NORTHERN TELECOM

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DIGITAL SWITCHING SYSTEMS

DMS*-100 FAMILY

NETWORK MODULES DESCRIPTION

* DMS is a trademark of Northern Telecom

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1. INTRODUCTION

GENERAL

1.01 This Practice describes the function of the Switching Network within the DMS-100 Family of Digital Multiplex Switching (DMS) systems. Refer to 297-1001-100 for the DMS-100 Family System Description.

1.02 The Network functions as a four-stage or two-stage time switch under control of Network Message Controllers (NMC). The NMCs are directly controlled by a Central Control Complex (CCC) or a DMS-Core.

* With the CCC, also referred to as the Central Control (CