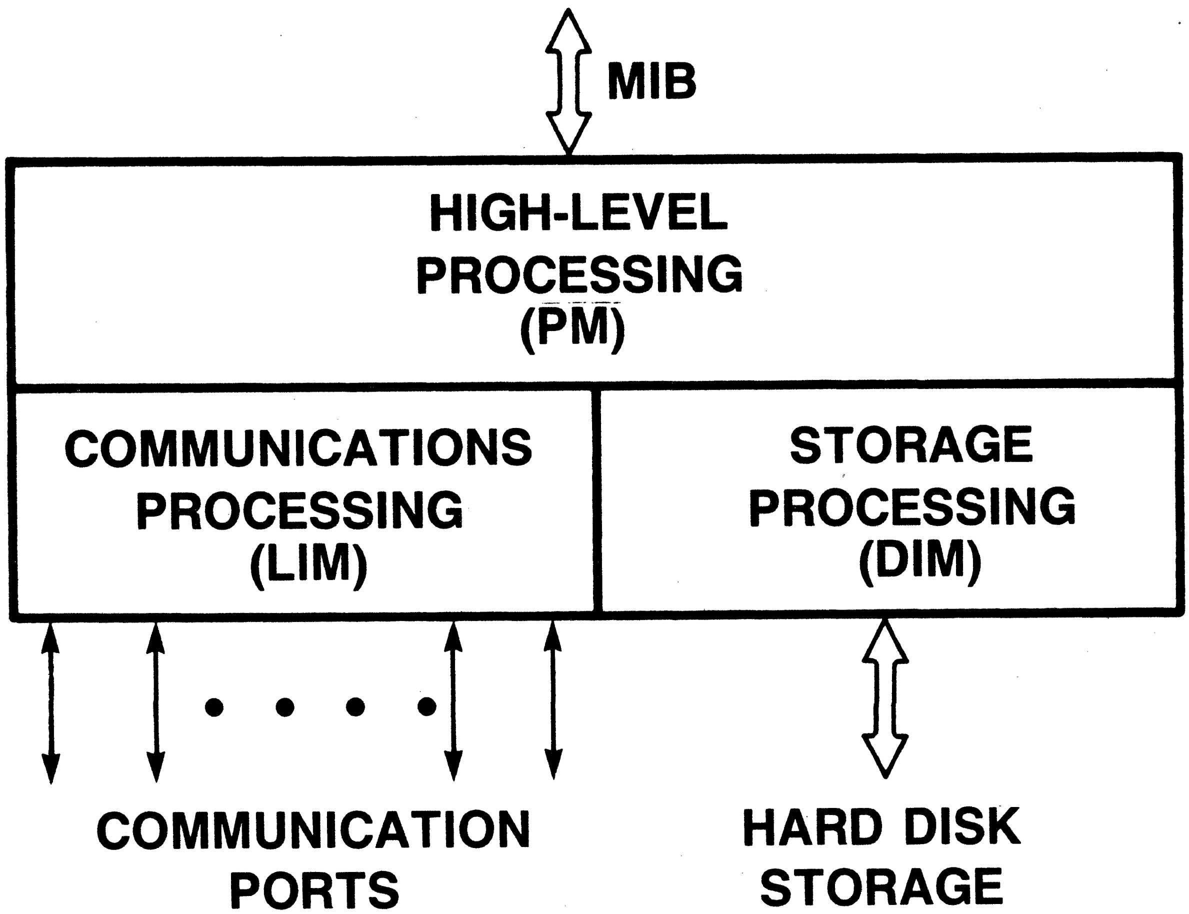
# PSN MODULES WHAT IS AN INTELLIGENT MODULE?

- An Intelligent Module is a Microprocessor Based PC Card of Which the CP9000 II Packet Switching Network has Three Types

  PM - Processor Module
  LIM - Line Interface Module
  DIM - Disk Interface Module

- An Intelligent Module is the "Opposite" of an I/O Module. I/O Modules are Supported/Driven by PMs, LIMs, and DIMs and They are not Microprocessor Based

# PSN MODULES CLASSIC COMPUTER ARCHITECTURE

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11/22/86

# PSN MODULES
# CP9000 SERIES II
# PROCESSING POWER

INTEL 186 - Approximately 400 K Instructions per Second 16 Bit Words

8 MHz

INTEL 286 - Approximately 800 K Instructions per Second 16 Bit Words

6 MHz

MMB - 16 Bit Wide Parallel Bus 500 K Words per Second Throughput

MIB - 10 Mbps Serial Bus - Ethernet Like
CSMA Type Access with CD
3000-4000 Packets per Second (50%) Utilization

# PSN MODULES
# PROCESSOR MODULE - GENERAL

The PM is used to provide general processing capabilities as well as to serve as an interface to the Message Interchange Bus (MIB). The main functional components of the PM are as follows:

- The Intel iAPX 286 Microprocessor with its High Performance 16-Bit Architecture
- Local Dual Ported Error Checking Correcting Random Access Memory (ECC RAM) of 512 Kilobytes per PM
- Local Erasable Programmable Read Only Memory (EPROM) of 128 Kilobytes per PM
- Nonvolatile RAM (NVRAM) Storage of 256 Bytes per PM
- Dual Bused MIB
- Intelligent MIB Controller (MIBC) for Interfacing to the 10 Megabit per Second MIBs
- Bused an Point-to-Point Debug Ports
- Multi-Master Bus (MMB) Interface for Access to Other Intelligent Modules in the Same Cluster
- Local Utility Timers, Interval Timers, and Time-of-Day Clock

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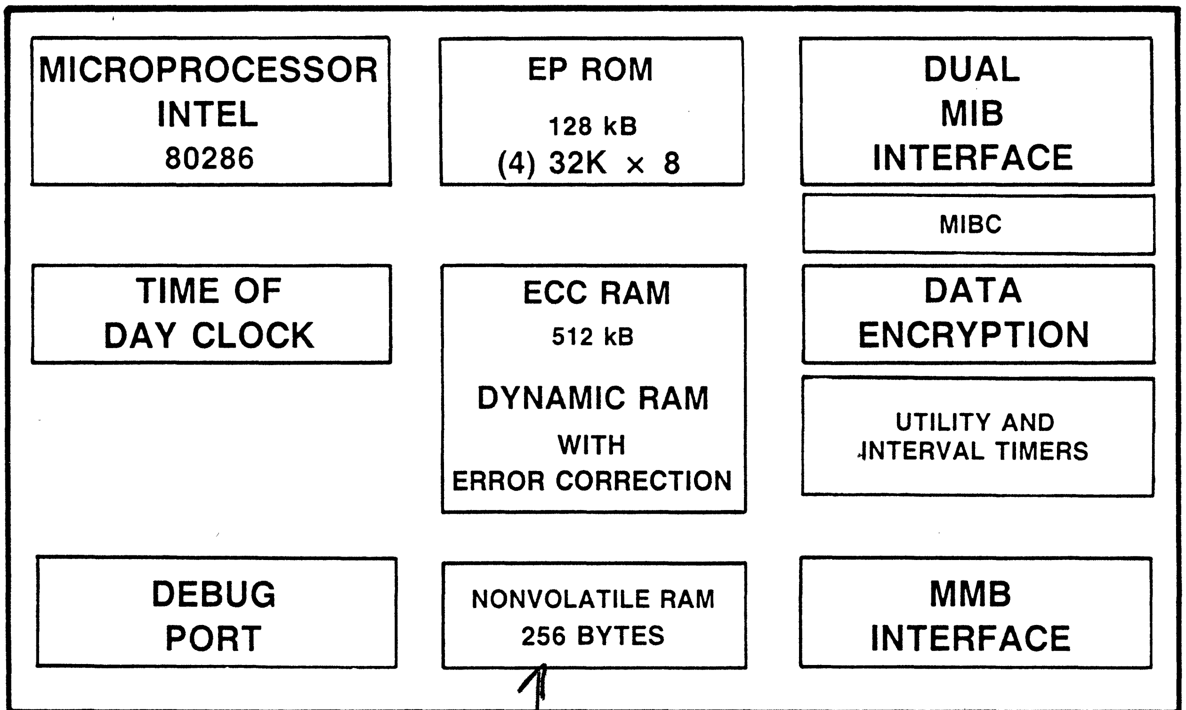
# PSN MODULES
# PROCESSOR MODULE

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INVENTORY DATA
READABLE FROM
THE NOC.

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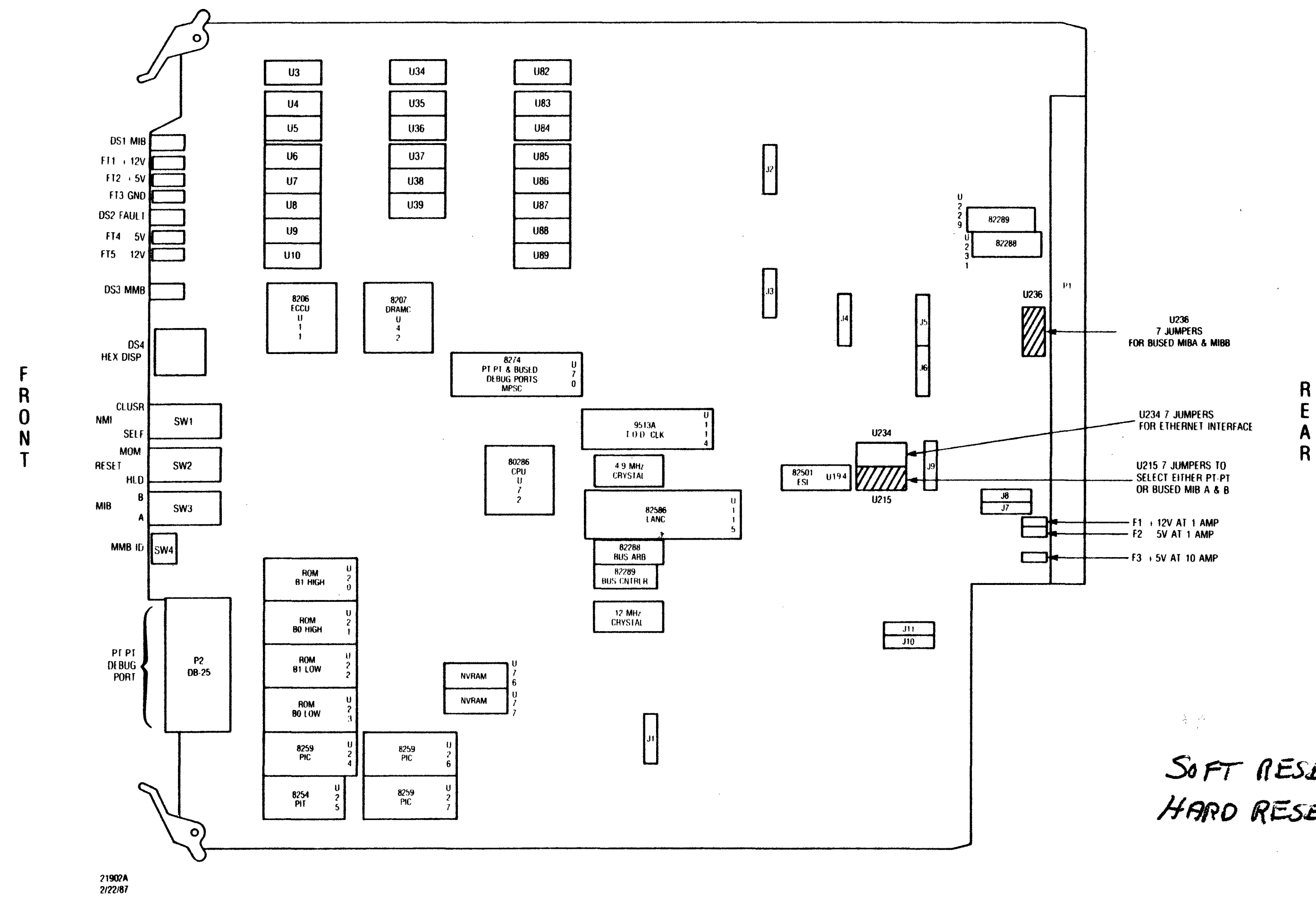
# PSN MODULES
# PROCESSOR MODULE

PROCESSOR MODULE




SOFT RESET LOCAL ONLY.
HARD RESET FROM NOC

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# PSN MODULES NUMERIC LED CODES FOR LEVEL 0 DIAGNOSTICS

| HEX LED Value | Processor Module | Line Interface Module | Disk Interface Module |
|---|---|---|---|
| 0 | Completed | Completed | Completed |
| 1 | RAM Test | RAM Test | RAM Test |
| 2 | ECC Test | ECC Test | ECC Test |
| 3 | EPROM Checksum | EPROM Checksum | EPROM Checksum |
| 4 | — | DMA 0 Test | DMA 0 Test |
| 5 | — | DMA 1 Test | DMA 1 Test |
| 6 | Timer 1 Test | Timer 0 Test | Timer 0 Test |
| 7 | Timer 2 Test | Timer 1 Test | Timer 1 Test |
| 8 | MMB Interrupts | MMB Interrupts | MMB Interrupts |
| 9 | NMI Logic Test | NMI Logic Test | NMI Logic Test |
| A | MMB Loopback | MMB Loopback | MMB Loopback |
| B | MIBC Test | SCC Test | Disk Access Test |
| C | NVRAM Checksum | NVRAM Checksum | NVRAM Checksum |
| D | — | — | — |
| E | — | — | — |
| F | — | — | — |

24256
11/03/86

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# PSN MODULES NUMERIC LED CODES FOR CLUSTER STARTUP

MODE 2

| HEX LED Value | Processor Module | Line Interface Module | Disk Interface Module |
|---|---|---|---|
| 0 | | | |
| 1 | ROM User Job | ROM User Job | ROM User Job |
| 2 | Estab Server Link | | |
| 3 | Call for ULD | | |
| 4 | Perform ULD | | |
| 5 | Call for DLL | | |
| 6 | DLL FRD and CSD | | |
| 7 | DLL Software | | |
| 8 | DLL Config Data | | |
| 9 | | | |
| A | | | |
| B | | | |
| C | | | |
| D | | | |
| E | | | |
| F | | | |

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# PSN MODULES NUMERIC LED CODES FOR CLUSTER OPERATION

HEX

| LED Value | Processor Module | Line Interface Module | Disk Interface Module |
|---|---|---|---|
| 0 | | | |
| 1 | | | |
| 2 | | Unswitched | |
| 3 | | Switched | |
| 4 | Non-MPM | | |
| 5 | | | Operational |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | RAM User Job | RAM User Job | RAM User Job |
| A | Primary IS | | |
| B | Backup IS | | |
| C | Primary OOS | | |
| D | Backup OOS | | |
| E | Primary Maint | | |
| F | Backup Maint | | |

24539
11/22/86

# PSN MODULES LINE INTERFACE MODULE (LIM) - GENERAL

The LIM is used to provide processing for up to eight serial communication ports. These ports can be software configured to support various data communication protocols. For this network, they will all be configured for bit synchronous operation. The various functional capabilities of the LIM are as follows:

- The Intel iAPX 186 Microprocessor with its High Performance 16-Bit Architecture
- Interval Timers, Internal Peripheral Interface, and Direct Memory Access (DMA) Controller Integrated into the iAPX 186 Microprocessor Chip
- Local Dual Ported ECC RAM of 512 Kilobytes per LIM
- Local EPROM of 64 Kilobytes per LIM
- NVRAM Storage of 256 Bytes per LIM
- Eight Serial Communication Ports Driven by Intelligent Multi-Protocol Serial Controller Chips
- Serial Communications Capable of Supporting Asynchronous, Byte Synchronous, and Bit Synchronous Protocols in Interrupt Driven Polled, or DMA Modes of Operation (Port 0 is the Only One that has DMA)
- Bused and Point-to-Point Debug Ports
- MMB Interface for Access to Other Intelligent Modules in the same Cluster
- Local Utility Timer and Time-of-Day Clock

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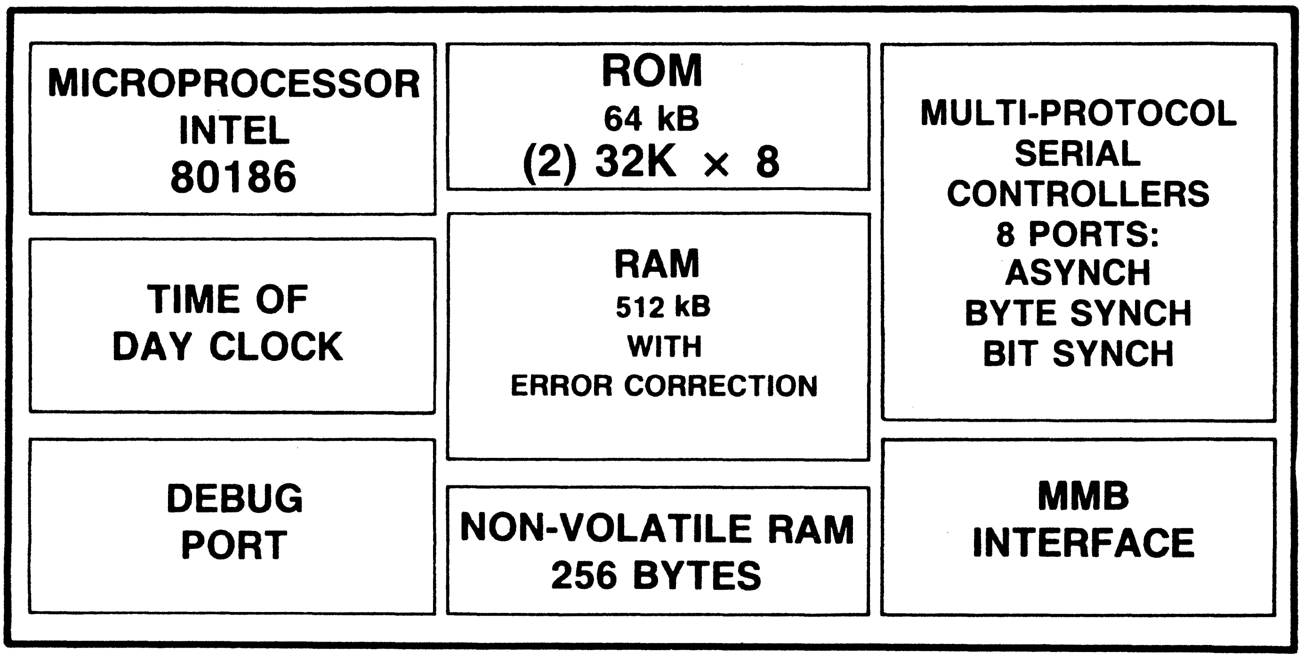
# LINE INTERFACE MODULE

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11/22/86

2-38E4256
30-OCT-87

# PSN MODULES DISK INTERFACE MODULE (DIM) - GENERAL

The DIM is used to provide processing for up to two Shugart Associates System Interface (SASI) channels. The various functional capabilities of the DIM are as follows:

- The Intel iAPX 186 Microprocessor with its High Performance 16-Bit Architecture
- Interval Timers, Internal Peripheral Interface, and Direct Memory Access (DMA) Controller Integrated into the iAPX 186 Microprocessor Chip
- Local Dual Ported ECC RAM of 512 Kilobytes per DIM
- Local EPROM of 64 Kilobytes per DIM
- NVRAM Storage of 256 Bytes per DIM
- Ability to Interface with Two SASI Channels
- Bused and Point-to-Point Debug Ports
- MMB Interface for Access to Other Intelligent Modules in the same Cluster
- Local Utility Timer and Time-of-Day Clock

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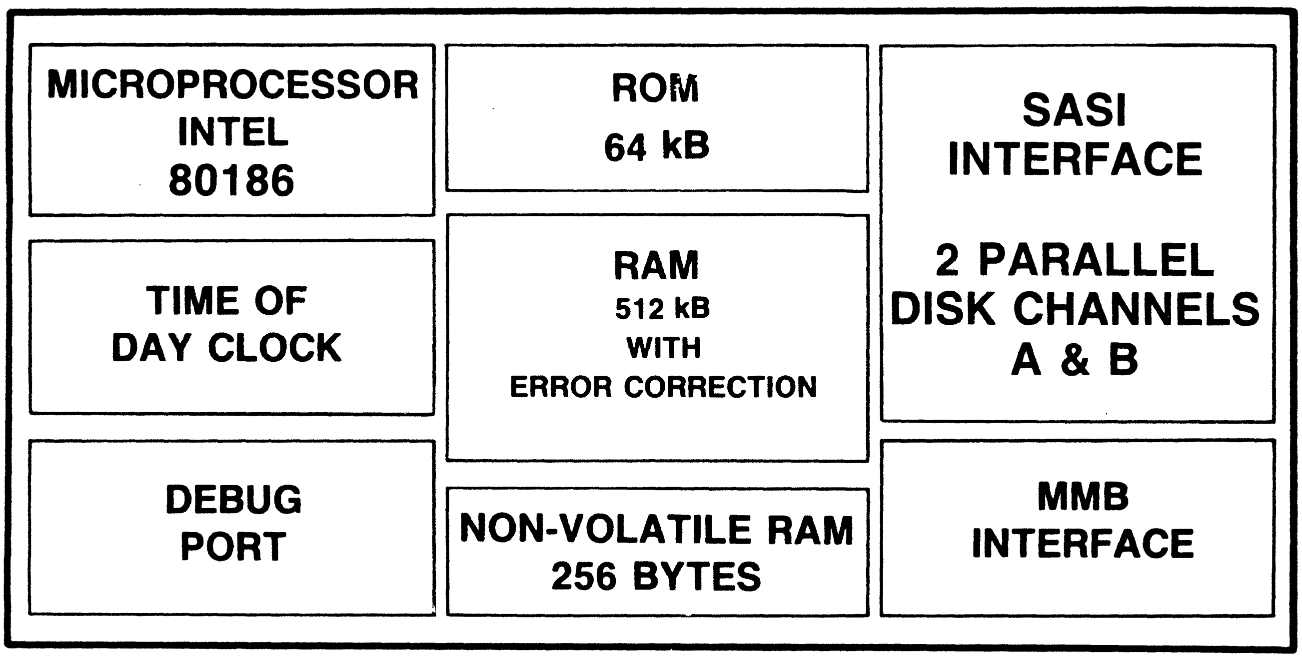
# PSN MODULES
# DISK INTERFACE MODULE

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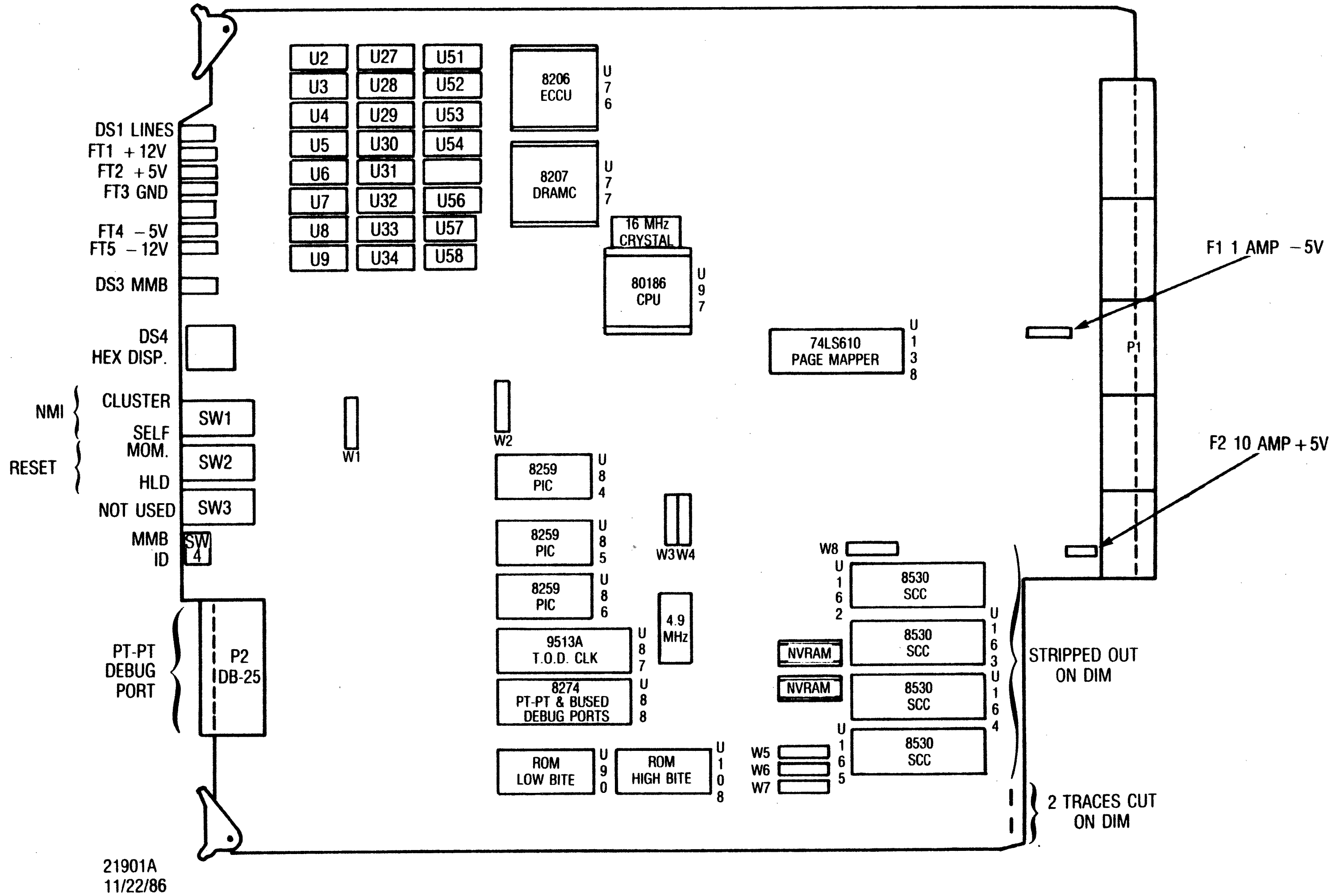
# PSN MODULES
# INTERFACE MODULE - LIM/DIM



# PSN MODULES
# WHAT IS AN I/O MODULE?

- **An I/O Module Provides a Physical Interface to the PMs, LIMs, or DIMs and it is not Microprocessor Based**

- **There are an Assortment of I/O Modules Available to Suit Your Interface Needs. They are:**

| | |
|---|---|
| RS-232C | - 8 Ports, LIM Supported |
| V.35 | - 2 or ~~4 Ports~~, LIM Supported |
| RS-449 DTE | - 4 Ports, LIM Supported |
| RS-449 DCE | - 4 Ports, LIM Supported |
| SASI | - 2 Channels, DIM Only |
| BRC | - 2 per Chassis |

# PSN MODULES RS-232C I/O MODULE - GENERAL

The RS-232 I/O module is used to electrically connect an intelligent Line Interface Module with up to eight communication lines each supporting an RS-232C interface. It contains four Communications Line Controller (CLC) devices. Each CLC is a VLSI device which performs the following functions:

- Data Transceiver Functions
- Separate Transmit and Receive Baud Rate Generation
- Send and Receive Function Signaling
- Switch Control Functions to Support a 1-for-N Redundancy Scheme used for Backing up Communication Lines

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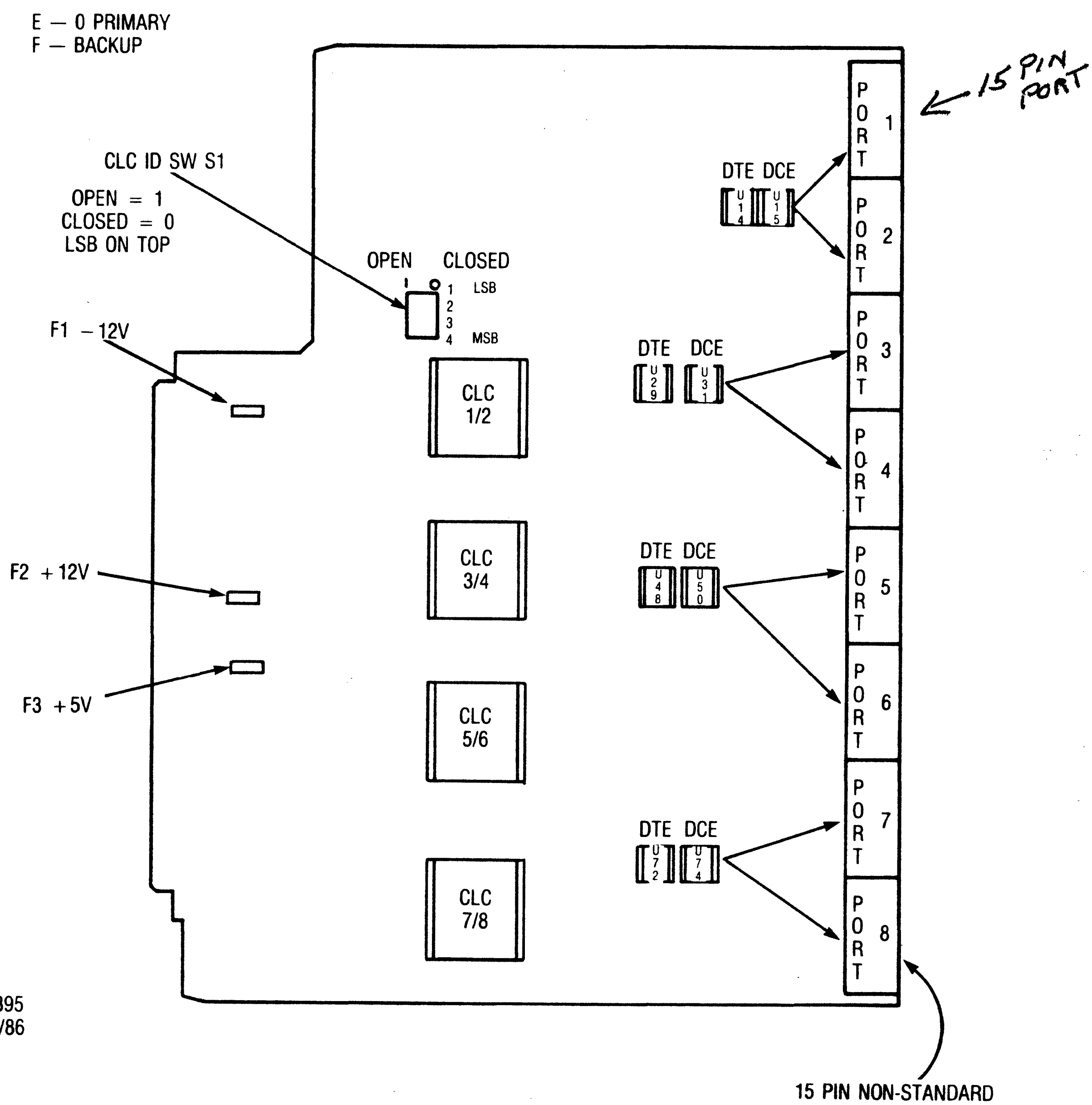
# PSN MODULES
# RS-232C 8 PORT I/O MODULE

PIGTAIL CABLE NEEDED

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30-OCT-87

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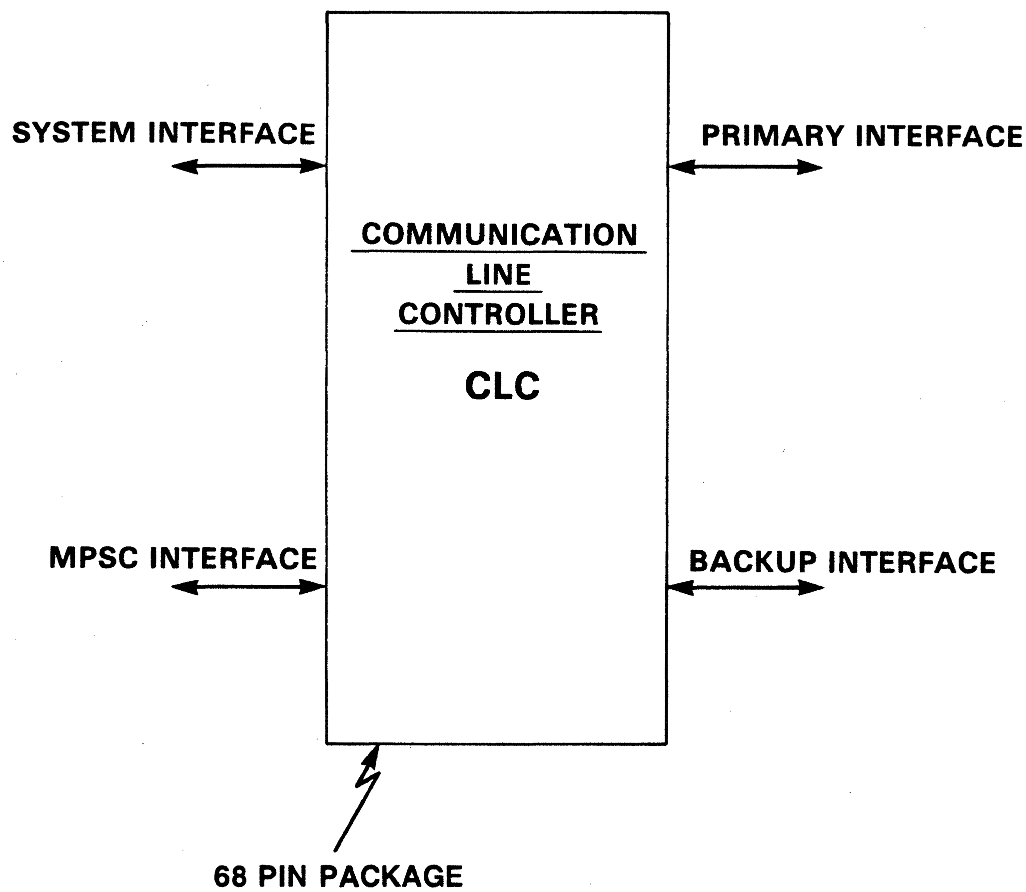
# PSN MODULES
# 68 PIN PACKAGE

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11/22/86

# PSN MODULES
# TWO - CHANNEL
# V.35 I/O MODULE - GENERAL

- **Provides Two V.35 I/O Ports Using a Single Non-Standard 25-Pin Connector per Port**
- **I/O Cable Converts from Non-Standard 25-Pin Module Resident Connector to a Standard 34-Pin Block type Connector**
- **Each Port Supports Full Duplex Operation**
- **Each Port Supports the Complete Set of V.35 Interchange Circuits**
- **Each Pair of Ports Configurable as DTE or DCE**
- **DTE/DCE Configuration Selectable via Software Readable Jumper Block**

# PSN MODULES
# TWO - CHANNEL
# V.35 I/O MODULE - GENERAL (Cont.)

- Provides Two Independent Baud Rate Generators per Port
- A 3-Bit Send Function and 3-Bit Receive Function Register Control and Monitor Modem Control Signals
- Programmable Local Loopback Capability
- Provides 1 for N Switching Capability
- One Fixed Outbound Clock Line, One Fixed Inbound Clock Line and One Selectable Inbound/Outbound Clock Line per Channel Allows Implementation of all DTE/DCE Clocking
- Electrically and Mechanically Compatible with AT&T DSU, (Data Service Unit)

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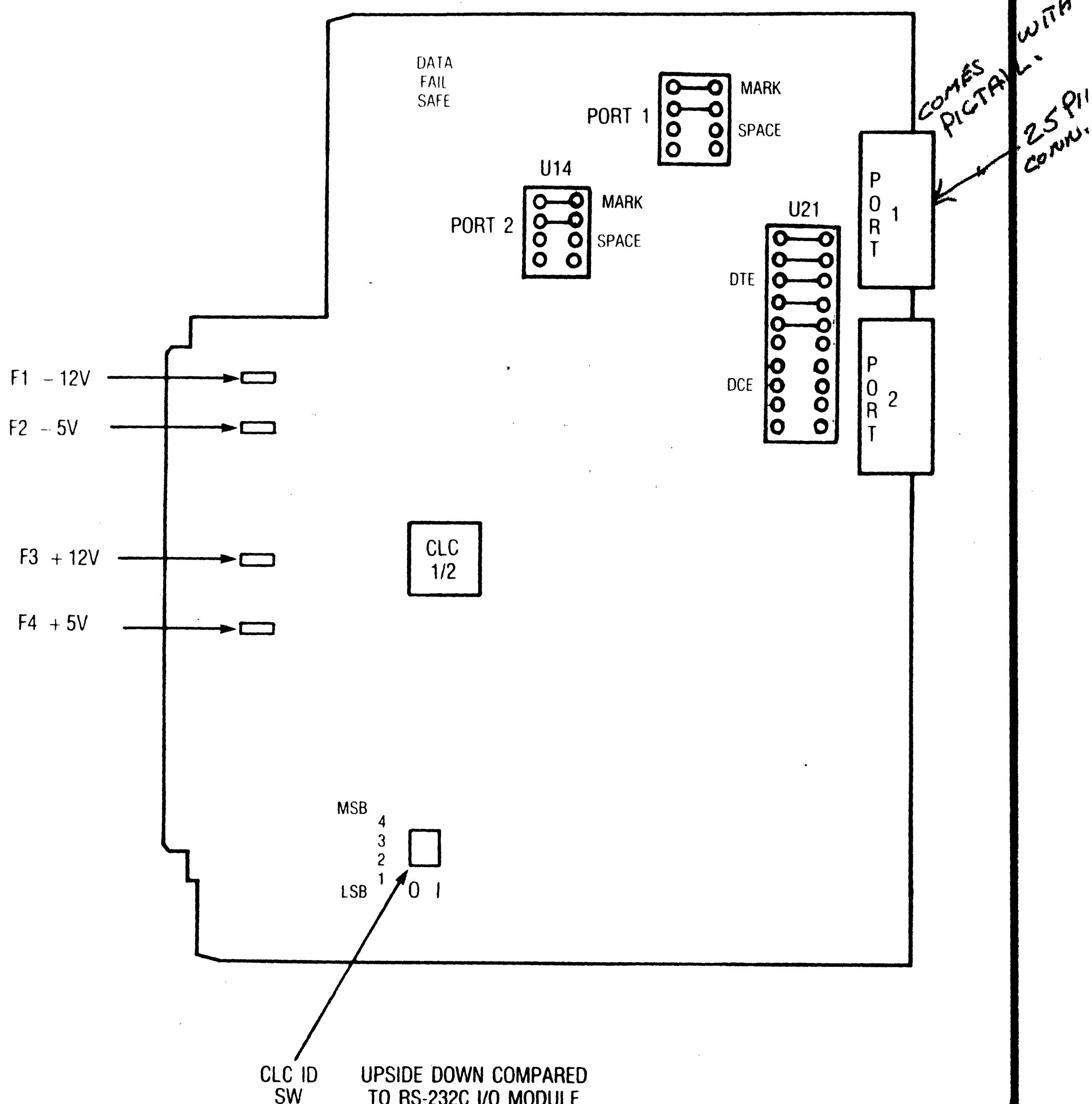
# PSN MODULES
# V.35 I/O MODULE

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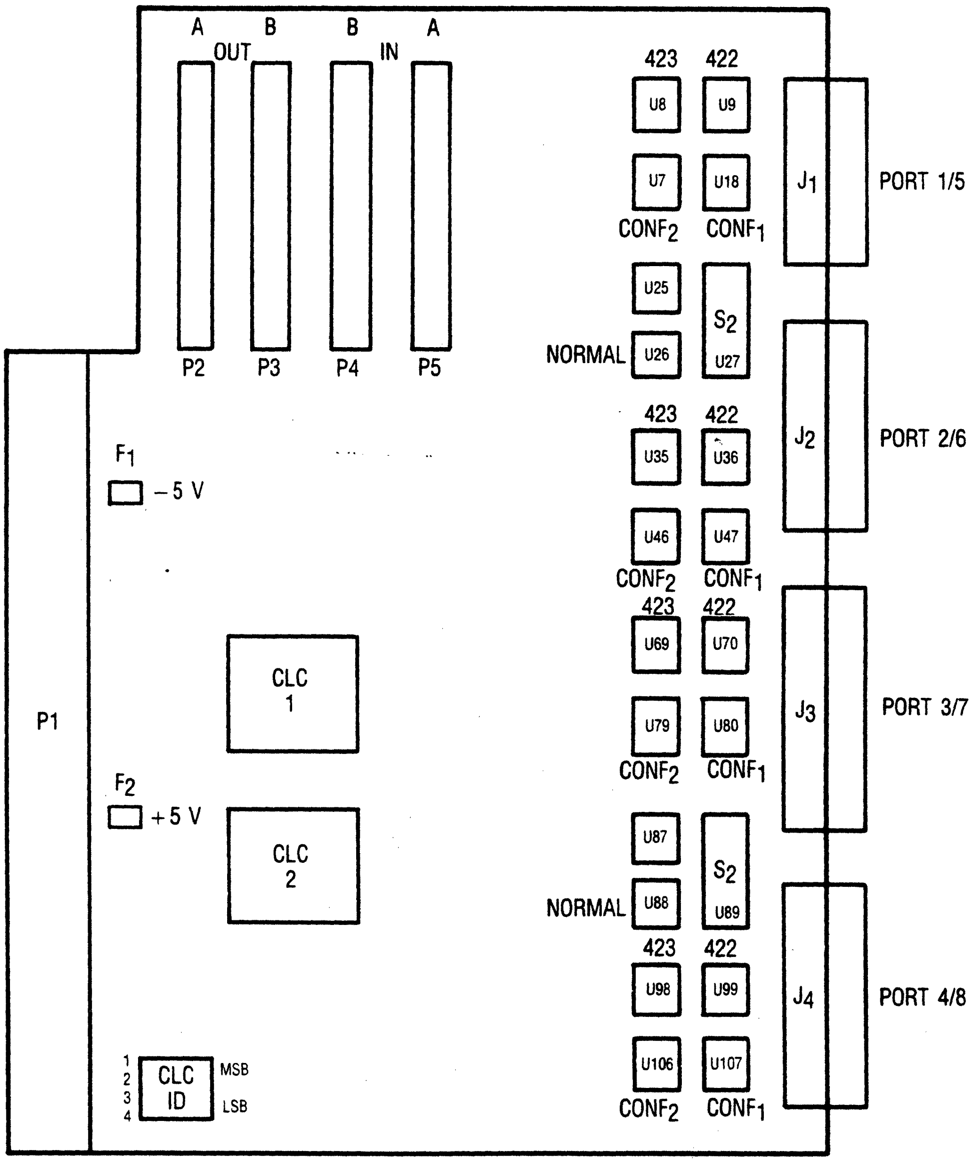
2/20/87

2-48E4256
29-OCT-87

# PSN MODULES
# RS-449 I/O MODULE

## (DCE & DTE Identical Layout)

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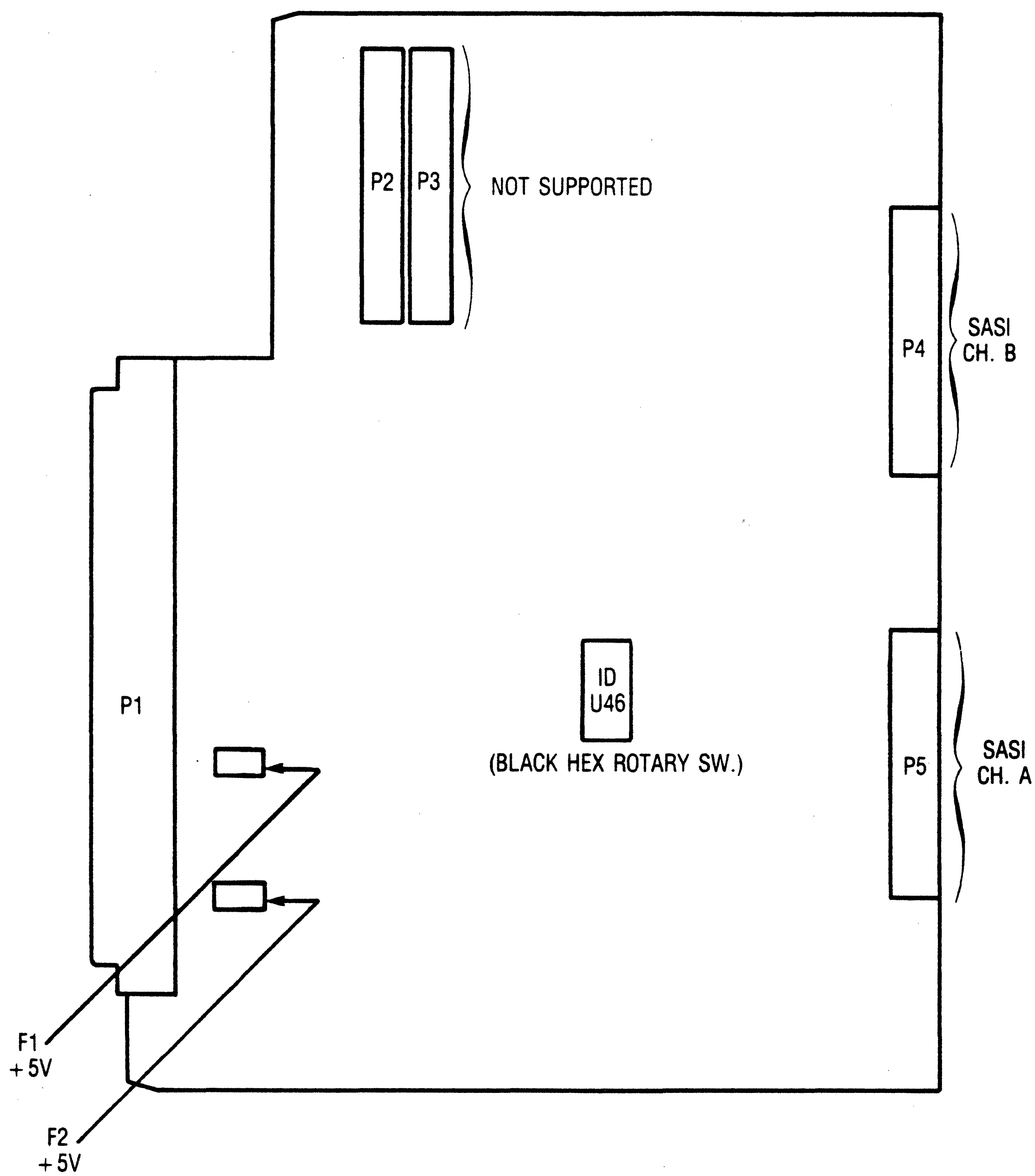
07/14/87

# PSN MODULES
# SASI I/O MODULE - GENERAL

The SASI I/O Module is used to electrically connect a DIM to a SASI bus. This bus serves as a mechanism to allow the DIM to communicate with an intelligent disk controller resident in a storage module chassis. The SASI I/O Module supports two SASI channels and can therefore connect to two disk controllers. Each disk controller supports storage modules (i.e., disk drives). The storage modules are used with the CP9000 Series II disk clusters to implement ASPs. They utilize 5 1/4 inch Winchester technology disks.

# PSN MODULES
# SASI I/O MODULE

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3/4/86

# PSN MODULES
# BUS REPEATER CARD - GENERAL

The Bus Repeater Card (BRC) is used to electrically extend one bused MIB from one CP9000 SII chassis to another. In this fashion, all data flow on the MIB of one chassis is extended to the MIB of another chassis, thereby enlarging the node.

- S1 controls Whether the BDP is Extended to the Next Chassis

  S1 1 Not Used
  2 Closed-Bused Debug Extended
  3 Not Used
  4 Not Used

- U18 is a Socket Where a MIB Terminator is Placed if the BRC is at the End of that Particular MIB

- Each Bused MIB that is Extended must be Terminated at its Extreme Ends

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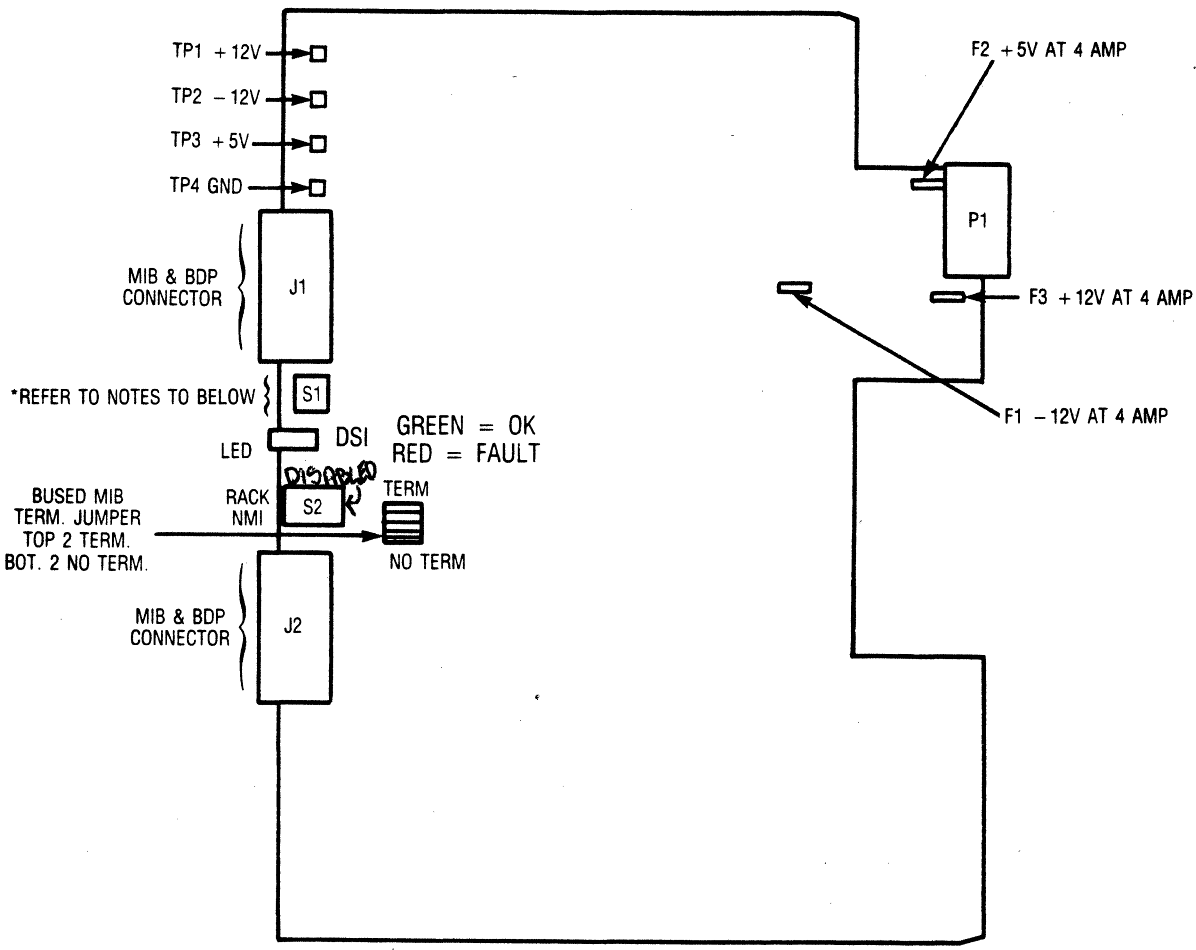
# PSN MODULES
# BUS REPEATER CARD




NOTES: S2 IS NOT USED
S1 USES ONLY SWITCH #2

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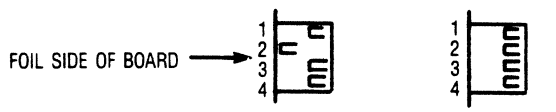
02/25/87




S2 CLOSED BDP IS NOT EXTENDED

S2 OPEN BDP IS EXTENDED

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# PSC REDUNDANCY 2.1.3

2-54E4256
30-OCT-87

# PSN SWITCHOVER LOGIC PSC SPARING

In General, a Spare is a Cluster that is Ready to Fill in for any Failed Cluster in a Designated Group. Some Terms Used to Discuss Sparing are:

- Redundancy Group
- Primary Cluster
- Backup Cluster
- 1-for-N Bus
- Switch In/Out
- Health Check Message

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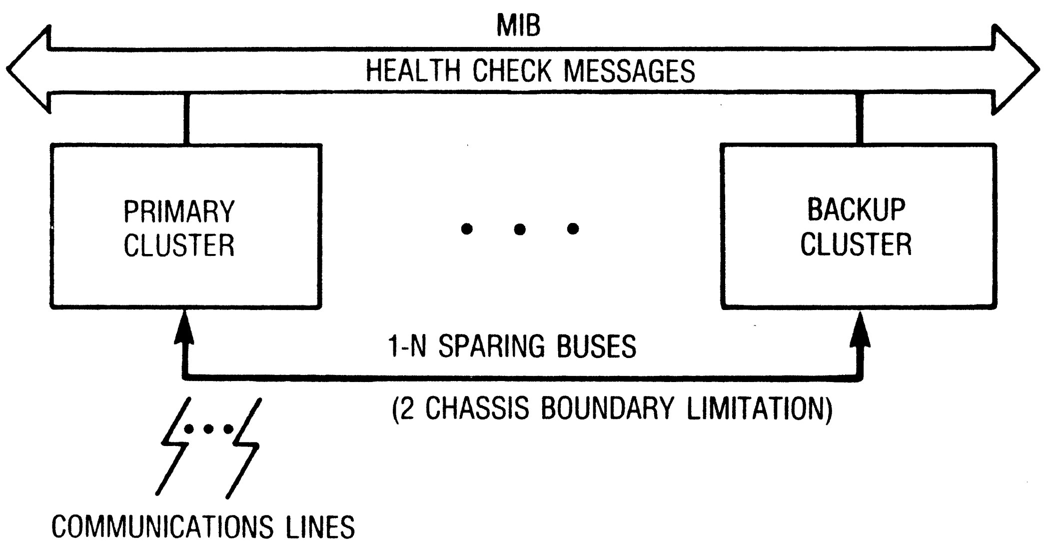
# PSN SWITCHOVER LOGIC
# PSC SPARING

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11/22/86

DEFAULT
PARAMETERS: HEALTH CHECK MSG. TIMER - 5 sec
" " " INTERVAL - 10 SEC
NUMBER OF MSG. ALLOWED TO MISS 3

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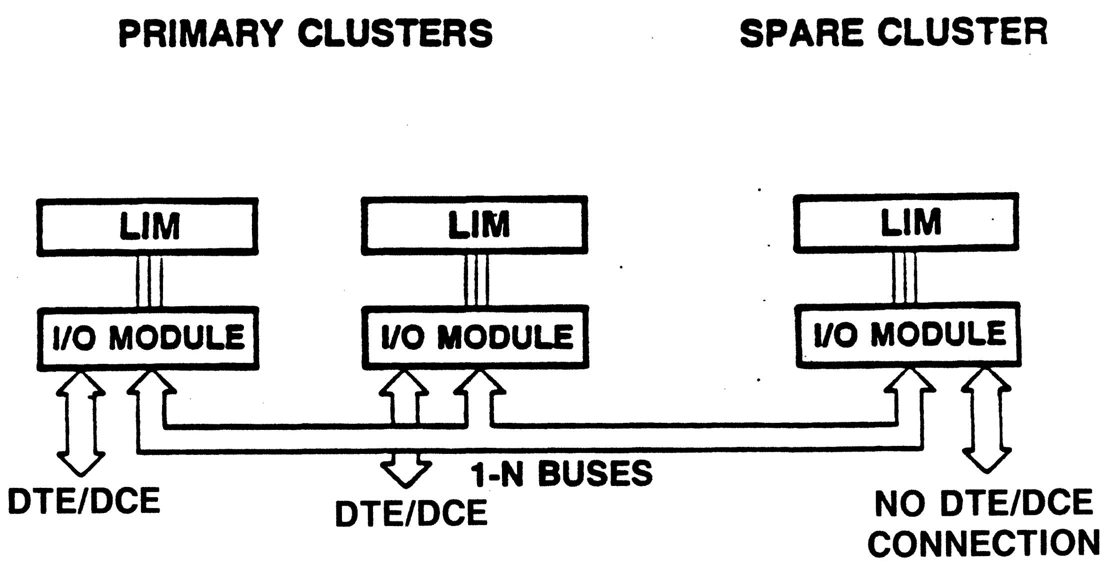
# PSN SWITCHOVER LOGIC REDUNDANCY GROUP

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# PSN SWITCHOVER LOGIC
# PRIMARY PSC FAILURE DETECTION

A Backup Cluster will Spare for a Primary when it Determines that Primary is not Fully Functional. The Two Mechanisms by which the Backup can Detect this are:

- Health Check Messages not Received on the MIB from its Primary PSC(s)
- Bad Health Check Message Received by PM from its Primary PSC(s)
- NOC OPERATOR FORCES A SWITCHOVER

# PSN SWITCHOVER LOGIC
# PSC BACKUP SWITCH-IN

When the Backup Deems it Necessary to Switch in, it will:

- Restart and Downline Load the Software and Configuration Data for the Primary PSC that it is Switching for and Generate a "Cluster Startup" Event

- Send the CLC ID Over the Backup Bus for the Primary it is Going to Switch-In for

- Start Operating as the Primary Would, and Send a "Cluster Operational" Event

# PSN SWITCHOVER LOGIC WHEN BEING SWITCHED OUT A PRIMARY WILL:

- Restart and Downline Load its Own Software and Configuration Data
- Establish and Maintain Connections to NCS Servers
- Accept Calls for Normal Control, Monitor, and Debug Functions
- Send Summary Status to its NCP
- Check its CLC to See if it has been Switched Back In
- It Stays Functionally Online but Regarding User Traffic it is Offline

# PSN SWITCHOVER LOGIC
# PSC SPARING
# CONFIGURATION RULES

- Sparing is Performed on a per Cluster Basis
- A Redundancy Group must be in the Same Chassis or in Two Vertically Adjacent Chassis (1&2, 2&3, 3&4)
- Sparing can only be Performed Between Clusters that are Configured on the Same 1-for-N Bus

# PSN SWITCHOVER LOGIC PSC SPARING CONFIGURATION RULES (Cont.)

- The Power must be Turned Off when a PSC is Added to a Redundancy Group or when a Redundancy Group is Added to a Node

- The CLC Addresses for all LIM's I/Os in a Cluster must be the same. The CLC IDs for Each Primary PSC must be Different in the same Redundancy Group

- The CLC ID of a Backup Cluster Must be 15, Primaries can be O-E Hex

- The Backup Cluster must be Set in Service at the NOC in Order for it to Spare

- The Backup Cluster must be a Superset of all the Clusters in the Redundancy Group

# PSN SWITCHOVER LOGIC THE PM/LIM HEX DISPLAY INDICATES THE CLUSTER SPARING STATE

**PM**

| LED | Indication |
|---|---|
| A | Primary in Service |
| B | Backup in Service |
| C | Primary Out of Service |
| D | Backup Out of Service |

means the cluster is not carrying traffic.

**LM**

| LED | Indication |
|---|---|
| 1 | Not Used in Backup when Switched |
| 2 | Unswitched |
| 3 | Switched |

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11/23/86

# PSN SWITCHOVER LOGIC CALLS ON BBLS DURING SWITCH-OUT

- Calls in Progress will be Dropped Back to the Source, and Reconnected if Possible via an Alternate Link
- Future Calls will be Routed Through the Switched-In Backup

# PSN SWITCHOVER LOGIC CALLS ON EDGE CLUSTERS DURING SWITCH-OUT

- Calls in Progress will be Disconnected. Calls must be Reestablished
- Future Calls will be Routed Through the Switched-In Backup

# WHEN AUTOMATIC SWITCHOVER OCCURS:

- Users Whose Source Cluster Switched Out Complain of Disconnection
- Other Users will Generally not be Aware that Anything Happened

# PSN SWITCHOVER LOGIC THE NOC OPERATOR HAS TWO SOURCES OF SWITCHOVER INDICATION

- "Cluster Restart" and "Cluster Operational" Events will be Sent
- In the Case of a Switched-In Backup, the Event Object Type Code will Show up as BCLST Rather than CLSTR
- Summary Status Monitoring will Indicate Whether a Cluster is Switched In or Out

# PSN SWITCHOVER LOGIC
# NOC OPERATOR CONTROL

- The NOC Operator can Force the Spare to Switch In or Out, or to Spare for a PSC other than the one it is Currently Switched in for when Necessary

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# CONFIGURATION RULES SUMMARY 2.1.4

2-69E4256
30-OCT-87

# CONFIGURATION RULES SUMMARY

## *Logical Elements*

1. System
   - Node(s)
   - NCP(s)
   - NOC(s)

2. Network
   - Nodes Connected by Backbone Links

3. Node
   - All Clusters on a Single MIB

4. Cluster
   - Comprised of Intelligent Modules and I/O Modules
   - Two Types: PSC(s) and ASP(s)

5. PSC
   - PM
   - 1-3 LIM(s)
   - One I/O per LIM (RS-232, V.35, RS-449)

6. ASP
   - PM
   - DIM
   - SASI
   - Controller
   - Disk Unit

7. Spare PSC I/Os
   - RS-232 → RS-449 → V. 35

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# CONFIGURATION RULES SUMMARY

## *Physical Elements*

1. Racks
   - One or two Racks per Node
   - Racks must be Adjacent -WITHIN 30' CABLE LENGTH
   - One to four Chassis
   - Ventilation Plenum Between Chassis 2 and 3
   - Factory Installed Blower

2. Chassis
   a. Standard Chassis
      - Twelve Intelligent Module Slots (Front)
      - Twelve I/O Module Slots (Rear)
      - Two BRC Slots for 0 - 2 BRCs
        - 0 - Single Chassis Node (Standalone Chassis)
        - 1 - Single MIB
        - 2 - Redundant MIB
      - Four Power Supplies (DC)
        - 1-for-3 Redundancy in Loaded Chassis
        - One Supply per four Intelligent Modules.

# CONFIGURATION RULES SUMMARY

## *Physical Elements (Cont.)*

b. Storage Chassis
   - Four Intelligent Module Slots (Front)
   - Four I/O Module Slots (Rear)
   - Four Disk Positions (Front)
   - Two Disk Controller Slots (Rear)
   - Two BRC Slots (Rear)
   - Four Power Supplies
     - Two for Disks
     - Two for Modules

3. Intelligent Modules
   - PM
   - LIM
   - DIM

4. I/O Modules
   - One per LIM (RS-232, RS-449, V.35)
   - One SASI per DIM
   - BRC Extends Bussed MIB

5. MMB Jumper Block
   - One Jumper per LIM/DIM
   - Two Terminators per Cluster

6. 1-for-N Cables
   - Bus Length Limited to two Adjacent Chassis.

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# OFFLINE DIAGNOSTICS OVERVIEW 2.1.5

2-73E4256
30-OCT-87

# OFFLINE DIAGNOSTICS OVERVIEW GENERAL

- Offline Diagnostics is a Software Tool Used to Verify the Functionality and Integrity of the CP9000 Series II Hardware - PSN Components

- It is Used not only as a Maintenance Device for Debugging by Maintenance Personnel, but also by Installation Personnel to Ensure Confidence in the Hardware Before it is Brought Online

- The Offline Diagnostic Software Tool Provides a Wide Variety of Commands and Tests which are Used to Analyze and Troubleshoot Hardware Problems to a Module and in many Cases a Functional Block Level

- Is only run Locally at the Node and is Loaded via the Point-to-Point Debug Port on any PM, LIM, or DIM Using a Compatible PC in Conjunction with a Terminal.

# OFFLINE DIAGNOSTICS OVERVIEW CAPABILITIES

- The Offline Diagnostic Package (Diagnostic Task Monitor, DTM) Provides the Following Capabilities
  - Exercises on PM, LIM, and DIM: CPU; RAM; NVRAM; MMB
  - Exercises Module Specific Areas such as: MIB for PMs; DMA and Line Tests for LIMs; Disk Tests for DIM
  - Exercises Cluster Level Capabilities via Cluster Tests
  - Exercises System Communications Capabilities via System Tests
  - Provides Error Messages upon Failure Indicating Failed Area
  - Provides Operational Status Information, Hardware Status Information, and Error Reports
  - Provides NVRAM Configuration Capability Important to Network Operations/Configuration
  - Relatively Easy to Learn

# OFFLINE DIAGNOSTICS OVERVIEW COMMAND LISTING

**There are 14 Different Commands and 59* Different Subcommands**

- **CONTROL/STATUS COMMANDS**
  - Start
  - Terminate
  - Chain
  - End Chain
  - Ex Chain
  - Report
  - Reconfigure
  - ERR
- **MEMORY READ/WRITE COMMANDS**
  - Display -- Bytes
  - Display -- Words
  - Set -- Byte
  - Set -- Word
- **UTILITY COMMANDS**
  - ECC

    NVRAM*

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# AUXILIARY SERVICE PROCESSOR 2.2

2-77E4256
30-OCT-87

# AUXILIARY SERVICE PROCESSOR FUNCTIONS

- Downline Load of Operational Software and Configuration Data for PSCs
- Fast Local Reload
- Upline Dump of PSC Memory to NCP
- Loads Data from NCP as Requested by its PSCs
- Call Setup Assistance
- Spooling of Call Records/Statistics/Events. – WHEN THE NCP IS UNAVAILABLE.

# AUXILIARY SERVICE PROCESSOR FUNCTIONS

## Downline Load

PSCs request pieces of downline load information from the ASP.

The ASP sends the pieces it caches on its disk to the requester.

If the ASP does not have a piece of information, it request it of its NCS server and, when it arrives, both caches it and sends it to the requestor.

## Change Notices and Reconciliation

The ASP receives change notices from its NCS server and checks them against the information it is holding. If the change corresponds to held PSC information, the ASP forwards the change notice to the PSCs it serves.

The ASP also checks the contents of its disk cache to be sure the pieces of information are not obsolete or corrupted, and replaces those that are.

## Upline Dump

PSCs starting up may send a memory image dump to the ASP. The ASP stores these dumps (one per PSC) in a dump cache on its disk.

Certain control commands (discussed in the next subsection, "Network Service Interface Functions"), transfer these dumps from an ASP to the NCP or allow them to be examined by an NOC operator.

# AUXILIARY SERVICE PROCESSOR FUNCTIONS

- **Network Service Interface Functions**
  - Request network services from the NCS
  - Forward information to the NCS
  - Respond to NCP Commands.

- **Forward Information to the NCS**
  - Call records (duplicates)
  - Statistics
  - Summary Status
  - Events

- **Responding to NCP Commands**
  - Report detailed status
  - Set up an upline dump trigger
  - Dump memory
  - Patch RAM
  - Change state
  - Restart cluster

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# NETWORK CONTROL PROCESSOR 2.3

2-81E4256
30-OCT-87

# NCP HARDWARE CONFIGURATION AND PROCESSOR

## Hardware Configuration - VAX 11/750

Depending upon the network size and the computer power needed, various DEC VAX computers can be used in the Network Control System. For this discussion of the Network Control System, the hardware components of the VAX 11/750 are used for the NCP of the system presented. The NCP VAX 11/750 configuration is shown in the following slide.

## Processor

The processor of the VAX 11/750 is a 32-bit microprogrammed processor. The VAX 11/750 includes the following hardware components:

- 8 kilobyte two-way set associative memory cache
- 8 byte prefetch instruction buffer
- 128 entry address translation buffer
- 24 kilobyte writable diagnostic control store
- Time-of-year clock
- Programmable realtime clock
- Integral memory management
- Optional customer-writable control store.

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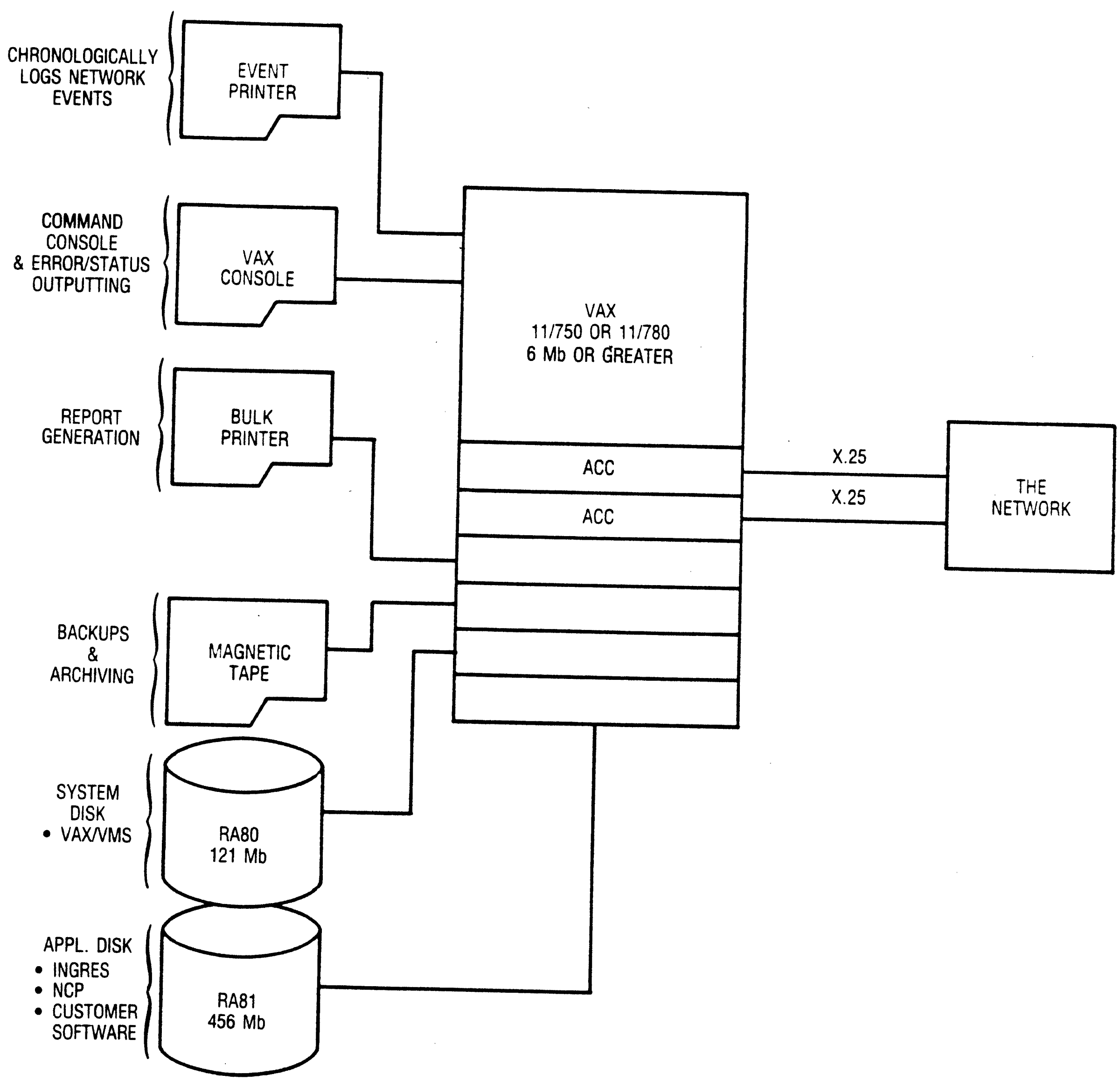
# NCP
# TYPICAL CONFIGURATION

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# NCP
# MAIN MEMORY

**Each VAX 11/750 is Configured with Six Megabytes of Dynamic MOS Random Access Memory. The Memory Features an Error Checking and Correcting Scheme (ECC) Which can Detect all Double Bit Errors and Detect and Correct all Single Bit Errors.**

# NCP
# VAX CONSOLE

Each VAX 11/750 has an LA100-BA Send/Receive Hardcopy Terminal to Function as a Console. The LA100-BA is a Desktop, Microprocessor Controlled, Multifont Hardcopy Terminal. The Print Speed is 240 Characters per Second. The VAX Console will be used to Perform the Following Functions:

- Boot the Operating System and Application Software
- Run Standalone Diagnostics
- Control the Master and Backup Roles of the VAX 11/750 as used in this System Application
- Perform VAX Maintenance Functions such as Backups, Making Tapes, and Transferring Files Using the Digital Command Language (DCL).

# NCP
# PRINTERS

Hardcopy Printers are used on the VAX 11/750 as Implemented for each NCP of this System. Each of These VAX 11/750s has a LA100-BA Receive Only Hardcopy Terminal to Function as an Event Printer. The Event Printer will Display Events as Generated by the System. An LP32 Bulk Printer is also Provided to Permit the Generation of Hardcopy Reports as Required.

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# NCP
# COMMUNICATION CONTROLLERS

Each VAX 11/750 is Configured with Several Types of Communication Controllers. The Following are Types of Controllers used in the VAX System:

- DMF 32
- ACC IF - 11/X.25 Synchronous Interface

# NCP
# DMF 32 MULTIPURPOSE COMMUNICATIONS CONTROLLER

The DMF 32 is an intelligent, high performance communication controller which enables a combination of modems and terminals to communicate with the VAX system. The DMF 32 uses Direct Memory Access (DMA) mode and Buffers in the controller to permit fast data transfers and reduce CPU overhead. It controls three basic interface types as follows:

a. An eight line, asynchronous interface for operation with modems and terminals. The eight lines can support speeds up to 19.2 kilobits per second each (full duplex). Two of the lines have modem control and split speed capability. The other six lines are for local terminal connections only. These lines may be used to connect VT100 terminals to the VAX 11/750. These additional terminals may be used to perform VAX operator functions as outlined above.

b. A single line synchronous interface for connection to a communication facility such as DECNET. This supports speeds up to 19.2 kilobits per second with double buffered DMA, modem control and support for both bit and byte oriented protocols. This interface can be used to perform intercomputer file transfers with remote VAXs (e.g., via DECNET)

c. A parallel interface for operating the LP 32 bulk printer.

# NCP
# ACC IF - 11/X.25
# SYNCHRONOUS INTERFACE

Each VAX 11/750 will be Configured with Two Advanced Computer Communications (ACC) IF - 11/X.25 Synchronous Interface Cards. Each VAX 11/750 can Support up to Four of These Interface Cards. The ACC Interface Card is a Unibus Device which Allows the VAX to Communicate with the Network. The Features of the ACC X.25 Interface are as Follows:

- DMA Transfers from the Host
- User Data Field of 128 Bytes Within Data Packets
- Fast Select Facility
- 32 Full Duplex Virtual Circuits per Card
- X.25 Level 1 in Hardware, Levels 2 and 3 in Firmware
- Network Link Speeds up to 19.2
- RS-232 Serial Interface

# NCP
# DISK SUBSYSTEMS

Each VAX 11/750 will have one System Disk and one Database Disk. Each of These Disk Types is Described on the Following Slides.

# NCP
# SYSTEM DISK

The System Disk Consists of an RA80 Subsystem which Includes a 121 Megabyte RA80. This Disk will be Used to Store the Following File Types:

- Operating System and Utility Programs
- Operating System Swap and Page Files
- Application Code and Program Data

The RA80 is Fixed Disk Based on Winchester Technology. It Supports Transfer Rates to 1.2 Megabytes per Second.

# NCP
# DATABASE DISK

Each VAX 11/750 will have one 456 Megabyte RA81 Disk Subsystem Functioning as the Database Disk. This RA81 Disk Subsystem Consists of a High Performance Winchester Technology RA81 Fixed Disk and a UDA 50 Intelligent Controller. This Controller Accelerates I/O Throughput, Performs Expanded Error Recovery, and Contains a Twelve Sector Data Buffer to Match the Disk's 2.2 Megabyte per Second Burst Data Rate to the VAX.

# NCP
# TAPE DRIVE

Each VAX 11/750 is Configured with One TU81 Magnetic Tape Subsystem. Magnetic Tape is Used for Operational Functions such as Intercomputer File Transfers and Disk Backups.

- Storage Capacity per 2400 Foot Reel is 140 Megabytes at 6250 Bits per Inch.
- Maximum Data Transfer Speed is 468 Kilobytes per Second

# NCP REQUIREMENTS FOR VAX HARDWARE ENVIRONMENT

- Operator's Consoles Dedicated to Running the NCP
- Tape Drive (1600 BPI)
- System Disk
- Unused 456 MB Hard Disk
- Report Printer
- Event Printer (LA100)
- 1 or 2 ACC Boards (UNA0: and UNB0:)
- VT100 (or VT102 or Equivalent) Terminal

# NCP
# SOFTWARE CONFIGURATION

The VAX 11/750 will use the standard VAX operating system VMS. VMS is a virtual memory, multitasking, multiprocessing operating system.

In addition to these DEC software products, and to the application software developed by HNS for this system, two non-DEC software packages are used on the NCP.

1. The driver for the ACC X.25 interface card(s). This driver will handle all of the I/O between the VAX 11/750 and the Network.

2. The INGRES DBMS package which will be used to manage some VAX 11/750 databases.

It should be noted that a VAX operator is required to start up the operating system and associated application software for the NCP. VAX operator services are also required to perform utility functions supported by VMS. These functions are performed at the VAX console required for each machine.

# NCP
# SOFTWARE INSTALLATION

- Takes Approximately one full day, Including INGRES
- Utilizes DEC Utility VMSINSTAL

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# NCP REDUNDANCY
# 2.3.1

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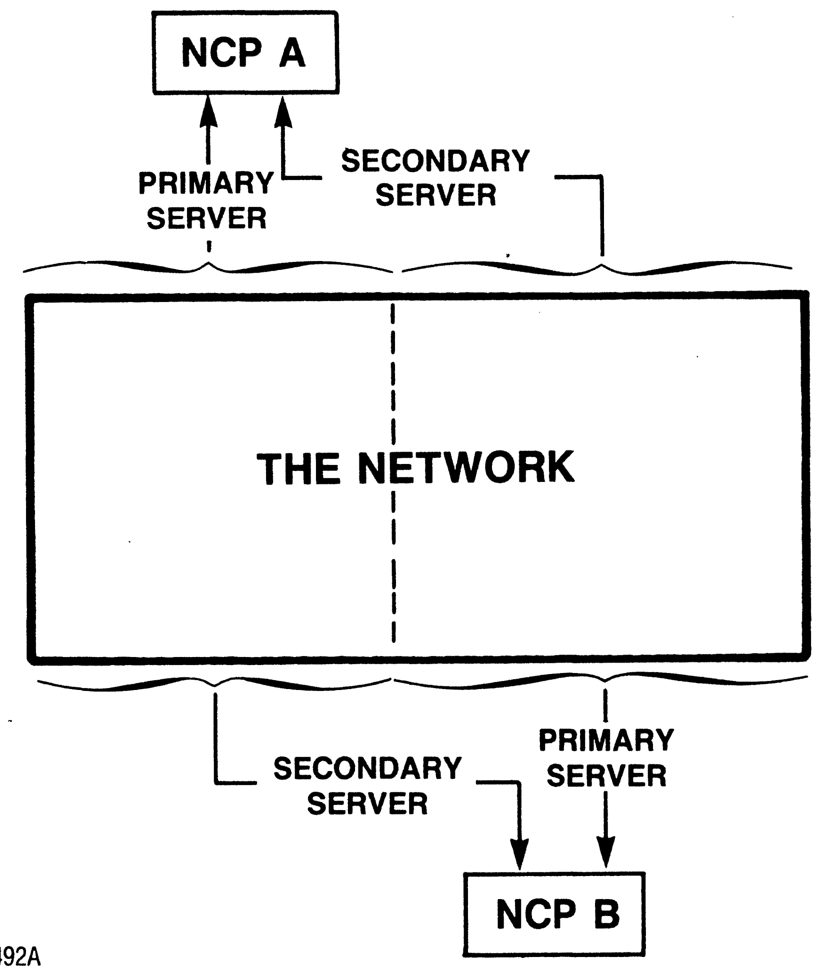
# NCP REDUNDANCY AND LOAD SHARING

- Two NCPs Online Simultaneously via the Supervisory Network
- Critical Network Data Sent to Two NCPs (such as Call Records)
- Automatic Load Sharing of Network Services via Proper Configuration of the Supervisory Network
- Colocation not Required
- Remote NOCs.

# NCP REDUNDANCY AND LOAD SHARING AS SHOWN BY THIS SUPERNET CONFIGURATION

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# NETWORK OPERATOR'S CONSOLE (NOC) 2.4

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30-OCT-87

# NOC GENERAL

In Previous Implementations, Convergent Technology (CT) Intelligent Work Station (IWS) was Used to Provide the IPN NOC Function. In Current and Future Implementations, The CT NGEN will be Used. The NOC Provides an Interface to Network Operators which Allows them to Monitor and Control the Network.

The CT NGEN is Supplied with an Operation System (CTOS) and a Number of Optional Software Packages. The NOC Application Uses:

- Forms Management
- X.25 Interface

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# NOC
# HARDWARE CONFIGURATION

- Processor Module (CP-002)
  - 80286 Microprocessor
  - One MB RAM (256K + 3 Expansion Cartridges)
  - Two RS-232 Ports
  - Centronics Parallel Printer Port
  - CTOS Clustering Ports (RS-422)
- Mass Storage Module (HD-013)
  - Twenty MB Hard Disk
  - Floppy Disk Drive
- VIDEO Module (VM-002)
  - Fourteen Inch Monochrome Monitor (Hi-Res)
  - Twenty-Nine Lines of 8 Chars
- Keyboard Module (KM-001)
  - Typewriter Style Plus Numeric, Soft-Function, and "Special" Keys
  - 80S1 Microprocessor
- Power Supply (Two Needed: PS-001)
  - Switch Selectable 110 V or 220 V Operation
  - Modular
- CTOS Proprietary X-Bus

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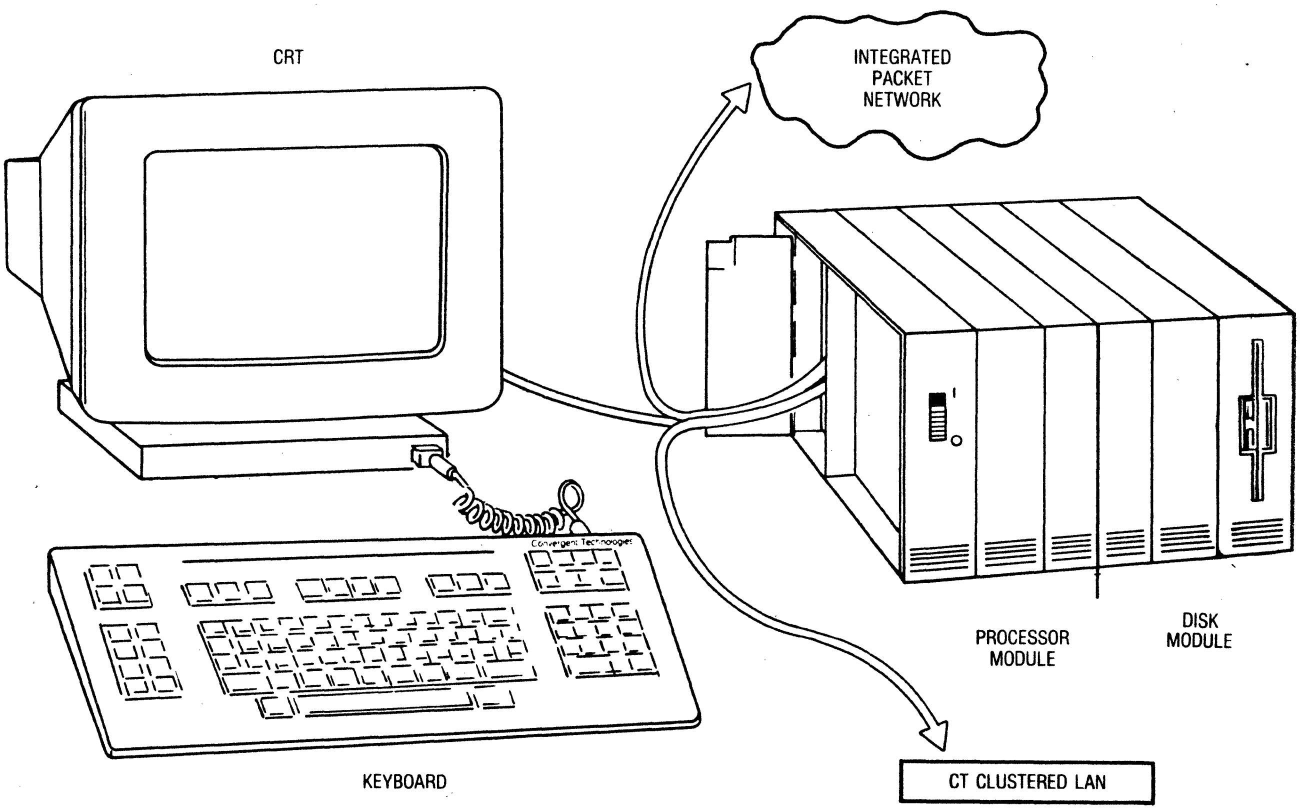
# NOC
# TYPICAL CONFIGURATION

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- **80286 Processor**
- **20 MB Disk**
- **14" CRT**
- **Keyboard**

# NOC OPERATING SYSTEM

The CT NGEN Uses the Standard Convergent Technologies Operating System (CTOS). This Provides a Realtime, Multitasking Environment. Any Number of Tasks and any Number of Processes per Task can be Run. The CTOS Kernal Provides an Event Driven, Priority Scheduling Dispatcher. Other Features of the Operating System are:

- Virtual Memory Segment Management
- Interprocess Communication Management
- File Management
- Device Management

# NOC SOFTWARE

## Forms Package:

The forms management package is used to format single screen displays. It consists of an interactive editor and runtime procedures that are called by the CT IWS application program. The editor is used to create the forms on the development system, and the runtime procedures are provided with the standard CT IWS. The forms prompt the user for data and return the data to the calling application.

## X.25 Interface Package:

The X.25 network interface package provides three levels of access to an X.25 network.

a. Packet Access Method - This allows the application program to send and receive individual control and data packets and to directly monitor the establishment of connections.

b. Sequential Access Method - This is built on the packet access level and provides the means for sending single bytes or streams of bytes without the application program being aware of lower level protocol considerations.

The package is Telenet and Tymnet certified and contains support of the 1980 CCITT Recommendations X.3, X.21, X.25, X.28, and X.29.

# NOC
# SYSTEM CONTROL
# FUNCTIONS - BY COMPONENT

| Functions \ Components | NCP | ASP | PSC | PORT | ~~MICOM PAD~~ |
|---|---|---|---|---|---|
| Desired State Control | | + | + | + | |
| Restart Control | | + | + | + | ~~+~~ |
| Call Clear Control | | | | + | |
| Call Reset Control | | | | + | |
| PSC Redundancy Control | + | | + | | |
| File Control | + | + | | | |

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# NOC SCREENS OVERVIEW
# 2.4.1

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30-OCT-87

# NOC SCREENS
# START-UP LOGO

Jul 18, 1985 Page No. 4

```
 GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC
GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC G
enesisNO                                                             sisNOC Ge
nesisNOC                                                             isNOC Gen
esisNOC                                                              sNOC Gene
sisNOC G                                                             NOC Genes
isNOC Ge                                                             OC Genesi
sNOC Gen                                                             C Genesis
NOC Gene                                                              GenesisN
OC Genes                                                             GenesisNO
C Genesi                                                             enesisNOC
 Genesis                                                             nesisNOC
GenesisN                                                             esisNOC G
enesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC Ge
nesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC Gen
```

(Press any key to continue)

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# NOC SCREENS
# DATE AND TIME SETUP SCREEN

JUL 18, 1985 PAGE NO. 3

```
GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC
GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC G
enesisNO                                                            sisNOC Ge
nesisNOC      Welcome to the Genesis Network Operator's Console      isNOC Gen
esisNOC                                                              sNOC Gene
sisNOC G                                                             NOC Genes
isNOC Ge                  Please Enter Date & Time:                  OC Genesi
sNOC Gen                        and press "GO"                       C Genesis
NOC Gene                (e.g. Thu 4 Oct 1984 1:00pm)                  GenesisN
OC Genes                                                             GenesisNO
C Genesi                 ___________________________                 enesisNOC
 Genesis                                                             nesisNOC
GenesisN                                                             esisNOC G
enesisNO                                                             sisNOC Ge
nesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC Gen
esisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC GenesisNOC Gene
```

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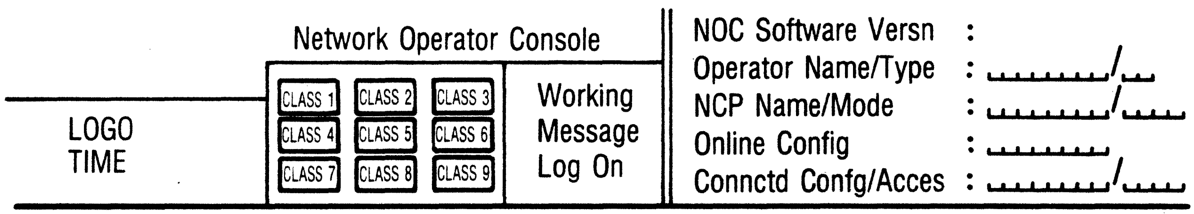
# NOC SCREENS
# BANNER LINE AREA

Jul 18, 1985 | Page No. 2

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# NOC SCREENS
# HELP SCREEN

Jul 18, 1985 Page No. 1

HELP

Menu Form Tree Structure

- MainMenu
  - (Logon)
  - ConfgMgmt
  - NetMgmt
    - Stats
    - CompDetl
    - GenDetl
    - Sum
    - EventMgmt
    - NetCntl
    - DistgMgmt
    - Debug
      - MemPatch
  - NetConfg
    - IntComp
      - CompOver
    - NetUser
      - Tpad
      - Hpad
    - Access
    - SysParms
    - ForGWDef
  - OperMgmt
  - RptGen
  - (BdcstMsgs)

Form Selection

Mark : ___________

f1 : ___________
f2 : ___________
f3 : ___________

f4 : ___________
f5 : ___________
f6 : ___________
f7 : ___________

f8 : ___________

f10: Highlight displayed Form/Menu

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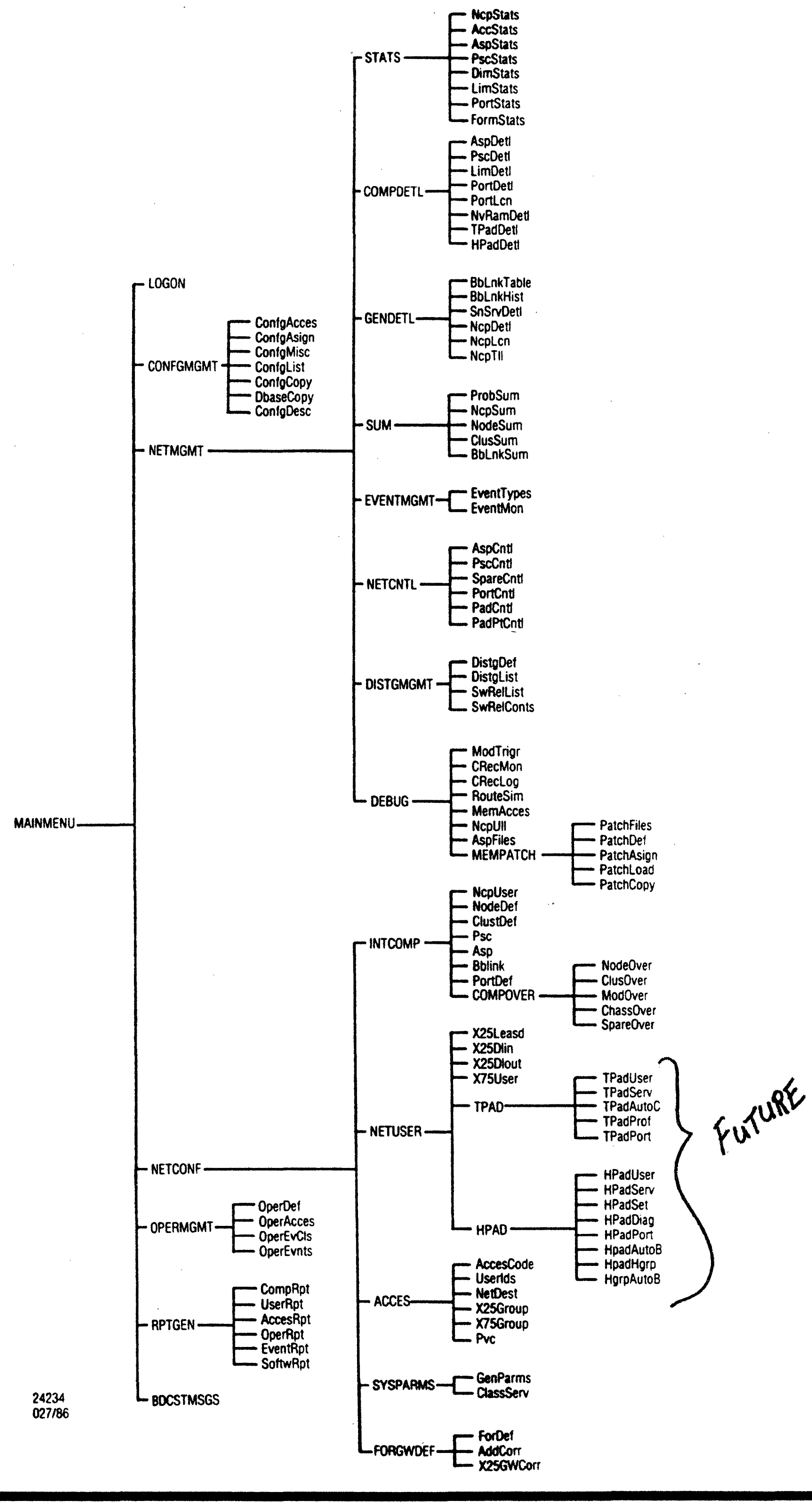
# NOC DETAILED TREE STRUCTURE

132 SCREENS

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# NOC SCREENS
# MAIN MENU

Jul 18, 1985 Page No. 5

-MAIN MENU- Quick Access - ___________ Main Selection Menu

f1 LOGON
Logon/off the NCS

f2 CONFG MGMT
Menu of Configuration Management forms

f3 NET MGMT
Menu of Network Management forms

f4 NET CONFG
Menu of Network Config entry forms

f5 OPER MGMT
Menu of Operator Management forms

f6 RPT GEN
Menu of Report Generation forms

f8 BDCST MSGS
Display Broadcast messages received from the MCP

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LOGON | CONFG MGMT | NET MGMT | NET CONFG | OPER MGMT | RPT GEN | | BDCST MSGS | | TOGGL PREV |

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# NOC SCREENS
# DETAILED TREE STRUCTURE

- MainMenu
  - Logon
  - ConfgMgmt
    - ConfgAcces
    - ConfgAsign
    - ConfgMisc
    - ConfgList
    - ConfgCopy
    - DbaseCopy
    - ConfgDesc
  - NetMgmt
    - Stats
      - NcpStats
      - AccStats
      - AspStats
      - PscStats
      - DimStats
      - LimStats
      - PortStats
      - FormStats
    - CompDetl
      - AspDetl
      - PscDetl
      - LimDetl
      - PortDetl
      - PortLcn
      - NvRamDetl
      - TPadDetl
      - HPadDetl
    - GenDetl
      - BbLnkTable
      - BbLnkHist
      - SnSrvDetl
      - NcpDetl
      - NcpLcn
      - NcpTll
    - Sum
      - ProbSum
      - NcpSum
      - NodeSum
      - ClusSum
      - BbLnkSum
    - EventMgmt
      - EventTypes
      - EventMon
    - NetCntl
      - AspCntl
      - PscCntl
      - SpareCntl
      - PortCntl
      - PadCntl
      - PadPtCntl
    - DistgMgmt
      - DistgDef
      - DistgList
      - SwRelList
      - SwRelConts
    - Debug
      - ModTrigr
      - CRecMon
      - CRecLog
      - RouteSim
      - MemAcces
      - NcpUll
      - AspFiles
      - MemPatch
        - PatchFiles
        - PatchDef
        - PatchAsign
        - PatchLoad
        - PatchCopy
  - NetConfg
    - IntComp
      - NcpUser
      - NodeDef
      - ClusDef
      - Psc
      - Asp
      - BbLnk
      - PortDef
      - CompOver
        - NodeOver
        - ClusOver
        - ModOver
        - ChassOver
        - SpareOver
    - NetUser
      - X25Leasd
      - X25Dlln
      - X25DlOut
      - X75User
      - TPAD
        - TPadUser
        - TPadServ
        - TPadAutoC
        - TPadProf
        - TPadPort
      - HPAD
        - HPadUser
        - HPadServ
        - HPadSet
        - HPadDiag
        - HPadPort
        - HpadAutoB
        - HpadHgrp
        - HgrpAutoB
      - X25GWLeasd
    - Acces
      - AccesCode
      - Userlds
      - NetDest
      - X25Group
      - X75Group
      - X25GWGroup
      - Pvc
    - SysParms
      - GenParms
      - ClassServ
      - NocParms
    - ForGWDef
      - ForDef
      - AddCorr
      - X25GWCorr
  - OperMgmt
    - OperDef
    - OperAcces
    - OperEvCls
    - OperEvnts
  - RptGen
    - CompRpt
    - UserRpt
    - AccesRpt
    - OperRpt
    - EventRpt
    - SoftwRpt
    - X25GWRpt
  - BdcstMsgs

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# BASIC
# NOC OPERATIONS
# 2.4.2

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30-OCT-87

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# GETTING STARTED
# 2.4.2.1

2-116E4256
30-OCT-87

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# LOGGING ON

1. Go to the <u>LOGON</u> Screen
2. Enter Operator Name and Password
3. Enter Desired NCP (the Default is the Master NCP)
4. Press [F1] (the Logon Function Key)

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-LOGON- Quick Access - .......... NCS Logon/off Form

Operator Name : ........
Operator Password :

Desired NCP (Master,Backup,NCPA,NCPB) : Master

f1 Logon
Log-on to Network Control System

f2 Logoff
Log-off the Network Control System

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Logon | Lgoff | | CONFG ACCES | | | | | Quick Acc | TOGGL PREV |

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**01/24/86**

# CONNECTING TO A CONFIGURATION

1. Go to the Config Access Screen

2. Connect to a Configuration

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-CONFG ACCES- Quick Access - .......... Configuration Access

Configuration Name : ........

**f1** Conn Read
Connect to configuration
with READ-ONLY access.

**f3** Off Chnge
Connect to Offline Config
with READ-WRITE access.

**f2** On Chnge
Connect to Online Config
with READ-WRITE access.

**f4** Disc
Disconnect from
configuration.

| Conn Read | On Chnge | Off Chnge | Disc | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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**234P215**
**01/10/86**

# NORMAL WORK

- Visit Screens to Perform Assigned Duties
- Monitor Banner Area for Updates, Especially: Notice of Broadcast Messages
- Go to <u>BDCST</u> <u>MSGS</u> Screen to Read any Messages

-BDCST MSGS- Quick Access - __________ Broadcast Msg Display Form

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Montr | | | | | | Quick Acc | TOGGL PREV |

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# LOGGING OFF

1. Go to LOGON Screen
2. Press [F2] (the <u>LGOFF</u> Key)

Jan 2, 1986 Page No. 6

-LOGON- Quick Access - ........... NCS Logon/off Form

Operator Name :
Operator Password :

Desired NCP (Master,Backup,NCPA,NCPB) : Master

F1 Logon
Log-on to Network Control System

F2 Lgoff
Log-off the Network Control System

| Logon | Lgoff | | CONFG ACCES | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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# BASIC NOC OPERATIONS
# NETWORK CONFIGURATION
# 2.4.3

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# NETWORK CONFIGURATION
# GENERAL

The Network Software Needs to Know about the Hardware Configuration. This is Primarily the Job of the Configuration Database, but each Cluster must also Contain some Initial Configuration Data in Firmware.

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# NETWORK CONFIGURATION
# THE CONFIGURATION DATABASE

The Configuration Database is Created by the NCP and Filled in at the NOC. In General, a Configuration Database will Contain:

- Physical Equipment Definitions
- Internal Component Definitions
- Network User Definitions
- Physical Connectivity
- ~~Local~~ Connectivity
  LOGICAL

# NETWORK CONFIGURATION MAJOR STEPS

The Major Steps in Defining a New Configuration Are:

- Create an Empty Configuration Database at the NCP Using NCPOP Command : Create DB
- Connect to it at the NOC
- Define the Internal Network Components
- Define the External Network Components

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# SYSTEM ARCHITECTURE 3.0

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# SYSTEM FEATURES 3.1

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# SYSTEM FEATURES
# NCP FEATURES

1. Redundant NCPs Online Simultaneously Load Sharing System Services and Administrative Functions.
2. Master, Backup Mode Reversal and State Control Provided Through NCP Terminal.
3. NCP and VAX/VMS Operator Interface Provided with Security Features.
4. Database Management Provided for all VAX/VMS Environments.
5. "On the Fly" Configuration Database Access and Change Capability Provided for both Online and Offline Databases.
6. Supports DECNET for use of Automatic Database Copy Between NCPs.
7. Statistic Collection and Performance Monitoring Provided via NCP and NOC.
8. Online Debugging Facilities Provided via NCP and NOC.

# SYSTEM FEATURES
# NCP FEATURES (Cont.)

9. Summary Network Status Collected by NCP Based on a Configurable Interval.

10. Detail Network Status Requested by NCP upon NOC Command.

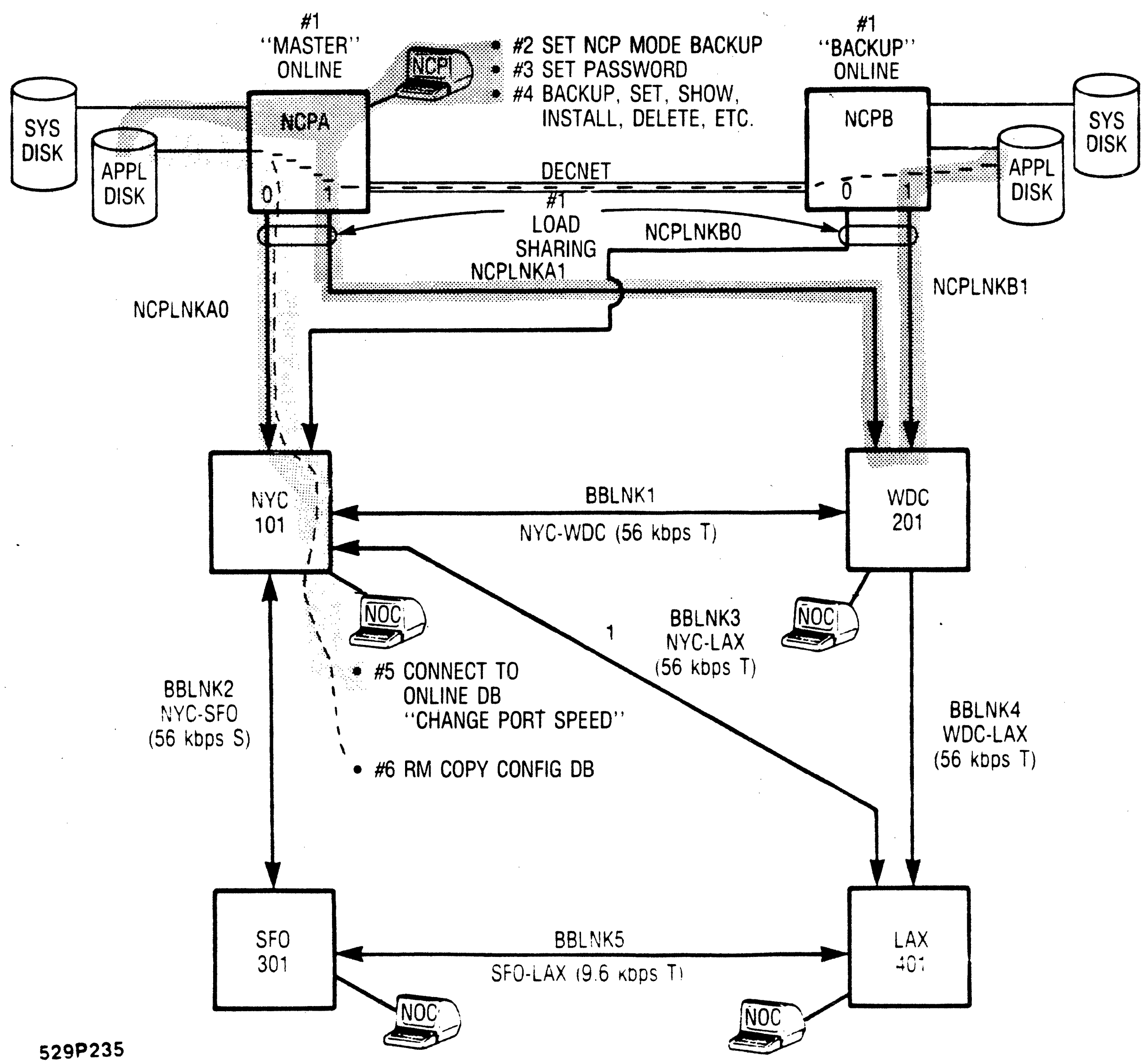
11. Detailed Network Component Control to the LCN Level.

12. Call Record Collection and Storage in Log Files Available for NOC Viewing and Billing Purposes.

13. Management and Storage of Network Events, Configurable at the NOC.

14. Management and Storage of NOC Operator Operations, Configurable at the NOC.

# SYSTEM FEATURES
# NCP FEATURES ILLUSTRATED (1-6)

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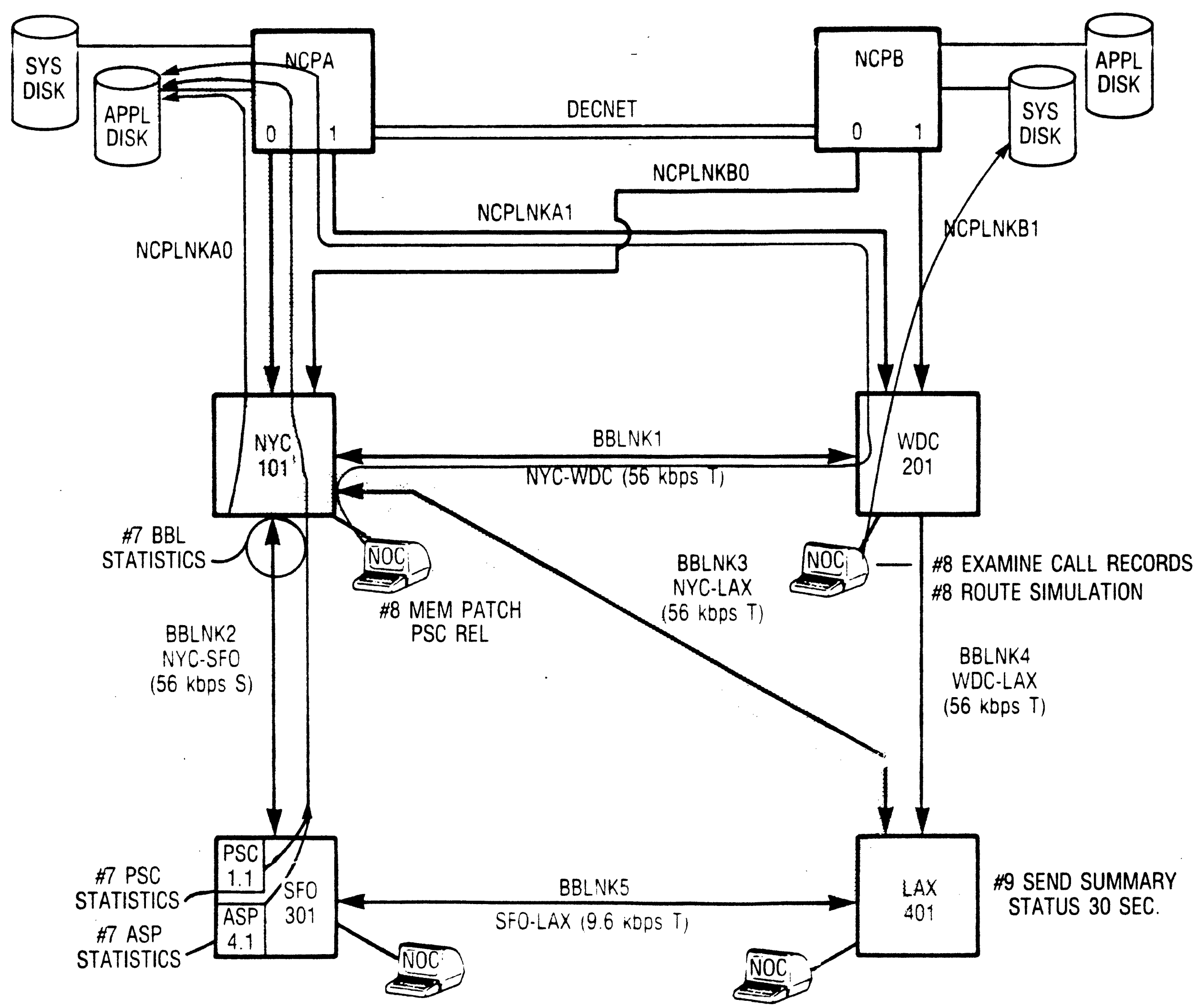
# SYSTEM FEATURES
# NCP FEATURES ILLUSTRATED (7-9)

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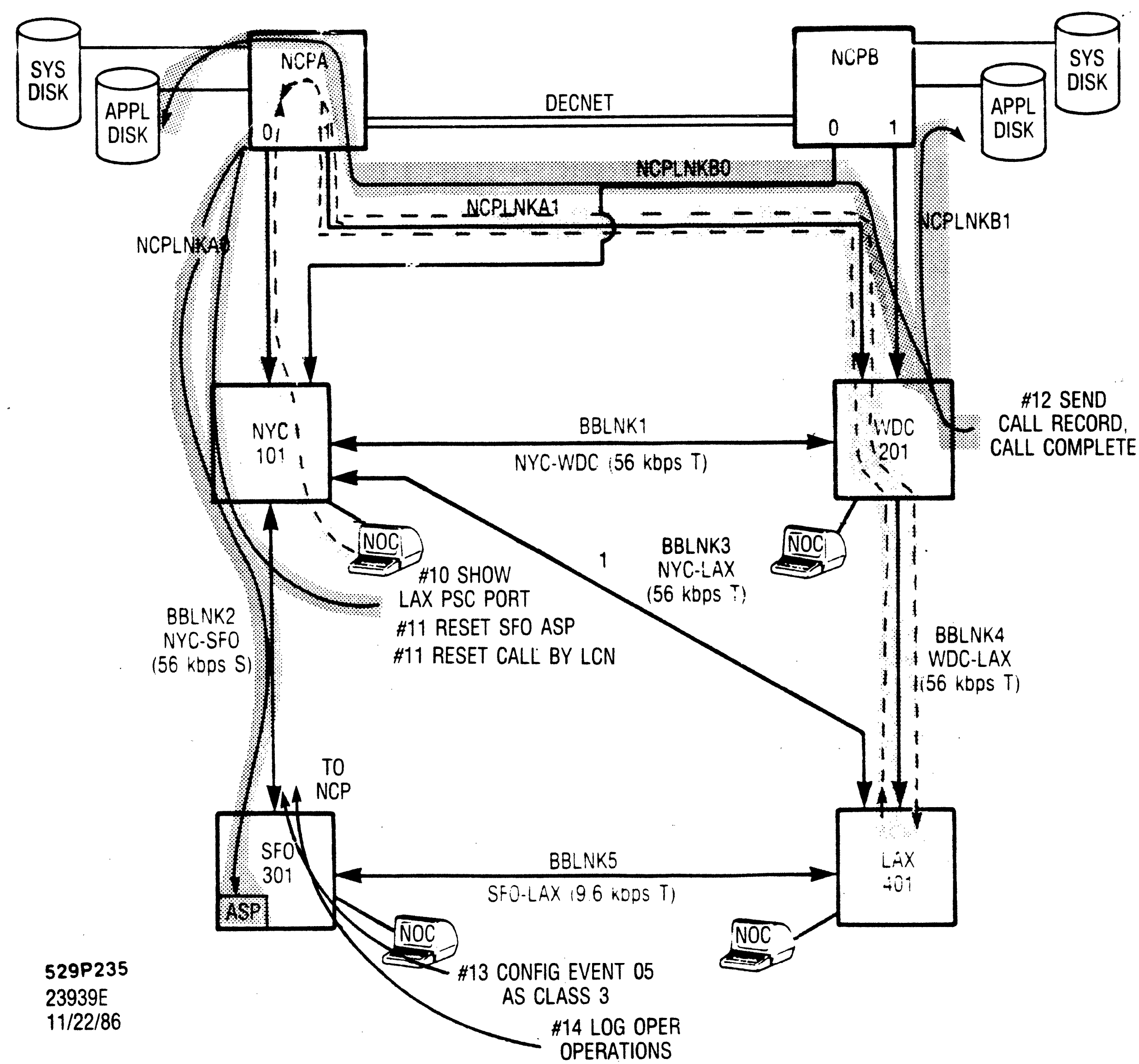
# SYSTEM FEATURES NCP FEATURES ILLUSTRATED (10-14)

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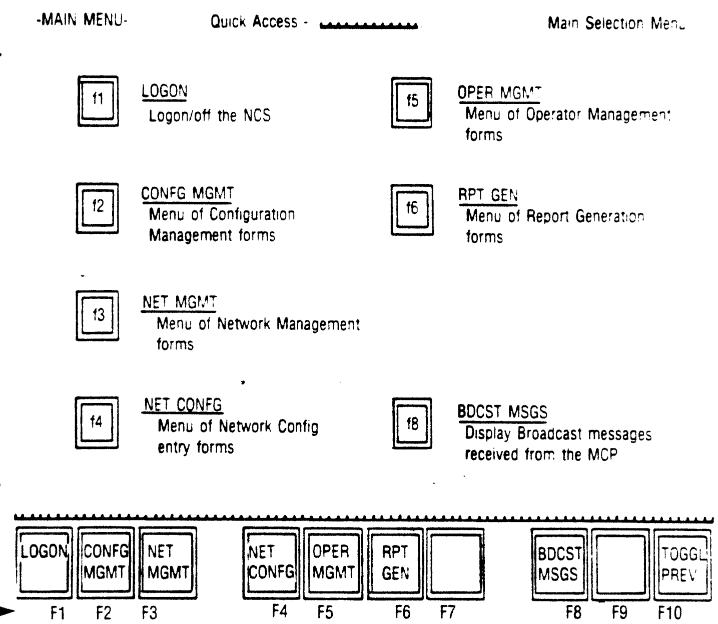
# SYSTEM FEATURES
# NOC FEATURES

- MENU DRIVEN
- SPECIAL KEY FUNCTIONS

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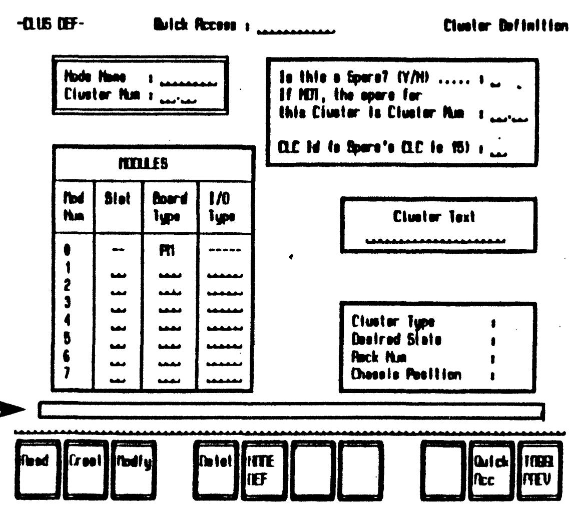
- FORMS BASED
- LOCAL DATA VALIDATION

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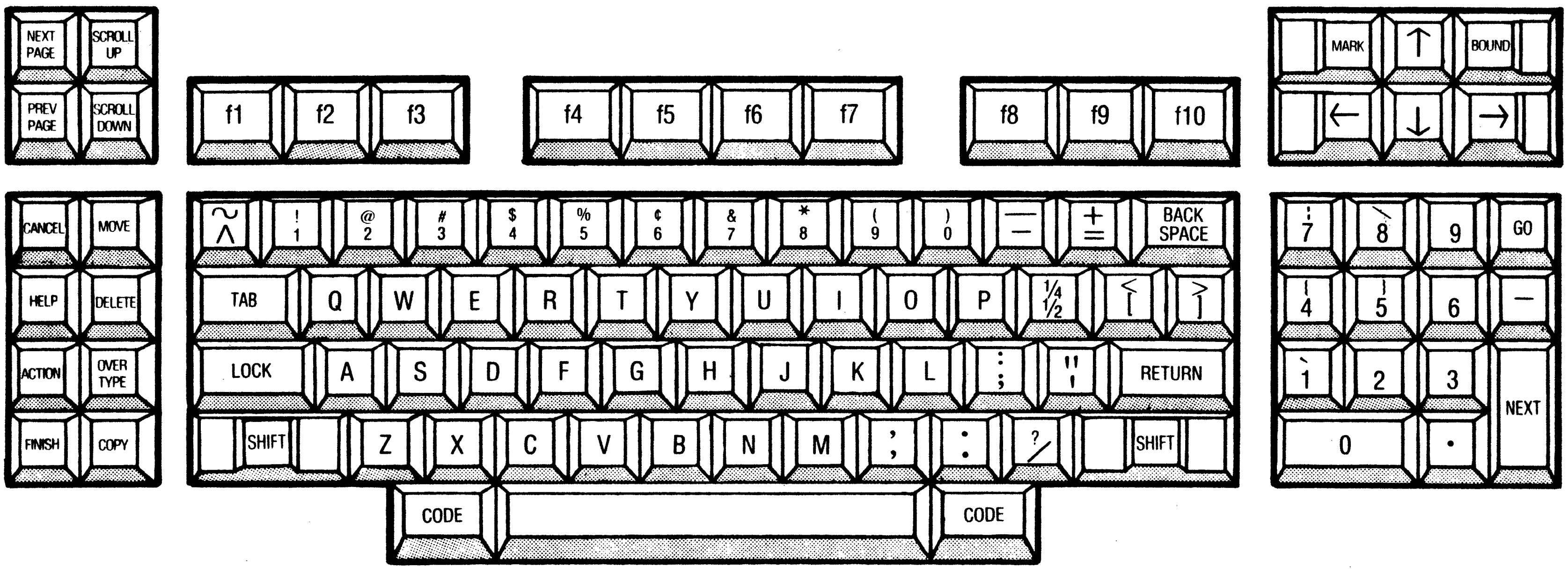
# SYSTEM FEATURES NOC FEATURES (Cont.)

## *Expanded Conventional Key Board*

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# NOC FEATURES
# OPERATOR MANAGEMENT

Network Operator Console

| | | | |
|---|---|---|---|
| 4:38:27 PM<br>Fri Jul 26, 1985 | OWS 1 OWS 2 OWS 3<br>OWS 4 OWS 5 OWS 6<br>OWS 7 OWS 8 OWS 9 | Working<br>Message<br>Log On | NOC Software Versn :WED 7/17 5pm<br>Operator Name/Type :NOC4 / 0<br>NCP Name/Mode :NCPA /MASTER<br>Online Config :A51START<br>Connctd Confg/Acces:ESHOB /CHANGE |

-OPER DEF- Quick Access - ________ Operator Definition

Operator Name : ______

Operator Type : __

Operator Password : ______

New Password : ______

f7 **New Passw**
Change the Password of the Operator CURRENTLY LOGGED-ON

Read | Creat | Modfy | Delet | | | New Passw | | Quick Acc | TOGGL PREV

Network Operator Console

| | | | |
|---|---|---|---|
| 4:38:27 PM<br>Fri Jul 26, 1985 | OWS 1 OWS 2 OWS 3<br>OWS 4 OWS 5 OWS 6<br>OWS 7 OWS 8 OWS 9 | Working<br>Message<br>Log On | NOC Software Versn :WED 7/17 5pm<br>Operator Name/Type :NOC4 / 0<br>NCP Name/Mode :NCPA /MASTER<br>Online Config :A51START<br>Connctd Confg/Acces:ESHOB /CHANGE |

-OPER ACCES- Quick Access - ________ Operator Function Key Access

Operator Type : __

| Form Name(s) | f1 | f2 | f3 | f4 | f5 | f6 | f7 | f8 | Next Page |
|---|---|---|---|---|---|---|---|---|---|
| ________ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| ________ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| ________ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| ________ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| ________ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| ________ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| ________ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| ________ | _ | _ | _ | _ | _ | _ | _ | _ | _ |

f7 **Help Names**
Display FormNames currently selected in Help Window.

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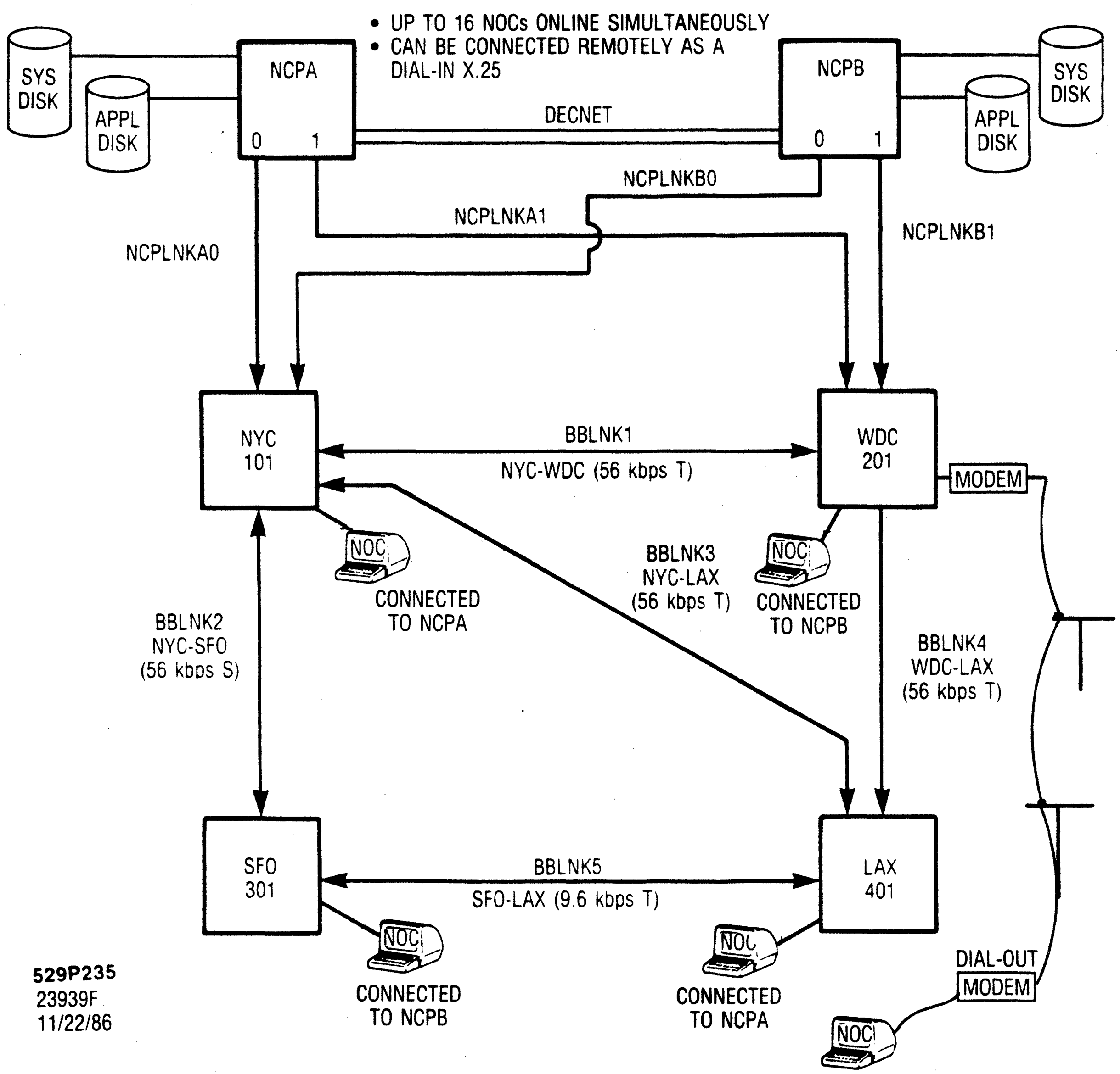
Read | | Modfy | | | | Help Names | | Quick Acc | TOGGL PREV

# SYSTEM FEATURES
# NOC FEATURES

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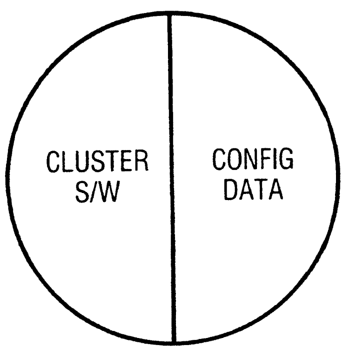
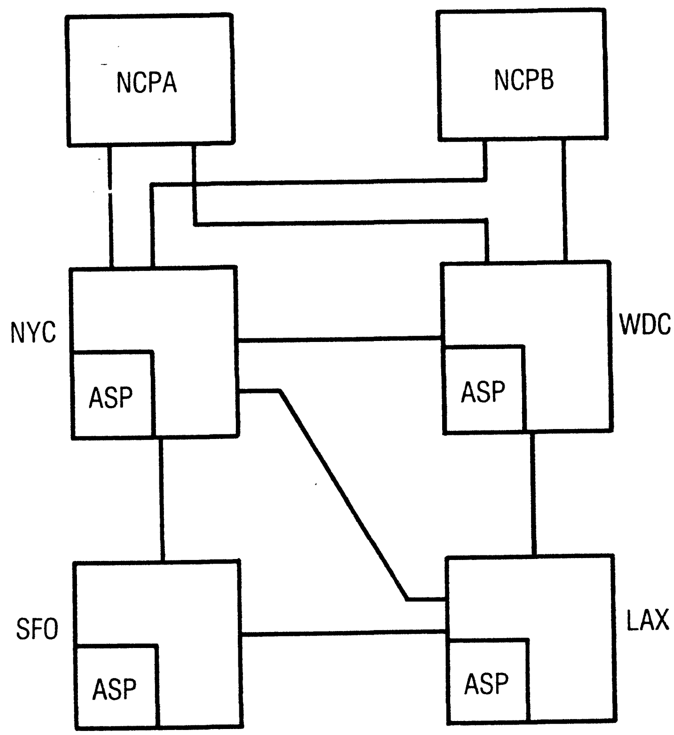
# SYSTEM FEATURES
# ASP FEATURES

- Distributed Local Storage
  - Cluster Software
  - Network Configuration Data



ASP




- Supernet Server of Network Services
  - CREC
  - STATUS
  - STATISTICS
  - EVENTS
- Call Setup Assistance
- Temporary Log File Storage
- Low Cost Redundant Network Management
- Centralized or Decentralized Network Control

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# SYSTEM FEATURES
# PSN FEATURES

- Fully Distributed Microprocessor Architecture (Adding a LIM to a Cluster Adds More Processing Power, Memory, Ports)
- Each PSC Capable of Source Routing, Reporting and Call Reconnection
- Redundant Fail Safe Operation Through Backup PSCs
- Provides User Interfacing While Adhering to X.25 and X.75 CCITT Standards
- Supports Async, Byte Sync, Bit Sync Operation
- Supports X.25 Leased, Dial-in, Dail-out Users; CUGs, Load Leveling, and Async/Sync PAD Support.
- Supports X.25 Gateways to Foreign Networks: Private-Foreign, Foreign-Private, Foreign-Foreign

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# SYSTEM TOPOLOGY 3.2

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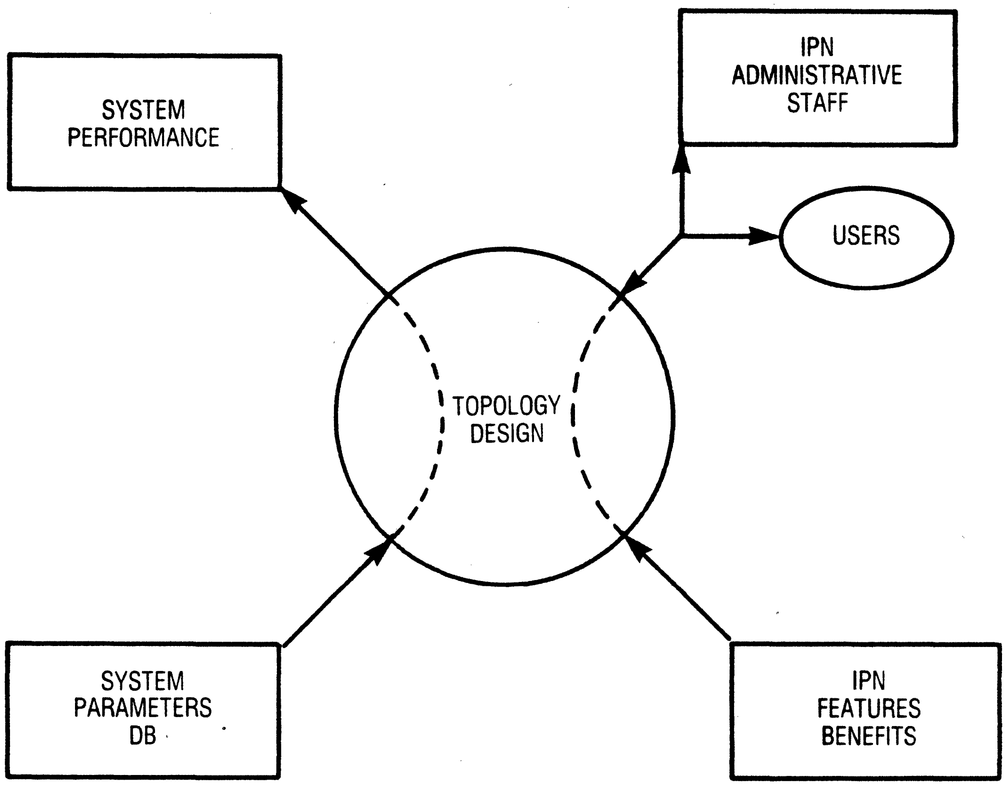
# SYSTEM TOPOLOGY DESIGN

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- Controls Access/Utilization of Features' Benefits
- Affects System Performance (Interacts w/ System Parameters)
- Classic Trade-off:  Cost vs. Performance
- Network Modeling Tool Available through HNS.

# SYSTEM TOPOLOGY CONSIDERATIONS

- Additional NOCs
  - Depending on Administrative and Debug Requirements, Other NOCs may be Distributed to Other Sites/Nodes.
- V.C. Fanout
  - Virtual Circuit Limitations are Determined by the Number of NCP Links and Fanout by ASPs, Therefore, PSCs/Node, ASPs/Node, and Nodes in the System Should be Carefully Considered, as well as the Supervisory Server Assignments.
- Traffic Resources
  - Careful Consideration Should be Given to the Number of Users/Node, the Estimated Traffic per Access Link and Backbone Link, and Proper Configuration of Each Link.
- Traffic Profiles
  - Type of Traffic, such as Interactive Batch Processing, etc., and Peak Traffic Periods Should be Estimated.
- User Parameters
  - Service Requirements, Facility Requirements, and Grouping of Users will Influence Topology Design

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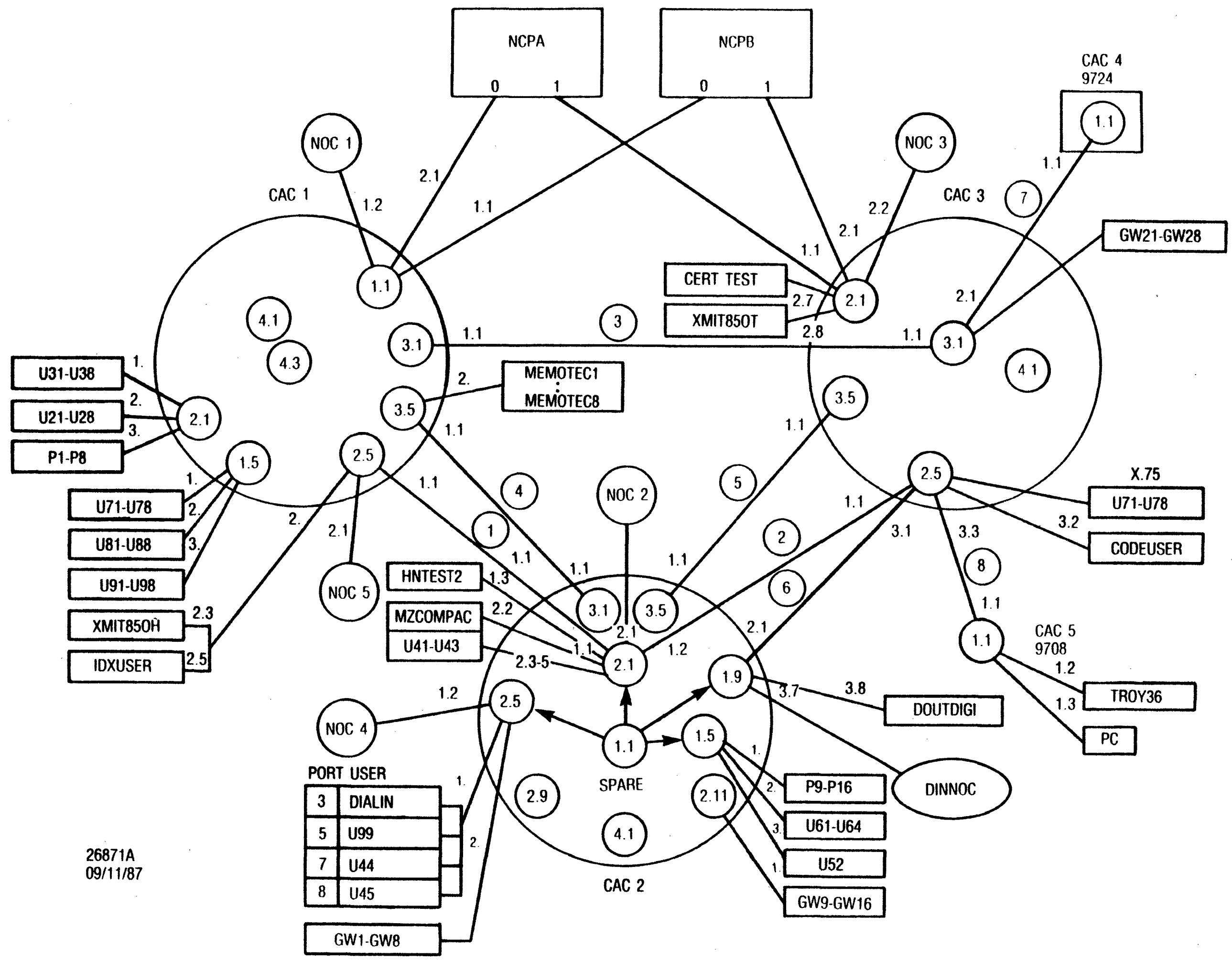
# TOPOLOGY EXAMPLE

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# SUPERVISORY NETWORK (SUPERNET) 3.3

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# SUPERVISORY NETWORK GENERAL

## *In-Class Reading*

The components of the NCS are required to communicate with each other and with Nodes and NOCs to support Network Services and Network Administration on an as needed basis. In order to facilitate this communication, an interconnection between the NCS, NOCs, and Nodes is provided and is called Supervisory Network. This supervisory network is implemented using the network itself and is used to perform all Network Services and some Network Administration functions.

Supervisory circuits are established between the components of the supervisory network. These circuits are set up using the same facilities and routing algorithm provided by the network to its users. In order to minimize the use of system resources, supervisory circuits are not set up (and cleared) for each transaction between system components. All supervisory circuits are maintained on a long-term basis and used to transport information when required by network operations.

Each PSC and each ASP in the network is configured with a primary and a secondary supernet server. PSCs may have either ASPs or NCPs as their servers. ASPs must have NCPs as their supernet servers. A component will direct all service requests to its primary server first. If the primary server cannot be reached, the component will redirect its request to its secondary server. The request will be redirected repeatedly from one server to another until the request is satisfied.

Ultimately, requests will arrive at the NCP that can perform all functions and hold all data and can, therefore, satisfy any request for service from a component of the network.

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# SUPERVISORY NETWORK SERVER ASSIGNMENTS

1. Allow the Network to do a "Cold" Start and Recover from Failures

2. Minimize the Time Required for a Cluster to get Address Translation Information (CSSI) from the NCP

3. Minimize the Backbone Link Loading Required for Clusters to Obtain Network Control System Services

4. Allow Clusters to Continue to Operate when there is a Single External Failure (e.g., Link Down, ASP Down). Allow Operation with Multiple Failures, if Possible

5. Balance Traffic Loads Among ASPs and Between NCPs

The SN Servers are Configured Using the -ASP- and -PSC- NOC Screens

Supernet Server NCS Names
Primary:
Secondary:

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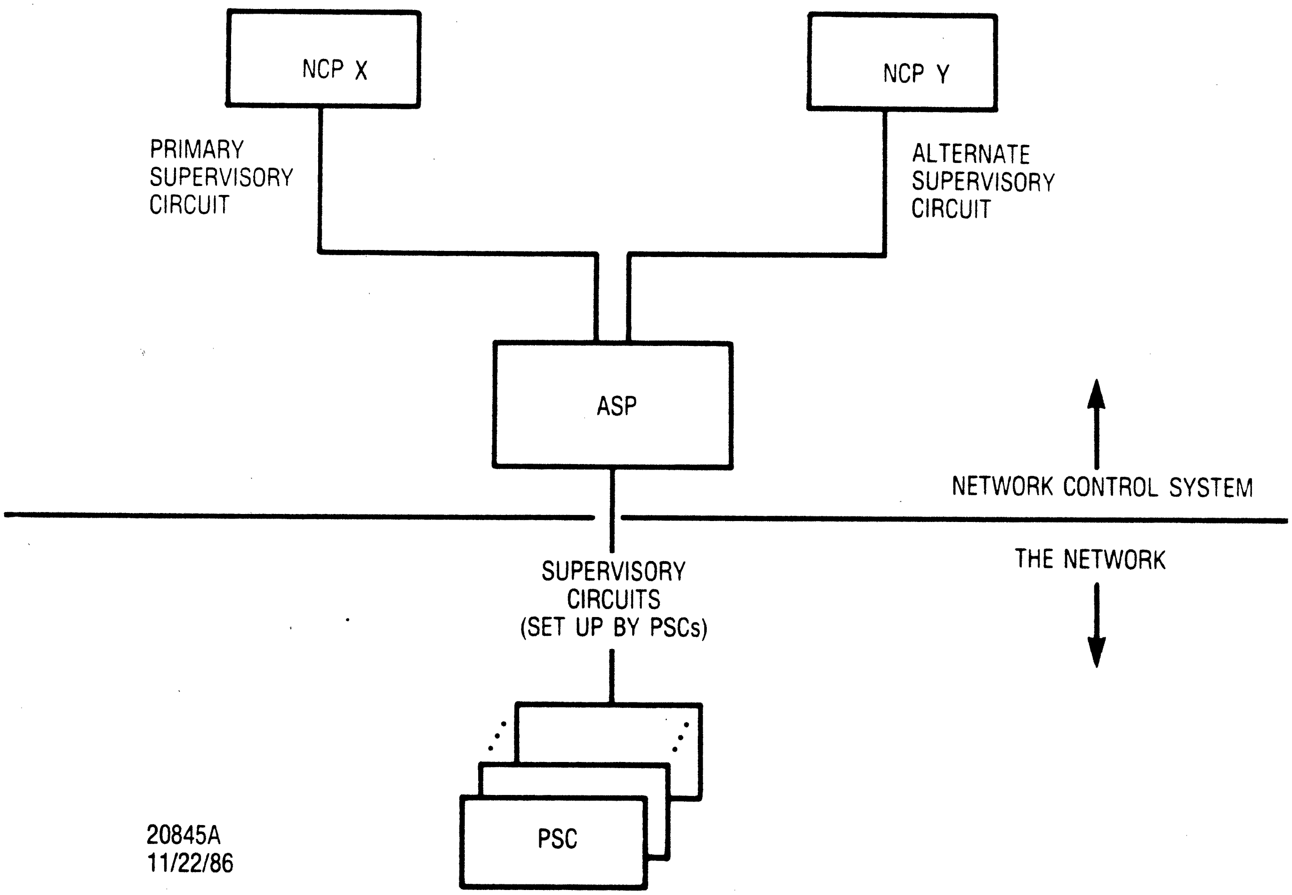
# ASP SUPERVISORY CIRCUITS

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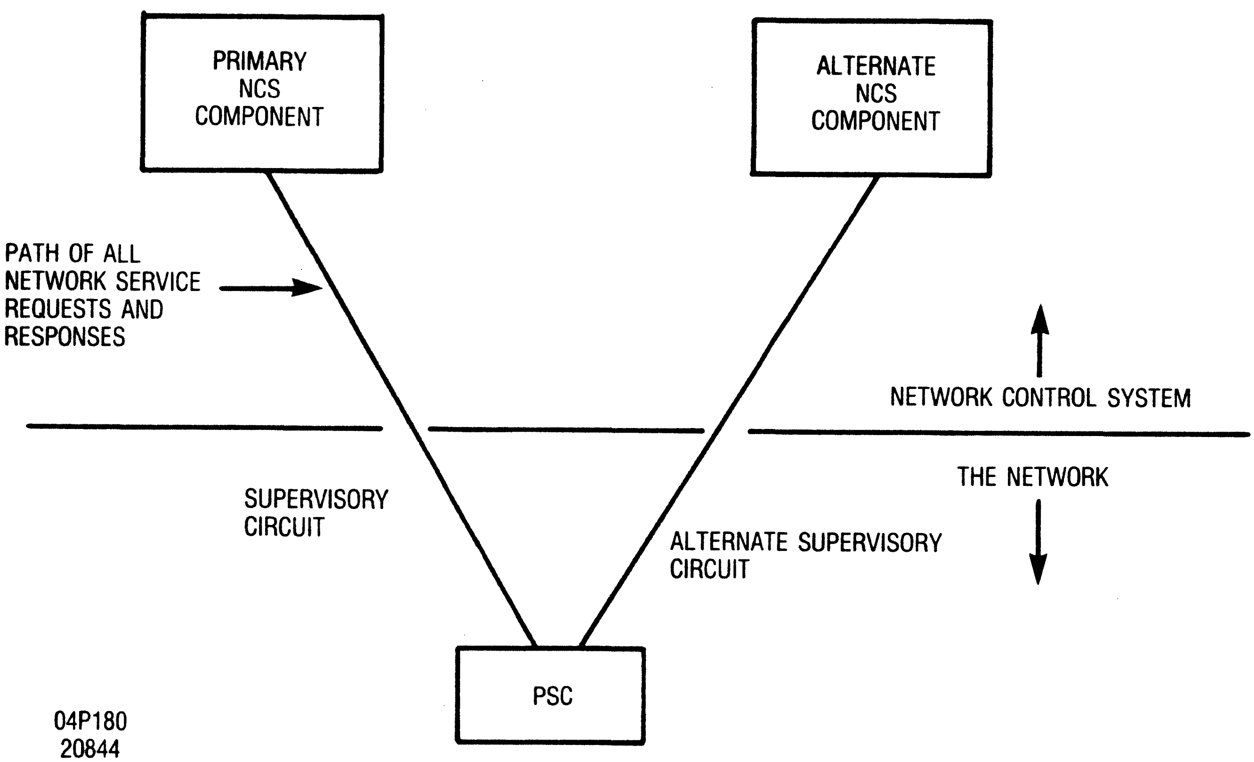
# PSC SUPERVISORY CIRCUITS

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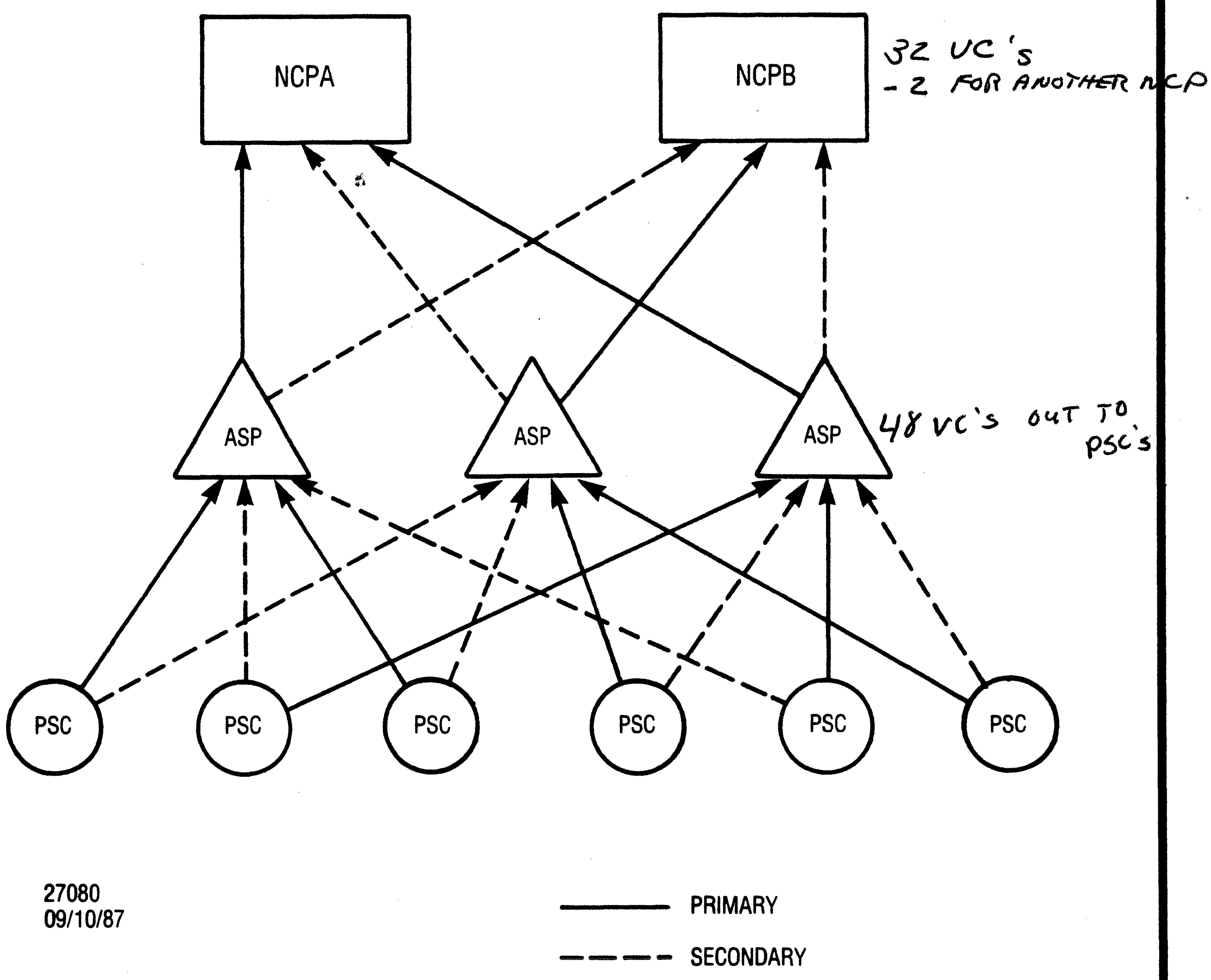
# SUPERVISORY NETWORK LOGICAL STRUCTURE

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# NETWORK SERVICE AND SN VIRTUAL CIRCUIT ENGINEERING

| | | NCPLNK NAME | | | | |
|---|---|---|---|---|---|---|
| | | NCPA0 | NCPA1 | NCPB0 | NCPB1 | |
| | NO. OF NCPLNKS | 1 | 2 | 3 | 4 | DESCRIPTION |
| NO. OF ASPs | 0 | 17 | 45 | 73 | 101 | NO. OF VCs FOR 1-4 NCPLNKS NO ASPs |
| | 10 | 247 | 275 | 303 | 331 | NO. OF VCs FOR 1-4 NCPLNKS 10 ASPs |
| | 17 | 408 | 436 | 464 | 492 | NO. OF VCs FOR 1-4 NCPLNKS 17 ASPs |
| | 45 | | 1080 | 1108 | 1136 | NO. OF VCs FOR 1-4 NCPLNKS 45 ASPs |
| | 73 | | | 1752 | 1780 | NO. OF VCs FOR 1-4 NCPLNKS 73 ASPs |
| | 101 | | | | 2424 | NO. OF VCs FOR 1-4 NCPLNKS 101 APPs |

NOTE: GUIDELINE FOR ALLOCATING VCs IS:

2 VCs NCP — NCP CONNECTIONS
1-16 VCs FOR 1-16 NOCs (4 PER NCP LINK)
9 VCs FOR NCP TO NETWORK CALLS
REMAINING VCs FOR NETWORK SUPERNET

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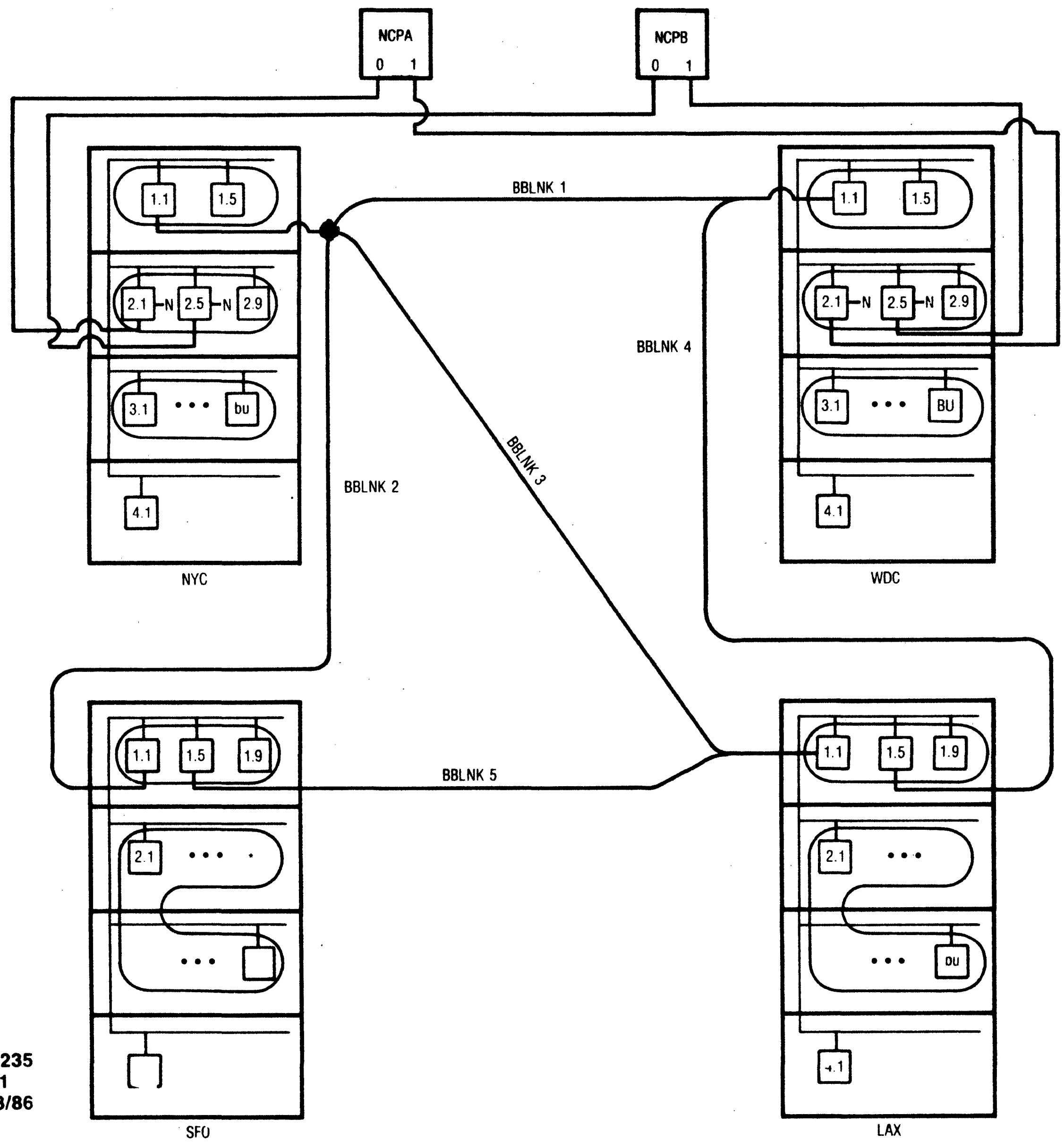
# EXAMPLE NETWORK PHYSICAL CONNECTIVITY

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# EXAMPLE NETWORK DLL AND SN ASSIGNMENTS

## New York City Node

| | PSC 1.1, 1.5, 3.1-X.Y | | NCP PSCs 2.1 & 2.5 | | Backup 2.9 | | ASP 4.1 | |
|---|---|---|---|---|---|---|---|---|
| | Primary | Secondary | Primary | Secondary | Primary | Secondary | Primary | Secondary |
| DLL Source | MIB to ASP 4.1 | MIB to PSC 2.1 | MIB to ASP 4.1 | NCP Link on LIM | MIB to ASP 4.1 | MIB to PSC 1.1 | ASP's Own Disk | MIB to PSC 2.5 |
| DLL Server | NCPA0 | NCPB0 | (Don't Care) | (Don't Care) | NCPA0 | NCPB0 | NCPA0 | NCPB0 |
| * SN Server | ASP: NYC 4.1 | ASP: WDC 4.1 | ASP: NYC 4.1 | NCP Link on LIM | ASP: NYC 4.1 | ASP: WDC 4.1 | NCPA0 | NCPB0 |

## Washington DC Node

| | PSC 1.1, 1.5, 3.1-X.Y | | NCP PSCs 2.1 & 2.5 | | Backup 2.9 | | ASP 4.1 | |
|---|---|---|---|---|---|---|---|---|
| | Primary | Secondary | Primary | Secondary | Primary | Secondary | Primary | Secondary |
| DLL Source | MIB to ASP 4.1 | MIB to PSC 2.1 | MIB to ASP 4.1 | NCP Link on LIM | MIB to ASP 4.1 | MIB to PSC 1.1 | ASP's Own Disk | MIB to PSC 2.5 |
| DLL Server | NCPA1 | NCPB1 | (Don't Care) | (Don't Care) | NCPA1 | NCPB1 | NCPB1 | NCPA1 |
| * SN Server | ASP: WDC 4.1 | ASP: NYC 4.1 | ASP: WDC 4.1 | NCP Link on LIM | ASP: WDC 4.1 | ASP: NYC 4.1 | NCPB1 | NCPA1 |

## San Francisco Node

| | Backbone 1.1 | | Backbone 1.5 | | Backup 1.9 | | PSC 2.1-X.Y | | ASP 4.1 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Primary | Secondary | Primary | Secondary | Primary | Secondary | Primary | Secondary | Primary | Secondary |
| DLL Source | MIB to ASP 4.1 | BBLNK: NYC-SFO | MIB to ASP 4.1 | BBLNK: SFO-LAX | MIB to ASP 4.1 | MIB to Acc. PSC | MIB to ASP 4.1 | MIB to PSC 1.1 | ASP's Own Disk | MIB to PSC 1.5 |
| DLL Server | ASP: NYC 4.1 | ASP: WDC 4.1 | ASP: LAX 4.1 | ASP: NYC 4.1 | ASP: NYC 4.1 | ASP: LAX 4.1 | ASP: NYC 4.1 | ASP: LAX 4.1 | NCPA1 | NCPB1 |
| * SN Server | ASP: SFO 4.1 | ASP: LAX 4.1 | ASP: SFO 4.1 | ASP: LAX 4.1 | ASP: SFO 4.1 | ASP: LAX 4.1 | ASP: SFO 4.1 | ASP: LAX 4.1 | NCPA1 | NCPB1 |

## Los Angeles Node

| | Backbone PSC 1.1 | | Backbone PSC 1.5 | | Backup PSC 1.9 | | PSC 2.1-X.Y | | ASP 4.1 | |
|---|---|---|---|---|---|---|---|---|---|---|
| DLL Source | MIB to ASP 4.1 | BBLNK: WDC-LAX | MIB to ASP 4.1 | BBLNK: NYC-LAX | MIB to ASP 4.1 | MIB to Acc. PSC | MIB to ASP 4.1 | MIB to PSC 1.1 | ASP's Own Disk | MIB to PSC 1.5 |
| DLL Server | ASP: WDC 4.1 | ASP: NYC 4.1 | ASP: NYC 4.1 | ASP: WDC 4.1 | ASP: WDC 4.1 | ASP: NYC 4.1 | ASP: WDC 4.1 | ASP: NYC 4.1 | NCPB0 | NCPA0 |
| * SN Server | ASP: LAX 4.1 | ASP: SFO 4.1 | ASP: LAX 4.1 | ASP: SFO 4.1 | ASP: LAX 4.1 | ASP: SFO 4.1 | ASP: LAX 4.1 | ASP: SFO 4.1 | NCPB0 | NCPA0 |

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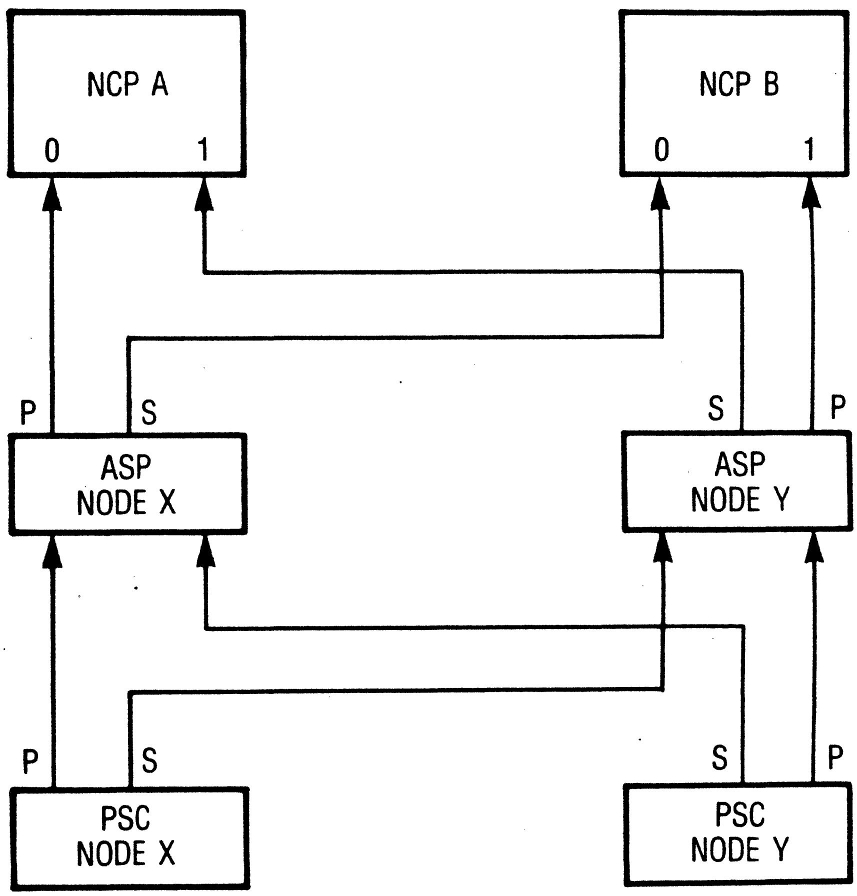
# ASP/PSN SN CONFIGURATION FOR BEST FAILURE TOLERANCE




P — PRIMARY SN SERVER PATH
S — SECONDARY SN SERVER PATH

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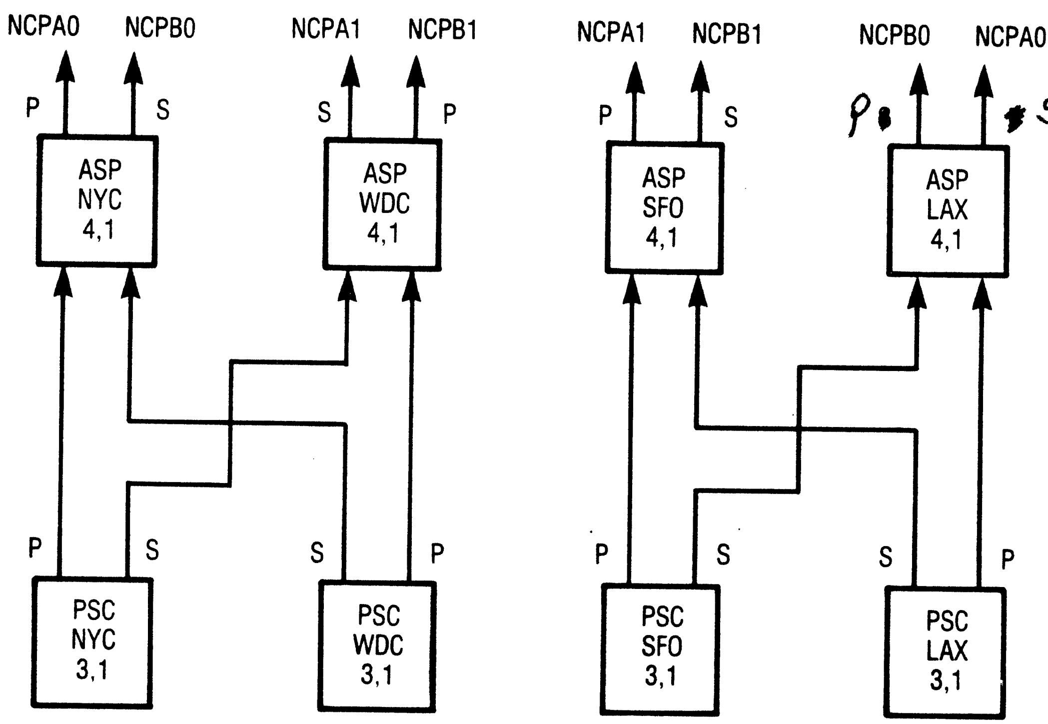
# EXAMPLE NETWORK

**The Supervisory Network Configuration Discussed has a Good Balance of Connections (and Possibly Traffic) Between NCPs, among NCP Ports, and among ASPs. The Following Diagram Illustrates this by Showing the SN Server Assignments for the ASPs and Typical PSCs in Each Node**

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# NETWORK RECONFIGURATION AND GROWTH 3.4

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# NETWORK RECONFIGURATION AND GROWTH GENERAL

The modularity of the CP9000 nodal hardware and software coupled with the IPN's online configuration capability allows for ease of growth and/or reconfiguration with minimum disruption to network users. No packet switching network remains static over time. New users will need new services, other users will change physical location, new traffic and new traffic patterns will require additional trunk allocations, and new line tariffs will make additional nodes economical. The Integrated Packet Network is designed to be a dynamic network. Therefore, when properly planned and executed, adding a new user, a new backbone Link, or even a whole node is usually accomplished without causing any service degradation or outages to current network users. This is of extreme importance when a phased implementation approach is needed to build a network.

# NETWORK RECONFIGURATION AND GROWTH GENERAL

- Modular Design: PSCs, Nodes
- Expandable Node Size (Number of PSCs)
- Interactive Adjustment of Performance Parameters and Configuration Data (NOC)
- Online or Offline DB Modification
- Two Step Growth Process:
  - Add Hardware
  - Modify Database(s)

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# NETWORK RECONFIGURATION AND GROWTH ADDING A NEW NODE TO A NETWORK

NODE SOFTW' LOAD ≈ 1. HR.

- Install Nodal Hardware at the Site
- Define Node in Configuration DB
- Inservice Clusters Download and Begin Operating
- Operational Nodes Remain Undisrupted
- Performance Along Load Paths may be Affected During DLL.

CAN NOT BE ADDED WITH POWER-ON:

MMB JUMPER BLOCKS

1 FOR N CABLES

DISC CONTROLLER CARD & RIBBON

SASI I/O CARD

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# NETWORK RECONFIGURATION AND GROWTH ADDING A CLUSTER TO A NODE

- MMB and 1-for-N hardware must be Pre-configured
- Add PM, LIM(s) and I/O Cards
- Define PSC in Configuration D~~Ø~~B
- Nodal Operation Remains Undisrupted
- Inservice PSC Downloads and Begins Operation
- Performance Along Load Path may be Affected During DLL
- An ASP may be Added Similarly

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# NETWORK RECONFIGURATION AND GROWTH ADDING A NEW USER

- Adding a new User to the Network Requires that a Port be Allocated to that User.

- If a Spare Port is Available on the Applicable Node, then the Installer need only Physically Connect the new User, then have the Network Operator add that User to the Online Configuration Database.

- No Other Users on that I/O Module or Cluster are Affected.

# NETWORK RECONFIGURATION AND GROWTH ADDING ADDITIONAL PORTS TO CLUSTERS

- At some Point, the Installer may run out of Physical Ports on the Available I/O Modules of the Clusters' LIMs on a Node.
- The Network Designer Would have to Indicate Whether Additional Trunks/Users can be Added to the Cluster, Based on Traffic Utilization and Other Standard Network Design Procedures.
- When Applicable, an LIM and its I/O Module can be Added to a Cluster.
- MMB and 1-for-N Hardware Must be Pre-Configured

# NETWORK RECONFIGURATION AND GROWTH ADDING A NEW BACKBONE LINK

- Adding a new Backbone Link is Almost Identical to Adding a User to the IPN.
- The Installer Need only Physically Connect the new Backbone Link (at both ends) onto Available Spare Ports.
- The Network Operator would then Define the Backbone Link to the Online Configuration Database via the Backbone Link Definition Screen.
- The NCP would Immediately Inform the Entire Network of that Backbone Link's Availability.
- Source Clusters would Route new and Reconnected Calls over the new Link.

# NETWORK RECONFIGURATION AND GROWTH ADDING ADDITIONAL NOCS TO THE NETWORK

- As the Network Grows, it may Become Desirable to have Additional NOCs to Further Distribute the Network Control Functions and Capabilities.

- NOCs Connect to the Network as X.25 DTEs, the Procedure is the Same as that for Adding any Other X.25 DTE.

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# IPN CAPACITY
# 3.5

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# IPN CAPACITY GENERAL

- Due to its Modular Hardware, it can be "Sized" to Meet Varying Requirements
- Capacity is Based on Component Capacity and not Actual Performance Related Capacity
- Actual Current Capacities are:
  - 202 Data Packets/sec per BBL — 65 BYTE PACKETS.
  - BBLs per LIM: ~~1~~ 2 @56K, ~~2~~ 4 @19.2, ~~4~~ 8 @9.6
  - Links are Supported on the Same LIM in CPAC 18 and Greater
  - MIB Processing 2,000 Packets/sec
  - Intra-Cluster Switching Time ≃25 mS
  - I/O Call Setup/sec per NCP or ASP

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# IPN CAPACITY
# NODAL BASIS

| | Port | Cluster | Single Rack 9000 NPX | Dual Rack 9000 NPX | 9724 RPX | 9708 RPX |
|---|---|---|---|---|---|---|
| **Physical Ports** | | | | | | |
| Minimum | - | 2 | 2 | N/A | 2 | N/A |
| Maximum | - | 24 | ~~288~~ 288 | 576 | 24 | 8 |
| **Maximum Virtual Circuits** | | | | | | |
| Backbone | 1,024 | 2,048 | 24,576 | 49,152 | 2,048 | 2,048 |
| Access | 255 | 512 | 6,144 | ~~122,288~~ 12,288 | 512 | 512 |
| **Access Lines** | | | | | | |
| Minimum | 1 | 1 | 1 | N/A | 1 | 1 |
| Maximum | 1 | 24 | 288 | 576 | 23 | 7 |
| **Trunks** | | | | | | |
| Minimum | 1 | 1 | 1 | N/A | 1 | 1 |
| Maximum | 4 | 12 | 144 | 288 | 12 | 4 |
| **Port Speeds Supported (bps)** | | | | | | |
| Minimum | 1.2k | N/A | 1.2k | 1.2k | 1.2k | 1.2K |
| Maximum | 64k | N/A | 64k | 64k | 64k | 19.2K |

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# NETWORK SERVICES
# 4.0

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# GENERAL
# 4.1

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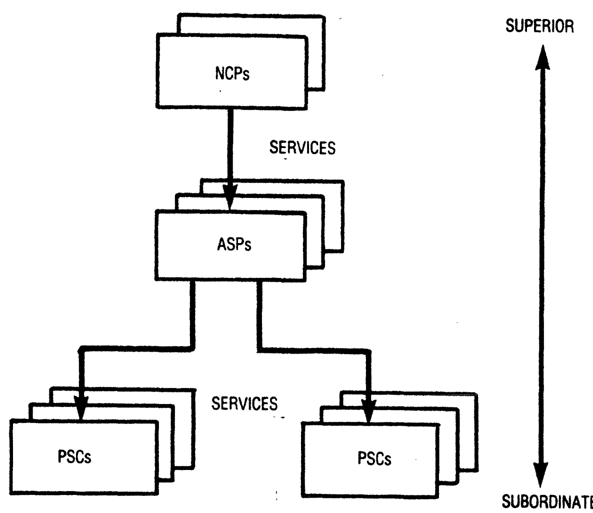
# NETWORK SERVICES GENERAL

## During Normal Operation:

- Clusters Require Certain data from NCS
- Clusters must Forward Certain data to NCS
- Data is Transferred via Network Service Processes
- Network Services Provided by NCS (ASPs and NCPs)
  - DLL
  - ULD
  - Address Translation
  - Access Restriction
  - Call Record Storage
  - Statistic Storage
  - Event Storage

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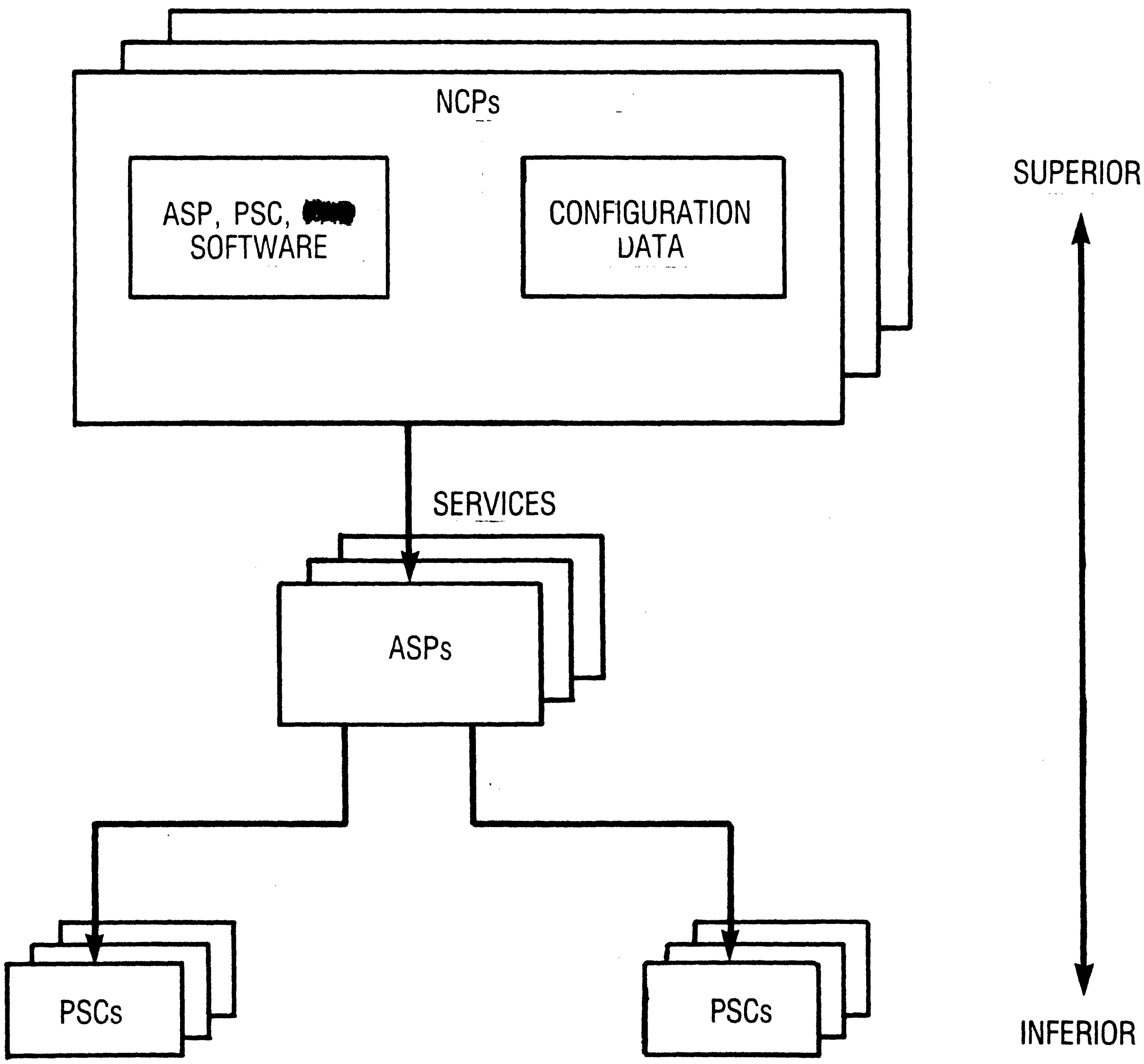
# NETWORK SERVICES DOWNLINE LOADING

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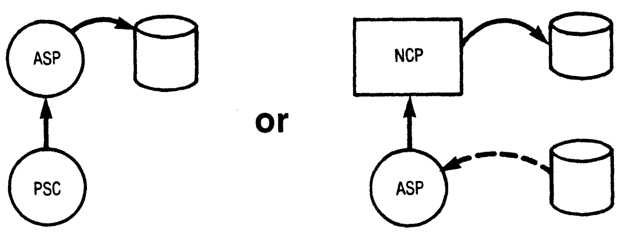
# NETWORK SERVICES UPLINE DUMP

- Debugging Tool
- Two Methods
  1) Restart Trigger
  2) By RAM Execution (32 Bytes)
- Stored on Disk

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- Offline Analysis Only

# NETWORK SERVICES ADDRESS TRANSLATION AND ACCESS RESTRICTION

- Address Translation Provided by NCS to Source PSCs during Call Setup

  Access Code → X.121 → INA
  (Mnemonic) (CCITT) (Physical)

- Access Restriction Checks

  1) Valid User
  2) Calling Address
  3) Calling → Called Address

# NETWORK SERVICES CALL RECORD STORAGE

- Call Records are Created in RAM of Source PSC
- Sent to NCS in Duplicate
- Contain Billing Data
- Stored by NCP in a Log File on Disk
- Processed Offline after Dump to Tape

# NETWORK SERVICES OPERATIONAL STATISTICS

- Stored Temporarily in Cluster Memory
- Forwarded Through NCS to NCP Log File
- Not Duplicated

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# NETWORK SERVICES
# LOG FILES

- The NCP Stores Certain Network Information (such as call Records and Statistics) in Circular Files, Called Log Files, Which Reside on the NCP's Applications Disk. The Following Log Files Exist:

| NCP Log File Type | Archive File Name |
|---|---|
| Event | EVTLOG |
| Call Recrd | CRMLOG |
| System Statistics | STTLOG |
| FUTURE → PAD Statistics | PADLOG |
| Error Messages | ERRLOG |
| Trace Messages | TRCLOG |
| Operator | OPRLOG |

- Log Files must be Archived to Tape

- Tape Processing Performed Offline

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# DOWNLINE LOADING
# (DLL)
# 4.2

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# DOWNLINE LOADING (DLL)

- **Two Types of DLL Data**
  1) Software Images
  2) Configuration Data

- **Two Types of DLL**
  1) Full DLL
     a) Startup (Cold Start)
     b) Cluster Restart
     c) New Component Software Configuration
  2) Partial DLL
     a) Configuration Changes
        – Change Notices ↓
        – Reconciliation ↑

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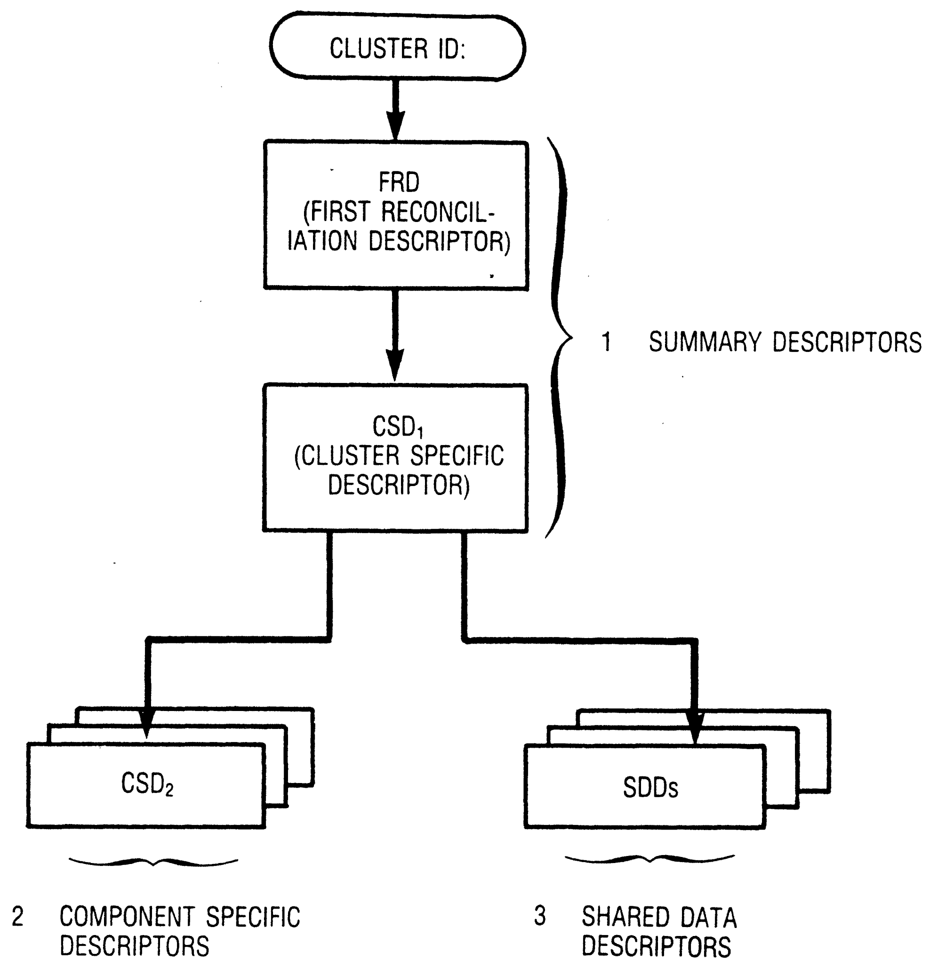
# DOWNLINE LOADING (DLL) DATA ORGANIZATION

## *Data Descriptors*

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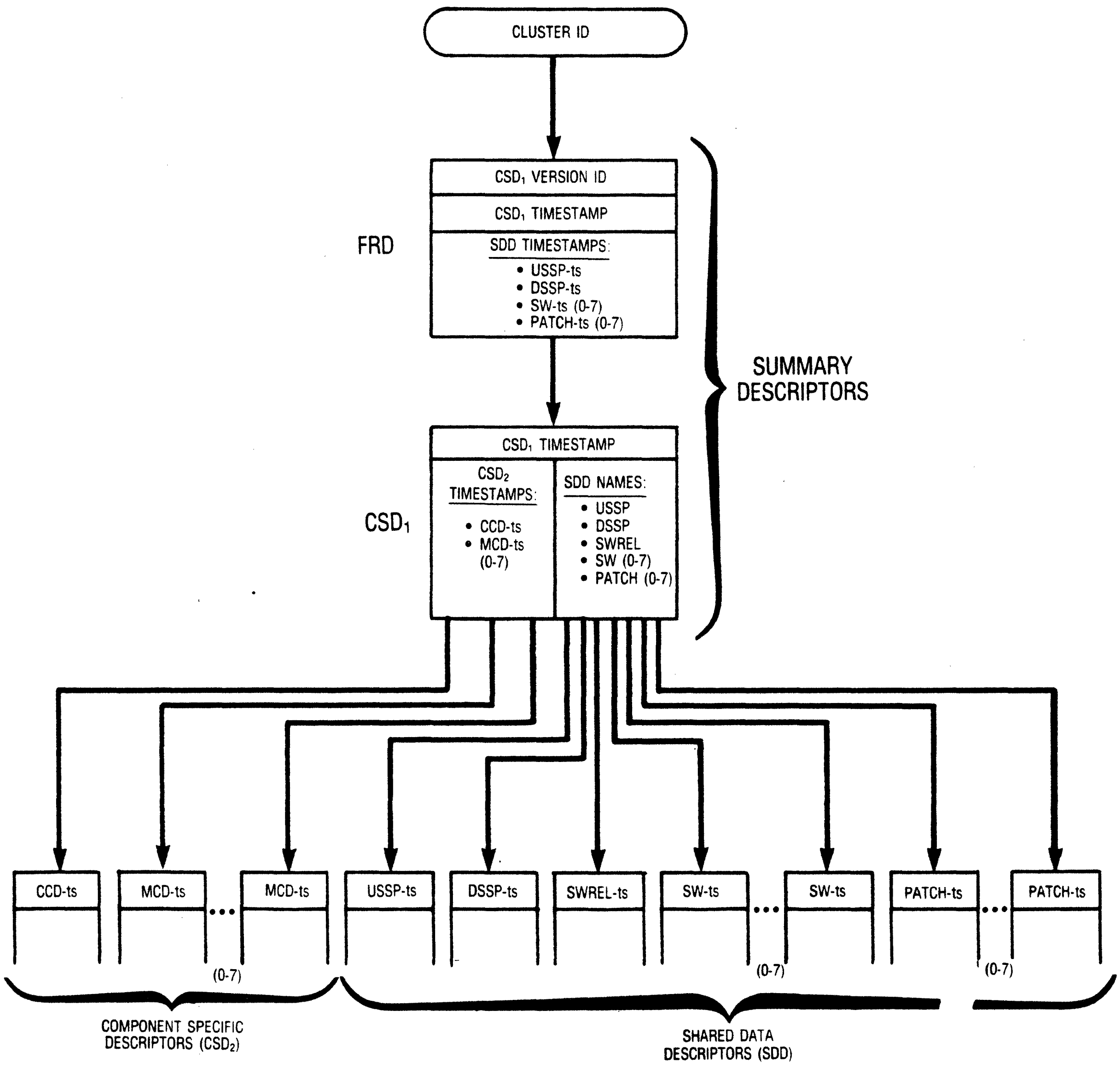
# DOWNLINE LOADING (DLL) DATA DESCRIPTOR FORMATS




CCD — CLUSTER CONFIGURATION DATA
MCD — MODULE CONFIGURATION DATA

USSP — UNIVERSAL SHARED SYSTEM PARAMETERS
DSSP — DATABASE SHARED SYSTEM PARAMETERS

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# DOWNLINE LOADING DATA DESCRIPTORS USAGE

- **When a NOC Operator Modifies DLL Data, the NCP:**
  1) Modifies Descriptor Data Field(s)
  2) Modifies Descriptor Timestamp
  3) Modifies Timestamps of all Higher Level Descriptors
- **FRD Timestamps:**
  - Reflect any Changes in Subordinate Descriptors
  - Basis for Reconciliation/Change Notices
- **DLL Requests:**
  - Initiated by Clusters
  - Made for a Specific Descriptor
  - Subordinate Descriptors Sent as Required

# DOWNLINE LOADING
# CHANGE NOTICE AND RECONCILIATION

- **Change Notice Process:**
  1) NOC Modifies DB
  2) NCP Broadcasts Name of Changed Descriptor(s) over all Supernet VCs
  3) ASPs Forward Change Notices to Affected PSCs ("Trickle-Down")
  4) Clusters Holding Modified Descriptor(s) Initiate Reconciliation

- **Reconciliation Process:**
  1) On Configured Interval, Cluster Obtains FRD
  2) Cluster Compares
     - Protocol Version ID
     - CSD Version ID and Timestamp
     - SDD Timestamps
  3) Restart Initiated if Required
  4) Otherwise, Cluster Continues Comparing Timestamps, Obtaining Changed Descriptors as Required
     - $CSD_1$s
     - SDDs
     - $CSD_2$s

# DOWNLINE LOADING BASIC PROCESS

- The Following Conditions Might Cause a Cluster to do a Full DLL:

  1. Cluster Power up
  2. PM does a Hardware Restart - Due to a Timer Restart, etc.
  3. The Reconciliation Function in the Cluster Finds a Change in One of its Descriptors (Software) Which Requires a Full DLL.

- The Process for a full DLL Follows:

  1. The Loading Cluster Uses Code in ROM
  2. It Establishes Communication to the NCS Server over a MIB or BBL, Which is Configured in NVRAM of its PM.
  3. It Establishes this Link in a User Access Mode.
  4. All Descriptors are Requested Top-Down and Loaded into the Requesting Clusters RAM.
  5. Clears the Call Used for the Load and Establishes its Supernet Connections after Doing a Startup Using the "New" Software and Configuration Data.
  6. Now that the Cluster is "Up" the MIB or BBL used for the Load as an Access Link can now be Used as a Regular MIB Link or BBL.

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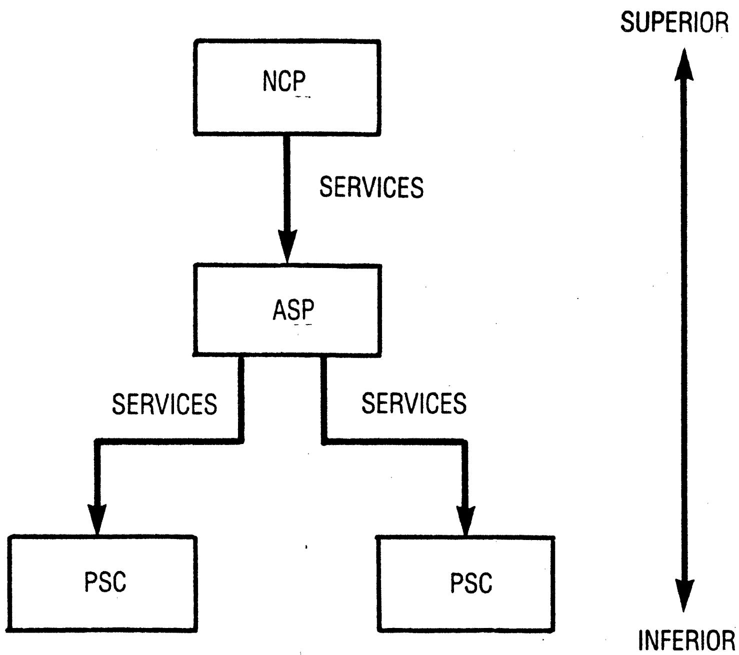
# DOWNLINE LOADING SERVICE HIERARCHY

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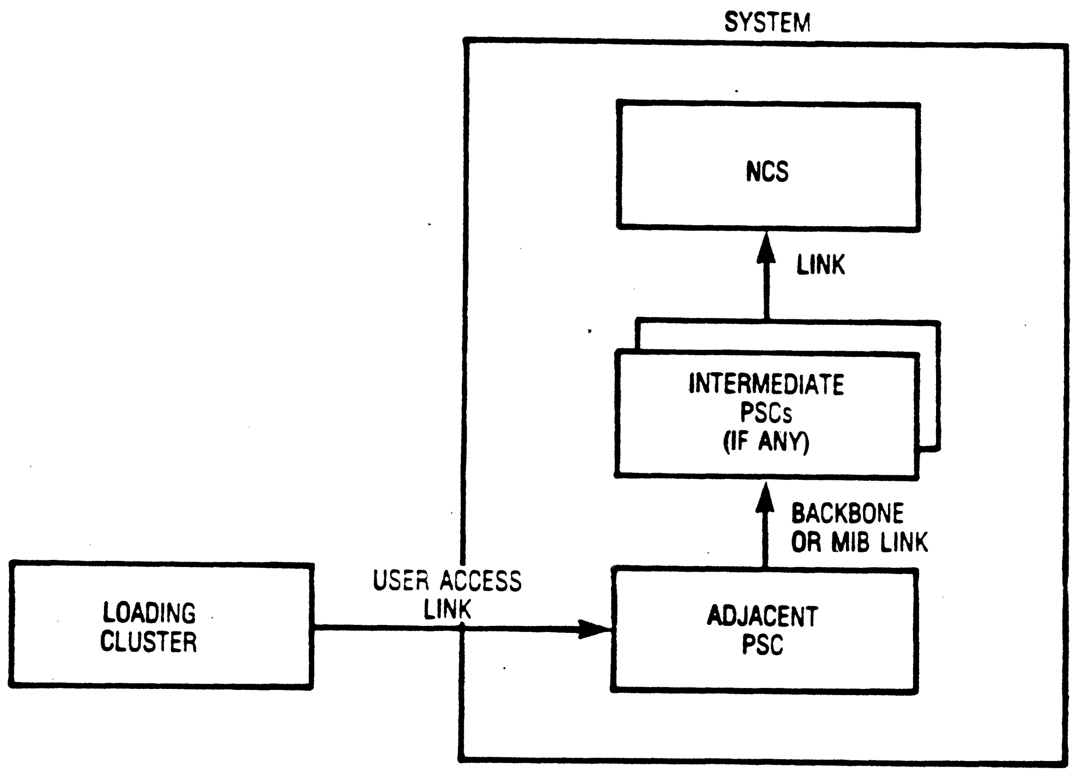
# DOWNLINE LOADING DURING A FULL DLL

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**361P235**
**01/24/86**
**10P188**

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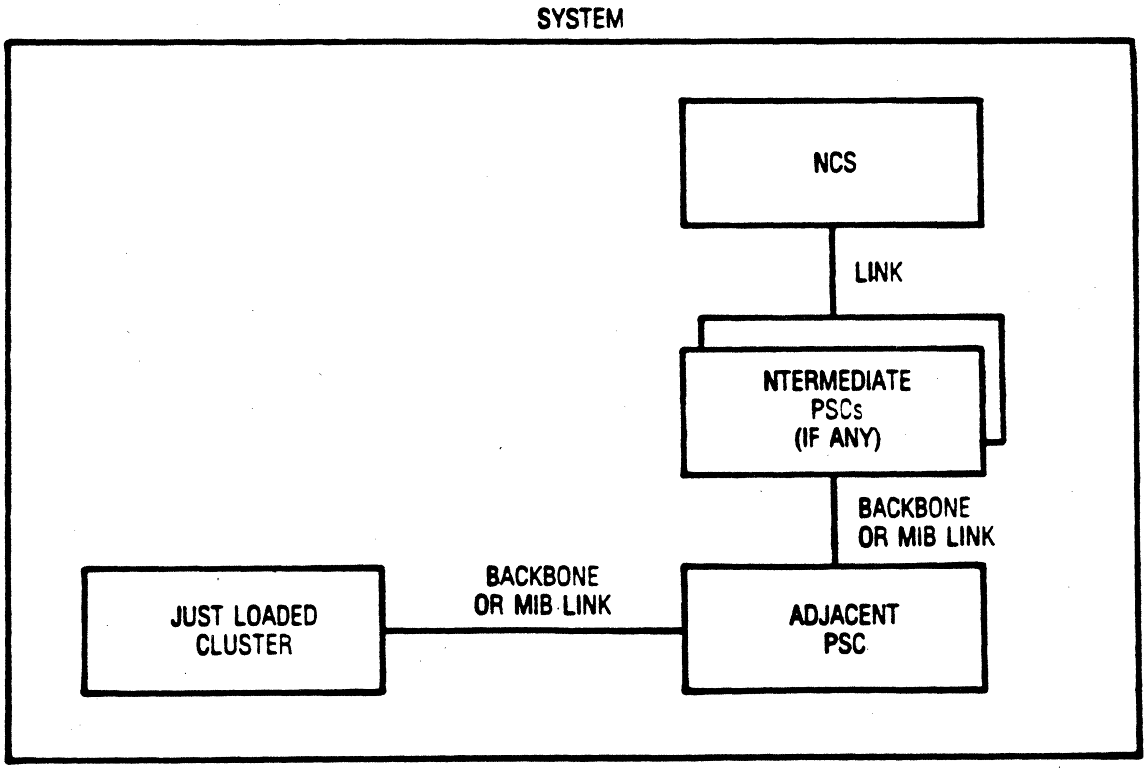
# DOWNLINE LOADING AFTER A FULL DLL

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**01/24/86**
**11P188**

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# DOWNLINE LOADING SERVER ACCESS

1. Primary Load Source - Primary Load Server
2. Primary Load Source - Secondary Load Server
3. Secondary Load Source - Primary Load Server
4. Secondary Load Source - Secondary Load Server

(Load Source is Configured in NVRAM of all PMs. Load Server is Configured at the NOC ASP and PSC Screens).

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# CONFIGURATION CONSIDERATIONS FOR DLLs

- Optimizing Network Cold Start
- Quick Reloading upon Restart
- Avoiding Isolation

# DOWNLINE LOADING OPTIMIZATION

HNS Recommends that:

- Clusters Adjacent to the NCP Should Load from the NCP
- Other Clusters Within the Adjacent Node Should Load Through the Operational Adjacent Cluster or a Local ASP Which is Loaded Through Those Clusters
- Backbone Clusters of Other Nodes Must Utilize Backbone Links to Obtain Downline Load Services
- Other Clusters of Other Nodes may Utilize the Backbone Cluster or a Local ASP Which Uses the Backbone Cluster.

# DOWNLINE LOADING PERFORMANCE

To Minimize Cluster Reload Time, the First Choice Server Should be:

- A Local ASP

- The Local Disk, in the Case of an ASP.

# DOWNLINE LOADING ISOLATION PREVENTION

To Prevent Isolation of a Node, HNS Recommends that:

- At Least One PSC in a Node must be Able to Obtain Downline Load Service from a Component Outside its Node
- For Nodes Having PSCs Directly Connected to an NCP, the NCP must be Identified as one of the Startup Choices for those PSCs.
- For Nodes not Having PSCs Connected to the NCP, One or More Backbone Clusters must be Served by NCS Components Outside that Node.

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# DLL PERFORMANCE EXAMPLE USING THE EXAMPLE NETWORK AND CASE RECOMMENDATIONS

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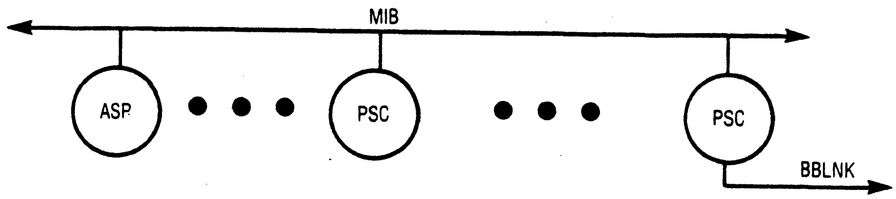
# CLUSTER DLL CASE RECOMMENDATIONS

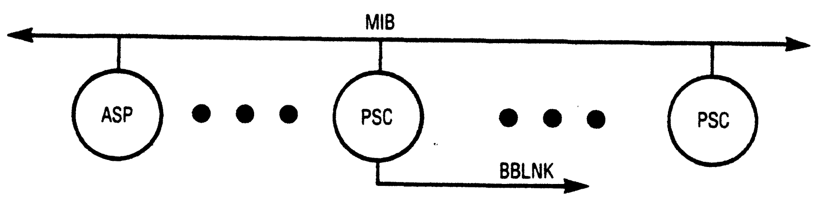
## Case 1: PSC with no BBLNK




**Primary:**
**Source – MIB to Local ASP**
**Server – ASP in Adjacent Node**

**Secondary:**
**MIB to PSC w/BBLNK**
**ASP in Another Node**

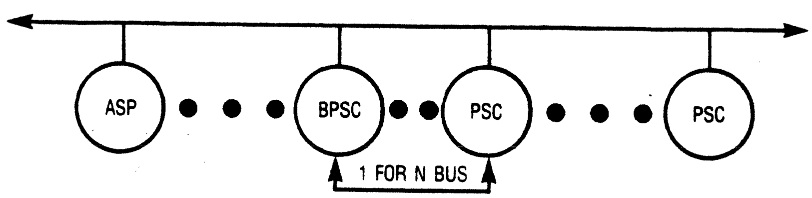
## Case 2: PSC with BBLNK




**Primary:**
**Source – MIB to Local ASP**
**Server – ASP in Adjacent Node**

**Secondary:**
**Port on LIM w/BBLNK**
**ASP in Another Node**

## Case 3: Backup PSC




**Primary:**
**Source – MIB to Local ASP**
**Server – ASP in Adjacent Node**

**Secondary:**
**MIB to PSC not in Group**
**ASP in Another Node**

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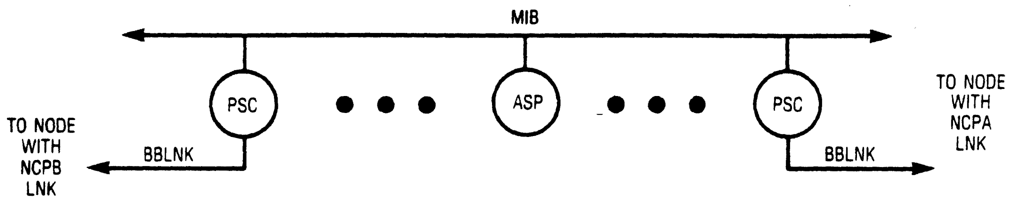
# CLUSTER DLL CASE RECOMMENDATIONS (Cont.)

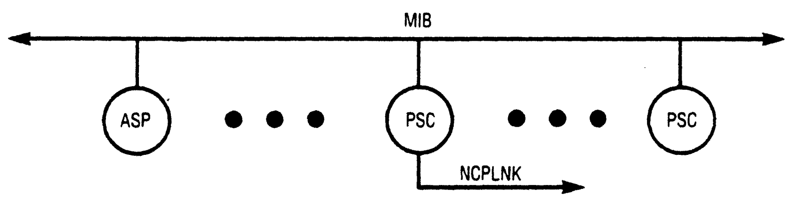
## Case 4: ASP




**Primary:**
**Source – Own Disk**
**Server – NCP "X"**

**Secondary:**
**MIB to PSC w/BBLNK**
**NCP "Y"**

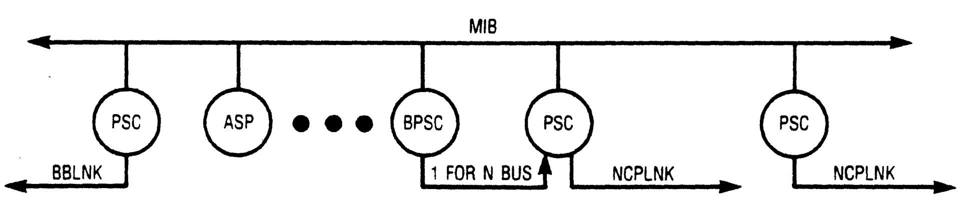
## Case 5: PSC with NCP Link




**Primary:**
**Source – MIB to Local ASP**
**Server – "Not Used"**

**Secondary:**
**Port on LIM w/NCPLNK**
**"Not Used"**

## Case 6: Backup PSC that Spares for Primary with NCP Link




**Primary:**
**Source – MIB to Local ASP**
**Server – One NCP Port Connected to this Node**

**Secondary;**
**MIB to PSC w/BBLNK**
**Other NCP Port**

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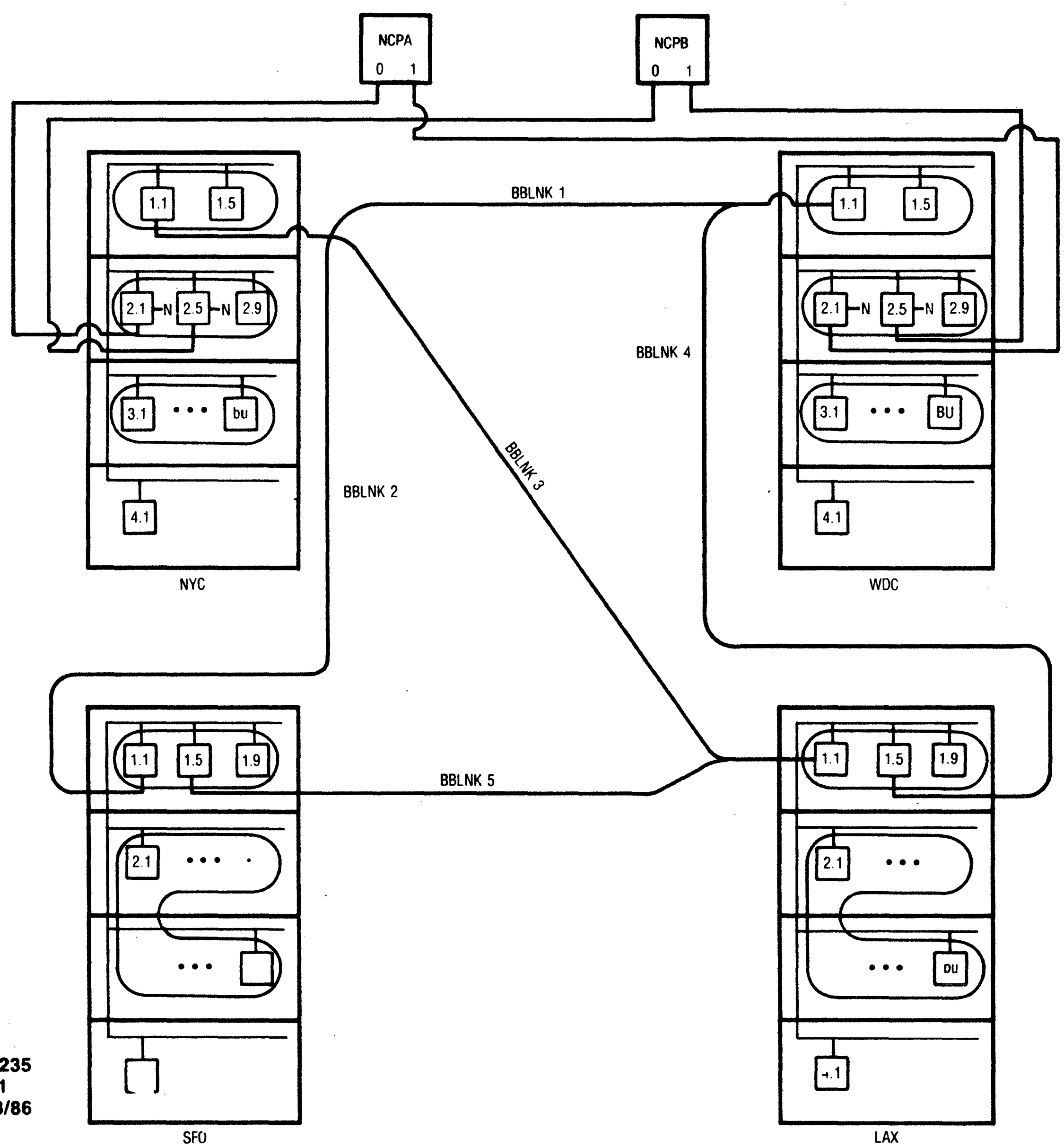
# EXAMPLE NETWORK PHYSICAL CONNECTIVITY

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# EXAMPLE NETWORK DLL AND SN ASSIGNMENTS

## New York City Node

| | PSC 1.1, 1.5, 3.1.X.Y | | NCP PSCs 2.1 & 2.5 | | Backup 2.9 | | ASP 4.1 | |
|---|---|---|---|---|---|---|---|---|
| | Primary | Secondary | Primary | Secondary | Primary | Secondary | Primary | Secondary |
| * DLL Source | MIB to ASP 4.1 | MIB to PSC 2.1 | MIB to ASP 4.1 | NCP Link on LIM | MIB to ASP 4.1 | MIB to PSC 1.1 | ASP's Own Disk | MIB to PSC 2.5 |
| * DLL Server | NCPA0 | NCPB0 | (Don't Care) | (Don't Care) | NCPA0 | NCPB0 | NCPA0 | NCPB0 |
| SN Server | ASP NYC 4.1 | ASP WDC 4.1 | ASP NYC 4.1 | NCP Link on LIM | ASP NYC 4.1 | ASP WDC 4.1 | NCPA0 | NCPB0 |

## Washington DC Node

| | PSC 1.1, 1.5, 3.1.X.Y | | NCP PSCs 2.1 & 2.5 | | Backup 2.9 | | ASP 4.1 | |
|---|---|---|---|---|---|---|---|---|
| | Primary | Secondary | Primary | Secondary | Primary | Secondary | Primary | Secondary |
| * DLL Source | MIB to ASP 4.1 | MIB to PSC 2.1 | MIB to ASP 4.1 | NCP Link on LIM | MIB to ASP 4.1 | MIB to PSC 1.1 | ASP's Own Disk | MIB to PSC 2.5 |
| * DLL Server | NCPA1 | NCPB1 | (Don't Care) | (Don't Care) | NCPA1 | NCPB1 | NCPB1 | NCPA1 |
| SN Server | ASP WDC 4.1 | ASP NYC 4.1 | ASP WDC 4.1 | NCP Link on LIM | ASP WDC 4.1 | ASP NYC 4.1 | NCPB1 | NCPA1 |

## San Francisco Node

| | Backbone 1.1 | | Backbone 1.5 | | Backup 1.9 | | PSC 2.1.X.Y | | ASP 4.1 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Primary | Secondary | Primary | Secondary | Primary | Secondary | Primary | Secondary | Primary | Secondary |
| * DLL Source | MIB to ASP 4.1 | BBLNK NYC SFO | MIB to ASP 4.1 | BBLNK SFO LAX | MIB to ASP 4.1 | MIB to Acc PSC | MIB to ASP 4.1 | MIB to PSC 1.1 | ASP's Own Disk | MIB to PSC 1.5 |
| * DLL Server | ASP NYC 4.1 | ASP WDC 4.1 | ASP LAX 4.1 | ASP NYC 4.1 | ASP NYC 4.1 | ASP LAX 4.1 | ASP NYC 4.1 | ASP LAX 4.1 | NCPA1 | NCPB1 |
| SN Server | ASP SFO 4.1 | ASP LAX 4.1 | ASP SFO 4.1 | ASP LAX 4.1 | ASP SFO 4.1 | ASP LAX 4.1 | ASP SFO 4.1 | ASP LAX 4.1 | NCPA1 | NCPB1 |

## Los Angeles Node

| | Backbone PSC 1.1 | | Backbone PSC 1.5 | | Backup PSC 1.9 | | PSC 2.1.X.Y | | ASP 4.1 | |
|---|---|---|---|---|---|---|---|---|---|---|
| * DLL Source | MIB to ASP 4.1 | BBLNK WDC LAX | MIB to ASP 4.1 | BBLNK NYC LAX | MIB to ASP 4.1 | MIB to Acc PSC | MIB to ASP 4.1 | MIB to PSC 1.1 | ASP's Own Disk | MIB to PSC 1.5 |
| * DLL Server | ASP WDC 4.1 | ASP NYC 4.1 | ASP NYC 4.1 | ASP WDC 4.1 | ASP WDC 4.1 | ASP NYC 4.1 | ASP WDC 4.1 | ASP NYC 4.1 | NCPB0 | NCPA0 |
| SN Server | ASP LAX 4.1 | ASP SFO 4.1 | ASP LAX 4.1 | ASP SFO 4.1 | ASP LAX 4.1 | ASP SFO 4.1 | ASP LAX 4.1 | ASP SFO 4.1 | NCPB0 | NCPA0 |

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# EXAMPLE NETWORK DLL PERFORMANCE UPON COLD START

| TIME | NYC | WDC | SFO | LAX |
|---|---|---|---|---|
| T0 | POWER UP | POWER UP | POWER UP | POWER UP |
| T1 | PSC 2.1 & 2.5 FAILS TO LOAD FROM ASP & LOADS FROM NCPLNK A0 & B0 | PSC 2.1 & 2.5 FAILS TO LOAD FROM ASP & LOADS FROM NCPLNK A1 & B1 | ALL CLUSTERS FAIL TO LOAD | ALL CLUSTERS FAIL TO LOAD |
| T2 | PSC 1.1, & 1.5 NOW LOAD THROUGH PSC 2.5 FROM NCPLNK B0 ALSO ASP 4.1 NOW LOADS FROM PSC 2.5 FROM NCP B0 | PSC 1.1 & 1.5 NOW LOAD THROUGH PSC 2.5 FROM NCPLNK B1 ALSO ASP 4.1 NOW LOADS FROM PSC 2.5 FROM NCPLNK B1 | ALL CLUSTERS FAIL TO LOAD | ALL CLUSTERS FAIL TO LOAD |
| T3 | REMAINING PSCs WOULD PROBABLY LOAD FROM THE ASP 4.1 FROM NCPA0 (PSC 3.1-X.4 & THEIR BACKUPS) | REMAINING PSCs WOULD PROBABLY LOAD FROM THE ASP 4.1 FROM NCPB0 (PSC 3.1-X.4 & THEIR BACKUPS) | PSC 1.1 LOADS FROM WDCASP OVER BBL 2 & PSC 1.5 LOADS FROM NYCASP OVER BBL 5<br>ALSO SFOASP LOADS THROUGH 1.5 FROM NCPA1 | PSC 1.1 LOADS FROM WDCASP OVER BBL 4 & PSC 1.5 LOADS FROM NYCASP OVER BBL3<br>ALSO LAXASP LOADS THROUGH 1.5 FROM NCPB |
| T4 | NODE OPERATIONAL | NODE OPERATIONAL | REMAINING PSCs LOAD LOCALLY OR REMOTE | REMAINING PSCs LOAD LOCALLY OR REMOTE |

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# UPLINE DUMP
# 4.3

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# UPLINE DUMP
# GENERAL

The Upline Dump Feature Allows an Operator to "Snatch" portions of a Packet Switching Cluster's Memory. It Transfers (RAM and ROM) Image Information from a PSC to the NCS Which Helps an Operator Diagnose Software Failures that Lead to PSC Resets. When Enabled, Upline Dumps take Place just Before a Full Downline Load and use the Same Virtual Circuit that is Established for the Downline Load. The Upline Dump Function Stores the Data that has been Transmitted at the NCP so that the Operator can View the Memory Contents.

# UPLINE DUMP
# THE PROCESS

- This Process is Typically Used after an Operator has Determined that a Particular Module/Cluster is not Operating Properly.
- NOC Operators Enable the Upline Dump Function via the Mod Trigger Screen on a per Module by Cluster Basis.
- "Setting Up" the Dump via F2 on this Screen Causes an Upline Dump Description Block to be Stored in the Module's RAM.
- The Description Block Informs the Module to do a Upline Dump from Specified Memory Locations Just Prior to a Nonpower Cluster Restart.
- After the Dump, the Cluster Clears the Description Block from RAM, so that no more Dumps will Occur until Commanded by the NOC.

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# UPLINE DUMP
# MOD TRIGGER SCREEN

```
M/A-COM          Network Operator Console   || NOC Software Versn :MED 7/17 5pm
                                            || Operator Name/Type :NOC4____/_0
                 CLUS 1  CLUS 2  CLUS 3  Working || NCP Name/Mode :NCPA____/MASTER
  4:38:27 PM     CLUS 4  CLUS 5  CLUS 6  Message || Online Config :R61START
Fri Jul 26, 1985 CLUS 7  CLUS 8  CLUS 9  Log On  || Connctd Config/Acces:JEFHDB__/CHANGE

-MOD TRIGR-        Quick Access - __________       Module Memory Dump Triggers

    Node Name    : ________  Module Num : _
    Cluster Num  : __.__ _

                          UPLINE DUMP TRIGGER
    On restart, dump memory from  Segment:Offset  address - ____:____
                              to  Segment:Offset  address - ____:____

                          RAM ADDRESS TRIGGER
    On executing  RAM code,   at  Segment:Offset  address - ____:____
    Dump 32 bytes of memory from  Segment:Offset  address - ____:____

[Read Both] [Set UpDmp] [Set RamAd]  [Clear Both] [ ] [ ] [ ]  [ ] [Quick Acc] [TOGGL PREV]
```

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# ADDRESSING & ACCESS RESTRICTIONS
# 4.4

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# ADDRESSING & ACCESS RESTRICTIONS
# X.121 ADDRESSING

- **The IPN Uses an Addressing Structure that is Completely Compatible with the CCITT Recommendation X.121 Format.**

- **Addresses are Structured in One of Two Formats:**

  DNIC - NPA - NXX - YYZZ
  DCC - N- NPA - NXX - YYZZ

  Where:

  DNIC = Four Digit Data Network Identification Number
  DCC = Three Digit Data Country Code
  N = Network Identifier
  NTN = NPA + NXX + YY + ZZ
  NTN = Network Terminal Number
  NPA = Area Code
  NXX = Local Exchange
  YY = Extension
  ZZ = Optional Sub-address

- **Users have the Option of Using all 14 Digits in this Format, or of Using Some Even Subset of those Digits.**

# ADDRESSING & ACCESS RESTRICTIONS X.121 ADDRESS IDENTIFIERS

This Addressing Scheme Offers Extreme Flexibility. In Effect, Addressing of this Format Allows the Network to Identify:

1. X.25 Access Links to Network Subscribers. These Links are X.25 DTEs.

2. Groups of X.25 Access Links Going from a Single Cluster to a Single Network Subscriber. The Group of Links is not Itself an X.25 DTE.

3. A Foreign Network X.121 Entity. Although the Foreign Network Entity is an X.25 DTE, the Network will consider an X.75 Link or X.25 Gateway as its Endpoint.

4. An Internal Network Management DTE in each Cluster. Although not Associated with a Physical Line, the Network Management DTE is Considered to be an X.25 Packet Level DTE.

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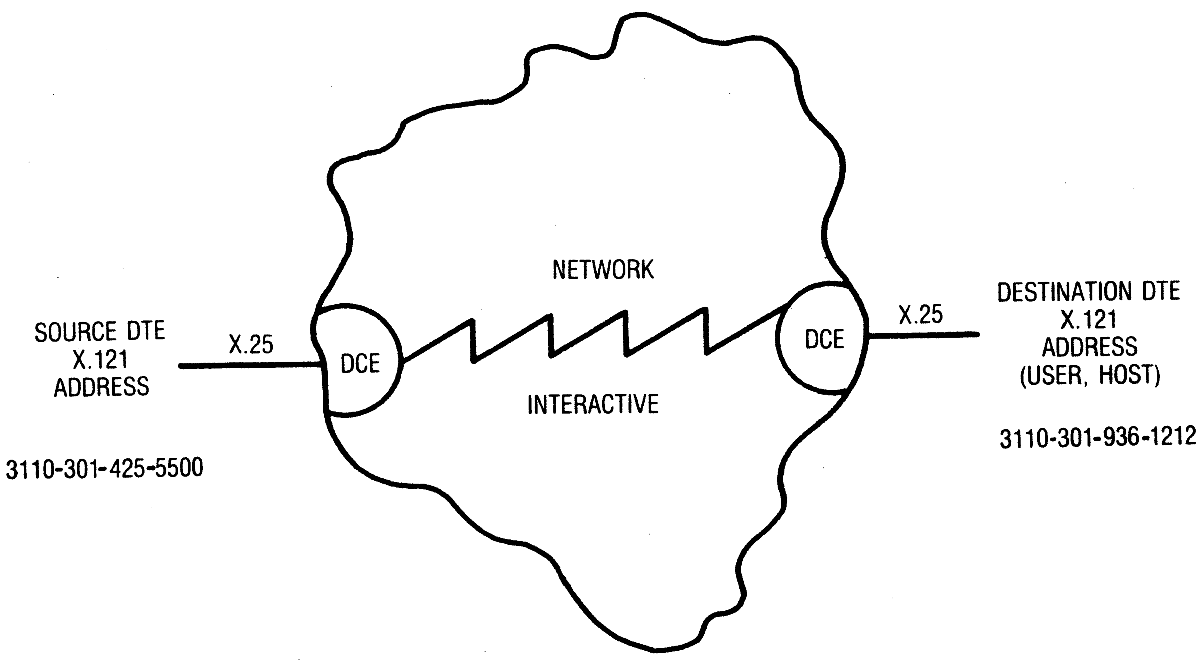
# ADDRESSING & ACCESS RESTRICTIONS ADDRESSING-X.25 ACCESS LINKS TO NETWORK SUBSCRIBERS

#1

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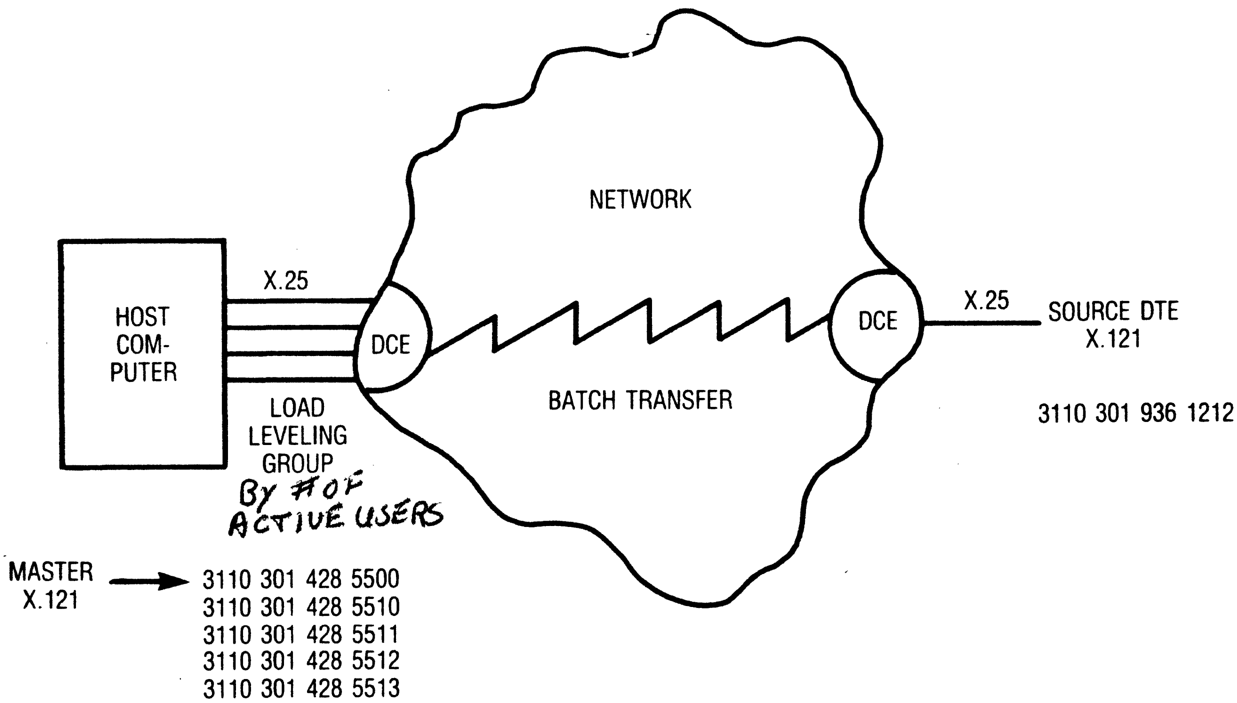
# ADDRESSING & ACCESS RESTRICTIONS ADDRESSING-GROUPS OF X.25 ACCESS LINKS

#2

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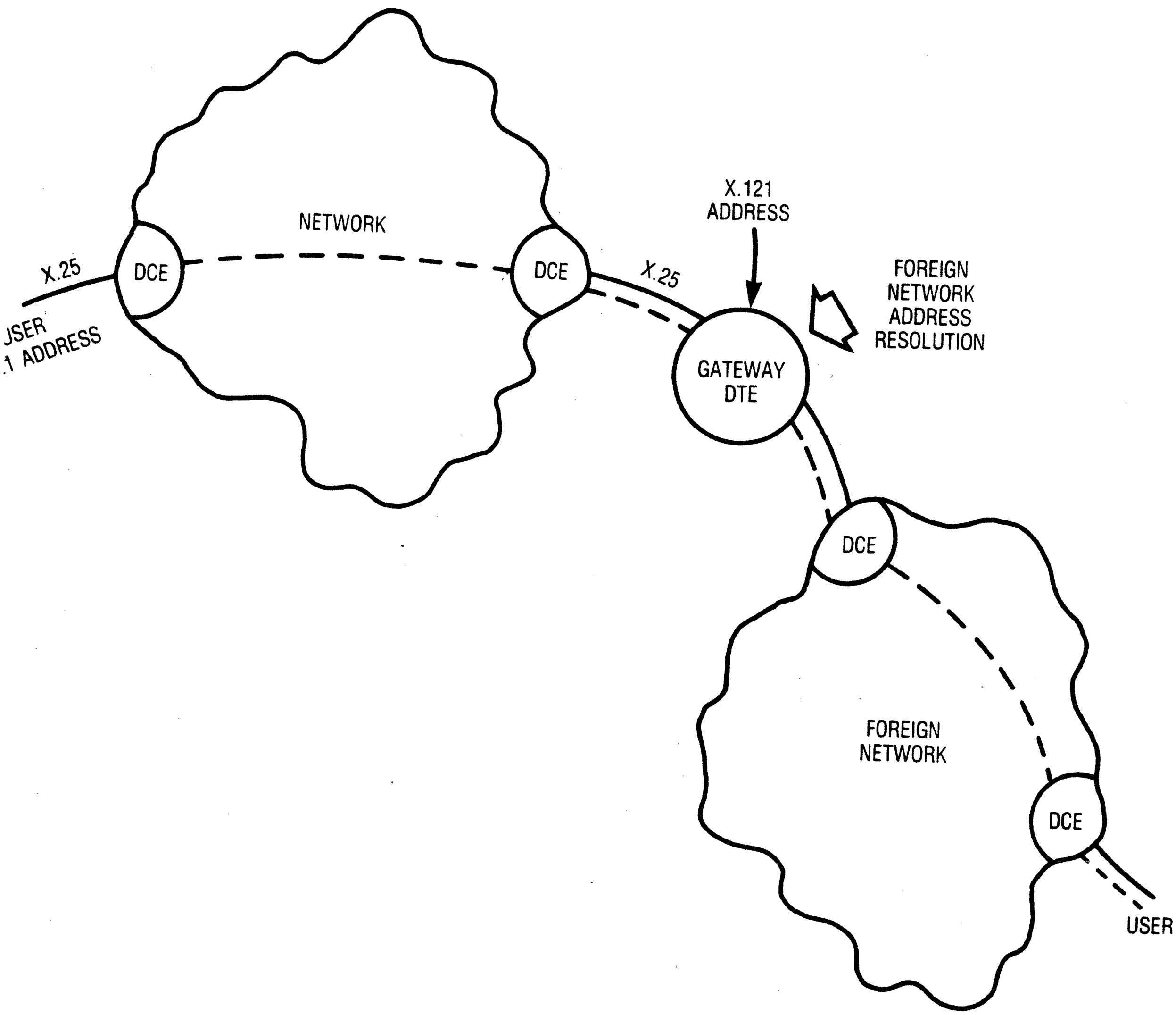
# ADDRESSING & ACCESS RESTRICTIONS ADDRESSING-FOREIGN NETWORK ENTITY

#3

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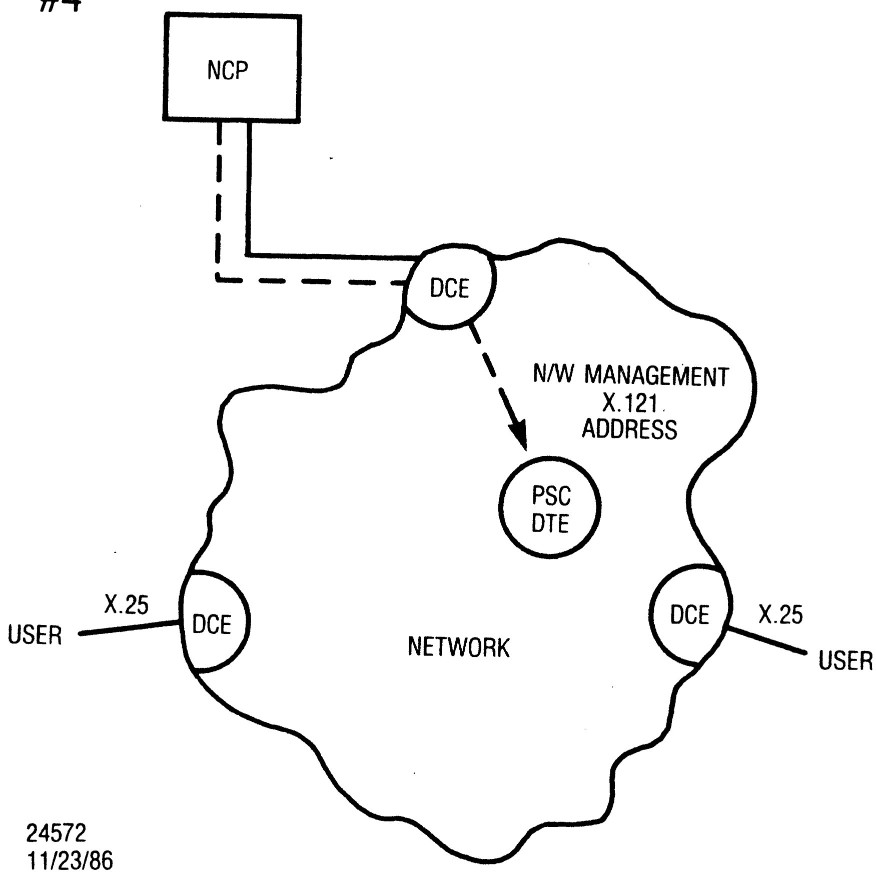
# ADDRESSING & ACCESS RESTRICTIONS ADDRESSING-NETWORK MANAGEMENT DTE

#4

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# ADDRESSING & ACCESS RESTRICTIONS ADDRESSING-X.121 TO INA CONVERSION (NCP)

- IPN Implements a Logical Addressing Scheme
- Addresses Assigned to Callable Network Entities Need have no Relationship to the Physical Location
- To Determine the Destination User's Physical Location Within the Network, the PSC and NCS Components Involved in Setting up the Call, Translate the X.121 Address to an Internal Network Address (INA)
- INA Reflects the True Physical Topology of the Network
- Users of the Network can Change their Physical Location, but Keep the Same Address
- This Feature also Allows Network Operators to Remotely Switch Network Users to Alternative hosts when, a Primary Host must be Taken Offline for some Period of Time, etc.

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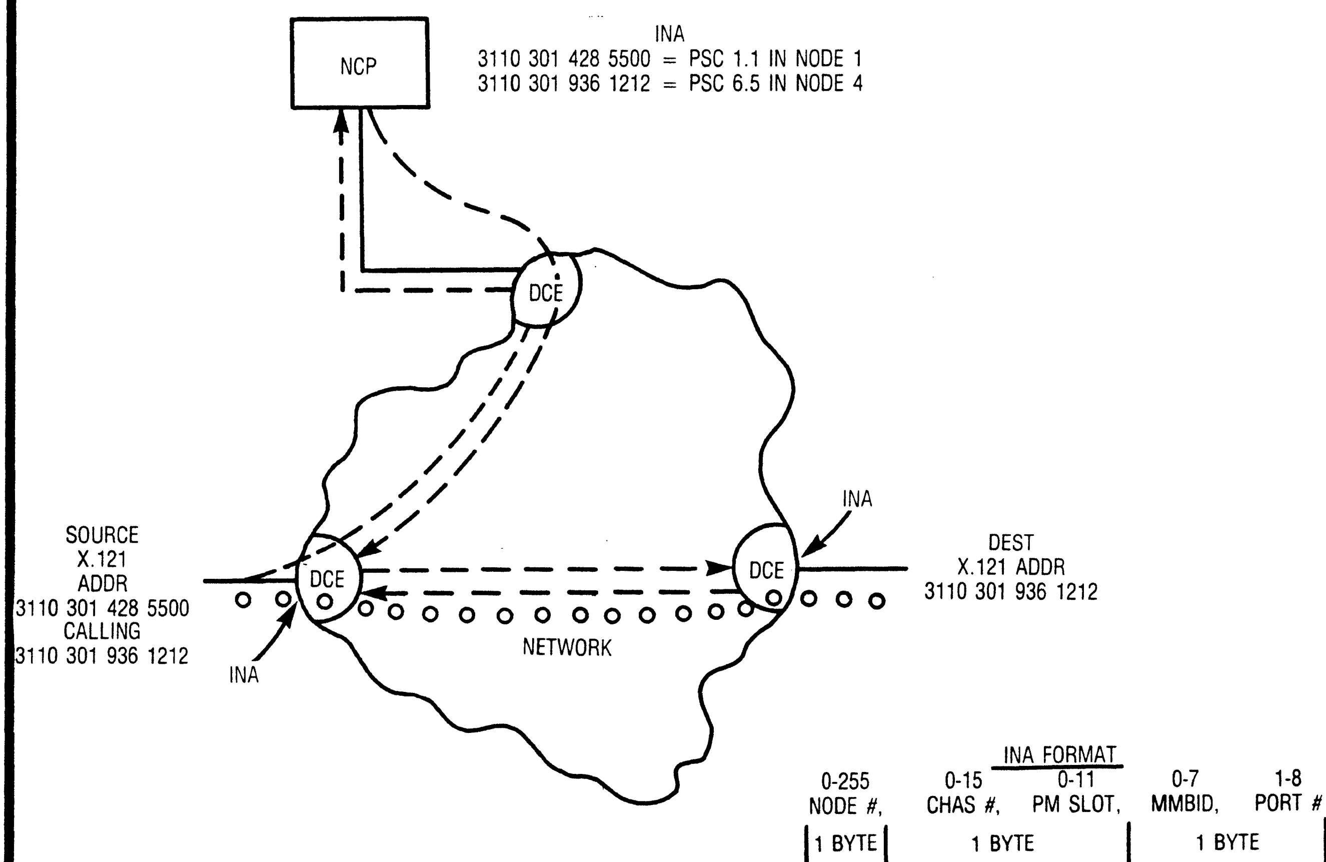
# ADDRESSING & ACCESS RESTRICTIONS ADDRESSING-X.121 TO INA CONVERSION (NCP)

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# ADDRESSING AND ACCESS RESTRICTIONS: INA FORMATS

## SINGLE PORT INA FORMAT

| BYTE \ BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | NODE NUMBER | | | | | | | | |
| 1 | 0 | SOP | XXXXXXXXXXXXXXXXXXXXXXX | | | | | | |
| 2 | CHASSIS NO. | | | | SLOT NO. | | | | CLUSTER NUMBER |
| 3 | MODULE NO. | | | PORT NUMBER | | | | | |

SOP = CALL TO SWITCHED-OUT PRIMARY PSC?
0 = NO
1 = YES

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## LOAD LEVELING GROUP INA FORMAT

| BYTE \ BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | NODE NUMBER | | | | | | | |
| 1 | 1 | 0 | XXXXXXXXXXXXXXXXXXXXXXX | | | | | |
| 2 | XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX | | | | | | | |
| 3 | LOAD LEVELING GROUP NUMBER | | | | | | | |

X = NOT USED

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# ADDRESSING & ACCESS RESTRICTIONS
# ACCESS RESTRICTIONS-GENERAL

- For Security of Address, Access Restrictions are Employed Under Centralized Control.

- Access Restrictions are Network Features that Allow the Network to Accept or Reject Individual Source User Call Requests Based on Configurable Attributes of the Calling and Called Entities Specified for that Call.

- The Network Implements FIVE Forms of Access Restrictions:

  1) Calling Address Restriction. Call Requests are Rejected at the Source PSC if the Calling Address Specified in the Call Request Packet does not Meet Certain Specifications Configured for the Source Port.

  2) ~~Calling~~/Called Address Restriction. Call Requests are Rejected if the Calling Address Does Not Meet Certain Specifications Configured for the Called Entity.

  3) Local Charge Prevention

  4) Reverse Charge Restriction

  5) Time Access Controls

# ADDRESSING & ACCESS RESTRICTIONS ACCESS RESTRICTIONS-ACCESS SPECIFIERS

- Access Restrictions are Based on the Use of Access Specifications Which may be Configured with User Access Links and Callable Entities to Describe Classes of Calling Addresses to be Accepted or Rejected.

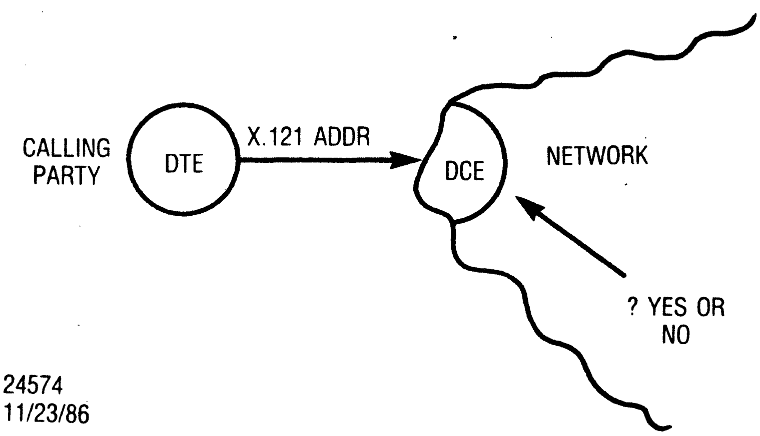
- Access Specification Consists of a Set of 0 to 16 Access Specifiers and is a Description of One Particular Subset of all of the Possible Calling Addresses Which Might Appear in the Calling Address Field of a Call Request Packet.

- Access Specifier Consists of a Digit (0-9) or "Wild Card" for each of the Address' 14-Digit Positions and an "Accept" or "Reject" Indication.

- Calling Address Matches and an Access Specifier if each Digit in the Calling Address Matches the Corresponding Digit in the Specifier or if the Corresponding Specifier Digit is an "*".

# ADDRESSING & ACCESS RESTRICTIONS CALLING ADDRESS RESTRICTION

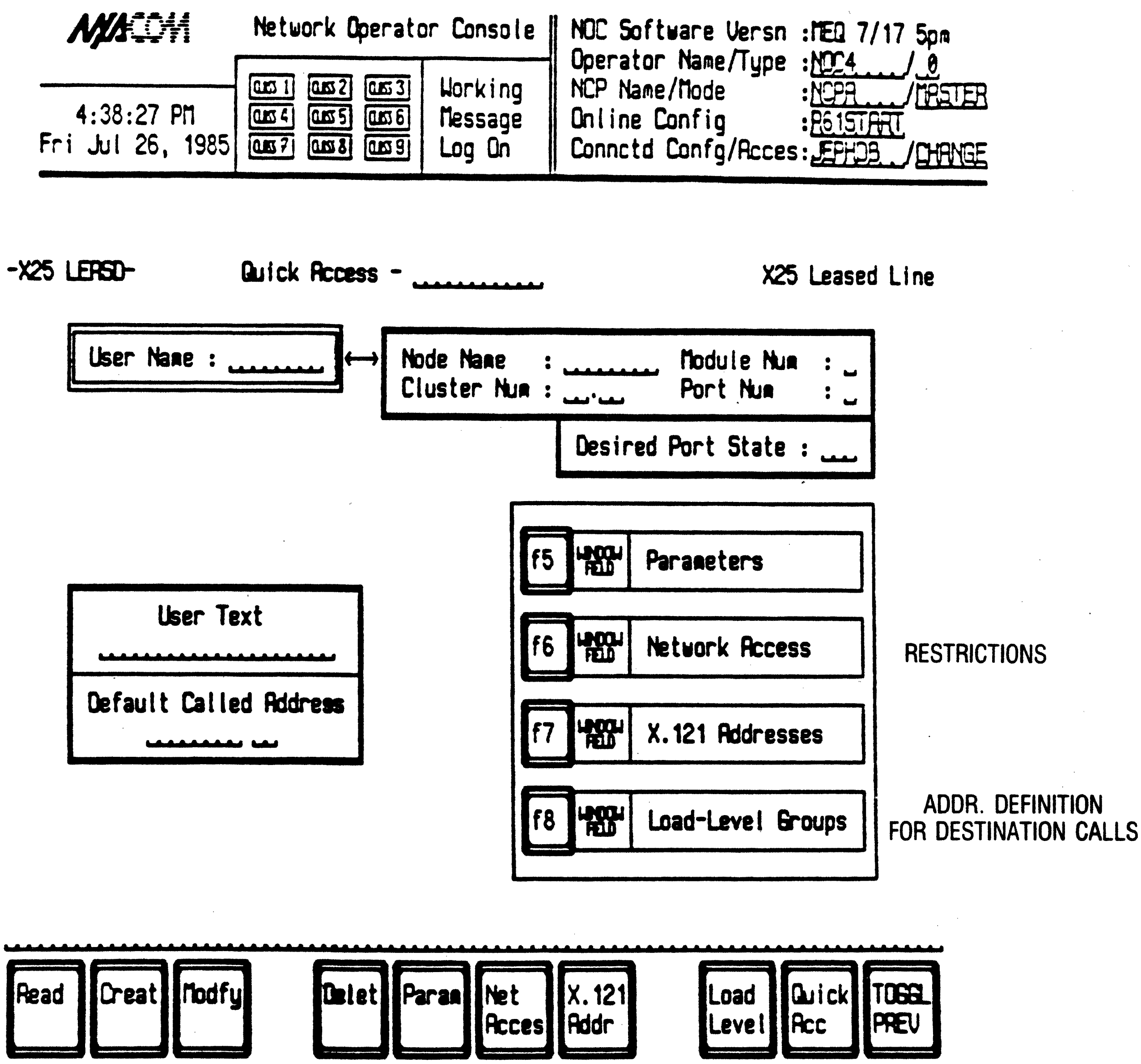
- **The Basic Calling Restriction Check is: "Is this Particular X.121 Calling/Source Address Allowed to Place a Call into the Network Through this Port?"**




- **The Calling Address must be Defined for this Port and it must not be Rejected by an Access Reject Specifier.**

**More detail follows .....**

# ADDRESSING & ACCESS RESTRICTIONS X.25 LEASED LINE SCREEN & SOURCE RESTRICTION WINDOWS

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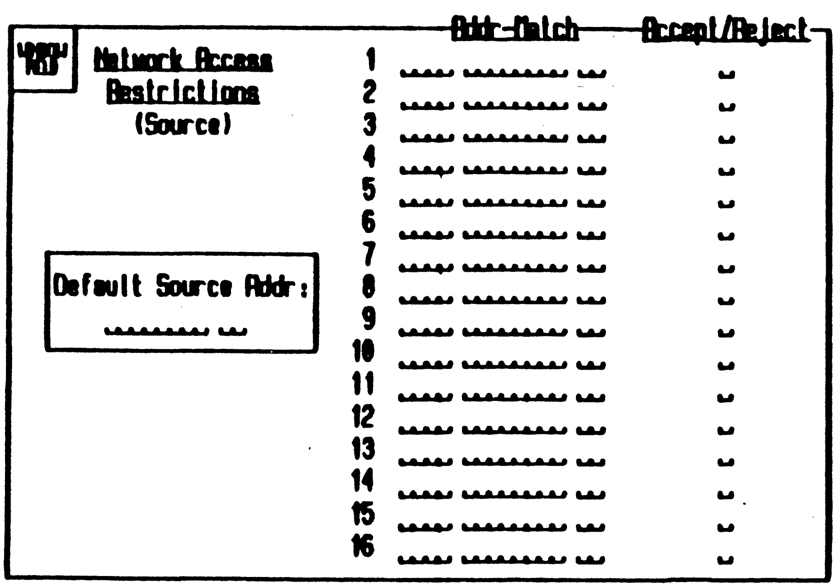
# ADDRESSING & ACCESS RESTRICTIONS
# CALL ADDRESS RESTRICTIONS

## X.25 Leased Line Network Access Window

**This Window is Used to Define Source Restrictions Placed on Calls Made into the Network Through this Access Port. The Window Contains Fields for Defining a Default Calling Address as well as an Area for Defining a List Address Specifiers. This List of Address Specifiers is Compared Against the Calling Address in an Incoming Call Request to Determine if the Call Should be Accepted.**

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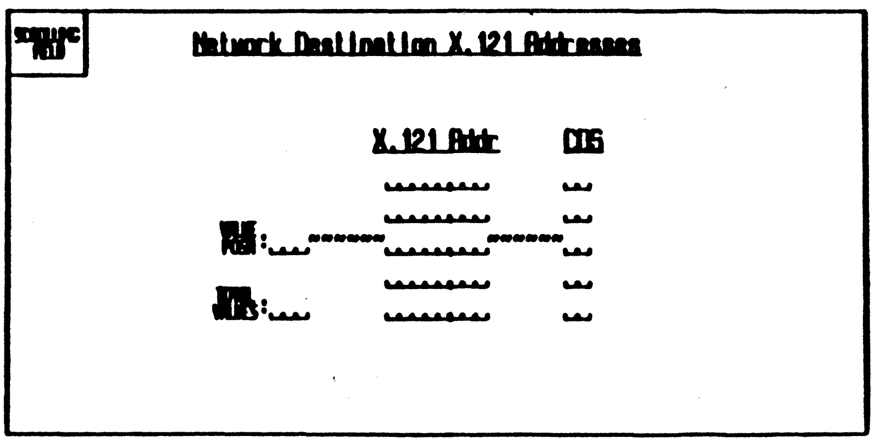
# ADDRESSING & ACCESS RESTRICTIONS
# CALL ADDRESS RESTRICTIONS

## X.25 Leased Line, X.121 Address Window

**This Scrolling Window defines the X.121 Addresses (Callable) Associated with a Network user.**

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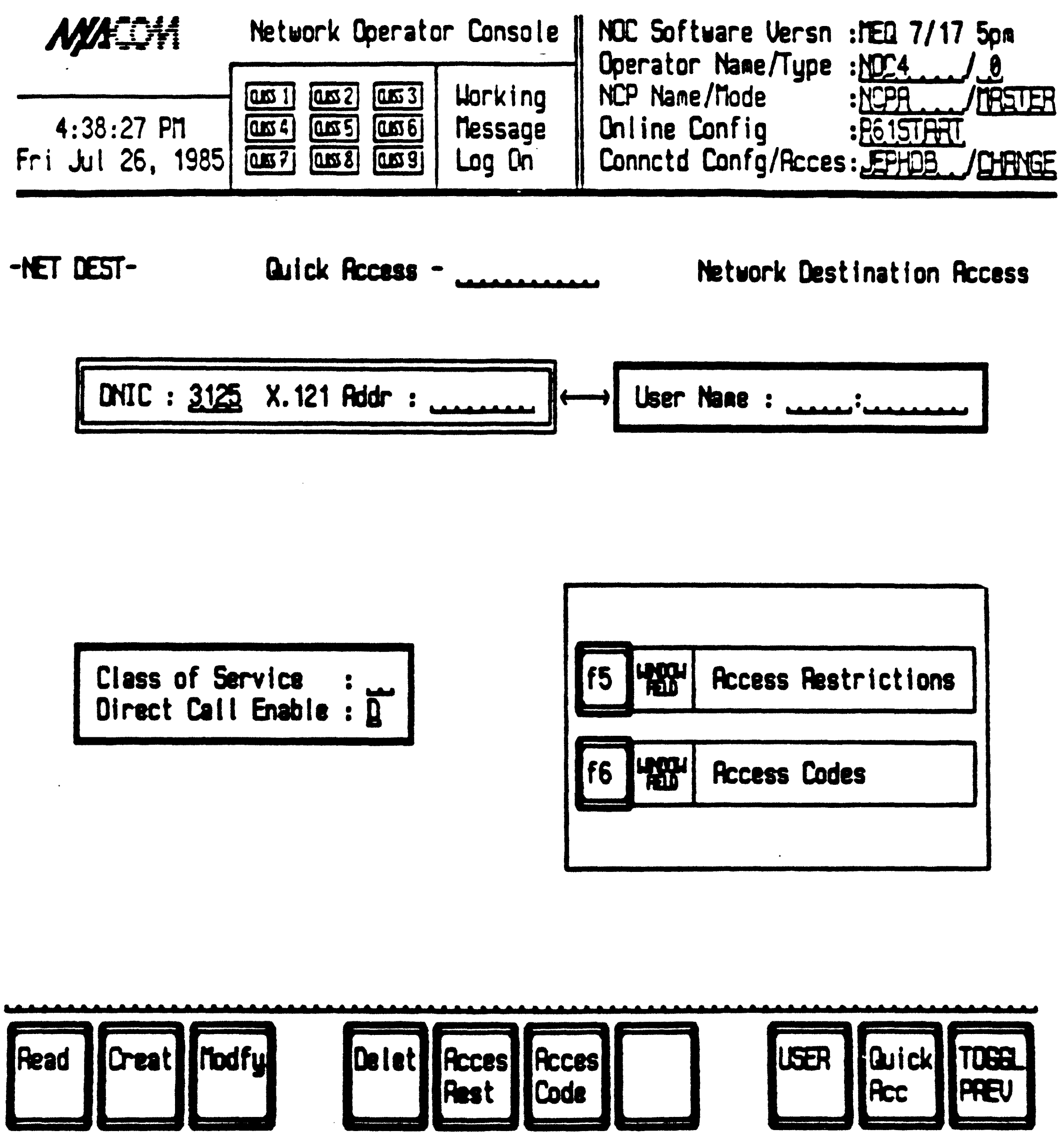
# ADDRESSING AND ACCESS RESTRICTIONS NET DEST SCREEN - CALLED ADDRESS RESTRICTIONS

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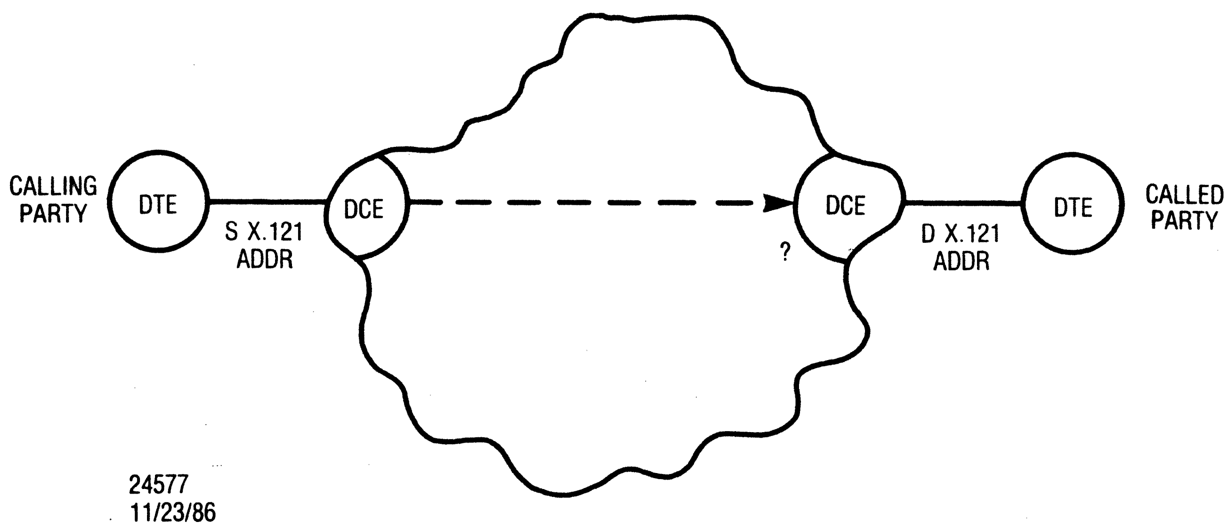
# ADDRESSING AND ACCESS RESTRICTIONS
# CALLED ADDRESS RESTRICTIONS

- The Basic Called Restriction Check is: "Is this Particular Source X.121 Address Allowed to Call this Destination X.121 Address?"




- The Called Address Must be one of the Allowed Destination Addresses for that Source Address

# ADDRESSING & ACCESS RESTRICTIONS CALLED ADDRESS RESTRICTIONS

Destination Access Restrictions Window. This Window is Used to Define Restrictions on who may Call this Destination X.121 Address. This List of Address Specifiers is Compared Against the Calling Address in an Incoming Call Request to Determine if the Call Should be Accepted.

SCROLLING FIELD

Destination Access Restrictions

| | Address Match | Expiration | Start Time | Stop Time | Start Day | Stop Day | Rev Chg | Acc/Rej |
|---|---|---|---|---|---|---|---|---|
| | DNIC/Addr/SubAddr | DD/MMM/YYYY | HH/MM | HH/MM | DDD | DDD | /Y | A/R |
| | | __-___-____ | __:__ | __:__ | | | | |
| | | __-___-____ | __:__ | __:__ | | | | |
| VALUE POSN: | | __-___-____ | __:__ | __:__ | | | | |
| TOTAL VALUES: | | __-___-____ | __:__ | __:__ | | | | |
| | | __-___-____ | __:__ | __:__ | | | | |

# ADDRESSING & ACCESS RESTRICTIONS
## ACCESS RESTRICTIONS - REVIEW

- X.121 Addresses are Assigned on a per Port Basis via the NET USER Screens  ex. X.25 Leased Line,  X.121 Address Window

- Source Port Restrictions are Assigned on a per Port Basis via the NET USER Screens Also ex. X.25 Leased Line, Network Access Window

- Allowable Calls to the DTE Through the Port are Defined Under NET DEST,  Access Restrictions Window on a per Source Address Basis.

# 4.5 X.25 GATEWAY

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# X.25 GATEWAY FUNCTIONS

- Physical Interface
- Address Correlation
- Address Format Adjustment
- Call Record Correlation
- Clear Cause Adjustment
  1) Set to Zero
  2) Set High Order Bit
  3) Pass
- Facility Processing (Pass/Strip)
- CUG Index Processing (Insert/Remove)

# FOREIGN NETWORK CALL PROCESSING

For call setups having two DNICs

1) Attempt X.25 Gateway Processing

↓ Failure

2) Attempt X.75 Gateway Processing

↓ Failure

3) Clear Call

# X.25 GATEWAY OUTGOING CALL PROCESSING


| CALL REQUEST | → | INCOMING CALL |
|---|---|---|
| CALLING = 3999 12345678<br>CALLED = 3110 30112345 | | CALLING = 3110 30111111<br>CALLED = 3110 30112345 |

ADDRESS CORRELATION TABLE

| 1 DTE ADDRESS | 2 GATEWAY ADDRESS | 3 LOCAL GATEWAY DESTINATION ADDRESS |
|---|---|---|
| 3999 12345678 | 3110 30111111 | 3999 |

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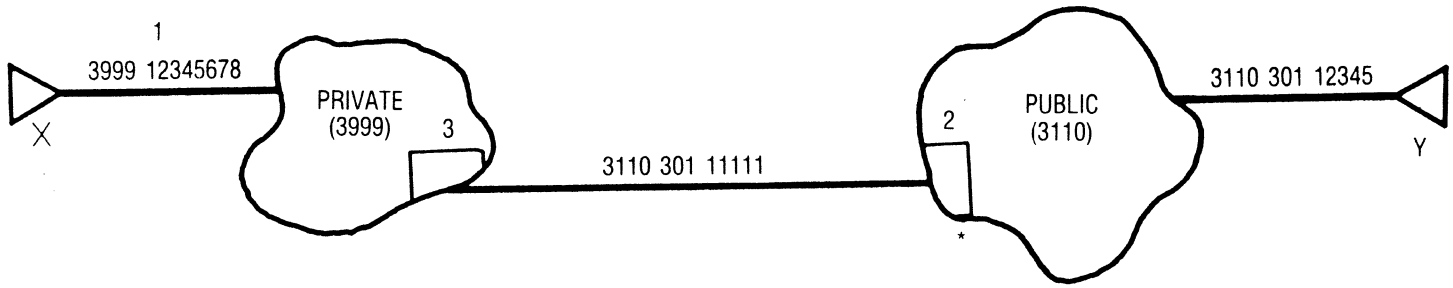
# X.25 GATEWAY OUTGOING CALL PROCESSING (SUB-ADDRESSING)




| INCOMING CALL → | CALL REQUEST |
|---|---|
| CALLING = 3999 12345678 10 | CALLING = 3110 30111111 00 |
| CALLED = 3110 30112345 01 | CALLED = 3110 30112345 01 |

ADDRESS CORRELATION TABLE

| 1 DTE ADDRESS | 2 GATEWAY ADDRESS | 3 LOCAL GATEWAY DESTINATION ADDRESS |
|---|---|---|
| 3999 12345678 10 | 3110 30111111 00 | 3999 |

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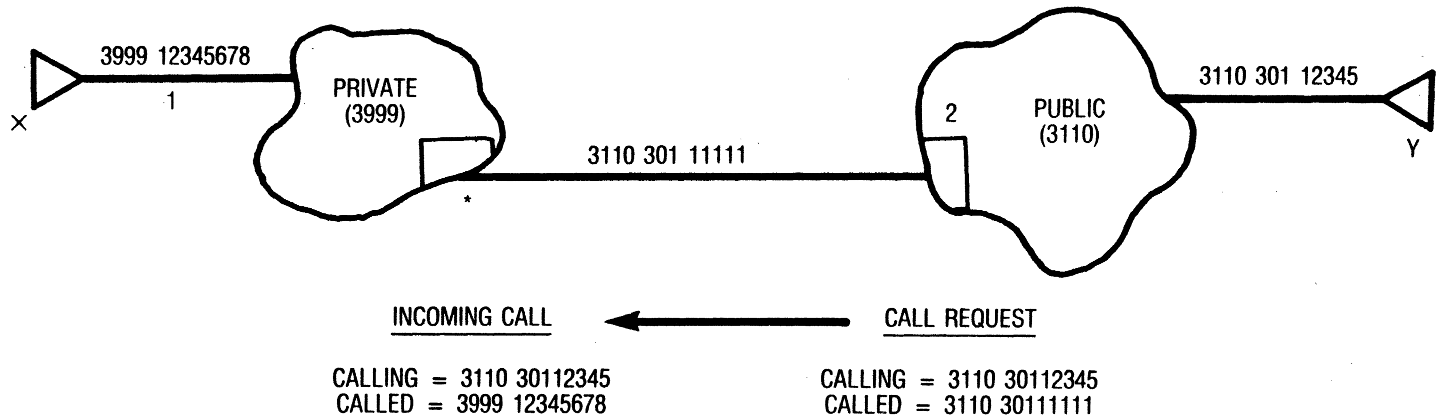
# X.25 GATEWAY INCOMING CALL PROCESSING




ADDRESS CORRELATION TABLE

| 1 DTE ADDRESS | 2 GATEWAY ADDRESS |
|---|---|
| 3999 12345678 | 3110 30111111 |

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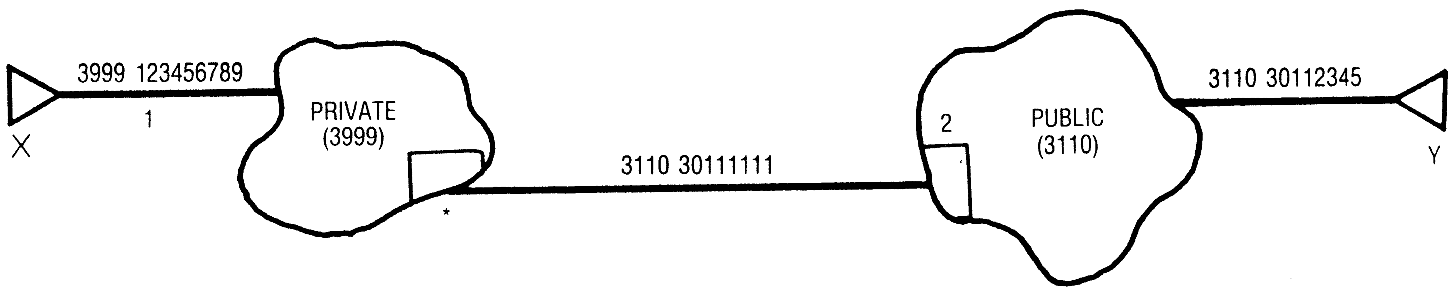
# GATEWAY INCOMING CALL (SUBADDRESSING)




INCOMING CALL ← CALL REQUEST

CALLING = 3110 30112345 01
CALLED = 3999 12345678 10

CALLING = 3110 30112345 01
CALLED = 3110 30111111 00

ADDRESS CORRELATION TABLE

| 1 DTE ADDRESS | 2 GATEWAY ADDRESS |
|---|---|
| 3999 12345678 10 | 3110 30111111 00 |

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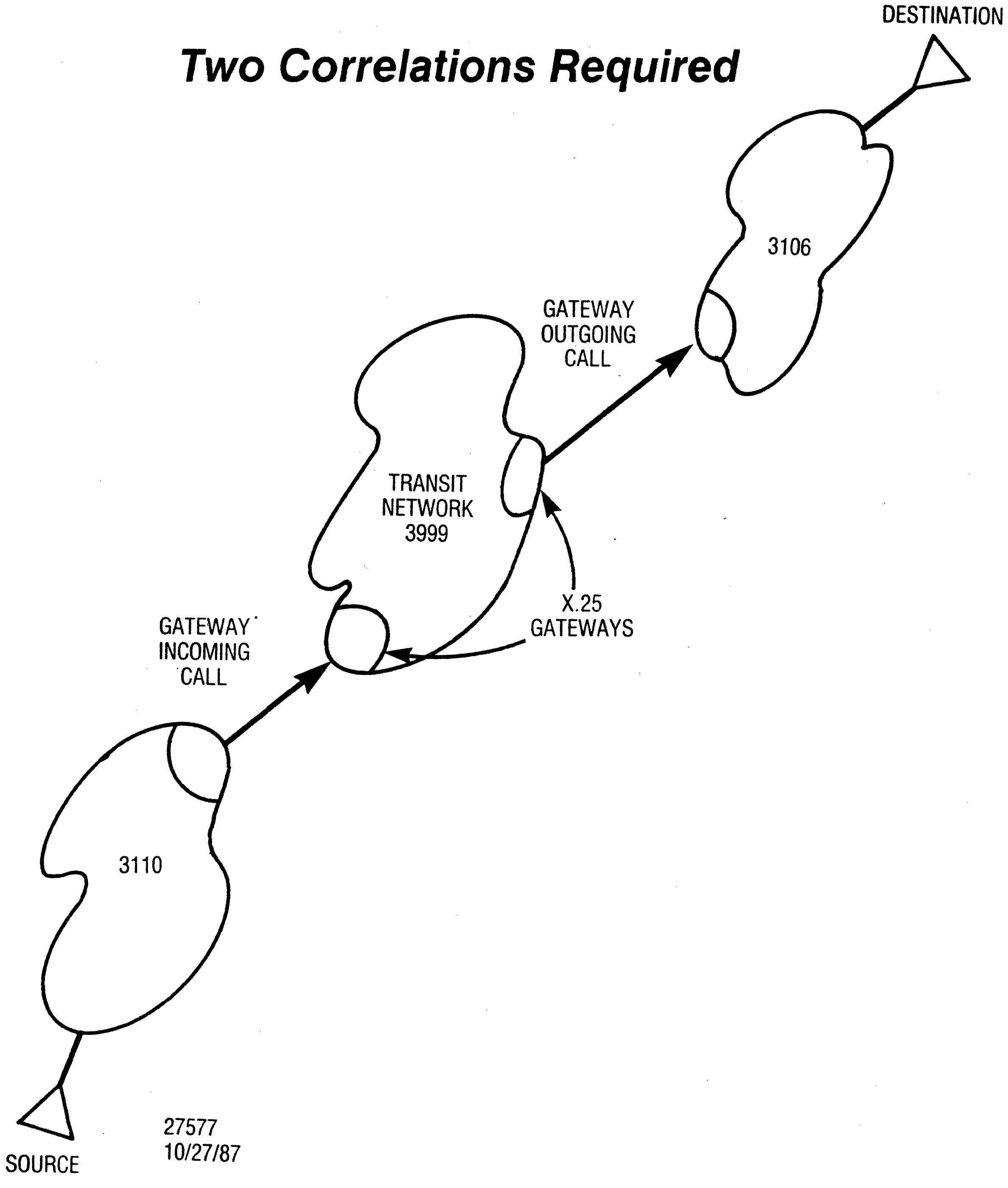
# X.25 GATEWAY TRANSIT NETWORK PROCESSING

## *Two Correlations Required*



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# STATISTICS
# 4.6

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# STATISTICS

- Collected at Several Levels:
  - Cluster
  - Module
  - Port
- Forwarded to NCS on Configured Interval
- Stored at NCP in STTLOG
- Counters:
  - Reset after Forwarding
  - Incremented to Threshold
  - Won't Rollover
- Accessed at NOC/NCP Consoles
- May be Archived to Tape
- Processed Offline

# STATISTICS
# GENERAL

Statistics can be Categorized into Three Groups; However, many NOC Screens Would have to be Visited to Obtain them. The Groups are:

- Link Statistics
- Resource Use Statistics
- Performance Statistics

# STATISTICS
# LINK

PMs Collect Statistics Concerning the use of both Access and Backbone Links. They Record for each Link:

1. General Status
   - Packet (Message) Type Counts
   - Error Counts
   - Characters Sent and Received
   - Frames Sent and Received
   - Retransmitted Frame Count
   - Timeout Counts
2. Detailed Physical-Level Port Configuration and Status
3. The Link-Level Configuration and Status
   - Current Link-Level Operational State (Normal, Maintenance)
   - Sequence Mode (Normal, Extended)
   - Link-Level Enable, Disable
   - Current Protocol State

# STATISTICS
# LINK (Cont.)

4. Packet-Level Configuration and Status

5. Link-Level Statistics on Backbone Links

   - Number of T1 Timeouts
   - Number of Transitions to Link Failure State
   - Total Number of Frames Transmitted
   - Total Number of Frames Received
   - Number of Times Link-Level Congestion Control Invoked

6. X.25 Packet-Level Statistics on Backbone Links

   a. Number of PVCs and SVCs Established
   b. Packet Counts
   c. Reconnects

# STATISTICS RESOURCE USE

PMs also Collects Statistics Concerning the Use of Cluster Resources. These Statistics are Collected to Determine the Use of:

- Memory Resources
- Processing Resources
- Timing Resources

# STATISTICS
# PERFORMANCE

Performance Statistics Collected by the NCP Include:

- Reliability of Network Components
- Throughput of Network Components
- Network Response Time

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# ASP STATISTICS

-ASP STATS- Quick Access - ________ ASP Statistics

NCS Name: ________ ⟷ Node Name : ________
Cluster Num: __.__

Last Stats Reset Hour:

| COMMAND MODULE | TRANSPORT LEVEL | MANAGEMENT DTE |
|---|---|---|
| Pkt Free Q Lo Mark | Flw Ctrls | Calls Est. |
| Pkt Free Q Hi Mark | TCs est. | |
| % CPU Utilization | TCs rel. | |
| **ASP STATS** | **APPLICATION LEVEL** | **DCE for DTE** |
| Curr. Avail. Disk | CSSRs to NCS | Tx Data Pkts |
| Max. Avail. Disk | Events to NCS | Rx Data Pkts |
| Disk Block Size | Call Recs to NCS | T12, T32, or |
| FRDs/MPDs Req. | CSSRs Lost | TB8Res T/Os |
| FRDs/MPDs Rec. | Statuses Lost | T10 or T30 T/Os |
| PSC DLL Req. Rec. | Statistics Lost | T11 or T31 T/Os |
| PSC ULD Req. Rec. | Events Lost | T13 or T33 T/Os |
| PAD DLL Req. Rec. | Call Recs Lost | DTE Orig. Resets |
| | | Reset Pkts Total |

| Read | | Montr | MIB Stats | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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# MIB STATISTICS DISPLAY

```
                         MIB Statistics Display
WINDOW
FIELD      DRIVER                                         LINK LEVEL
         CRC Errs          :                       Tx                  Rx
Frame Align Errs :                 Frames :
No Resources           :                 REJs    :
DMA Overruns           :                 FRMRs  :
DCD Sense Errs        :                 T1 Timeouts       :
CTS Errs                   :                 Link Failures     :
Collision Errs          :                 Local Flow Cntl :
DMA Underrun          :                                   PACKET LEVEL
Short Frames           :        Tx Data Pkts :                 Tx Choke Pkts
No EOF Errs            :        Rx Data Pkts :                 Tx Speed-Up Pkts
Tx Deferrals           :                 T12 Timeouts :
Collisions               :                 T10 Timeouts :
SQE Tests                :                 T11 Timeouts :
Tx Frames                :                 T13 Timeouts :
Rx Frames                :
```

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# FORMATTED PORT STATISTICS

-FORM STATS- Quick Access - ______ Formatted Port Statistics

Node Name : ______ Module Num : _
Cluster Num : __.__ Port Num : _

Last Stats Reset Hour:

| PHYSICAL LEVEL | LINK LEVEL | | | PACKET LEVEL |
|---|---|---|---|---|
| | | Tx | Rx | Tx Data Pkts |
| | | | | Rx Data Pkts |
| Tx Underruns | Frames | | | T12, T32, or |
| Rx Overruns | REJs | | | TBBRes T/Os |
| FCS Errors | FRMRs | | | T10 or T30 T/Os |
| Rec. Disabled | SABMs | | | T11 or T31 T/Os |
| Carrier Lost | | | | T13 or T33 T/Os |
| Carrier Timeout | | | | DTE Orig Reset Pkts |
| Tx Aborts | T1 Timeouts | | | Tx Reset Pkts Total |
| Rx Aborts | Link Failures | | | Tx Choke Pkts |
| | Local Flow Cntl | | | Tx Speed-Up Pkts |

| Read | | Montr | | | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|---|

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# CALL RECORDS 4.5

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# CALL RECORDS

- Describe each Network Call in Detail
- Used for Subscriber Billing
- Created by Source Cluster
- Forwarded to NCS:
  - At Call Setup
  - At Call Clear
  - At Configured Intervals During Call
- Duplicated over Supernet
- Stored at NCP in CRELOG
- Accessed at NOC/NCP Consoles
- May be Archived to Tape
- Processed Offline

# CALL RECORDS CREATED FOR THESE CALL TYPES

1. Calls Established in Response to Call Request Packets Received from Network Users. This does not Include Point-to-Point Calls Placed over Backbone Links as Segments of a User-to-User Call.

2. Permanent Virtual Circuits.

3. Supervisory Network Calls that are Established by PSCs or ASPs.

4. Calls Established to Perform Full Downline Loads.

5. Calls Rejected by the Network or the Destination DTEs.

# CALL RECORDS CONTENTS: TAPE FORMAT

| BYTE OFFSET | DESCRIPTION | |
|---|---|---|
| 0 | START DATE | YEAR |
| 1 | | MONTH |
| 2 | | DAY |
| 3 | START TIME | HOUR |
| 4 | | MINUTE |
| 5 | | SECOND |
| 6 | | HUNDREDTH |
| 7 | CALL TYPE | |
| 8 | SOURCE X.121 ADDRESS LENGTH | |
| 9-15 | SOURCE X.121 ADDRESS | |
| 16 | FOREIGN X.121 ADDRESS LENGTH | |
| 17-23 | FOREIGN X.121 ADDRESS | |
| 24-27 | SOURCE PORT INA | |
| 28-29 | SOURCE LCN | |

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# CALL RECORDS CONTENTS: TAPE FORMAT (Cont.)

| | |
|---|---|
| 30 | SOURCE PORT SPEED |
| 31 | SOURCE PAD PORT |
| 32 | SOURCE PAD SPEED |
| 33 | SOURCE TYPE |
| 34 | LENGTH OF LOGON FACILITY |
| 35-51 | LOGON FACILITY |
| 52 | PER-CALL FACILITIES |
| 53 | SUBSCRIPTION FACILITIES |
| 54-56 | CALL IDENTIFIER |
| 57-60 | TRANSIT NETWORK DNICs |
| 61 | COS |
| 62 | DESTINATION X.121 ADDRESS LENGTH |
| 63-69 | DESTINATION X.121 ADDRESS |
| 70 | PRIVATE/FOREIGN X.121 CALLED ADDRESS LENGTH |
| 71-77 | PRIVATE/FOREIGN X.121 CALLED ADDRESS |
| 78-81 | DESTINATION PORT INA |
| 82-83 | DESTINATION LCN |
| 84 | DESTINATION PORT SPEED |
| 85 | DESTINATION TYPE |
| 86-117 | INAs IN ROUTE (EXCLUDING SOURCE AND DESTINATION INAs) |
| 118-119 | ROUTE LENGTH |
| 120 | CLEARING CAUSE |
| 121 | DIAGNOSTIC CAUSE |

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# CALL RECORDS CONTENTS: TAPE FORMAT (Cont.)

| | | |
|---|---|---|
| 122-125 | CHARACTER COUNT IN | |
| 126-129 | CHARACTER COUNT OUT | |
| 130-133 | PACKET COUNT IN | |
| 134-137 | PACKET COUNT OUT | |
| 138-141 | SEGMENT COUNT IN | |
| 142-145 | SEGMENT COUNT OUT | |
| 146 | END DATE | YEAR |
| 147 | | MONTH |
| 148 | | DAY |
| 149 | END TIME | HOUR |
| 150 | | MINUTE |
| 151 | | SECOND |
| 152 | | HUNDREDTH |
| 153-159 | SPARE | |

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# SYSTEM ADMINISTRATION AND MANAGEMENT 5.0

5-1E4256
30-OCT-87

# SYSTEM ADMINISTRATION AND MANAGEMENT GENERAL

Network Administration and Management Functions are Provided by the NCS. Being one of the most advanced in industry today, the NCS provides these functions through a series of management modules working in tandem with a centralized database in the NCP(s). This database provides information that is valuable to network operations - status, problem areas, activity/ performance, diagnostics, etc. The distribution of these functions over multiple NCPs, ASPs and NOCs provides optimum operation efficiency in the areas of dynamic reconfiguration, network control, and problem solving.

# NCS FUNCTION ALLOCATION

| FUNCTION | NCP | ASP |
|---|---|---|
| Downline Load S/W to Network Nodes | X | X |
| Downline Load of Configuration to Network Nodes | X | X |
| Cluster Upline Dump Storage | X | X |
| Call Record Storage | X | X |
| Statistics Storage | X | X |
| Address Translation | X | X |
| Class of Service Access | X | X |
| Access Restriction Checks | X | X |
| Network Operation Interface | X | |
| System Configuration Management | X | |
| Event Storage and Management | X | |
| System Monitoring | X | |
| System Control | X | |
| System Debug (CREC, Patch) | X | |
| Report Generation | X | |

# SYSTEM ADMINISTRATION AND MANAGEMENT GENERAL

- **The NCS Components Provides the Following Administrative and Management Functions Which are Divided as**

  - System Debug Management
    1. Event Management
    2. Component Control
    3. Debug Tools

  - Configuration Management
    1. NCS Components
    2. Network Components
    3. Databases

  - Performance Monitoring
    1. NCPs
    2. ASPs
    3. PSCs
    4. Links

  - Report Management
    1. Components
    2. Users & Access
    3. Operator & Events
    4. Software

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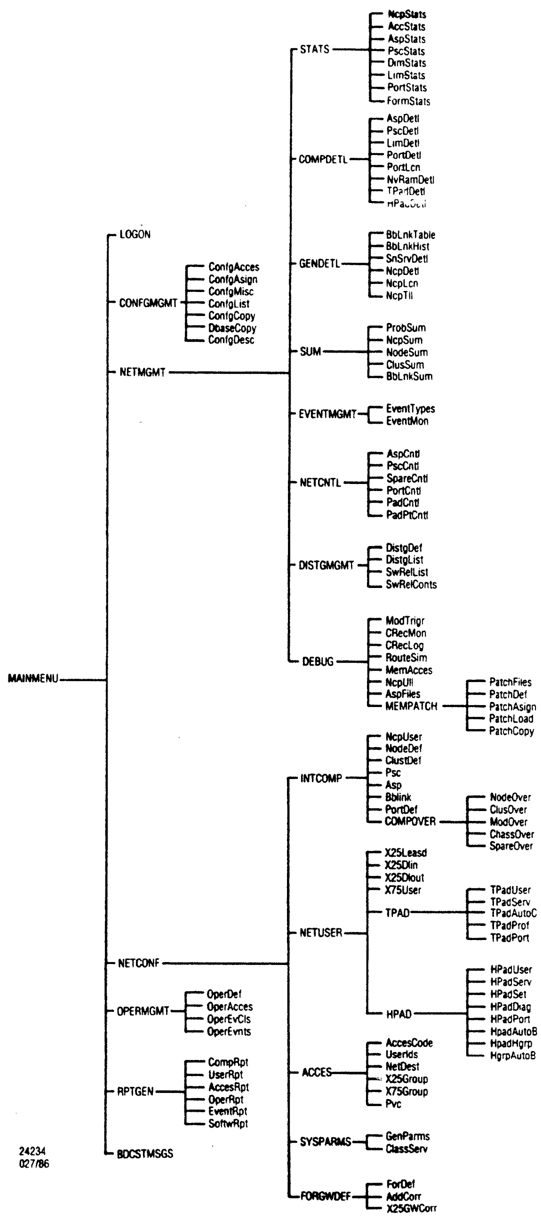
# SYSTEM ADMINISTRATION AND MANAGEMENT NOC SCREEN CATEGORIES



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# SYSTEM DEBUG MANAGEMENT 5.1

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30-OCT-87

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# EVENT MANAGEMENT
# 5.1.1

5-7E4256
30-OCT-87

# EVENTS

Events are:

- Alarm Conditions, Errors or Significant Occurrences.
- Made Known to Certain Network Operators via Flashing Indicators on the NOC Banner Line.
- Displayed, Reported (NOC Screens), and Centrally Printed (Event Printer).
- Duplicated and Recorded on the NCP(s) Disk and can be Archived to Tape.

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# EVENTS SAMPLE HARDCOPY

| TIME | SEQ # | SEVERITY | OUTSTANDING | SOURCE | CLUSTER # | EVENT TYPE | DESCRIPTION | OBJECT | CLUSTER # | MODULE/ PORT # | SUPPORTING DATA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 17:02:43 | 26 | 6 | * | NCP :NCPA | | 850 | Cluster Not Reporting Summary Status | CLSTR:CAC3 | 2 1 | | |
| 17:03:01 | 4 | 4 | * | CLSTR:CAC1 | 1 1 | 1046 | Access Link Down<br>Diagnostic Code = 183. | USER :NOC1 | 1 1 | 1 2 | * |
| 17:03:01 | 5 | 4 | * | CLSTR:CAC1 | 1 1 | 1045 | Access Link Up<br>Diagnostic Code = 0. | USER :NOC1 | 1 1 | 1 2 | * |
| 17:03:19 | 27 | 6 | * | NCP :NCPA | | 851 | Cluster Reporting Summary Status NOW | CLSTR:CAC3 | 2 1 | | |
| 17:05:45 | 4 | 8 | * | ASP :CAC1 | 4 1 | 1005 | Disk Cache Reconciled | | | | |

TIME: HRS:MIN:SEC
SEQ #: IDENTIFIES EVENT AT NCP (0-255)
SEVERITY: 1-9
OUTSTANDING: * = NOT CLEARED
SOURCE: REPORTING COMPONENT

EVENT TYPE: 0-9999
DESCRIPTION: 40 CHARACTERS OF TEXT
OBJECT: COMPONENT CAUSING THE EVENT
SUPPORTING DATA: MORE TEXT * = YES
CLUSTER: CHASSIS #/PM SLOT #

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11/23/86

# EVENTS

- Events are Configured by the NOC Operator According to:

  1. Major or Minor
  2. Class
  3. Severity
  4. NOC Operator Type (Alarm Enabling)

- Event Types (0-9999) are Hard Coded at the NCP, Therefore only Class and Severity Configurable.

# EVENTS
# EVENT TYPES SCREEN

M/A-COM Network Operator Console

4:38:27 PM
Fri Jul 26, 1985

| | | | |
|---|---|---|---|
| CLASS 1 | CLASS 2 | CLASS 3 | Working |
| CLASS 4 | CLASS 5 | CLASS 6 | Message |
| CLASS 7 | CLASS 8 | CLASS 9 | Log On |

NOC Software Versn :MEQ 7/17 5pm
Operator Name/Type :NOC4 / 0
NCP Name/Mode :NCPA /MASTER
Online Config :P61START
Connctd Confg/Acces:JEPHDB /CHANGE

-EVENT TYPES- Quick Access - __________ Event Type Parameters

Event Type : ____

Class : _
Severity : _
Description : ______________________________

| Read | | Modfy | | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

24590
11/21/86
043P345
09/19/86

# EVENTS
# MAJOR EVENT ASSIGNMENTS

- Once Class and Severity are Assigned to each Event Type, then the Determination must be made as to Which Sub Group of Severity Levels are to be Considered Major.
- Any Event Considered to be Major must be Cleared by the NOC Operator Privileged to do so.
- Major Event Severity is Assigned at the Gen Parms Screen.

# EVENTS
# GEN PARMS SCREEN

| M/A-COM | Network Operator Console | NOC Software Versn | :MEQ 7/17 5pm |
| --- | --- | --- | --- |
| | | Operator Name/Type | :NOC4 / 0 |
| 4:38:27 PM | CLASS 1, CLASS 2, CLASS 3 / Working | NCP Name/Mode | :NCPA /MASTER |
| Fri Jul 26, 1985 | CLASS 4, CLASS 5, CLASS 6 / Message | Online Config | :P61START |
| | CLASS 7, CLASS 8, CLASS 9 / Log On | Connctd Config/Acces | :EPH03 /CHANGE |

-GEN PARMS- Quick Access - ________ General Shared System Parameters

**Network Parameters**

| | | |
| --- | --- | --- |
| Reconciliation Timer | _____ | (sec) |
| Initial Response Timer | ____ | (sec) |
| Subsequent Response Timer | ___ | (sec) |
| UnReconciled Timer | _____ | (sec) |
| Health Message Interval Timer | _____ | (sec) |
| Health Check Interval Timer | _____ | (sec) |
| Health Check Threshold Count | ___ | |
| Broadcast Poll Interval Timer | _____ | (sec) |
| Summary Status Timer | ____ | (sec) |
| Statistics Timer | __ | (hrs) |
| PVC Retry Timer | ___ | (sec) |
| Call Record Timer | _____ | (min) |
| CSSI TimeOut | ____ | (sec) |
| RSP Check PSC Status Timer | _____ | (sec) |
| RSP Forward PSC Status Timer | _____ | (sec) |
| Supernet Status Check Timer | _____ | (sec) |

**NCP System Parameters**

| | | |
| --- | --- | --- |
| Major Event Severity | _ | |
| Pad Polling Interval | __ | (hrs) |

| Read | | Modfy | | | | | | Quick Acc | TOGGL PREV |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

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09/19/86

# EVENTS
# NOC TYPE TO EVENT CLASS ASSIGNMENT

- On a per NOC Operator Type Basis, Event Class Notification is Assigned under the Operator Management Screens, OPER EVCLS Screen

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# EVENTS
# NOC TYPE TO EVENT
# CLASS ASSIGNMENT
# OPER EVCLS SCREEN

M/A-COM Network Operator Console

| | | | NOC Software Versn :MEQ 7/17 5pm |
|---|---|---|---|
| | CLASS 1 CLASS 2 CLASS 3 | Working | Operator Name/Type :NOC4 / 0 |
| 4:38:27 PM | CLASS 4 CLASS 5 CLASS 6 | Message | NCP Name/Mode :NCPA /MASTER |
| Fri Jul 26, 1985 | CLASS 7 CLASS 8 CLASS 9 | Log On | Online Config :P61START |
| | | | Connctd Confg/Acces:JEPHDB /CHANGE |

-OPER EVCLS- Quick Access - __________ Operator Event Class Enable

Operator Type : _

Event Classes Enabled (Y/N)

CLASS 1 : _ CLASS 2 : _ CLASS 3 : _

CLASS 4 : _ CLASS 5 : _ CLASS 6 : _

CLASS 7 : _ CLASS 8 : _ CLASS 9 : _

| Read | | Modfy | | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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# COMPONENT CONTROL
# 5.1.2

5-16E4256
30-OCT-87

# COMPONENT CONTROL GENERAL

System Control Functions are used to Recover from Detected Problems. These Functions alter the PSC or NCS Equipment Operating States, but do not alter Equipment Characteristics. The Types of System Control Functions Provided are as Follows:

- Equipment State Control
- Equipment Restart Control
- NCP Control
- Cluster Redundancy Control
- Port Loopback Control
- Call Control.

# COMPONENT CONTROL EQUIPMENT STATES

- The State of a Component Consists of its:

  1. Desired Operating State - Determined by NOC Operators.

and

  2. Current Operating State - Determined by the 'Health" of that Component.

- There are four States that NOC Operators can Control:

  1. Undefined - not in the Config DB
  2. Out of Service - not Functional
  3. In Service - Online
  4. Maintenance - Offline or Camped-on

- Camped-on is a Special State where Components can be Changed to the Maintenance State Without Disrupting calls in Progress ACCEPTS NO NEW CALLS, CONTINUES TO PROCESS ACTIVE CALLS.

# COMPONENT CONTROL EQUIPMENT RESTART

- Restarting a Cluster or Port Causes the Component to Reset and Reinitialize all Hardware and Software
- Other Clusters in the Node are not Affected unless they Rely on the Restarted Component for Data Transmission Functions
- When Restarted, all Calls are Cleared, Call Record and Statistics Stored in the Cluster are Lost
- A Full DLL is Initiated and an Upline Dump may Occur Prior to the DLL is so Enabled

# COMPONENT CONTROL
# ASP CNTL SCREEN

-ASP CNTL- Quick Access - __________ ASP Control

NCS Name : ________ ⟷ Node Name : ________ Cluster Num : __.__

f1 **Reset**
RESET the ASP

f2 **Ins**
Put the ASP into the IN SERVICE state

f3 **Mnt**
Put the ASP into the MAINTENANCE state

f4 **Out**
Put the ASP into the OUT OF SERVICE state

f7 **Dwnld Db**
Download the ADP Database to the ASP.

| Reset | Ins | Mnt | Out | | | Dwnld Db | | Quick Acc |
|---|---|---|---|---|---|---|---|---|

# COMPONENT CONTROL
# PSC CNTL SCREEN

| | | | |
|---|---|---|---|
| M/A-COM | Network Operator Console | | NOC Software Versn :MEQ 7/17 5pm |
| | CLASS 1 CLASS 2 CLASS 3 | Working | Operator Name/Type :NOC4 / 0 |
| 4:38:27 PM | CLASS 4 CLASS 5 CLASS 6 | Message | NCP Name/Mode :NCPA /MASTER |
| Fri Jul 26, 1985 | CLASS 7 CLASS 8 CLASS 9 | Log On | Online Config :A61START |
| | | | Connctd Confg/Acces:JEPHDB /CHANGE |

-PSC CNTL-　　Quick Access - ________　　PSC Control

Node Name : _______ Cluster Num : __.__ _

f1 **Reset**
RESET the PSC

f3 **Mnt**
Put the PSC into the MAINTENANCE state

f2 **Ins**
Put the PSC into the IN SERVICE state

f4 **Out**
Put the PSC into the OUT OF SERVICE state

| Reset | Ins | Mnt | Out | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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# COMPONENT CONTROL
# PORT CNTL SCREEN

M/A-COM Network Operator Console

| | | |
|---|---|---|
| CLASS 1 | CLASS 2 | CLASS 3 |
| CLASS 4 | CLASS 5 | CLASS 6 |
| CLASS 7 | CLASS 8 | CLASS 9 |

Working
Message
Log On

4:38:27 PM
Fri Jul 26, 1985

NOC Software Versn :MEQ 7/17 5pm
Operator Name/Type :NOC4 / 0
NCP Name/Mode :NCPA /MASTER
Online Config :R61START
Connctd Confg/Acces:JEPHDB /CHANGE

-PORT CNTL- Quick Access - ________ PORT Control

Node Name : _______ Cluster Num : __.__ Module Num : _ Port Num : _

f1 Reset
RESET the PORT

f2 Ins
Put the PORT into the IN SERVICE state

f3 Mnt
Put the PORT into the MAINTENANCE state

f4 Out
Put the PORT into the OUT OF SERVICE state

f5 Enabl ExtLb
Enable External Loopback

f6 Cancl ExtLb
Cancel External Loopback

f7 Clear Calls
Clear ALL calls on this port

| Reset | Ins | Mnt | Out | Enabl ExtLb | Cancl ExtLb | Clear Calls | PORT DETL | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

24597
11/21/86
094P345
09/19/86

# COMPONENT CONTROL
# CLUSTER SPARING CONTROL

- Typically, there is more than one Redundancy Group within a Node
- There is the Possibility that more than one Cluster could Fail within a Redundancy Group
- Two Functions are Provided to the NOC Operator to ‘Control” Sparing:

  1. Initiate Sparing
  2. Clear a Spare

- The Following NOC Screen is Used to Control Spare PSCs

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# COMPONENT CONTROL
# SPARE CNTL SCREEN

M/A-COM    Network Operator Console

| | | |
|---|---|---|
| 4:38:27 PM<br>Fri Jul 26, 1985 | CLUS 1 CLUS 2 CLUS 3<br>CLUS 4 CLUS 5 CLUS 6<br>CLUS 7 CLUS 8 CLUS 9 | Working<br>Message<br>Log On |

NOC Software Versn :MED 7/17 5pm
Operator Name/Type :NOC4 / 0
NCP Name/Mode :NCPA /MASTER
Online Config :P61START
Connctd Config/Acces:JEPHDB /CHANGE

-SPARE CNTL-    Quick Access - ________    PSC Sparing Control

Node Name : ______   Primary Cluster Num : __.__

f1 **Force Spare**
Force configured Backup to SWITCH IN for the Primary.

f2 **Clear Spare**
Force configured Backup to SWITCH OUT for the Primary.

| Force Spare | Clear Spare | | | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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5-24E4256
30-OCT-87

# COMPONENT CONTROL
# CALL CLEARING CONTROL

The Call Control function allows an NOC operator to clear or to reset any network call, or to clear all calls on a given port. To clear a specific call, the operator must specify either the call source DTE address (and logical channel) or the call destination DTE address (and logical channel).

# COMPONENT CONTROL
# PORT LOOPBACK

- An NOC Operator can set a Port into the Maintenance State
- The NOC Operator can then Cause that Port to Internally Connect its TX to its RX Time
- This can be Controlled via the Following NOC Screen

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# COMPONENT CONTROL
# PORT CNTL SCREEN

| | | | |
|---|---|---|---|
| | Network Operator Console | | NOC Software Versn :MEQ 7/17 5pm |
| | CLASS 1 CLASS 2 CLASS 3 | Working | Operator Name/Type :NOC4 . . . / 0 |
| 4:38:27 PM | CLASS 4 CLASS 5 CLASS 6 | Message | NCP Name/Mode :NCPA . . . /MASTER |
| Fri Jul 26, 1985 | CLASS 7 CLASS 8 CLASS 9 | Log On | Online Config :A61START |
| | | | Connctd Confg/Acces:JEPHDB . /CHANGE |

-PORT CNTL- Quick Access - __________ PORT Control

Node Name : ________ Cluster Num : ___.___ Module Num : _ Port Num : _

**f1** Reset
RESET the PORT

**f2** Ins
Put the PORT into the IN SERVICE state

**f3** Mnt
Put the PORT into the MAINTENANCE state

**f4** Out
Put the PORT into the OUT OF SERVICE state

**f5** Enabl ExtLb
Enable External Loopback

**f6** Cancl ExtLb
Cancel External Loopback

**f7** Clear Calls
Clear ALL calls on this port

| Reset | Ins | Mnt | Out | Enabl ExtLb | Cancl ExtLb | Clear Calls | PORT DETL | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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09/19/8

5-27E4256
30-OCT-87

# COMPONENT CONTROL
# NCP CONTROL

- NCP Control Functions can only be Initiated from an NCP Console

- There are 3 General Categories:

  1. NCP Startup
  2. NCP Mode
  3. NCP Shutdown

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# DEBUG TOOLS
# 5.1.3

5-29E4256
30-OCT-87

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# DEBUG TOOLS
# NOC DEBUG SCREENS

-DEBUG- Quick Access - ___________ Online Debugging Menu

f1 MOD TRIGR
Set Module memory dump Triggers

f5 MEM ACCES
Read/Write memory in remote devices

f2 CREC MON
Call Record Monitor Display

f6 NCP ULL
List/Delete Upline Loaded Files at the NCP

f3 CREC LOG
Call Record Log Display

f7 ASP FILES
List/Delete and Upline Load Files at the ASP

f4 ROUTE SIM
Obtain a Simulated Call Route

f8 MEM PATCH
Menu of Forms to build Memory Patches

| MOD TRIGR | CREC MON | CREC LOG | ROUTE SIM | MEM ACCES | NCP ULL | ASP FILES | MEM PATCH | | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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10/27/87

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30-OCT-87

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# DEBUG TOOLS
# GENERAL

- Any error condition or failure of a network component would cause one of nine event indicators to flash in the banner line area of each NOC screen.

- The network operator can then use the EVENT MON NOC screen to determine what problem has occurred in the network and where the problem, and to plan the correct course of action for alleviating it.

- The operator's ability to collect additional data via Summary and Detailed Status aids in this Effort.

- The NVRAM DETL NOC screen gives an overall look at the memory status of individual modules in a cluster

- A bad checksum or wrong storage count might indicate that this specific module has been corrupted and is not properly performing its functions.

# DEBUG TOOLS
# UPLINE DUMP

- One of the Primary Debugging Tools Available in the IPN is the Upline Dump Feature.
- This Feature Allows an Operator to Snatch Portions of a Cluster's Memory in order that they can Diagnose Software Failures
- The Data is Stored at the NCP and can be Viewed by the NOC Operator
- The MOD TRIGR NOC Screen is the Mechanism Which Enables the Operator to Request an Upline Dump.
- Operators who are Familiar Enough with the System would then be able to use the Software Patching Feature to Modify (Correct) the Contents of the Cluster's Memory

# DEBUG TOOLS
# MOD TRIGR SCREEN

M/A-COM Network Operator Console

| | | | | |
|---|---|---|---|---|
| 4:38:27 PM<br>Fri Jul 26, 1985 | CLASS 1 CLASS 2 CLASS 3<br>CLASS 4 CLASS 5 CLASS 6<br>CLASS 7 CLASS 8 CLASS 9 | Working<br>Message<br>Log On | NOC Software Versn<br>Operator Name/Type<br>NCP Name/Mode<br>Online Config<br>Connctd Confg/Acces | :MEQ 7/17 5pm<br>:NOC4 / 0<br>:NCPA /MASTER<br>:P61START<br>:EPHDB /CHANGE |

-MOD TRIGR-  Quick Access - __________  Module Memory Dump Triggers

Node Name : ________ Module Num : _
Cluster Num : __.__ _

**UPLINE DUMP TRIGGER**

On restart, dump memory from Segment:Offset address - ____:____
to Segment:Offset address - ____:____

**RAM ADDRESS TRIGGER**

On executing RAM code, at Segment:Offset address - ____:____
Dump 32 bytes of memory from Segment:Offset address - ____:____

| Read Both | Set UpDmp | Set RamAd | Clear Both | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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**09/19/86**

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30-OCT-87

# DIAGNOSTICS
# SOFTWARE PATCHING

- The Software Patching Feature Allows an NOC Operator to Literally Change the Contents of a Cluster's Memory in an Online Fashion

- Temporary or Permanent Patching Available

- Small Patch Changes to Portions of a Cluster's Memory do not Require that the Cluster be Taken out of Service

- A powerful Fault Correction Tool, Software Patching Should only be Performed by the Most Experienced Network Operators

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# DEBUG
# TOOLS
# CALL RECORDS

5-35E4256
30-OCT-87

# DEBUG TOOLS
# CALL RECORDS
# CREC MON

-CREC MON- Quick Access - ........... In-Progress Call Record Display

S StrtTime Calling X.121 Called X.121 Call Type COS

Number of
Records left
to display:

| First Page | Full Displ | | Selec Param | | | | Ports | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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# DEBUG TOOLS
# CALL RECORDS
# FULL CALL RECORD DISPLAY

Full Call Record Display

WINDOW FIELD

| | |
|---|---|
| Start Date/Time : / | Type/COS : / |
| Clear Date/Time : / | ClearCause/DiagCode: / |
| Callng X.121 Addr : | Route Length : |
| Foreign Callng Addr: | Transit Network ID : |
| Srce INA (port): | Call ID : |
| Called X.121 Addr : | User ID : |
| Priv/For Calld Addr: | Access Code : |
| Dest INA (port): | Per-Call Facilities : |
| Route - Port 1 : | Subscription Facil. : |
| Port 2 : | Type Srce/Dest : / |
| Port 3 : | LCN at Srce/Dest : / |
| Port 4 : | Port Speed Srce/Dest: / |
| Port 5 : | Srce PAD Port/Speed : / |
| Port 6 : | Char Count In/Out : / |
| Port 7 : | Pkt Count In/Out : / |
| Port 8 : | Sgmnt Count In/Out : / |

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10/27/87

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# DEBUG TOOLS
# CALL RECORDS
# CREC LOG

```
-CREC LOG-          Quick Access - ___________         Call Record Log Display
S Start Date/Time       Calling X.121     Calld X.121          Call Type  ClCs Dg
```

| First Page | Full Displ | | Selec Param | | | | ClDat Ports | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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# DEBUG TOOLS
# ROUTE SIMULATION

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# DEBUG TOOLS
# ROUTE SIMULATION

-ROUTE SIM- Quick Access - __________ Route Simulation Form

| | | | |
|---|---|---|---|
| Node Name : ________ | Module : _ | ⟷ Node Name : ________ | Module : _ |
| Cluster : __.__ | Port : _ | Cluster : __.__ | Port : _ |

Class of Service : __
Source Traffic Parameter : ___

**Proposed Route**

Backbone Link Port; 1 :
2 :
3 :
4 :
5 :
6 :
7 :
8 :

Estimated Traffic Value :

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Read Route | | | | | | | | Quick Acc | TOGGL PREV |

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# CONFIGURATION MANAGEMENT 5.2

5-41E4256
30-OCT-87

# CONFIGURATION MANAGEMENT GENERAL

Network Configuration has the Following Properties:

- Changes only as a Result of NOC Commands
- A Subset of the Network Configuration Data is DLL from the NCP
- It is Used by NCS Components to Control their Operations

Two Forms of Configuration Data Maintained at NCP

- Source - This Form is Used by the NOC
- Image - This Form is DLL by the NCP to System Components

NOC Operators can Perform to General Functions on this Data

- Enter and modify all Source Data
- Control its Implementation

# CONFIGURATION MANAGEMENT
# CONFIGURATION CHANGES

Four Types of Configuration Changes are Allowed:

- Online Configuration Changes: Changes Made to the Online Configuration. Components of the System are informed of these Changes Immediately. The Same Changes are Simultaneously Made to the Offline Configuration, if Possible

- Offline Configuration Changes: Changes Made to the Offline Configuration. These are Implemented in the System at Some Later Time by the Offline Configuration Implementation Procedure

- Offline Configuration Implementation: The Offline Configuration Becomes the Online Configuration and is Implemented in the System

- Fallback Configuration Implementation: The Fallback Configuration Becomes the Online Configuration and is Implemented in the System

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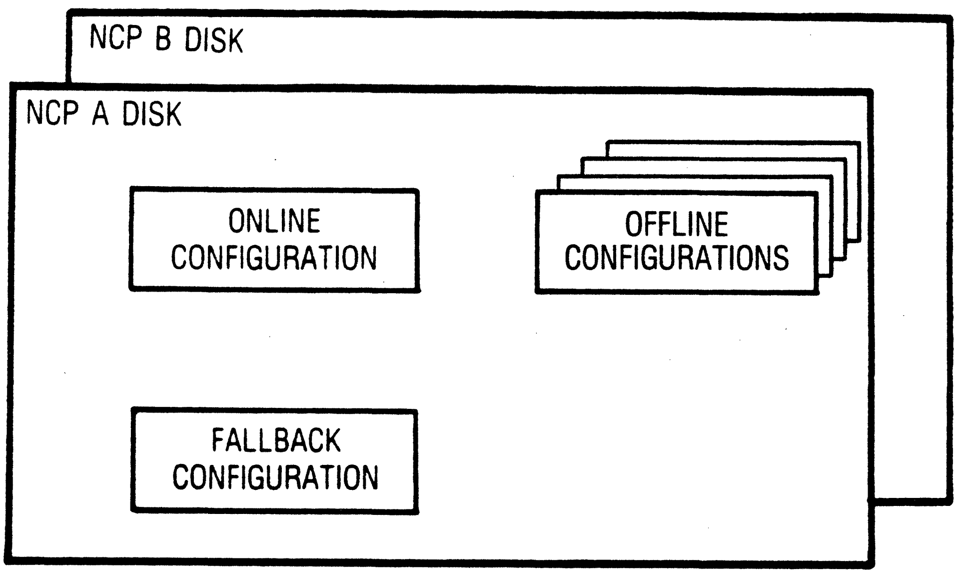
# CONFIGURATION MANAGEMENT CONFIGURATIONS ON THE NCP'S DISK

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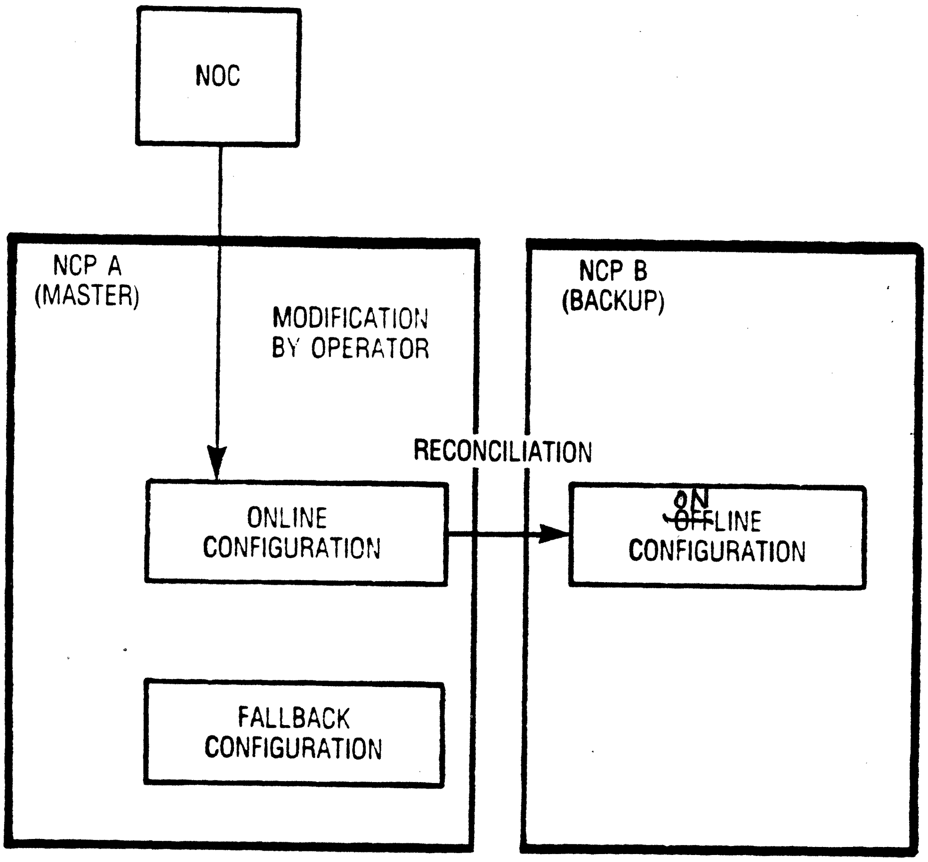
# CONFIGURATION MANAGEMENT ONLINE CONFIGURATION CHANGES

- Changes can be Made by an NOC Operator Directly to the Online Configuration of Master NCP Only
- Each Time an NOC Operator who is Modifying the Online Configuration Presses the 'Write" or 'Delete" Function Key on a Single NOC Screen, the Change is Immediately Made to the Online Configuration on Disk
- Notification of that Change is Sent out to the System as Required to Implement the Particular Change
- Changes Made to the Master's Online Configuration are also Made to the Back-Up's Online Configuration
- The Operator will be Informed of the Success or Failure of the Change to the Online Configuration
- The Change will be Made to the Master's Online Configuration Whether or not it Succeeds in the Back-Up's Online Configuration

# ONLINE CONFIGURATION CHANGE




NOTE: Duplicated in Backup NCP

**235P235**
**241P224**
**21453**
**01/24/86**

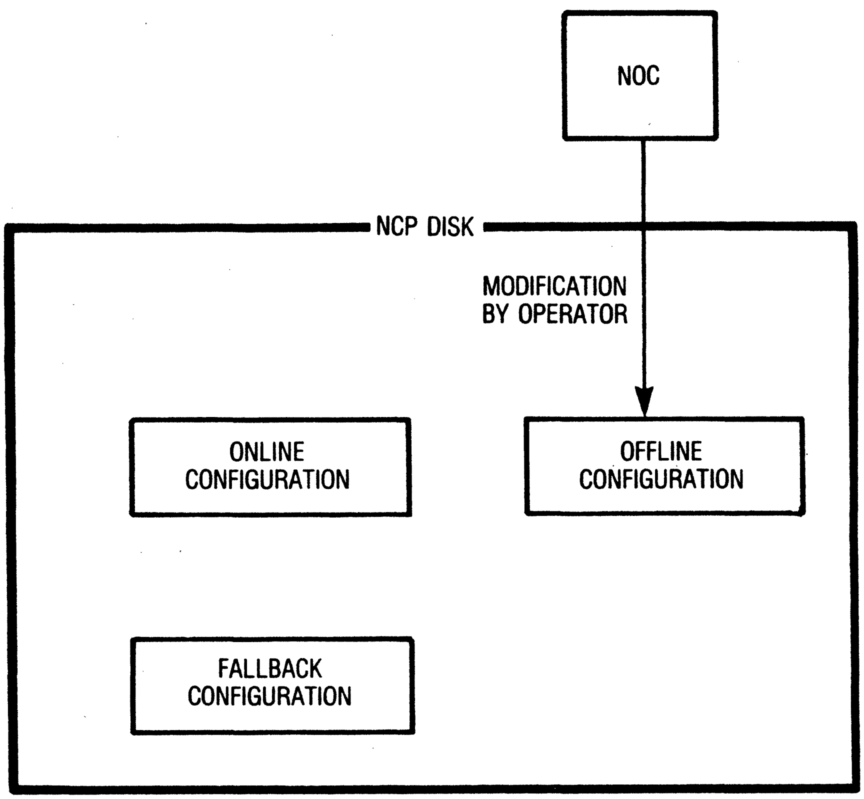
# CONFIGURATION MANAGEMENT OFFLINE CONFIGURATION CHANGES

- There are Offline Configurations Which are Either:
  - A Complete Configuration of the Network to be Implemented at Some Time in the Future
  - A Configuration Which is Being Edited and is not yet Complete
- Once the Offline Configuration is Completely Edited, it can be Implemented in the Network
- The Offline Configuration is "How I want my Network to Look When I Decide to Implement this Configuration"

# OFFLINE CHANGES

An Operator can Change the Offline Configuration at any Time Without Affecting the Operation of the Network

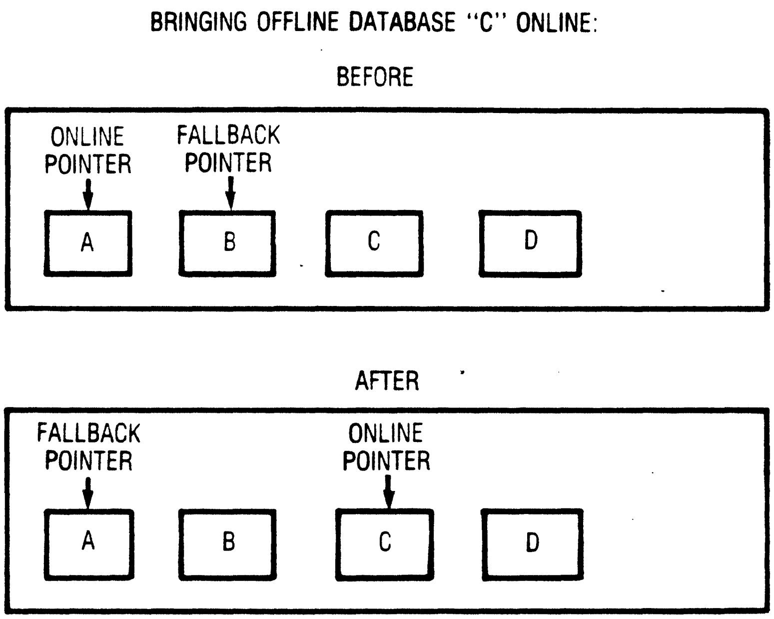
The Following Diagram Illustrates Offline Configuration Changes:




242P224
21454
01/24/86

NOTE: Changes Made to Offline will be Duplicated in Backup NCP

# CONFIGURATION MANAGEMENT OFFLINE CONFIGURATION IMPLEMENTATION

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11/20/86
**237P235**
**02/25/86**

## NOTE:

- **When the Offline Configuration has been Implemented in the Master NCP, the Backup NCP is also Notified of that Occurrence, and it will Attempt to do the Same**
- **The Backup will Send a Notification of the Success or Failure of the Implementation Operation**

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# CONFIGURATION MANAGEMENT
# FALLBACK CONFIGURATION

- There is a Single Fallback Configuration on Disk Which is the Configuration of the Network just Before the Offline Configuration was Last Implemented
- This Configuration Provides a way to Restore the Network's Configuration to the way it was Before the Offline Configuration was Implemented
- If, for Example, the Offline Configuration is Implemented and There are Several Mistakes, the NOC Operator can Implement the Fallback Configuration and Restore the Network to its Previous Condition
- The Fallback Configuration Cannot be Modified by the Operator

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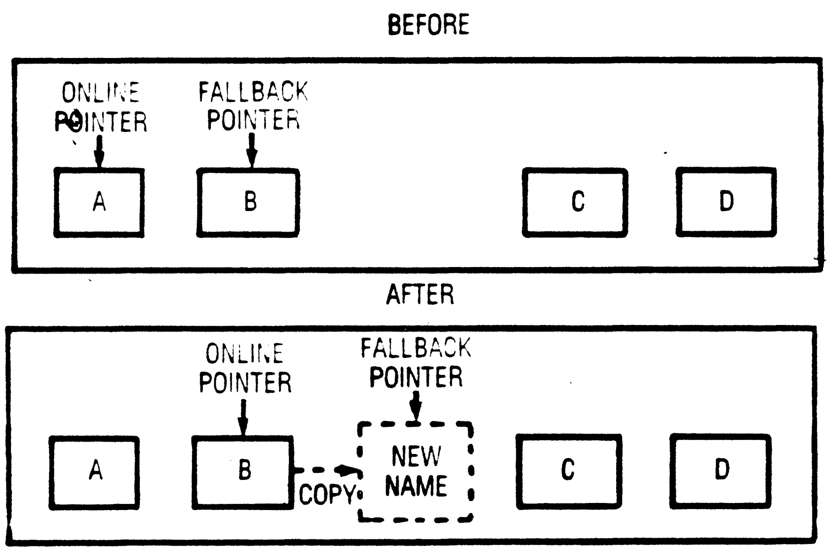
# CONFIGURATION MANAGEMENT FALLBACK CONFIGURATION

- The Fallback Configuration is Never Edited by an Operator, but is Simply a Copy of the Previous Online Configuration
- It is Provided to Aid the Operator in Quickly Restoring the Former Configuration of the Network After an Offline Configuration with Many Errors has been Implemented




NOTE:

- When Configuration Fallback has been Performed in the Master NCP, the Backup NCP is also Notified and it will Attempt to do the Same
- It will send a Notification of the Success or Failure of the Fallback Operation

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11/20/86

# CONFIGURATION MANAGEMENT
# COPYING CONFIGURATIONS

The Following Local Copy Commands are Provided:

- Copy Online to Offline - The Entire Contents of the Online Configuration are Copied to the Offline Configuration
- Fallback to Offline - The Entire contents of the Fallback configuration are Copied to the Offline Configuration
- Remote Copy (between NCPs) is available if DECNET is installed

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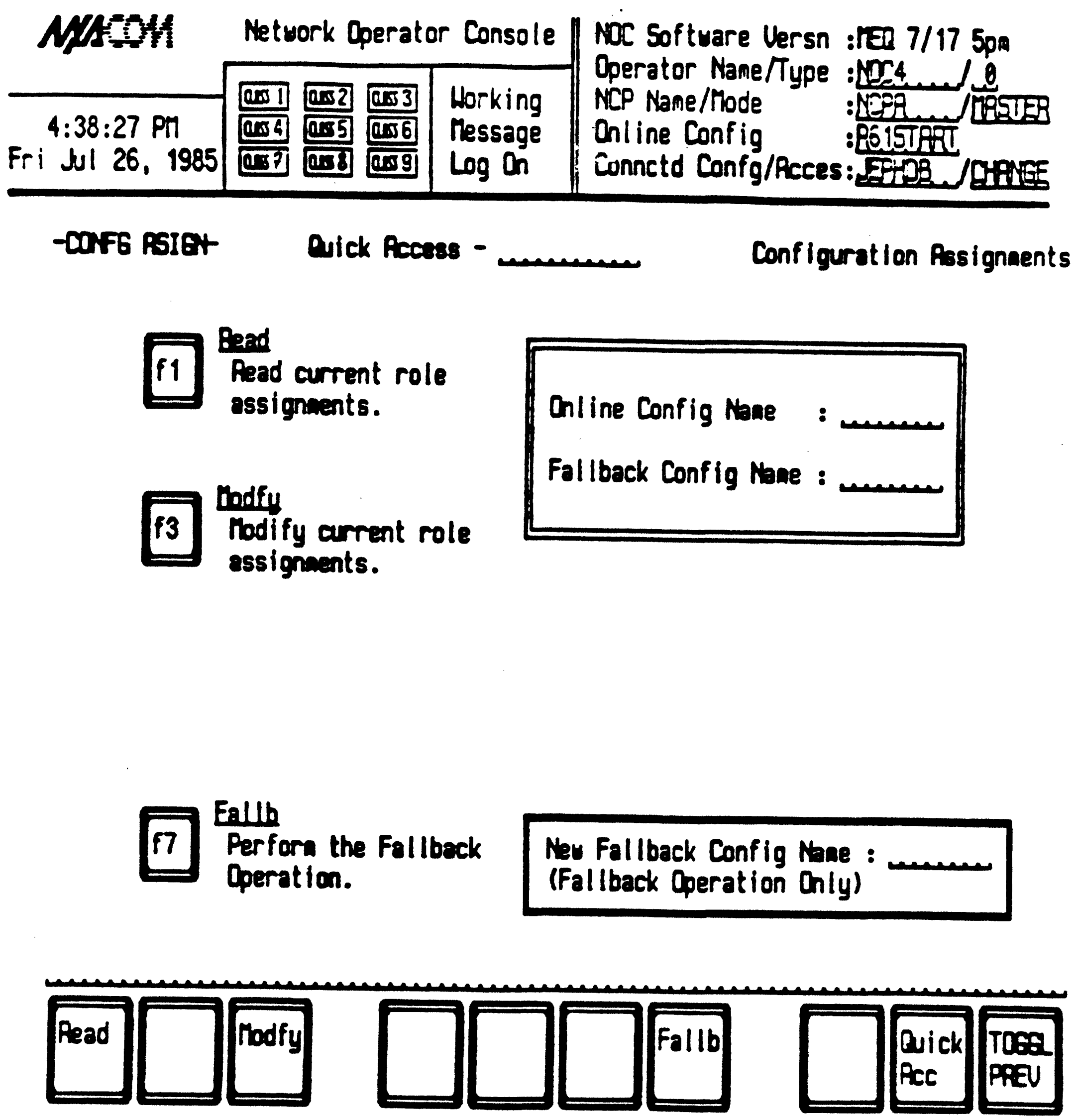
# CONFIGURATION MANAGEMENT SCREEN USED TO IMPLEMENT A COPY DB

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5-53E4256
30-OCT-87

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# CONFIGURATION MANAGEMENT EXAMPLE OF CONFIGURATION SCREEN

M/A-COM Network Operator Console

| | | | |
|---|---|---|---|
| 4:38:27 PM<br>Fri Jul 26, 1985 | CLASS 1 CLASS 2 CLASS 3<br>CLASS 4 CLASS 5 CLASS 6<br>CLASS 7 CLASS 8 CLASS 9 | Working<br>Message<br>Log On | NOC Software Versn :MED 7/17 5pm<br>Operator Name/Type :NOC4 / 0<br>NCP Name/Mode :NCPA /MASTER<br>Online Config :R61START<br>Connctd Confg/Acces:EPHOB /CHANGE |

-BBLNK- Quick Access - ________ Backbone Link

BackBone Name : ________

Text : ________

| Node Name : ________ Module : _<br>Cluster : __.__ Port : _<br>Desired Port State : __ | ⟷ | Node Name : ________ Module : _<br>Cluster : __.__ Port : _<br>Desired Port State : __ |
|---|---|---|

| Link Parameters | | |
|---|---|---|
| Baud Rate : _____ | Max Outst Frames : __ | Link Type : _ |
| Frame Sequencing : 128 | Max Simult Calls : __ | Link Capacity : ____ |

Read | Creat | Modfy | Delet | | | | | Quick Acc | TOGGL PREV

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30-OCT-87

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# PERFORMANCE MONITORING
# 5.3

5-55E4256
30-OCT-87

# PERFORMANCE MONITORING GENERAL

Network performance monitoring functions, available via NOCs, report on network operation, but do not alter network operation. Two types of monitoring functions are provided:

- Summary Status Monitoring Functions give a high-level summary of current network operation
- Detailed Status Monitoring Functions show the Current Operating States and Characteristics of Specific Network Components

Networking Monitoring Functions are Supplemented by "Event" Functions and Component Local Diagnostic Functions

# PERFORMANCE MONITORING GENERAL (Cont.)

- A Hierarchy of Detailed Component Status is Available to NOC Operators.

- Detailed Status is Available for PSCs, Modules, and Ports

- Detailed Component Status Includes the Following:
  - Current Operating State
  - Utilization
  - Maintenance Conditions Active (loopback, campon)
  - Error Conditions Active
  - Error Rates
  - Services Provided
  - Services Required
  - Service Rates

# PERFORMANCE MONITORING GENERAL (Cont.)

- The NCP Periodically Receives and Stores Summary Status for the Back-up NCP Nodes, Clusters, and Backbone Links. This Stored Summary Status is Available to NOC Operators via Status Display Screens

- Two Types of Summary Status Data are Recorded for Applicable Components: Current Operating State and Utilization

- The Current Operating State of Network Component is Defined as Either Active, Failed, or Unknown

- Component Utilization Consists of Data Concerning the Component's Performance

- PSCs periodically send Summary Status to the NCP. The NCP Timestamps and Stores Received Status

- Components from Which Status has Recently Been Received are considered Active or Failed Based on the Report Contents

- Current Operating State of Components from Which Status has not Recently Been Received is Considered to be Unknown

# PERFORMANCE MONITORING COMP DETL SCREEN

M/A-COM Network Operator Console

| | | |
|---|---|---|
| 4:38:27 PM<br>Fri Jul 26, 1985 | CLASS 1 CLASS 2 CLASS 3<br>CLASS 4 CLASS 5 CLASS 6<br>CLASS 7 CLASS 8 CLASS 9 | Working<br>Message<br>Log On |

NOC Software Versn :MEQ 7/17 5pm
Operator Name/Type :NOC4 / 0
NCP Name/Mode :NCPA /MASTER
Online Config :P615TART
Connctd Confg/Acces:JEPHDB /CHANGE

-COMP DETL- Quick Access - ________ Component Detailed Status Menu

f1 RSP DETL
RSP Detailed Status

f2 PSC DETL
PSC Detailed Status

f3 LIM DETL
LIM Detailed Status

f4 PORT DETL
PORT Detailed Status

f5 PORT LCN
Port Logical Channel Connections

f6 NVRAM DETL
Non-Volatile RAM Detailed Status

f7 TPAD DETL
TPad Detailed Status

f8 HPAD DETL
HPad Detailed Status

RSP DETL | PSC DETL | LIM DETL | PORT DETL | PORT LCN | NVRAM DETL | TPAD DETL | HPAD DETL | | TOGGL PREV

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# PERFORMANCE MONITORING
# PSC DETL SCREEN

M/A-COM Network Operator Console

| | | |
|---|---|---|
| CLASS 1 | CLASS 2 | CLASS 3 |
| CLASS 4 | CLASS 5 | CLASS 6 |
| CLASS 7 | CLASS 8 | CLASS 9 |

Working
Message
Log On

4:38:27 PM
Fri Jul 26, 1985

NOC Software Versn :MEQ 7/17 5pm
Operator Name/Type :NOC4 /0
NCP Name/Mode :NCPA /MASTER
Online Config :R615TART
Connctd Confg/Acces:JEPHDB /CHANGE

-PSC DETL- Quick Access - PSC Detail Status

Node Name :
Cluster Num :

PSC STATE
Desired :
Current :

UTILIZATION
Active Calls :
Free Buffers :
Buffer Pool Size :
Low Buffer Count :

SPARING
PRImary/BACKup :
Switch IN/OUT :

LIM STATUS

| Mod# | Ports Up Down Other |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |

Date/Time :

| Read | | Montr | | | | LIM DETL | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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# PERFORMANCE MONITORING
# BBLNK SUM SCREEN

M/A-COM Network Operator Console

NOC Software Versn :MEQ 7/17 5pm
Operator Name/Type :NOC4 . . . / 0
NCP Name/Mode :NCPA . . . /MASTER
Online Config :B61START
Connctd Config/Acces:JEPHDB . /CHANGE

4:38:27 PM
Fri Jul 26, 1985

QUES 1 QUES 2 QUES 3
QUES 4 QUES 5 QUES 6
QUES 7 QUES 8 QUES 9

Working
Message
Log On

-BBLNK SUM- Quick Access - . . . . . . . . . . BackBone Link Summary Status

Display BAD links only? : N

| Link | Last Updt | Util | DSta | Status | Link | Last Updt | Util | DSta | Status |
|---|---|---|---|---|---|---|---|---|---|

First Page | | Montr | | | | BBLNK | | Quick Acc | TOGGL PREV

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# REPORT MANAGEMENT
# 5.4

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# REPORT MANAGEMENT

- Through the use of the NOC and the Database in the NCP, Configurable Data is Made Available to Network Operators
- Extensive Hard Copy Reporting Facilities are also Provided by the Master NCP on the Contents of its Databases
- They are Output to the High-Speed Printer Located at the Master NCP Site
- The following Types of Formatted Reports are Available
  - System Configuration
  - Network User Data
  - Address Translation Data
  - Network Operator Data
  - Events
  - Software

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# SYSTEM INTERFACES 6.0

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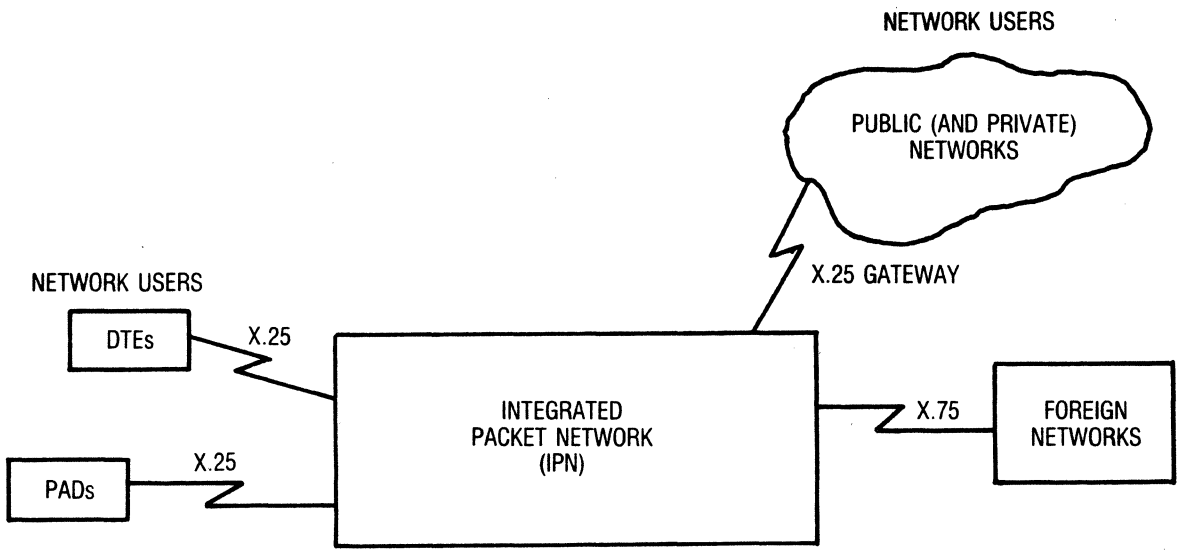
# IPN EXTERNAL NETWORK INTERFACES

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# X.25 PROTOCOL

- CCITT 1980, Yellow Book, Vol. VIII (-2)
- X.21 bis Physical Level
  - V.24/RS-232
  - V.35
- LAPB Link Level, Modulo 8 or 128
- Services
  - Switched Virtual Circuit (SVC)
  - Permanent Virtual Circuit (PVC)
- Facilities
  - Fast Select
  - Fast Select Acceptance
  - M & D-Bit Modification
  - Reverse Charging
  - Flow Control Negotiation
  - DDAF Acceptance

# X.75 PROTOCOL

- CCITT 1980, Yellow Book
- X.21 bis Physical Level
  - V.24/RS-232
  - V.35
- LAPB Link Level, Module 8 or 128
- Single Link Procedure
- Virtual Circuit Service
- Network Utilities
  - Transit Network ID
  - Call Identifier
- D-bit Modification Facility

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# OVERVIEW OF X.25 AND X.75 6.1

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# X.25 INTERFACE

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# X.25
# PHYSICAL LEVEL
# 6.1.1

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# X.25 INTERFACE: PHYSICAL LEVEL

| Item | Supported by Network | | |
|---|---|---|---|
| | Sup | C/F | Range |
| Speed | Y | C | RS232-C: 2400 bps. 4800 bps, 9600 bps, 16000 bps, 19200 bps, V.35: 4800 bps, 9600 bps, 56 kbps, 64 kbps |
| Leased Access | Y | C | Y/N |
| Switched Access Dial-Out | Y | C | Y/N |
| Switched Access Dial-In | Y | C | Y/N |
| DCE/DTE (for Leased Access) | Y | C | DTE or DCE (for both RS-232C and V.35) |

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# X.25
# LINK LEVEL
# 6.1.2

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# X.25 INTERFACE: LINK LEVEL

| Item | Network | | |
|---|---|---|---|
| | Sup | C/F | Range |
| LAPB (BitSync) | Y | F | |
| K (Maximum number of outstanding frames) | Y | C | 1 to 7 |
| N1 (Maximum number of bits in an I frame) | Y | C | 1080 bits<br>2104 bits<br>4152 bits |
| N2 (Maximum number of retransmissions) | Y | C | 1 to 20 |
| T1 (Retransmission Timer) | Y | C | 1-99 (or Default Formula) |
| T2 (Response Timer) | Y | C | 1 to 100 Tenths of secs |
| Frames Types: | | | |
| I Frame | Y | F | |
| RR Command Frame | Y | F | |
| RR Supervisory Frame | Y | F | |
| RNR Command Frame | Y | F | |
| RNR Supervisory Frame | Y | F | |
| REJ Command Frame | Y | F | |
| REJ Supervisory Frame | Y | F | |
| SABM Frame | Y | F | |
| UA Frame | Y | F | |
| DISC Frame | Y | F | |
| FRMR Frame | Y | F | |
| DM Frame | Y | F | |

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# X.25
# PACKET LEVEL
# 6.1.3

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# X.25 INTERFACE: PACKET LEVEL

| Item | Network Sup | F/C | Range |
|---|---|---|---|
| Virtual Call Service | Y | C | Y/N |
| Permanent Virtual Call Service | Y | C | Y/N |
| Packet Sequencing | Y | C | Mod 8 or 128 |
| Window Size | Y | C | 1-7 |
| Maximum Packet Size | Y | C | 128,256, 512 |
| Highest LCN used for PVCs (HPVC) | Y | C | 0-4096 |
| Highest LCN used for SVCs (HVC) | Y | C | 1-4096 HVC> = HPVC |
| Maximum Number of Logical Channels | Y | C | 1-200 |
| Timeout T10 | Y | F | 60 secs |
| Timeout T11 | Y | F | 180 secs |
| Timeout T12 | Y | F | 60 secs |
| Timeout T13 | Y | F | 60 secs |

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# X.25 INTERFACE: PACKET LEVEL (Cont.)

| Item | Network Sup SVC | Network Sup PVC | F/C | Range |
|---|---|---|---|---|
| Packet Types: | | | | |
| Incoming Call | Y | N | | |
| Call Connected | Y | N | | |
| Call Request | Y | N | | |
| Call Accepted | Y | N | | |
| Clear Indication | Y | N | | |
| Clear Request | Y | N | | |
| Clear Confirmation | Y | N | | |
| Data | Y | Y | | |
| Interrupt | Y | Y | | |
| Interrupt Confirmation | Y | Y | | |
| Receive Ready | Y | Y | | |
| Receive Not Ready | Y | Y | | |
| DTE Reject | N | N | | |
| Reset Request | Y | Y | | |
| Reset Indication | Y | Y | | |
| Reset Confirmation | Y | Y | | |
| Restart Request | Y | Y | | |
| Restart Indication | Y | Y | | |
| Restart Confirmation | Y | Y | | |
| Diagnostic | Y | Y | C | Y/N |
| Packet Fields: | | | | |
| M-bit | Y | Y | F | |
| D-bit | Y | Y | F | |
| Q-bit | Y | Y | F | |
| X.25 Facilities: | | | | |
| Fast Select Acceptance | Y | N | C | Y/N |
| Incoming Calls Barred | Y | N | C | Y/N |
| Outgoing Calls Barred | Y | N | C | Y/N |
| Reverse Charging Acceptance | Y | N | C | Y/N |
| D-bit Modification | Y | Y | C | Y/N |
| Flow Control Negotiation | Y | Y | C | Y/N |
| DDAF Acceptance | Y | Y | C | Y/N |

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# X.25
# PACKET LEVEL SERVICES

| SERVICES | AVAILABILITY |
|---|---|
| CALL | YES |
| PERMANENT VIRTUAL CIRCUIT | YES |
| DATAGRAM | NO |

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# X.25
# NON-X.25 FACILITIES SUPPORTED

| NR | SUBSCRIPTION FACILITIES | SVC | PVC |
|---|---|---|---|
| 1 | LOAD LEVELING | YES | NO |
| 2 | CALLING ADDRESS RESTRICTION | YES | NO |

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# X.75 INTERFACE

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# X.75
# PHYSICAL LEVEL
# 6.1.4

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# X.75 INTERFACE: PHYSICAL LEVEL

| Item | Supported by Network | Fixed (F)/ Config(C) | Range |
|---|---|---|---|
| **PHYSICAL LEVEL:** | | | |
| Speed | Y | C | RS-232C: 2400 bps, 4800 bps, 9600 bps, 16000 bps, 19200 bps<br>V.35: 4800 bps, 9600 bps, 56 kbps, 64 kbps |
| DCE/DTE | Y | C | DCE or DTE (for both RS232-C and V.35) |

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# X.75
# LINK LEVEL
# 6.1.5

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# X.75 INTERFACE: LINK LEVEL

| Item | Supported by Network | | Fixed (F)/ Config (C) | Range |
|---|---|---|---|---|
| LINK LEVEL: | | | | |
| Procedure—SLP (LAPB) | Y | | F | |
| Address Selection | Y | | C | A/B |
| Frame Sequencing | Y | | C | Modulo 8/Modulo 128 |
| K (Maximum Number of Outstanding Frames) | Y | | C | Modulo 8: 1 to 7<br>Modulo 128: 1 to 127 |
| N1 (Maximum Number of Bits in an I Frame) | Y | | F | 2104 Bits (263 Bytes) |
| N2 (Maximum Number of Retransmissions) | Y | | C | 1 to 20 in Increments of 1 |
| T1 (Retransmission Timer) | Y | | C | 1 to 99 secs in Increments of 1.0 sec |
| T2 (Response Timer) | Y | | C | 1-100 Tenths of secs |
| Frame Types: | M8 | M128 | | |
| I Frame | Y | Y | F | |
| RR Command Frame | Y | Y | F | |
| RR Supervisory Frame | Y | Y | F | |
| RNR Command Frame | Y | Y | F | |
| RNR Supervisory Frame | Y | Y | F | |
| REJ Command Frame | Y | Y | F | |
| REJ Supervisory Frame | Y | Y | F | |
| SABM Frame | Y | Y | F | |
| SABME Frame | Y | Y | F | |
| UA Frame | Y | Y | F | |
| DISC Frame | Y | Y | F | |
| FRMR Frame | Y | Y | F | |
| DM Frame | Y | Y | F | |

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# X.75
# PACKET LEVEL
# 6.1.6

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# X.75 INTERFACE: PACKET LEVEL

| Item | Supported by Network | | Fixed (F)/ Config (C) | Range |
|---|---|---|---|---|
| PACKET LEVEL: | | | | |
| Virtual Call Service | Y | | F | |
| Permanent Virtual Call Service | N | | | |
| Packet Sequencing | Y | | F | Modulo 8 |
| Window Size | Y | | F | 2 |
| Maximum Packet Size | Y | | F | 128 Bytes |
| Highest LCN Used for VCs (HVC) | Y | | C | 1 to 255 |
| Maximum Number of Calls | Y | | C | 1 to 200 |
| Logical Channel Order Selection | Y | | C | Highest/Lowest |
| Timeout T30 | Y | | F | 180 seconds |
| Timeout T31 | Y | | F | 200 seconds |
| Timeout T32 | Y | | F | 180 seconds |
| Timeout T33 | Y | | F | 180 seconds |
| Packet Types: | SVC | PVC | | |
| Call Connected | Y | N | F | |
| Call Request | Y | N | F | |
| Clear Request | Y | N | F | |
| Clear Confirmation | Y | N | F | |
| Data | Y | N | F | |
| Interrupt | Y | N | F | |
| Interrupt Confirmation | Y | N | F | |
| Receive Ready | Y | N | F | |
| Receive Not Ready | Y | N | F | |
| Reset Request | Y | N | F | |
| Reset Confirmation | Y | N | F | |
| Restart Request | Y | N | F | |
| Restart Confirmation | Y | N | F | |

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# X.75 INTERFACE: PACKET LEVEL (Cont.)

| Item | Supported by Network | | Fixed (F)/ Config (C) | Range |
|---|---|---|---|---|
| | SVC | PVC | | |
| **Packet Fields:** | | | | |
| M-bit | Y | N | F | |
| D-bit | Y | N | F | |
| Q-bit | Y | N | F | |
| **X.75 User Facilities** | | | | |
| D-bit Modification | Y | N | C | Y/N |
| **Non-X.75 User Facilities** | | | | |
| Member of a Load Leveling Group | Y | N | C | Y/N |
| Calling Address Rest. | Y | N | C | Y/N |
| **X.75 Utilities:** | | | | |
| Transit Network Identification | Y | N | F | |
| Call Identifier | Y | N | F | |
| Utility Marker | Y | N | C | Y/N |

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# X.75
# NETWORK UTILITIES

| NR | PER-CALL BASIS | VC |
|---|---|---|
| 1 | TRANSIT NETWORK IDENTIFICATION | YES |
| 2 | CALL IDENTIFIER | YES |
| 3 | FAST SELECT INDICATION | NO |
| 4 | THROUGHPUT CLASS INDICATION | NO |
| 5 | WINDOW SIZE INDICATION | NO |
| 6 | PACKET SIZE INDICATION | NO |
| 7 | CLOSED USER GROUP INDICATION | NO |
| 8 | CLOSED USER GROUP WITH OUTGOING ACCESS INDICATION | NO |
| 9 | REVERSE CHARGING INDICATION | NO |
| 10 | UTILITY MARKER | YES |

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# DATA TRANSFER
# 7.0

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# DATA TRANSFER
# PACKET SWITCHING

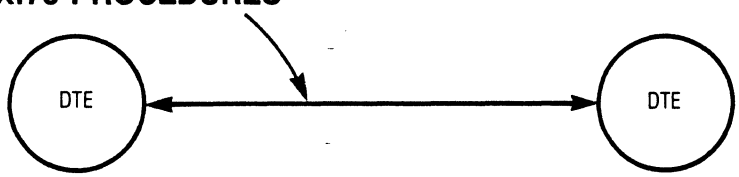
- User Data is Packetized
- Packets Contain:

| HEADER | DATA |
|---|---|

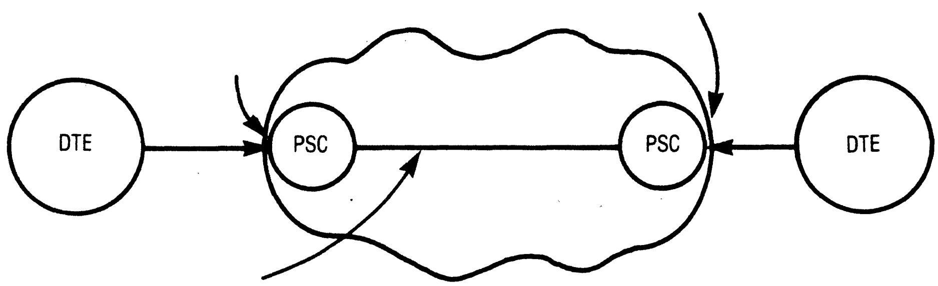
- Header Contains:
  - Packet Type
  - Source Address
  - Destination Address
- Data Portion
  - Contents and Format Defined by User Application
- Separate Packet per each Data-stream
  - Point-to-Multipoint
  - Multiple Channel Point-to-Point

# DATA INTEGRITY

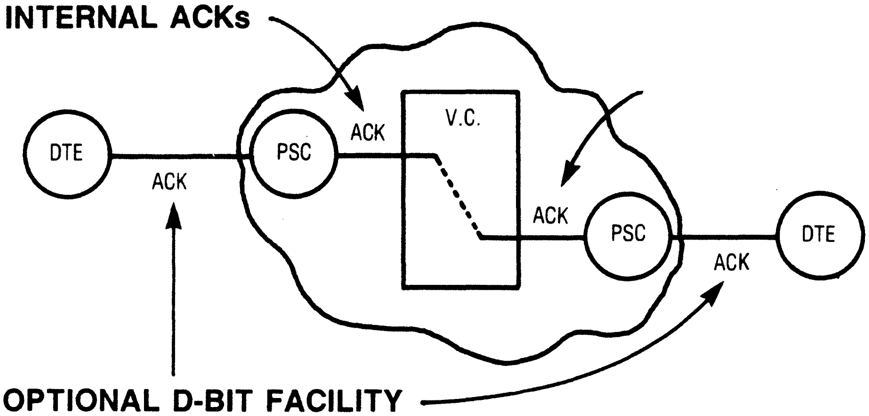
- **X.25/X.75 PROCEDURES**




- **PM/LIM HARDWARE (ECC RAMs)**




- **BBL PROTOCOL (ENHANCED X.75)**
- **INTERNAL ACKs**




- **OPTIONAL D-BIT FACILITY**

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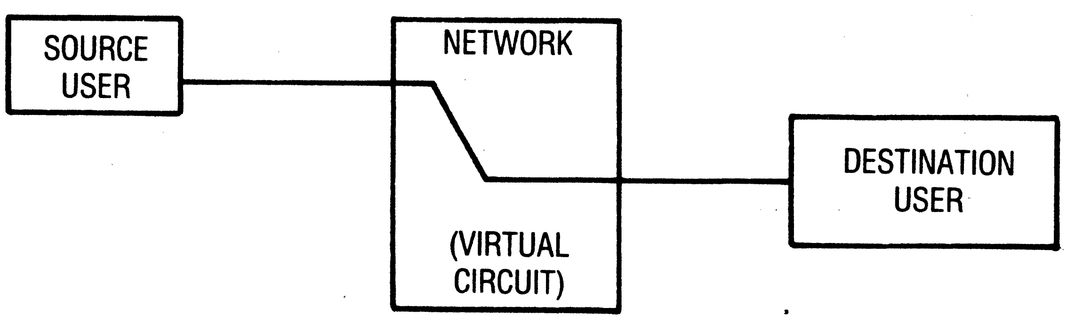
# DATA TRANSFER VIRTUAL CIRCUIT

- User Data Streams in a Packet Switching Network are Transferred Across Virtual Circuits
- A Virtual Circuit Implies a "Path" or "Connection" between the source and destination DTEs
- The IPN Supports both Switched Virtual Circuits (SVCs) and Permanent Virtual Circuits (PVCs)

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# DATA TRANSFER
# SVCs

- An SVC is a Defined "Path" or Route Through the IPN that Exists for the Duration of a Call Between the Source and Destination Users
- The Route is First Determined by the Source Cluster During Call Set-up. This Assures Optimum Use of Network Resources to Meet User Needs (Classes of Service)
- At any Given Time During the Call, all Packetized Information Between the Source and Destination DTEs Follows one Defined Path, Precluding the Possibility that any Packets Might be Lost or Delivered Out-of-Sequence

# DATA TRANSFER
# PVCs

The Network also Supports PVCs. The Call is Set Up by the Network Operators at the Time of Subscription. The Users May then Assume that the Call is Always Present and there is no Requirement that this Type of Call be Set Up or Cleared by the User. To Ensure the Highest Availability, PVCs are Subject to the Same Dynamic Routing Algorithm as SVCs

# DATA TRANSFER VIRTUAL CIRCUIT RECONNECTION FEATURE

- SVCs and PVCs Affected
- Failure Recovery Functions:
  - Alternate Path Establishment
  - Data Transfer Synchronization
    - DTE-to-DTE
    - P(S), P(R)
  - Data Loss Prevention

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# DATA TRANSFER VIRTUAL CIRCUIT RECONNECTION PROCESS

- Call Reconnect Identifier (CRI) Exchanged at call setup (DCE-to-DCE)
- Network Failure (BBL, NODE, PSC)
  1) Source PSC finds Alternate path (Routing Algorithm)
     - Success: Send Reconnect Packet to Destination PSC
     - Failure/Destination Timeout: Clear DTE Circuit
  2) Destination PSC Validates Packet Against CRI
  3) Destination PSC sends Reconnect Accepted Packet to Source PSC
- Synchronize Source-Destination P(R), P(S)
- Reconnection Counter Incremented by Source PSC for:
  - Call Record
  - Statistics

# DATA TRANSFER
# VIRTUAL CIRCUIT REROUTING

- Both SVCs and PVCs are Subject to the VC Rerouting Feature of the IPN.
- This Feature may be Controlled by two System Parameters:
  - Recosting Interval
  - Rerouting Cost Delta
- A Recosting Interval of zero Effectually Disables VC Rerouting

# DATA TRANSFER
# VIRTUAL CIRCUIT REROUTING (Cont.)

- When Enabled, the Network

  1) Evaluates the cost of each Existing call route at an elapsed time equal to the Recosting Interval. (Recommended value: 30 min.)

  2) Determines the Savings (if any) which might be Realized by Rerouting the call

  3) If the Cost of the New Route is less than the Cost of the Current Route by a Margin greater than or equal to the Rerouting Cost Delta . . .

  4) The Network Follows VC Reconnect Procedures (Previous Page) to Reroute the call over the "Cheaper" Route

# CALL ROUTING

- Source Routing (vs. Node-by-Node)
- Efficient - Avoids Routing Loops
- Conserves Resources
  - Memory
  - CPU time

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# CALL SETUP
# 7.1

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4-NOV-87

# CALL SETUP PACKET

- Header
  - Calling User (Optional)
  - Called User (Required)
  - Optional Services (e.g., Fast Select)
  - LCN (Source)
- Data
  - Fast Select Data (Optional)

# CALL SETUP

**NCS PROCESSOR**

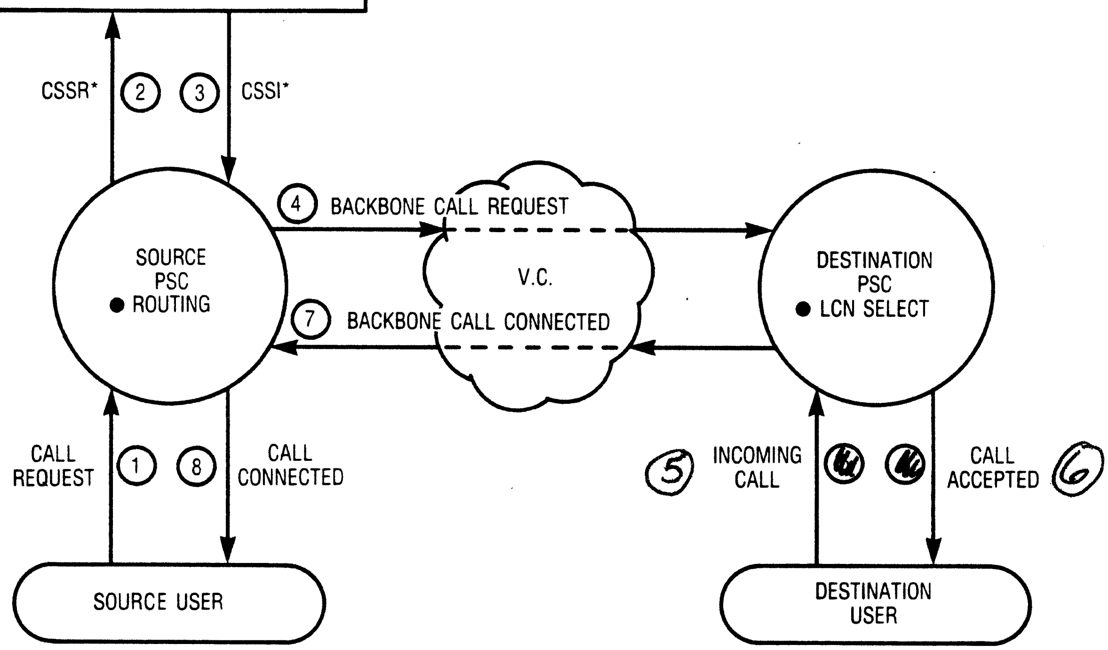
- ACCESS RESTRICTION CHECKS
- ADDRESS TRANSLATION
- COS ASSIGNMENT CLASS OF SERVICE

**CSSR***

- SOURCE INA
- SOURCE X.121
- DESTINATION ADDRESS
- LCN

**CSSI***

- SOURCE INA
- DESTINATION INA
- LCN
- COS
- ACCEPT/REJECT CODE

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*CSSR = CALL SETUP SERVICE REQUEST
*CSSI = CALL SETUP SERVICE INFORMATION

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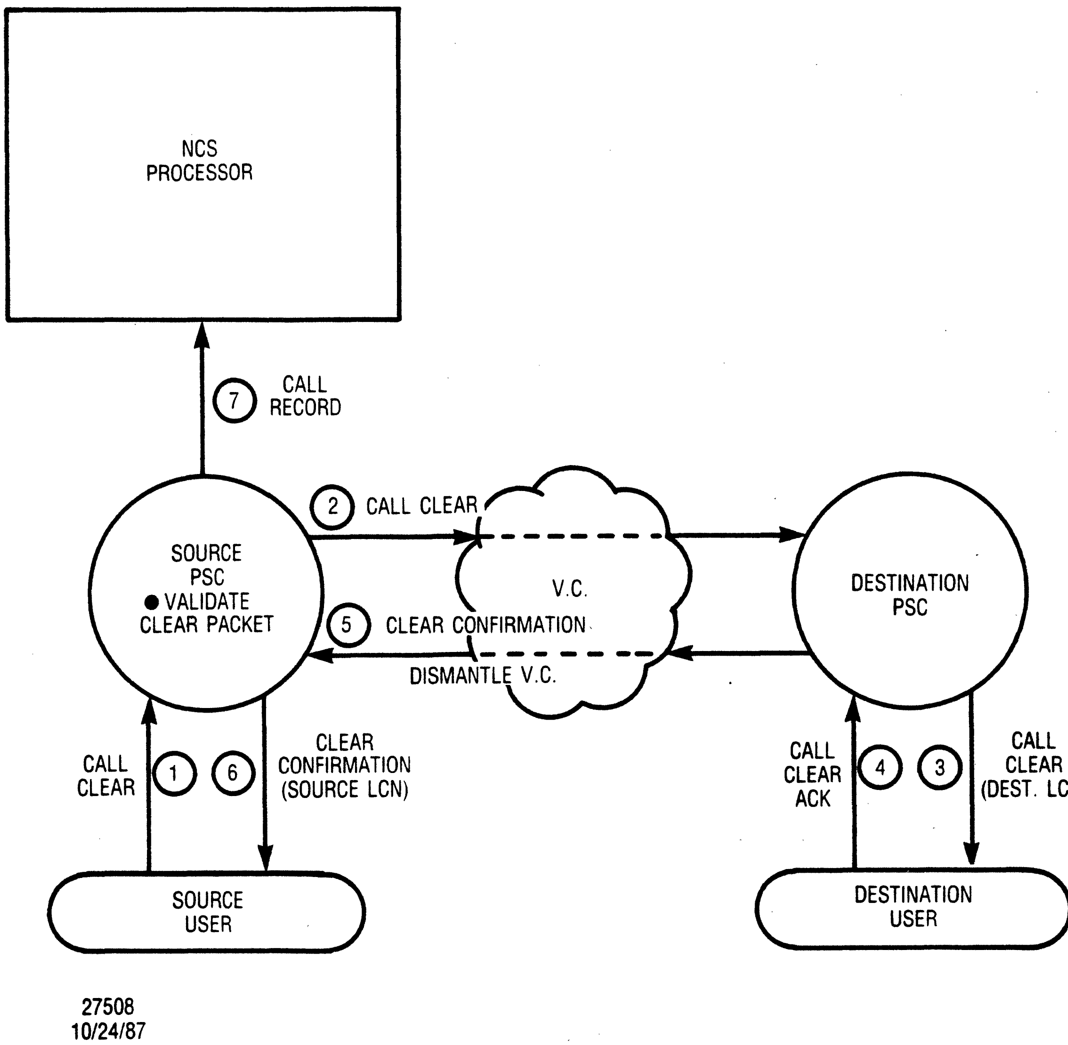
# CALL CLEARING



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# ROUTING
# 7.2

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# ROUTING

- Call: a Real-Time Connection Between DTEs
- IPN Must Choose Physical Call Route Prior to call Setup and Data Transfer
- Call Records Retain Route Knowledge after Call Clearing
- Internodal vs. Intranodal Routes

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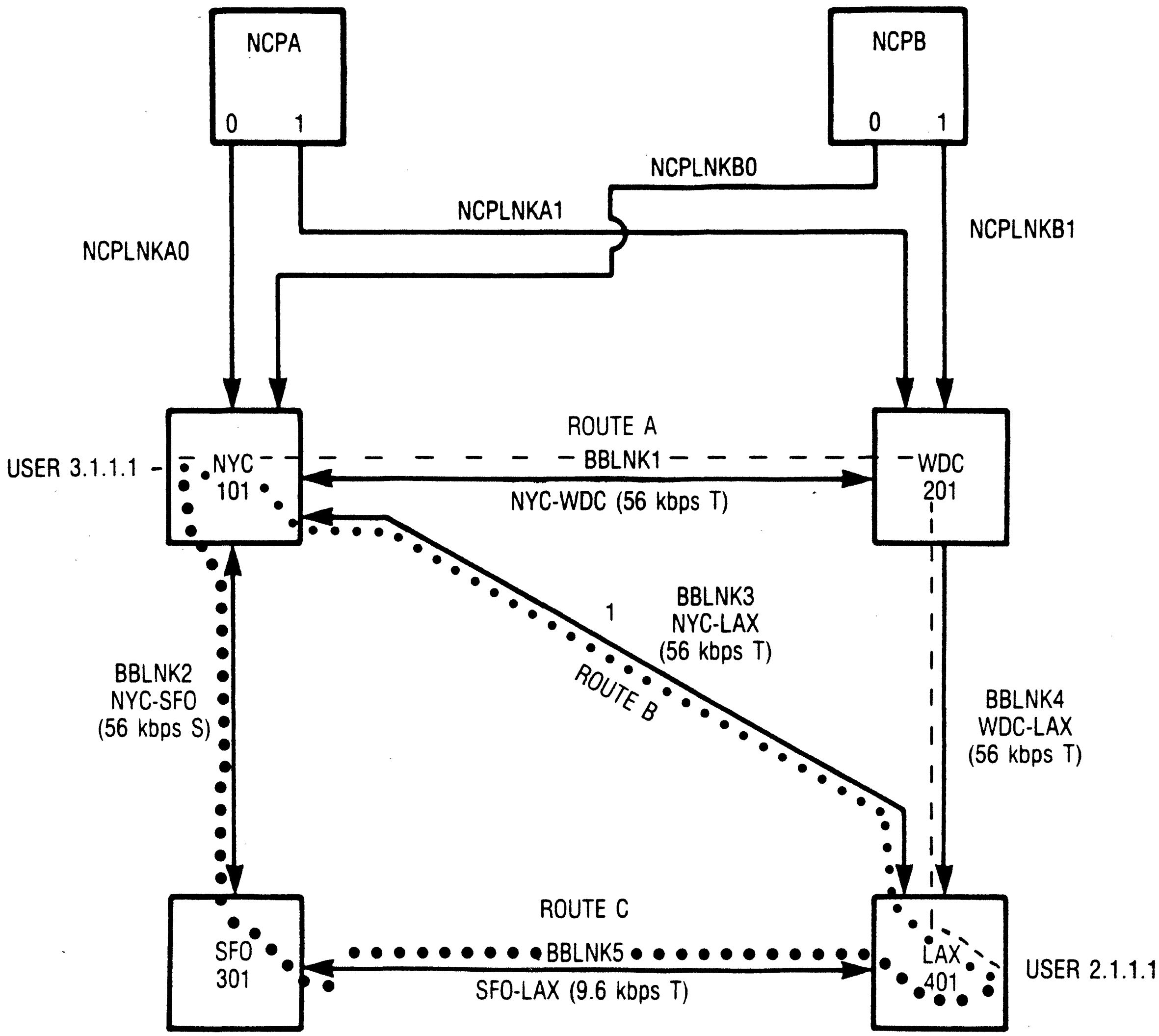
# NETWORK ROUTE FOR EXAMPLE NETWORK

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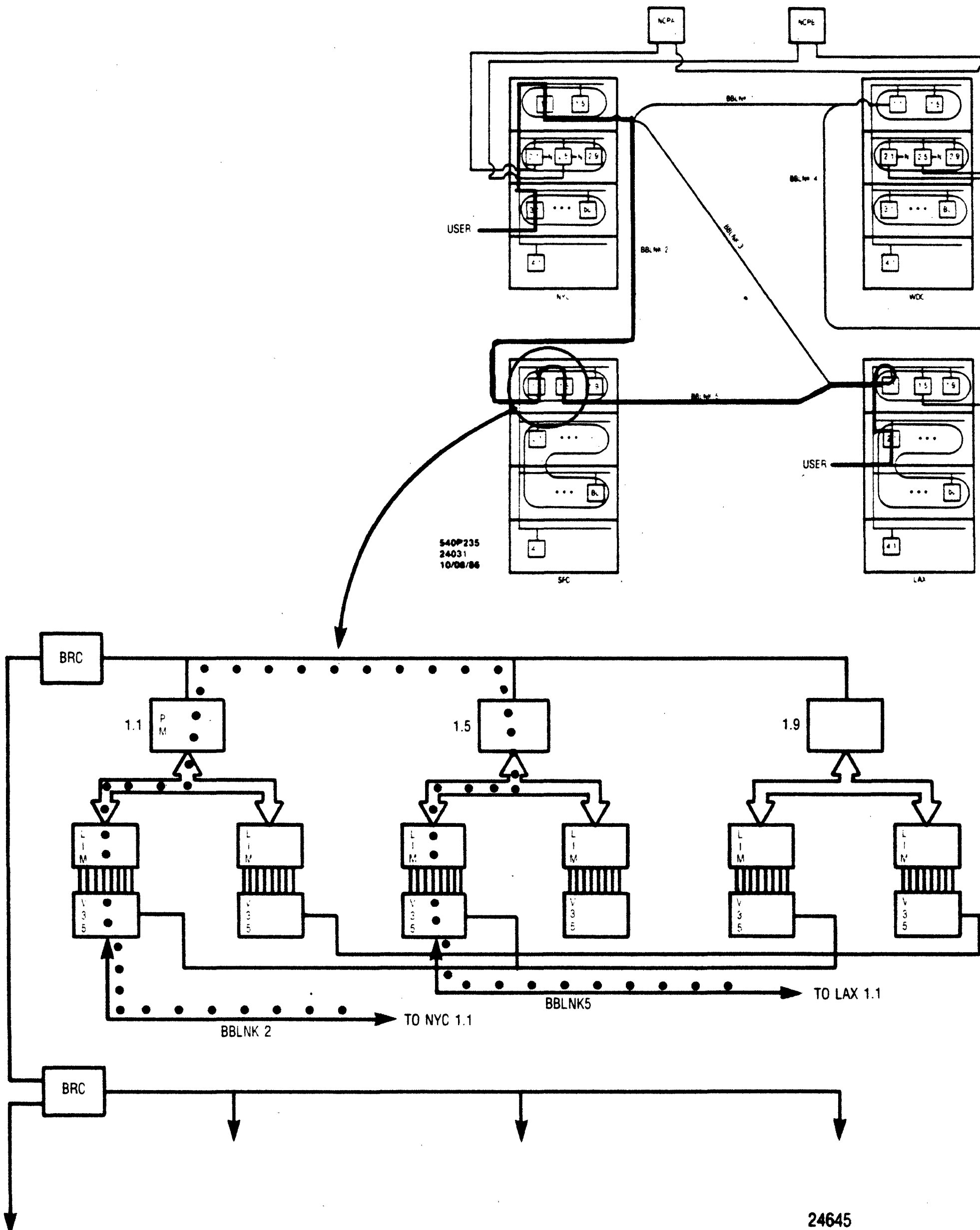
# EXAMPLE NETWORK - ROUTE C AT NODE SFO CLUSTERS 1.1 AND 1.5



# ROUTING: INTERNODAL VS INTRANODAL

- Internodal: Chosen by Source PSC
- INTRA ~~Inte~~rnodal: Chosen by Intermediate PSCs
- MIB Capacity vs. BBL Capacity
  - 10 Mbps vs 64 Kbps
  - MIB Transit time Negligible
  - MIB Crossings (Intranodal Route) Disregarded in Routing

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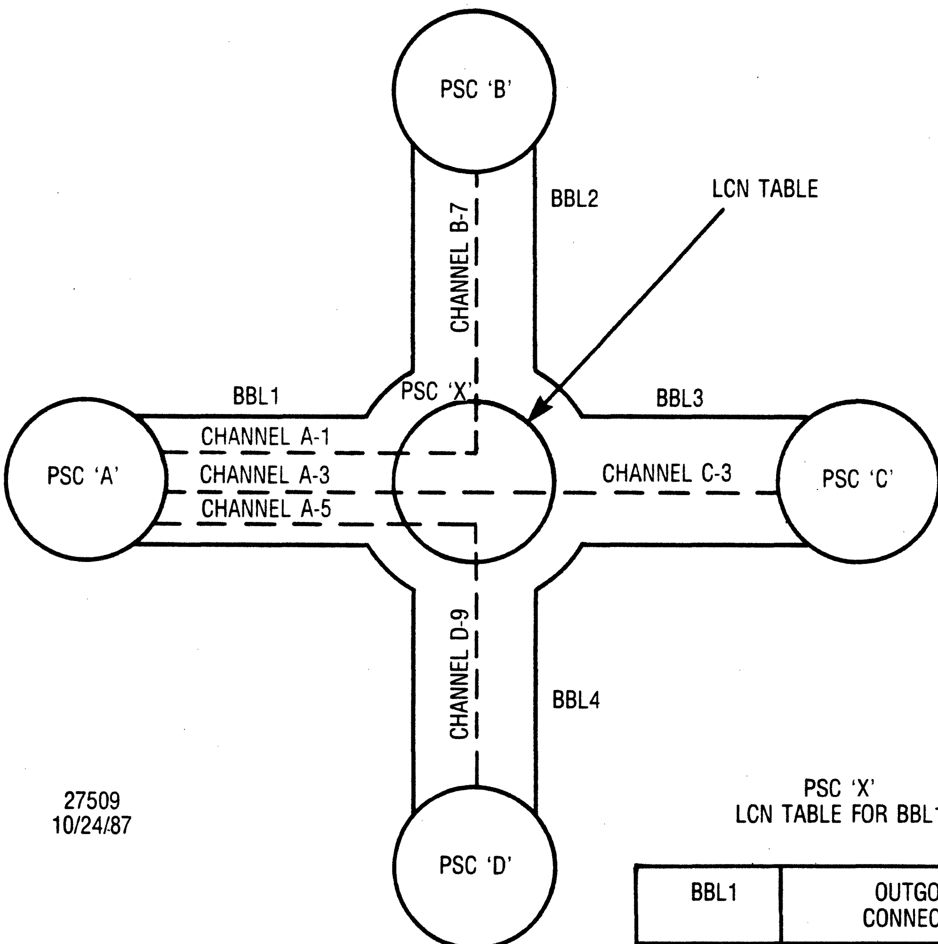
# INTRANODAL ROUTING: LCN CORRELATION TABLE

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PSC 'X'
LCN TABLE FOR BBL1

| BBL1 | OUTGOING CONNECTION | |
|---|---|---|
| LCN | LINK # | LCN |
| 1 | 2 | 7 |
| 2 | - | - |
| 3 | 3 | 3 |
| 4 | - | - |
| 5 | 4 | 9 |
| 6 | - | - |
| | ETC. | |

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# ROUTING ALGORITHM
# 7.2.1

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# ROUTING ALGORITHM FEATURES

- Route "Length"
  - Dimensionless
  - Measure of Link Desirableness
  - "Short" Routes Favored
  - Configurable Parameter
- Source Routing (vs. Node-by-Node)
  - Avoids Routing Loops
  - Conserves Network Resources (e.g., Memory)

# ROUTING ALGORITHM

Source Clusters Consider the Following Factors in Determining a Route for the Call:

- Network topology - The Connections of All Backbone Links Which are Currently Capable of Carrying Traffic
- Backbone Link Type - The Link type is an Arbitrary Number with Regard to the Routing Algorithm, but it is Used to Represent Link Categories Such as: Satellite Links or Terrestrial Links (Range 1-16)
- Remaining Backbone Link Capacity - the "Unused" Transmission Capacity Which remains on Each Backbone Link (Range 0-65535)
- Backbone Link Congestion - The Delay at Each Link caused by the Queue of Packets to be Transmitted on that Link (Range 0-255 ms)
- COS - The Class of Service of the Call to be Routed (Range 1-16) FIRST 4 RESERVED FOR SUPERNET,
- Call Traffic - The Amount of Traffic the Call being Routed is Estimated to Offer (Range 0-255)

# ROUTING DATA STRUCTURES

- BBL Table
- COS Table
- SLTP
  OURCE INK RAFFIC ARAMETER

# DATA STRUCTURE FEATURES

- Distributed - Each PSC Holds a Copy
- Two Types
  - Static/Configurable
  - Dynamic
- Available - Maintained Independently of Routing Attempts

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# ROUTING ALGORITHM BACKBONE LINK TABLE

- Static/Configurable
- Dynamic
- Accurate - Unavailable Links Omitted
- Current - Defines Operating Topology

| INA 1 | INA 2 | (1-16) LINK TYPE | (0-65535) REMAINING CAPACITY | (0-255 ms) QUEUEING DELAY |
|---|---|---|---|---|
| | | | | |
| | | | | |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| | | | | 255 = ∞ |

$\underbrace{\text{INA 1 \quad INA 2 \quad LINK TYPE}}_{\text{CONFIGURED}}$ $\underbrace{\text{REMAINING CAPACITY \quad QUEUEING DELAY}}_{\text{DYNAMIC}}$

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INA = NODE. CHASSIS. SLOT. MODULE. PORT

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# BBLNK TABLE NOC SCREEN

-BBLNK TABLE- Quick Access - __________ Backbone Link Table

Node Name : _______ Cluster Num : __.__ _

| Link Name | Utilization | Rem Capacity | Type | Delay |
|---|---|---|---|---|
| | | | | |

First Page | | | | | | | | Quick Acc | TOGGL PREV

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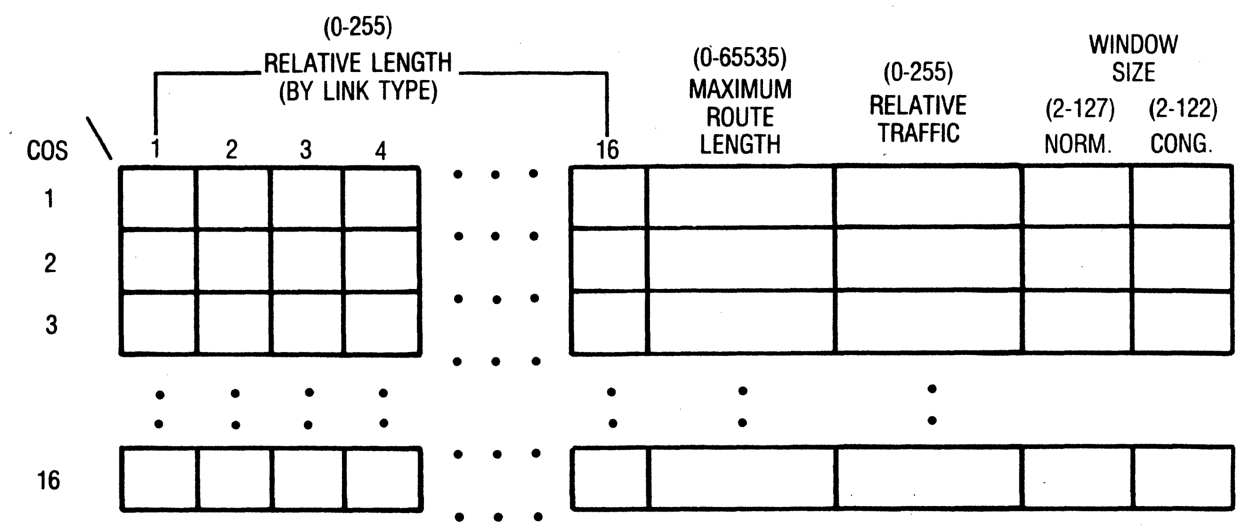
# ROUTING ALGORITHM CLASS OF SERVICE TABLE

- Static/Configurable
- Prioritizes User Service

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# COS AND WINDOW SIZE

- COS Influences Internal Windows
- High Priority COS → Large Window
- Low COS calls are "Throttled"
- Window Sizes:
  - Normal = 2 - 127
  - Congested = 2 - 122

# CLASS OF SERVICE ASSIGNMENTS

- 16 Classes of Service (COS)
- HNS Recommends COS 1 - 4 be Reserved for System Level calls

  1- Supernet Calls
  NCP → PSC/ASP calls

  2- Reserved

  3- NOC → NCP Calls
  PSC → NCP DLL Requests

  4- PSC → ASP DLL Requests
- COS 5 - 16 for Subscribers (12 Classes)

# ROUTING: COS NOC SCREEN

-CLASS SERV- Quick Access - ________ Class of Service

Class of Service Number : __

| Link Type | Relative Length |
|---|---|
| 1 | ___ |
| 2 | ___ |
| 3 | ___ |
| 4 | ___ |
| 5 | ___ |
| 6 | ___ |
| 7 | ___ |
| 8 | ___ |
| 9 | ___ |
| 10 | ___ |
| 11 | ___ |
| 12 | ___ |
| 13 | ___ |
| 14 | ___ |
| 15 | ___ |
| 16 | ___ |

Description:
________________________________________

Max Route Length ............... : _____
Relative Traffic Factor ........ : ___
Normal Window .................. : ___
Congested Window ............... : ___

| Read | | Modfy | | | | | | Quick Acc | TOGGL PREV |
|---|---|---|---|---|---|---|---|---|---|

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# SOURCE LINK TRAFFIC PARAMETER

- Used in Routing Algorithm
- Associated with Source Port
- Configured for X.25/X.75 User Ports
- Estimates Traffic Originating at Port

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# ROUTING ALGORITHM PROCEDURE 7.2.2

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# ROUTING PROCEDURE

## 1. Estimate Call Traffic:

Estimated Traffic = Rel Traff (COS Table) * SLTP (Port Parm)

## 2. Remove BBLs where:

Rem Capacity < Estimated Traffic
(BBL Table)

## 3. Calculate BBL Lengths:

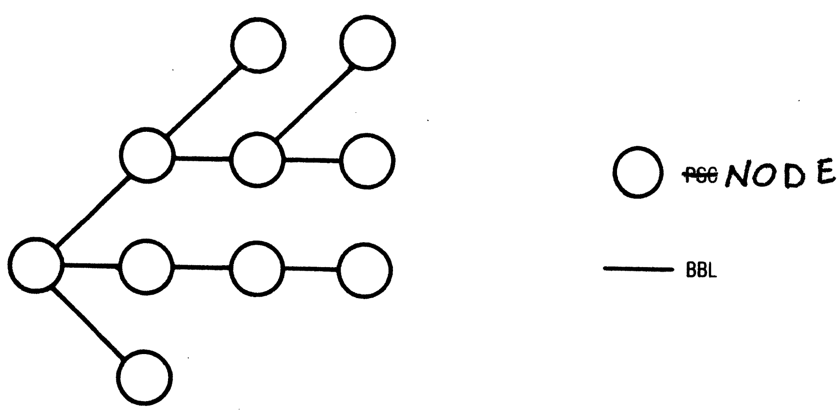
For each BBL:

Length = Rel. Length (COS Table) + (Queue Delay ÷ 10) (BBL Table)

If Length = ∞, Remove BBL

## 4. Build Minimum Length Path Tree

Route Length = Link A Length + Link B Length + ...

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# ROUTING PROCEDURE (Cont.)

5. IF Destination Node Not in Tree:
   THEN Reject Call Request

6. IF Route Length > Max Route Length
   (COS Table)
   THEN Reject Call Request

7. Send Call Setup Packet to Destination
   - Each PSC Validates
     - Link Availability
     - Buffer Availability

8. IF Call Setup Fails
   THEN 1. Remove Unavailable Link
   2. Retry Routing Procedure

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# MINIMUM PATH TREE

1. Draw Topology Labeled by Link Types

2. Determine COS

3. Calculate Length for Each BBL Type

| Link Name | Link Type | REL Length | + [QDelay/10] | = Length |
|---|---|---|---|---|
| BBL 1 | 1 | | | |
| BBL 2 | 3 | | | |
| BBL 3 | 1 | | | |
| BBL 3 | 1 | | | |
| BBL 4 | 1 | | | |
| BBL 5 | 2 | | | |

4. Label each BBL with its Length

5. Draw Source Node of Path Tree

6. For each node, Compute Length of each Possible Route and Select the "Shortest Route"

7. Working from the "Nearest" to the "Farthest" Node, Draw the Tree to each Node, Labeling each Link with its Name and Length

# ROUTING
# DIRECT DESTINATION ADDRESSING FACILITY (DDAF)

- Overrides Routing Algorithm
- INA vs X.121
- Forced Port-by-Port Routing
- Example: Measuring Link Delays During Debug

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# ROUTING EXAMPLES
# 7.2.3

# ROUTING ALGORITHM EXAMPLE 1: MINIMUM TRANSIT DELAY

One Class of Service, say COS 1, might be one which Requires the Minimum Data Transmit Delay Possible Regardless of any other Factors. Suppose that the Network is made up of Backbone Links with the Following Characteristics:

| Type | Description |
|---|---|
| 1 | 56 kbps Terrestrial Links |
| 2 | 9.6 kbps Terrestrial Links |
| 3 | 56 kbps Satellite Links |

The Lengths of each of These Link Types need to be set in the Class of Service Table for this Class of Service. Since the Length in this Table is a Relative Avoidance Factor, the Length set Should be Proportional to the Average Transit Delay on a Link of that Type. There are four Components to the Average Transit Delay:

- Propagation Delay on the Link
- Transmission time for an Average Length Packet of this Class of Service
- Switching time Through a Node
- Queuing Delay on the Link.

# ROUTING ALGORITHM EXAMPLE 1: MINIMUM TRANSIT DELAY (Cont.)

The Queueing Delay Factor is Built into the Routing Algorithm, so only the First Three Factors need to be Considered. Assume the Following:

- One-way Satellite Link Propagation Delay is 260 ms
- One-way Terrestrial Link Propagation Delay is 10 ms
- The Average Packet is 1000 bits long (Including Overhead)
- Intranodal Switching Delay is 20 ms.

Then the Delay Factors for each link type are:

- 56 kbps Terrestrial: 10 ms + 18 ms + 20 ms = 48 ms
- 9.6 kbps Terrestrial: 10 ms + 104 ms + 20 ms = 134 ms
- 56 kbps Satellite: 260 ms + 18 ms + 20 ms = 298 ms.

# ROUTING ALGORITHM EXAMPLE 1: MINIMUM TRANSIT DELAY (Cont.)

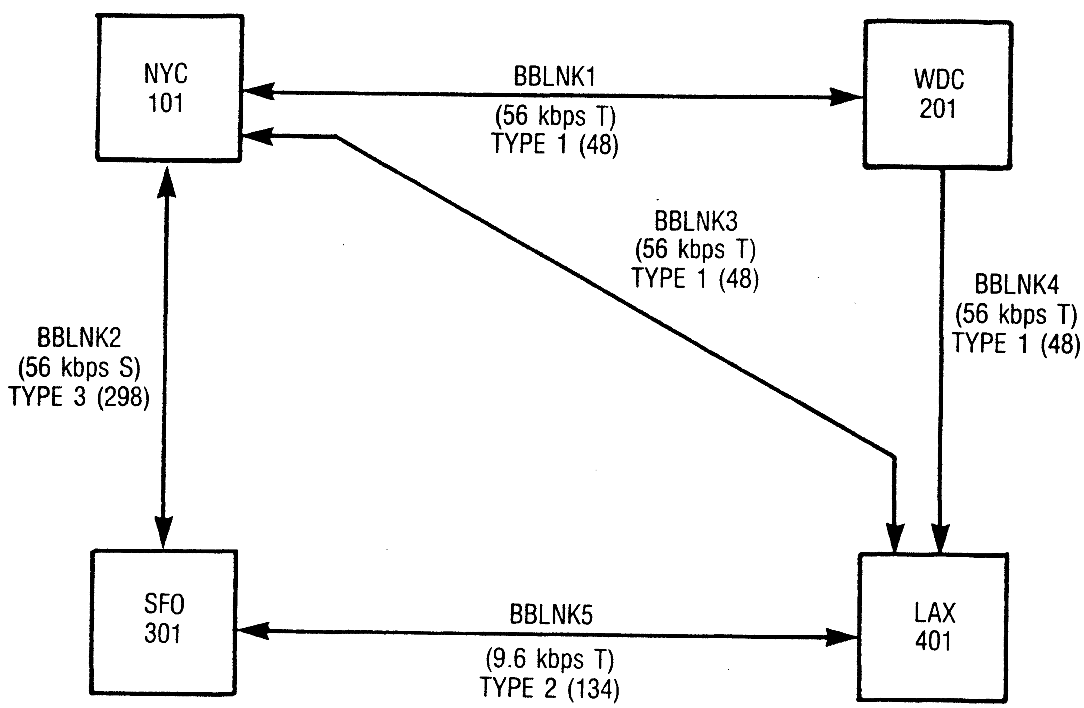
Therefore, the Class of Service Table Might look like this:

| | RELATIVE LENGTH (BY LINK TYPE) | | | | | | MAXIMUM ROUTE LENGTH | RELATIVE TRAFFIC |
|---|---|---|---|---|---|---|---|---|
| COS | 1 | 2 | 3 | 4 | . . . | 16 | | |
| 1 | 48 | 134 | 298 | | . . . | | | |

- ~~The Routing Algorithm will Favor Type 2 Links (56 kbps - terrestrial) over Type 3 links (9.6 kbps - terrestrial) and Type 3 Links over Type 1 Links (56 kbps - Satellite). This does not mean that only Type 2 Links will be used. It does mean that Type 2 Links will be Heavily Favored in the Absence of Significant Queuing Delay.~~

# ROUTING ALGORITHM EXAMPLE 1: MINIMUM TRANSIT DELAY (Cont.)

## *Network Topology*




*ASSUME QUEUING DELAY = 0

REL. LENGTH ( )

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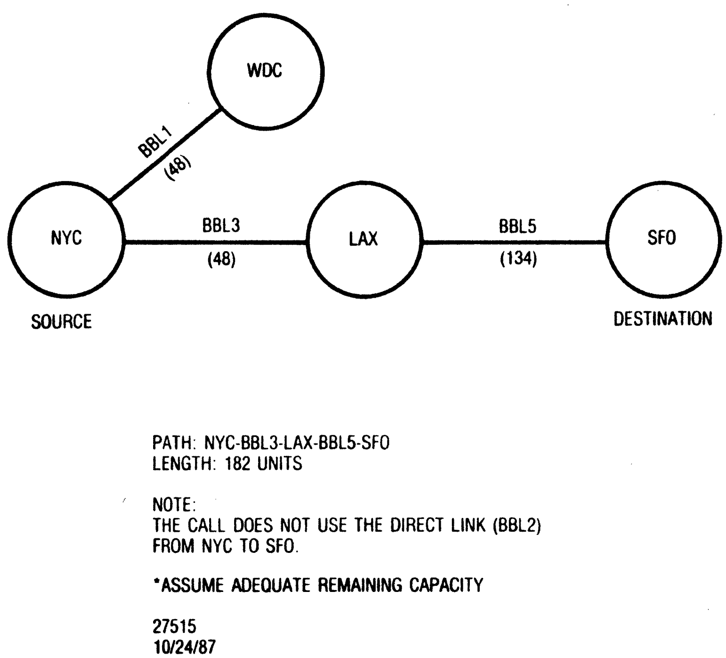
# ROUTING ALGORITHM EXAMPLE 1: MINIMUM TRANSIT DELAY (Cont.)

## *Minimum Length Path Tree*




**Path:** NYC-BBL3-LAX-BBL5-SFO

**Length:** 182 Units

**Note:** The call does not use the Direct Link (BBL2) from NYC to SFO.

* Assume Adequate Remaining Capacity

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# ROUTING ALGORITHM EXAMPLE 2: MINIMUM COST

Another Possible Class of Service, say COS 2, is one where a Large Volume of data is to be sent, but where data Transit Delay is not Important. The link Lengths for this Class of Service might be set Based on the cost of Providing the Transmission Facilities. Assume, for Example, the Following link costs:

- 56 kbps Terrestrial Links: \$10,000/mo./56 kbps = \$179/mo./1 kbps
- 9.6 kbps Terrestrial Links: \$3,000/mo./9.6 kbps = \$312/mo./1 kbps
- 56 kbps Satellite Links: \$4,000/mo./56 kbps = \$71/mo./1 kbps.

Then the Class of Service Table for this Class of Service might be filled out as Follows:

| | RELATIVE LENGTH (BY LINK TYPE) | | | | | | MAXIMUM ROUTE LENGTH | RELATIVE TRAFFIC |
|---|---|---|---|---|---|---|---|---|
| COS | 1 | 2 | 3 | 4 | . . . | 16 | | |
| 1 | 48 | 134 | 298 | | . . . | | | |
| 2 | 179 | 312 | 71 | | . . . | | | |

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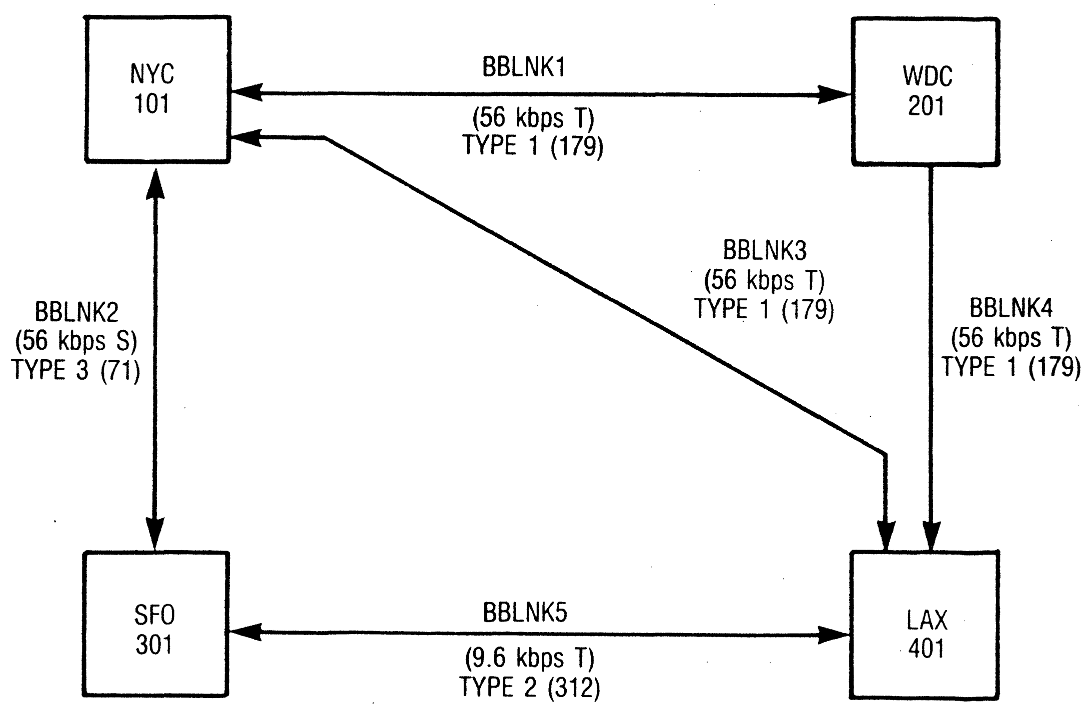
# ROUTING ALGORITHM EXAMPLE 2: MINIMUM COST (Cont.)

## *Network Topology*

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*ASSUME NO QUEUING DELAY

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# ROUTING ALGORITHM
# EXAMPLE 2: MINIMUM COST (Cont.)

## *Minimum Length Path Tree*

PATH: NYC-BBL2-SFO
LENGTH: 71 UNITS

*ASSUME ADEQUATE REMAINING CAPACITY

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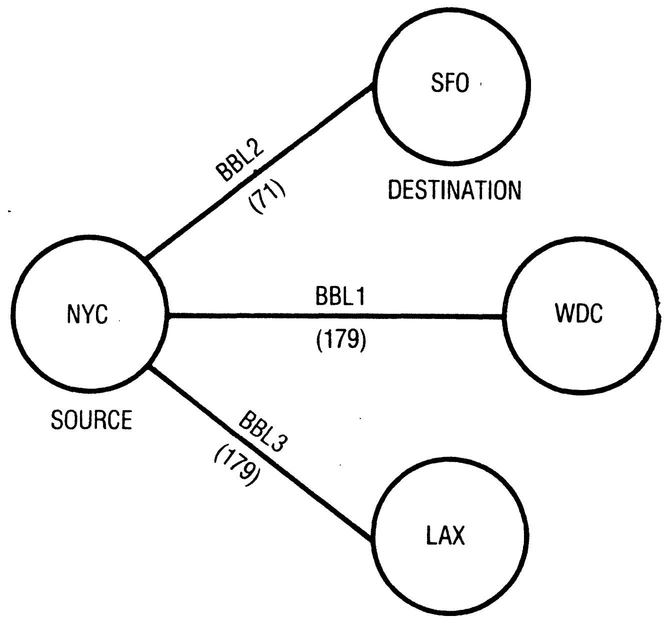


**Path: NYC-BBL3-SFO**
**Length: 71 Units**

*** Assume Adequate Remaining Capacity**

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# ROUTING ALGORITHM
# EXAMPLE 3: PRIVATE ROUTE

Cases may arise where it is Desirable to put only calls of a Particular Class of Service on a Particular Link or set of Links. This might occur if it is Desirable to put Downline Loads or Supervisory Traffic on their own links or if a user pays for a Transmission Facility for his Private use. To accommodate these cases, these "Private" Links are Assigned a Unique type, say Type 4, and the Valid Users are Given a Unique COS, say COS 3. The COS Table might look like this:

| | RELATIVE LENGTH (BY LINK TYPE) | | | | | | | MAXIMUM |
|---|---|---|---|---|---|---|---|---|
| COS | 1 | 2 | 3 | 4 | . . . | 16 | ROUTE LENGTH | RELATIVE TRAFFIC |
| 1 | | | | Inf | . . . | | | |
| 2 | | | | Inf | . . . | | | |
| 3 | Inf | Inf | Inf | 0 | . . . | | | |

Inf = Infinite Length

# ROUTING ALGORITHM
# EXAMPLE 3: PRIVATE ROUTE (Cont.)

In this Example, Link Type 4 can only be used by COS 3, and calls of COS 3 ~~can only be made on Type 4 Links~~. It is also Possible by Configuring Other Values in the Class of Service Table for calls of COS 3 Simply to Favor (not Exclusively) Type 3 Links while Letting no other Class of Service use these Links.

| | RELATIVE LENGTH (BY LINK TYPE) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| COS | 1 | 2 | 3 | 4 | . . . | 16 | MAXIMUM ROUTE LENGTH | RELATIVE TRAFFIC |
| 1 | 48 | 134 | 298 | Inf | . . . | | | |
| 2 | 179 | 312 | 71 | Inf | . . . | | | |
| 3 | 48 | 134 | 298 | 0 | . . . | | | |

# ROUTING ALGORITHM: EXAMPLES CLASS PARTICIPATION

Draw the Minimum path tree for:

1. COS 2 from NYC to LAX where:
   - BBL6 = 56 kbps S from SFO-LAX
2. COS 2 from NYC to SFO where:
   - Queuing Delay on BBL2 = 255
3. COS 1 from WDC to SFO where:
   - Queuing Delay on BBL4 = $\alpha$

# 7.3
# CONGESTION & FLOW CONTROL

# CONGESTION & FLOW CONTROL GENERAL

The Objective of Congestion and Flow Control is to Limit the Amount of Traffic Which the Network Accepts from Users to Levels Which it can Carry Efficiently. These Mechanisms Work Together to Prevent Significant Build Up of Buffered Data Within the Network and to Restore Normal Operation if Build Up does Occur.

# 7.3.1
# DEFINITIONS

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# DEFINITIONS
# CONGESTION: THE PROBLEM

## *In a PSC:*

Congestion: A Low Number of Available Data Buffers

Cause: Received Data > Transmitted Data (For a Significant Period)

Possible Results for the User:

- Poor Response
- Call Blocking
- Call Clearing
- ~~Data Loss~~s

# DEFINITIONS: THE SOLUTION: FLOW CONTROL

## *Flow Control Objectives:*

PSC:

- Prevent Congestion (Low Free Buffer Count)
- Reverse Blocked/Congested Conditions
- Manage and Recover from Persistent Congestion

User:

- Avoid Call Clearing
- Avoid Call Blocking
- ~~Avoid Data Loss~~
- Good Response

Overall:

- Assumption: Correct Network Design
  - User Interface
  - Size
  - Topology
  - Supernet
  - System Parameters

- Avoid Basic Cause: Receive > Transmit
  1) User Interface
  2) Internally

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# 7.3.2
# FLOW CONTROL ISSUES

# FLOW CONTROL ISSUES

- Buffer Management Scheme
- Determining Congestion
- Efficiency of Mechanisms
  - Sensitivity
  - Speed

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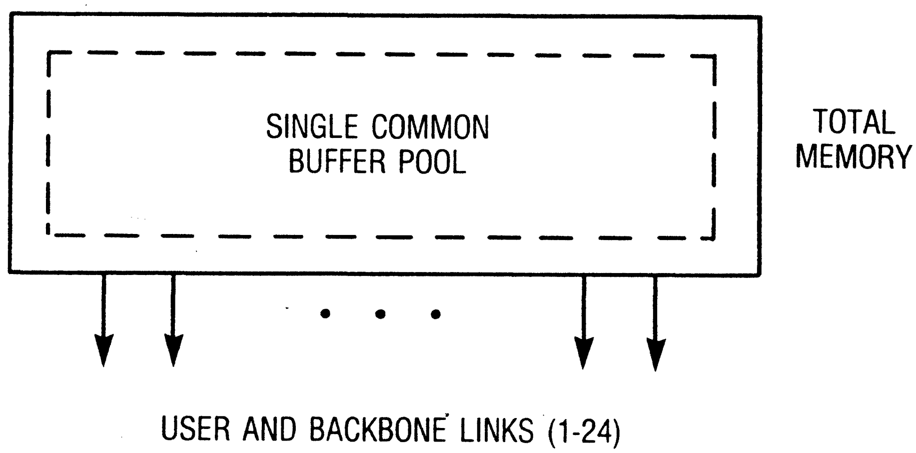
# BUFFER MANAGEMENT SCHEMES

**1) Per Cluster Buffer Pool**

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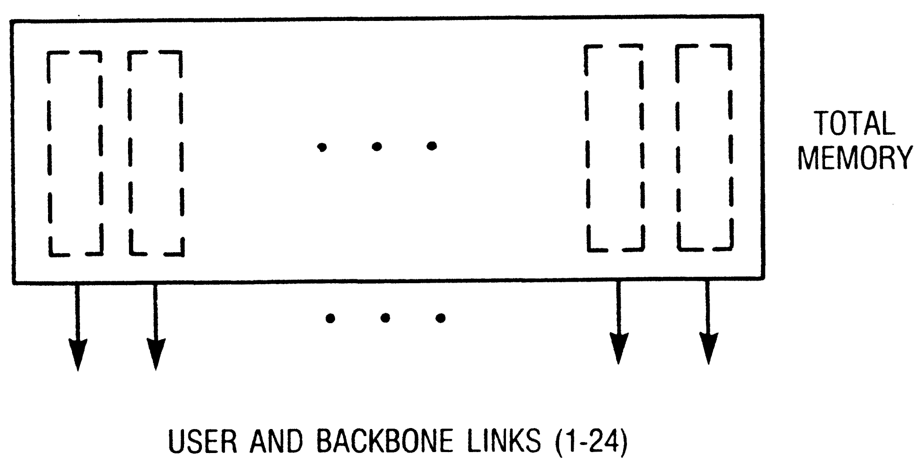
**+ Reduced Memory/Statistical Requirements**

**- Monopolies: Buffer "Hogging" by One or More Links**

**2) Per Link Buffer Pool**

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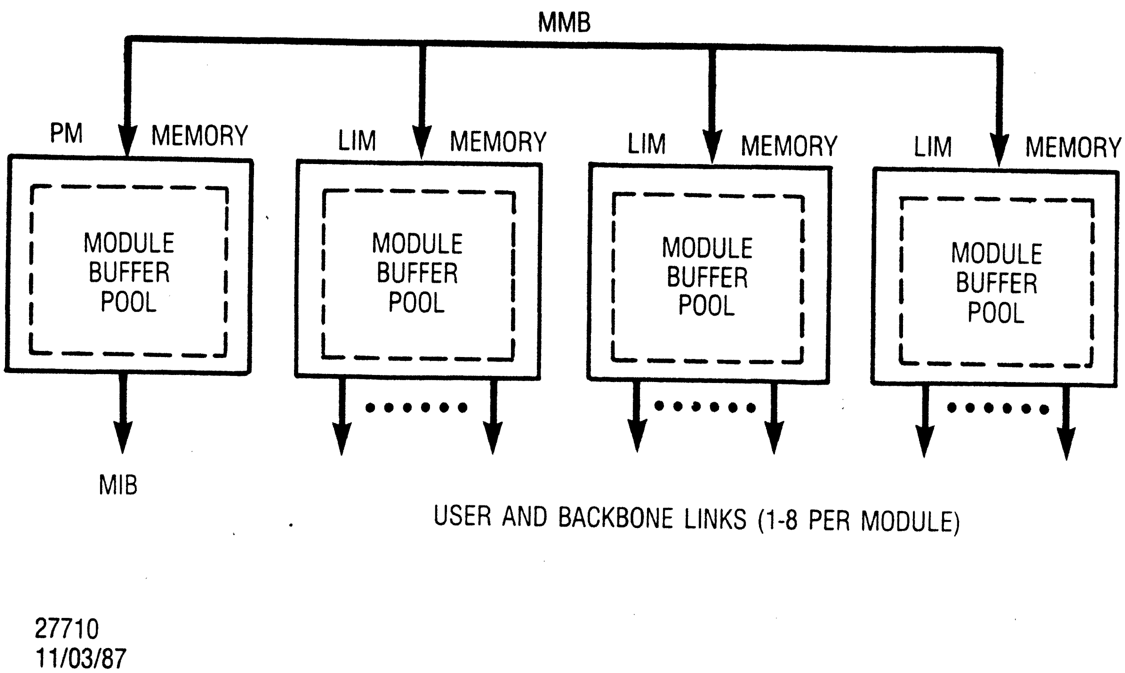
**+ No Monopolies (Buffer "Hogging" ---> Blocking)**

**- Statistical Complexity ---> Limits Number of Links per Cluster**

# BUFFER MANAGEMENT SCHEMES (Cont.)

3) Per Module Buffer Pool




+ **Reduced Memory Requirements**
+ **Statistical Sharing of Resources (per Link)**
+ **Controls Link Monopolies (Buffer "Hogging")**

# DETERMINING CONGESTION

- **Four Congestion Levels**

POSSIBLE CONGESTION DEFINITION TABLE

| LEVEL | NUMBER ACTIVE PORTS | | | | | | | | MODULE CONGESTION |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| CRITICAL | (90) | (65) | | | | | | | |
| MODERATE | | | | | | | | | |
| SLIGHT | | | | | | | | | |

PERCENT MODULE BUFFERS USED

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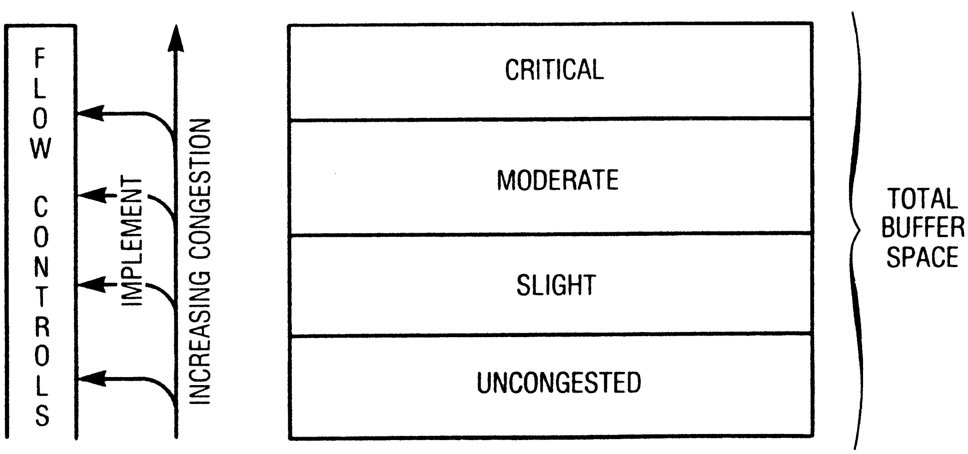
- **Two Congestion Areas**
  1) **Module - Percent Total Buffers in-Use**
  2) **Port - Percent Module Buffers in-Use for Port Transmit Queue**




- **Port Congestion is a Function of # Active Ports**
- **Congestion Level = Larger (Module, Port)**

# EFFICIENCY OF MECHANISMS

- Receiver - Initiated
  - Congestion: Receive > Transmit
  - Transmit-Initiated Control:
    a) Worsens Congestion
    b) Clears Uncongested Resources
- Speed/Sensitivity
  - Speedy Distribution of Flow Control Info is Critical
  - Control Packets Queued to Head of TX Queues
  - Local Controls Vs. "Back-Pressure"

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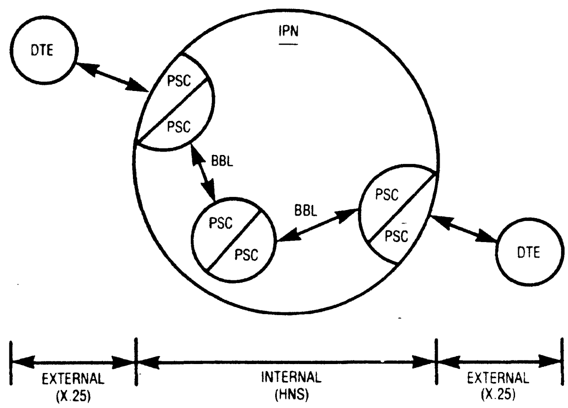
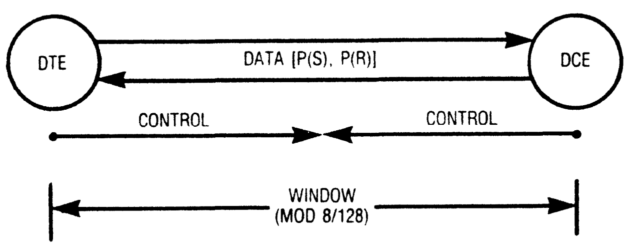
# FLOW CONTROL MECHANISMS: EXTERNAL




- Objective: Limit Receive = Transmit Rates for DCE Clusters
- Based on Congestion of Access PM/LIM

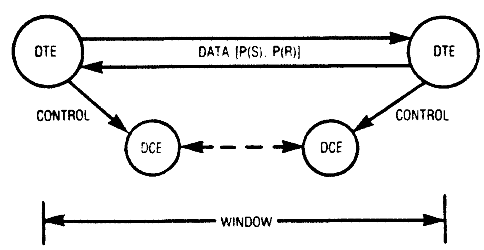
1) DTE-DCE (Receiver-Initiated)

- Local Window Negotiation
- RNR/RR
- Reset (07), Clear (05,) Restart (03), Indication - (Cause Code)
- Reject Calls




2) DTE-DTE (Receiver-Initiated)

- End-to-End Window Negation

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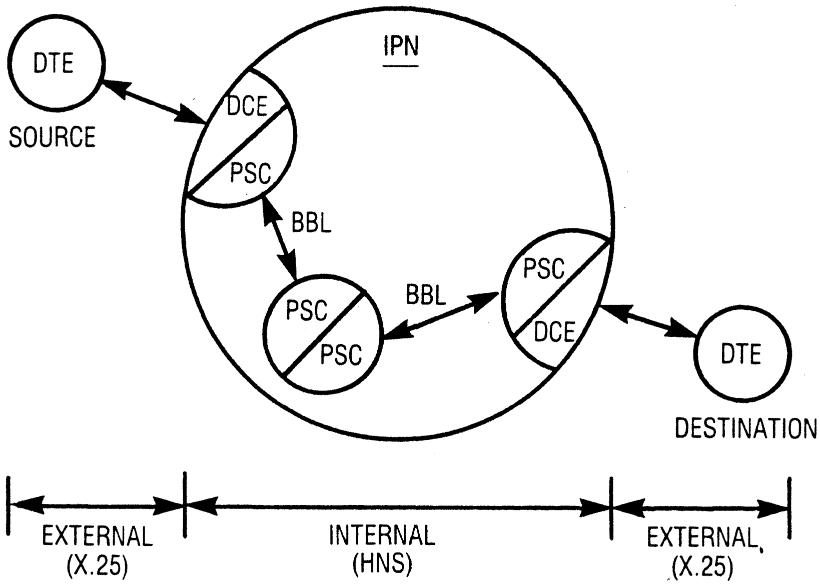
# FLOW CONTROL MECHANISMS: INTERNAL

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- **Edge Clusters:**
  1) **Call Setup/Routing Controls**
  2) **Internal (DCE-DCE) End-to-End Windowing**

- **Backbone Clusters:**
  3) **Packet Level Windowing**
  4) **Link Level Windowing**
  ~~5) Link Clearing~~
  6) **Call Clearing**

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# INTERNAL FLOW CONTROL MECHANISMS: EDGE CLUSTERS

## 1) Call Setup/Routing Flow Controls

Remaining Capacity (R.C.)

- Reported by Endpoint PSCs for Local BBLs
- Add/Subtract Estimated Traffic from R.C. of BBL for each Call Setup/Clear
- Low RC ----> Reject Call Setups
- PSC Congestion Affects RC for Local BBLs

CHANGE IN FREE BUFFER COUNTS

| CONGESTION LEVEL | REPORTED CAPACITY PER LINK | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | .......... | N |
| CRITICAL | 0 | 0 | 0 | | 0 |
| NON-CRITICAL | ACTUAL VALUE | | | | |

Queueing Delay (Q.D.)

- Based on Length of BBL Transmit Queue


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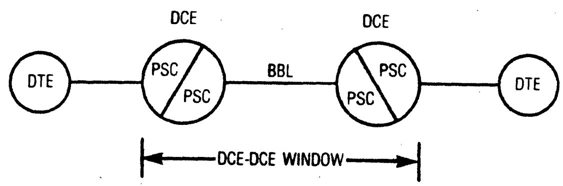
- High ~~[illegible]~~ QD ----> ~~Reject Call Setups~~ AVOID CONGESTED LINKS AT CALL SET UP TIME.

# INTERNAL FLOW CONTROL MECHANISMS: EDGE CLUSTERS

## 2) Internal (DCE-DCE) End-to-End Windowing

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- Objective:
  1) Prevent Calls from "Hogging" Network Resources
  2) Limit Number of Outstanding Packets per Call
  3) Allocate Resources Desirably Among COSs
  4) Control Congestion in Edge Clusters

- Methods:
  - Configured per COS
  - Implemented per VC
  - Controlled by Edge PSCs (DCEs)
  - Independent/Bidirectional
  - Normal vs. Congested
  - May Affect DTE-DCE Windows

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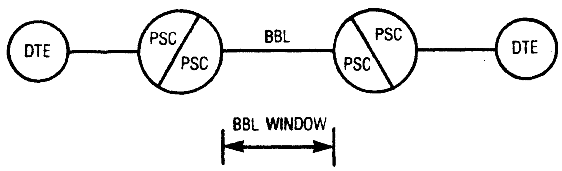
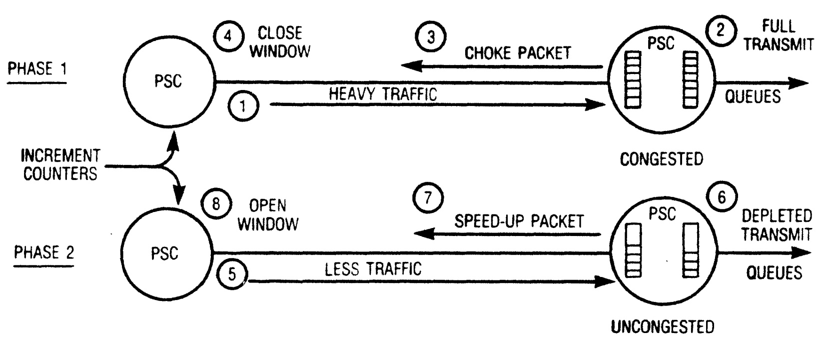
# INTERNAL FLOW CONTROL MECHANISMS: BACKBONE CLUSTERS

## 3) BBL Packet Level Windowing




- **Objectives:**
  - Limit Number Outstanding Packets on Link
  - Limit Receive = Transmit Rates for BBL Clusters
- **Method:**
  - Configured per BBL
  - Window Affects all Incoming VCs
  - Receiver Controlled
  - Independent/Bidirectional
  - Choke/Speed-up Packets
  - Based on Congestion of Receive PSC

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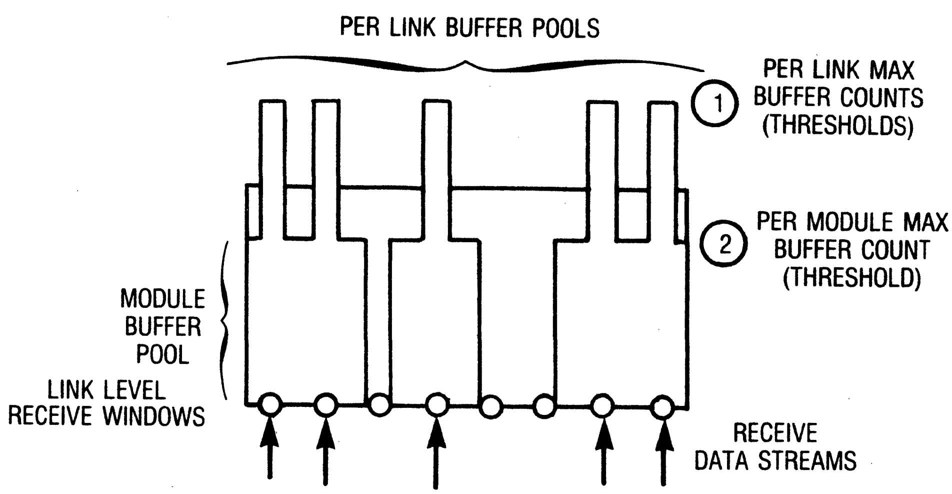
# INTERNAL FLOW CONTROL MECHANISMS: BACKBONE CLUSTERS (Cont.)

## 4) Link Level Windowing (Severe Congestion)

- **Objectives:**
  1) Supplement Packet Level Flow Control During Severe Congestion
  2) Rectify a Zero Free Buffer Count (Module or Link)
- **Methods: A. Flow Control Triggers**

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*IPN*™

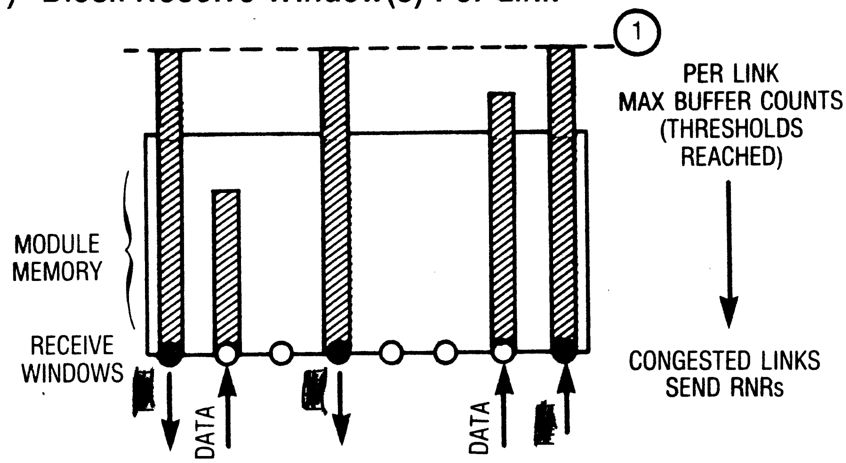
*Training Department*

# INTERNAL FLOW CONTROL MECHANISMS: BACKBONE CLUSTERS (Cont.)

## 4) Link Level Windowing (Cont.)

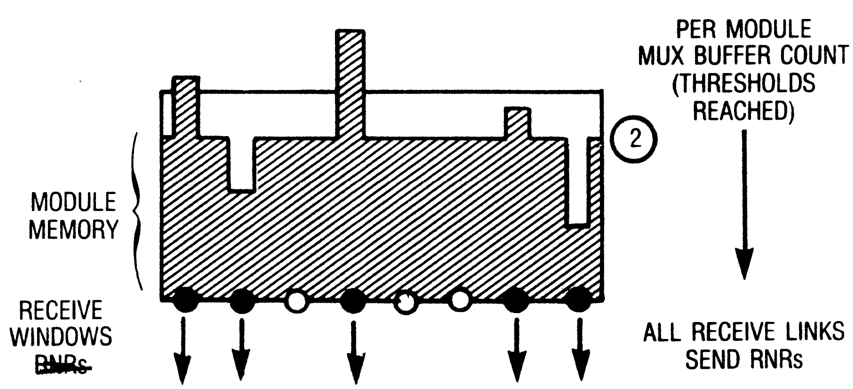
- **Methods (Cont.): B. Triggered Responses**

**1) Block Receive Window(s) Per Link**




Drop Packets + Retransmit

**2) Block Receive Windows Per Module**




Drop Packet + Retransmit

27758
11/04/87 ~~3) As Queues Deplete, Unblock Windows (Send RBs)~~

# INTERNAL FLOW CONTROL MECHANISMS: BACKBONE CLUSTERS (Cont.)

## 5) BBL Clearing (Severe Congestion)

- Objective:
  - Prevent "Gridlock" on all BBLs After Link Level Blocking
- Methods:
  - Resets BBLs With Highest <u>Receive</u> Packet Counts
  - All Calls on BLL Cleared to Source PSC (DLE)
  - Associated Buffers Released
  - ~~Other BBLs Unblock Windows~~
  - Cleared Calls Rerouted/Reconnected (if Possible)
- Notes:
  1) Clearing Congested BBLs with High Transmit Counts May Actually <u>Worsen</u> Conditions and Clear Uncongested Modules
  2) If an Entire Module is Congested (vs. One Link), More Than One Link Will Be Cleared

# INTERNAL FLOW CONTROL MECHANISMS: BACKBONE CLUSTERS (Cont.)

## 5) Call Clearing (Severe Congestion)

- Objective:
  - Limit Data Flow into Network when other Mechanisms have Failed to Control Congestion
- Methods:
  - Initiated by Backbone PSC
  - Choose calls at Random
  - This is not fair*
  - Send Clear Indicatio nto DTE
  - Associated Buffers Released

* But it is the way it is

# APPENDIX A

# INTEGRATED PACKET NETWORK (IPN) GLOSSARY OF ACRONYMS

## GLOSSARY OF ACRONYMS

| | |
|---|---|
| **ACC** | Advanced Computer Communications |
| **ACU** | Automatic Calling Unit |
| **ASCII** | American Standard Code for Information Interchange |
| **ASP** | Auxiliary Service Processor |
| **ASYNC** | Asynchronous |
| **AUTODIN** | Automatic Digital Network |
| | |
| **BNS** | Basic Network Services |
| **BPS** | Bits per Second |
| **BRC** | Bus Repeater Card |
| | |
| **CCITT** | Consultative Committee on International Telegraph and Telephone |
| **CLC** | Communications Line Controller |
| **CMDR** | Command Reject |
| **COMM** | Communication |
| **COS** | Class of Service |
| **CP** | Communications Processor |
| **CRC** | Cyclic Redundancy Check |
| | |
| **CRI** | Call Reconnect Identifier |
| **CRT** | Cathode Ray Tube |
| **CSD** | Cluster Specific Descriptor |
| **CSPDN** | Circuit Switched Public Data Network |
| **CT** | Convergent Technologies |
| **CTOS** | Convergent Technologies Operating System |
| **CUG** | Closed User Group |
| | |
| **DBMS** | Database Management System |
| **DCE** | Data Circuit-Terminating Equipment |
| **DCL** | Digital Command Language |
| **DDS** | Dataphone Digital Service |

| | |
|---|---|
| **DEC** | Digital Equipment Corporation |
| **DIM** | Disk Interface Module |
| **DISC** | Disconnect |
| **DLE** | Data Link Escape (ASCII Character) |
| **DLL** | Downline Load |
| **DM** | Directory Manager |
| **DMA** | Direct Memory Access |
| **DNIC** | Data Network Identification Code |
| **DTE** | Data Terminal Equipment |
| **DTM** | Diagnostic Task Monitor |
| **ECC** | Error Checking and Correcting |
| **EGW** | Ethernet Gateway Cluster |
| **EIA** | Electrical Industrial Association |
| **ENS** | Extended Network Services |
| **ENS** | External Network Server |
| **EPROM** | Erasable Programmable Read Only Memory |
| **EEPROM** | Electrically Erasable Programmable Read Only Memory |
| **FRD** | First Reconciliation Description |
| **FRMR** | Frame Reject |
| **GPM** | Gateway Processor Module |
| **HDLC** | High-Level Data Link Control |
| **I** | Information |
| **IA5** | CCITT International Alphabet No. 5 |
| **ID** | Identification |
| **IEEE** | Institute of Electronic and Electrical Engineers |
| **INA** | Internal Network Address |

| | |
|---|---|
| **INB** | Internodal Bus |
| **IPL** | Initial Program Load |
| **IWS** | Integrated Workstation |
| **I/F** | Interface |
| **I/O** | Input/Output |
| | |
| **kb** | Kilobyte |
| | |
| **LAP** | Link Access Procedure |
| **LAPB** | Link Access Procedure Balanced |
| **LOGN** | Logical Channel Group Number |
| **LCN** | Logical Channel Number |
| **LED** | Light Emitting Diode |
| **LIM** | Line Interface Module |
| | |
| **Mb** | Megabyte |
| **MIB** | Message Interchange Bus |
| **MIBC** | Message Interchange Bus Controller |
| **MLP** | Multilink Procedure |
| **MMB** | Multi-Master Bus |
| **MPM** | Master Processor Module |
| **MPSC** | Multiprotocol Serial Controller |
| **MTBF** | Mean Time Between Failure |
| | |
| **NAF** | Network Administrative Function |
| **NCP** | Network Control Processor |
| **NCS** | Network Control System |
| **NOC** | Network Operator Console |
| **NSC** | Network Service Center |
| **NVRAM** | Nonvolatile Random Access Memory |
| **NVRP** | Nonvolatile RAM Profile |

## GLOSSARY OF ACRONYMS (Cont.)

| | |
|---|---|
| **OS** | Operating System |
| | |
| **PAD** | Packet Assembler/Disassembler |
| **PAD/PSC** | M/A-COM Integral Asynchronous PAD |
| **PC** | Printed Circuit |
| **PM** | Processor Module |
| **PSC** | Packet Switching Cluster |
| **PSPDN** | Packet Switched Public Data Network |
| **PSTN** | Public Switched Telephone Network |
| **PT-PT** | Point-to-Point |
| **PVC** | Permanent Virtual Circuit |
| | |
| **RAM** | Random Access Memory |
| **REC** | Receive |
| **REJ** | Reject |
| **RNR** | Receiver Not Ready |
| **ROM** | Read Only Memory |
| **RR** | Receiver Ready |
| **RX** | Receive |
| | |
| **SABM** | Set Asynchronous Balanced Mode |
| **SABME** | Set Asynchronous Balanced Mode Extended |
| **SAF** | System Administration Function |
| **SASI** | Shugart Associates System Interface |
| **SCC** | Serial Communications Controller |
| **SI** | Synchronization Initiate |
| **SII** | Series II |
| **SIO** | Serial Input/Output |
| **SIP** | Synchronization in Progress |
| **SLP** | Single Link Procedure |
| **SN** | Switching Node |
| **SPF** | Shortest Path First |

## GLOSSARY OF ACRONYMS (Cont.)

| | |
|---|---|
| **SSP** | Simple Standard Profile |
| **STE** | Signaling Terminal Equipment |
| **SVC** | Switched Virtual Circuit |
| **SYS** | System |
| | |
| **TBD** | To Be Determined |
| **TBS** | To Be Supplied |
| **TSP** | Transparent Standard Profile |
| **TX** | Transmit |
| | |
| **UA** | Unnumbered Acknowledge |
| | |
| **VC** | Virtual Circuit |
| **VLSI** | Very Large Scale Integration |
| **VMS** | Virtual Memory System |
| | |
| **WATS** | Wide Area Telephone Service |
| **WP** | Working Profile |

# APPENDIX B

# IPN GLOSSARY OF TERMS

## GLOSSARY OF TERMS

**1-for-N Bus**

The bus used within the CP9000 SII to implement cluster sparing.

**1-for-N Switching (Sparing)**

The practice of providing one spare cluster that acts as a backup for N other clusters. Upon failure of one of the active clusters, the spare steps in and takes over.

**Access Code**

A field in an X.25 call request packet through which a subscriber specifies a destination DTE without having to use an X.121 address. It is an ASCII string of up to 8 characters.

**Access Code Translation**

NCS function of converting an access code to an X.121 address.

**Access Link**

A communication path permitting access between system users and the system.

**Access Specification**

A list of 0 to 32 access specifiers that can be configured with a user access port or called entity to restrict the class of calling addresses, and which can be configured with a calling entity to restrict the class of calling addresses.

**Access Specifier**

A single description of a class of addresses to be accepted or rejected in conjunction with the access restriction functions.

**Address Translation**

NCS function consisting of X.121 translation and access code translation.

**ASCII**

American National Standard Code for Information Interchange - A character set using 7 or 8-bit coding for information interchange among data processing and data communications systems.

**Autocall Switched Virtual Circuit**

A path from a PAD through the network which is automatically set up by the PAD.

**Auxiliary Service Processor (ASP)**

A component of the NCS based on CP9000 SII disk clusters. For this system, it supports the basic network service set.

**Backbone**

Interconnection of network switching nodes.

**Backbone Link (BBL)**

The physical medium interconnecting network switching nodes.

**Backup Databases**

Database maintained by the backup NCP. It provides for system level redundant data integrity in case of master NCP or master database failure.

**Backup NCP**

An alternate source of network services, databases, and administrative functions. It is maintained by normal administration functions to be prepared in case of master NCP failure.

**Banner Line**

A display line at the top of a NOC that displays the customer logo, date/time, network state indicators, and the name of the current network operator.

**Baseline**

The system design which includes the features and functionality of the NCS (i.e., NCPs, NOCs and ASPs), PSCs and PADs.

**Bootstrap Configuration**

Minimum physical and logical configuration required to bring the network into operation.

**Bulk Printer**

A high-speed line printer which is used to print lengthy reports, code listings, etc.

**Bus Repeater Card (BRC)**

A CP9000 Series II Interface Card used for connecting MIBs.

**Call**

(or virtual call) - In X.25 a call is the communication of two DTEs using a virtual circuit identified by logical channel identifiers at the respective DTE/DCE interfaces.

**Call Record**

A logical record which contains information pertaining to a given call (i.e., start time, stop time, source, destination, etc.)

**CCITT**

*Consultative Committee for International Telephony and Telegraphy* - An international organization of communication carriers responsible for developing telecommunications standards by making recommendations.

**Chassis**

A CP9000 SII rack mountable unit which includes a backplane, power supplies, and card slots for intelligent and nonintelligent modules. Chassis are provided in three forms: standard module enclosures, storage module enclosures, and tempest enclosures. Tempest enclosures can only be mounted in a Tempest rack, which are not typical for most commercial applications.

**Class of Service (COS)**

A parameter defined for each callable entity in the network which is one factor used in determining the routes of calls through the network to that entity. The class of service also determines the number of outstanding data packets which are allowed within the network on the call.

**Cluster**

A group of up to eight CP9000 SII intelligent modules which are connected via an MMB. Each cluster must contain at least one PM. All modules within a cluster must be configured adjacently within the same chassis.

**Communications Line Controller (CLC)**

A custom LSI device that handles two serial lines. CLCs handle line redundancy switching, clock generation, loopback, and other serial interface requirements.

**Congestion**

A network condition that causes information to be delayed or interrupted, even though capacity may be available elsewhere in the network.

**CP9000 SII**

A second generation multiprocessor data communication switching system developed by M/A-COM Telecommunications. It is the system from which most of the network components are created. Commonly referred to as IPN.

**CUG**

*Closed User Group* - An X.25 user facility that allows a predetermined group of users to contact and be contacted by members of that group alone.

**Datapac**

The national public PSN of Canada

**Datex-P**

The national PSN of West Germany

**D bit**

Delivery confirmation bit - Used in X.25, the setting of the D bit in data packets indicates whether delivery acknowledgment of the packet is required from the local DCE or from the remote DTE. It therefore allows the choice between local and end-to-end acknowledgment. D bit = 0 → local ack; D bit = 1 → end-to-end ack.

**DCE**

*Data Circuit-Terminating Equipment* - the network side of the user-to-network interface.

**DCS**

Belgium PDN

**DDX**

The national public PSN of Japan

**Debug Port**

An RS-232 Port on the CP9000 SII that is used by software and field service personnel for installation, diagnostic, and debug purposes.

**DECNET**

Software that provides communications (part of VMS operating system) between VAX processors over a physical medium (X.25, LAN, etc.)

**Disk Cluster (ASP)**

CP9000 SII logical cluster type supporting storage modules within nodes. In this system the ASP is supported on disk clusters.

**Disk Interface Module (DIM)**

A CP9000 SII intelligent module used to control access to CP9000 SII storage modules.

**DN-1**

Netherlands PDN

**DNIC**

*Data Network Identifier Code* - The first four digits of a network address that identify the continent, country, and the network being addressed.

**Downline Load (DLL)**

Transfer of software and configuration data from the NCS to PSCs, ASPs, and PADs.

**DTE**

*Data Terminal Equipment* - The device, generally belonging to a data communications user, that provides the functional and electrical interface to the communications medium. NOTE: In X.25 parlance, DTE and DCE generally refer to packet mode (X.25) devices.

**Edge**

Source and destination points at the extremity of the network.

**Event**

An alarm condition, error, or significant occurrence within the network.

**Event Printer**

A hardcopy terminal that displays operator messages and events as they are reported by the network.

**Fail-soft Operation**

An operational characteristic whereby failures of individual components only reduce network performance rather than causing loss of service to some users.

**Fallback Configuration**

Configuration of the system just before the offline configuration was last implemented.

**Fanout**

Term used to describe a limitation on the number of simultaneous virtual circuits that can be maintained by a single NCP.

**Fast Select**

An X.25 optional user facility by which user data may be transmitted as part of the control packet that establishes a virtual connection. (Call Request Packet)

**Flow Control**

A procedure for controlling the rate of data transfer between two nominated points in the network, usually the DTE and DCE.

**Foreign Network**

A separate and distinct network that is external to this network.

**Function Key**

A special key that can be programmed to initiate a predefined function when pressed.

**Gateway**

A node or switch that permits communication between two dissimilar networks.

**HDLC**

High Level Data Link Control - Data link control procedure specified by the International Standards Organization (ISO), that stipulates the format of frames.

**Header**

The initial part of a data block, frame, or packet that provides basic information about the handling of the rest of the block.

**Host**

A system user providing application services to other system users.

**Ingres**

Relational database management system that is used to set up and maintain all databases (i.e., events, patches, configuration, software distribution, operator and system parameters).

**Intelligent Module**

A CP9000 SII module which contains a microprocessor and associated peripheral functions. The types are processor modules (PMs), Line Interface Modules (LIMs), and Disk Interface Modules (DIMs).

**Internal Network Address (INA)**

A data structure used to describe data which reflects the actual topology of the network. A numbering system internal to the network is used.

**Itapac**

Italy PDN

**I/O Module**

A CP9000 SII Nonintelligent Module which provides electrical isolation and interfacing. (RS-232C, V.35, RS-449 DTE, RS-449 DCE, SASI, BRC, MIB Gateway)

**LAP**

*Link Access Protocol* - The data link protocol specified by older versions (prior to 1980) of X.25 at level 2 but still permitted and therefore usable. All new implementations of X.25 must use LAPB. As of 1984 CCITT X.25 only LAPB is required.

**LAPB**

*Link Access Protocol Balanced* - The data link protocol specified by the 1980 version of X.25 at level 2 that determines the frame exchange procedures.

**Line**

The physical transmission medium between two adjacent network components.

**Line Interface Module (LIM)**

A CP9000 SII Intelligent Module which provides processing for up to eight serial ports.

**Link**

The logical transmission path between two adjacent network components.

**Logical Channel (LC)**

A bi-directional logical association between two DTEs connected by a virtual circuit through which these DTEs exchange information. A channel is only apparent at the respective DTE/DCE interfaces.

**Logon**

Term describing the action of user connection to the network.

**M bit**

More data bit - Setting this bit in a data packet indicates that at least one or more data packet required to complete a message of contiguous data.

**Master Database**

Database maintained by the master NCP. This is the standard database to which all service processor databases must reconcile.

**Master NCP**

The primary source of network services, databases, and administrative functions.

**Menu**

A list of functions that can be performed through operator command at an NOC.

**Message Interchange Bus (MIB)**

A redundant, Ethernet-like, serial 10 MHz bus used to connect clusters.

**MIB Gateway I/O Module**

A CP9000 SII Nonintelligent Module which is used to connect the point-to-point MIB of one PM to a Bus Repeater Card of another node or to a point-to-point MIB of another PM.

**Module**

The basic building block of the CP9000 SII. There are two classifications of modules: Intelligent (PM, LIM, and DIM) and Nonintelligent (I/O Modules).

**Multi-Master Bus (MMB)**

A CP9000 SII parallel bus which is used to interconnect modules within a cluster.

**Network (NW)**

The interconnecting CP9000 SII switching components. The network is a subset of the system.

**Network Components**

The user access equipment and switching nodes that make up the network.

**Network Configuration**

The database that contains the information that directs the network components so that they are capable of functioning together as a communications network.

**Network Control Processor (NCP)**

A system component which provides all system administration, database, and network service functions of the NCS.

**Network Operator (NOC Operator)**

A person who is responsible for performing various network maintenance functions which include monitoring and controlling the network.

**Network Operator Console (NOC)**

A convergent technologies workstation which provides the human interface to the NCS. A NOC interfaces to either NCP.

**Network Service**

NCS functions which are designed to satisfy requests for service from network components such as nodes and PADs. Basic, extended, and administrative services are supported by this system.

**Node**

A number of CP9000 SII clusters bused together on a single MIB.

**Nonintelligent Module**

A CP9000 SII I/O Module which has no microprocessor and which is used to provide electrical isolation and interfacing.

**NVRAM**

*Nonvolatile RAM* which is located on each of the intelligent modules. Capacity is 256 bytes.

**Offline Configuration**

A database which contains past or future configurations of the system. Network operators may edit offline configurations via NOCs to implement configuration changes. Offline configurations can be transformed into online configurations by a network operator.

**Online Configuration**

The database held within an NCP which holds the present system configuration.

**Operating System (OS)**

A program or set of programs that provide an interface between the computer hardware and the computer operator. Operating systems provide computer services such as I/O management, multitask scheduling, and memory mapping.

**Operating Function**

NCS software operations that are designed to satisfy requests for services received from network operators through NOCs.

**OSI Model**

*Open System Interconnection Model* for Network Architecture - A network reference model created by the OSI and adhered to by the CCITT. The model segments the data communication concept into seven layers and defines the functionality of each layer.

**Packet Switching**

A data transmission technique whereby data elements are divided into small quanta or packets at a source, routed through a network, and reassembled at a destination for subsequent processing.

**Packet Switching Cluster (PSC)**

A CP9000 SII logical cluster type. It supports internodal bus links, access links, and backbone links, and Ethernet gateways dependent on its configuration.

**PAD**

*Packet Assembler/Disassembler* - Software that converts from the native protocol of a terminal or host to the X.25 packet mode protocol.

**Permanent Virtual Circuit (PVC)**

A path through the network in which the source and destination parties always assume that the path is present. They never get involved with setting up or clearing the calls that may be required to establish or to tear down the path.

**Port**

Physical network connection that services access links and backbone links.

**PPS**

*Packet Switching Stream* - The national public PSN of the United Kingdom,

**Processor Module (PM)**

A CP9000 SII intelligent module which provides general processing capability as well as interfacing to the MIB or Ethernet.

**Profile**

The basic unit of system configuration data entered by a network operator.

**PSPDN**

Packet Switched Public Data Network

**PSTN**

Public Switched Telephone Network

**Q bit**

Qualified bit - When set in data packets the Q bit signifies that the packet's user data is a control signal for the remote device, not a message for its user.

**Quick Access**

The method of accessing a particular screen on the NOC directly by entering its name rather than by following the regular sequence of the menu hierarchy.

**Rack**

A CP9000 SII enclosure that houses, powers, and cools up to four chassis.

**RAM**

Random access memory is volatile with read and write capability; located on each of the intelligent modules.

**Reconnect**

A network feature in which automatic reestablishment of alternate paths for virtual circuits is made whenever link failures cause the original paths to be broken.

**ROM**

Read only memory that is nonvolatile and is located on each of the intelligent modules.

**Service List**

List of identities of system components to which PADs, PSCs and service processors go for NCS services.

**Service Processor**

Logical processor of the NCS. Service processors can perform network services and therefore accommodate system expansion. They are either NCPs or ASPs.

**Source Routing**

The routing technique in which the entire route of a call is included in the call packet by the source cluster.

**Standard Module Enclosure**

CP9000 SII chassis used to hold up to 12 intelligent modules.

**Storage Module**

A disk or tape drive meeting standard 5 1/4" physical configuration and supporting the SASI.

**Storage Module Enclosure**

CP9000 SII chassis used to hold up to 4 intelligent modules and up to 4 storage modules (disks).

**Supervisory Network (Supernet)**

An interconnection of virtual circuits between the NCS and PSCs. Network services and some administrative functions are controlled over this supervisory network on an as-needed basis.

**SVC**

(or virtual call) Switched Virtual Call - A temporary logical association between two physically separate DTEs that exist only for the duration of the data transfer. Call setup and clearing procedures are required with an SVC.

**System**

The equipment and software that M/A-COM Telecommunications is designing, developing, and specifying to implement this packet switching network and associated network control functions.

**System Administration**

Functions of the NCS that enable network operators to monitor and control the operation of the system as a whole.

**System Component**

Any hardware component that makes up the system. This includes the CP9000 SII in the network, the VAX 11/780 in the NCS, and the Burroughs B-26 as NOCs.

**System Configuration**

The network configuration data stored on disk at a NCP. It is downline loaded in the network components as required. It directs the interaction of the network components and their users so they function successfully as a communications network. These data are READ ONLY for the network components.

**Tariffs**

The formalized charges for telecommunications services that are filed and approved by state and federal regulatory organizations.

**Telepac**

Switzerland PDN

**Terminal Pad (TPAD)**

A Pad which services a system users asynchronous terminal.

**Timestamp**

Data that indicates time as stored within logical records.

**Transpac**

The national public PSN of France

**Upline Dump**

The process of upline loading cluster RAM to the NCS for debugging purposes.

**Upline Load**

The process of transferring data from a network component to the NCS. Types of data which are upline loaded include: Call Records, Statistics Records, and Cluster Program Codes.

**Venus-P**

Japan PDN

**Virtual Circuit (VC)**

A defined path through the network which exists for the duration of communication between the source and destination parties.

**Window**

The major element of the flow control mechanism used to prevent the over-load of a packet network. The window size indicates the number of packets a given user can have outstanding (unacknowledged) in a network at any given time. Separate window parameters exist for the link and packet levels.

**X.1**

Defines the classes of service that may be offered by an international public data network.

**X.2**

Defines the user facilities that should be internationally available on all public networks.

**X.3**

Defines the user facilities that should be internationally available from the packet assembler/disassembler (PAD) facility when this is offered by a public data network.

**X.20 bis**

Defines the physical interface between a DTE-C and a DCE on a public data network where the access to the DCE is made via asynchronous modems.

**X.21**

Defines the interface between a DTE and a DCE of a public data network where the access to the network is made over synchronous digital lines. Presently X.21 is usually applied to public data networks using circuit switching.

**X.21 bis**

Defines the physical interface between a DTE and a DCE of a public data network where the access to the DCE is made via synchronous modems and voice-band lines. Equivalent to RS-232C and V.24/V.28

**X.25**

Defines the interface between a DTE and a DCE for packet-mode operation on a Public Data Network (PDN).

**X.25 Level 1**

X.21 or X.21 bis - Specifies mechanical, functional, and electrical characteristics of physical interface between packet mode DTE and DCE; Transmission medium is digital or analog, full-duplex, point-to-point synchronous circuit; RS- 232 (V.24) and V.35 specification fall under X.21 and X.21 bis.

**X.25 Level 2**

HDLC LAPB - Specifies frame level interface, i.e., link access procedures to be used over DE-to-DCE interface; functions include error detection and correction, link setup, link disconnect, link reset, and link level flow control procedures; Level 2 ensures accuracy of data transferred across physical link.

**X.25 Level 3**

The packet level defines procedures and formats by which DTEs establish, maintain, and clear data transfer calls; defines two essential services - switched virtual circuit (SVC) and permanent virtual circuit (PVC); specific procedures and formats are stipulated for call setup, call clearing, data transfer, reset, and interface restart.

**X.28**

Defines the interface between a DTE-C (e.g., an asynchronous character-mode terminal) and a Packet Assembly/Disassembly (PAD) facility offered by a Public Data network (PDN) in the same country.

**X.29**

Defines the interface for the exchange of control information and user data between a packet-mode DTE and a remote Packet Assembly/Disassembly (PAD) facility over a packet switching network.

**X.75**

Defines the interface for the connection of two packet switching networks and, therefore, applied to international data communications between PSNs.

**X.121**

Defines the international addressing conventions applied to DTEs connected to public data networks; converted to a INA by the NCS.

# APPENDIX C

# IPN STANDARD PRODUCT DOCUMENT SET LISTING

# Appendix C
# Integrated Packet Network (IPN)
# Standard Product Documentation Set

***IPN Network Control Processor (NCP) Operator's Procedure Manual*** (Document 8000806)

Describes the procedures to be followed by NCP operators managing the NCP.

***IPN Network Control Processor (NCP) Operator's Reference Manual*** (Document 8000807)

Describes the syntax and result of each NCP console command. Intended as a reference for operators following the companion Procedures Manual.

***IPN Network Operator's Procedure Manual*** (Document 8000808)

Describes how the network operator can configure, monitor, and control the network using the Network Operator Console (NOC).

***IPN Network Operator's Reference Manual*** (Document 8000809)

Describes the purpose and utilization of each NOC screen. Intended as a reference for operators following the companion Procedures Manual.

***IPN Configuration Manual*** (Document 8000810)

Describes the rules for configuring the hardware elements within the IPN system, including NCPs, NOCs, and network nodes.

***IPN System Software Installation*** (Document 8000811)

Describes the procedures for installing the system software and making the IPN system operational.

***IPN Offline Diagnostics User's Manual*** (Document 8000812)

Describes the operation of the offline diagnostic software package for the CP9000 Series II Equipment

***IPN Tape format Reference Manual*** (Document 8000813)

Describes the format of the tapes to which NCP log files are archived.

***IPN CP9708 Micro Packet Exchange Integral Diagnostic User's Manual*** (Document 8000822)

Describes the diagnostic applications of the CP9708 Micro Packet Exchange.

***IPN Network Operator's Console Screen Displays*** (Document 8000823)

Provides reference printouts of all NOC screens.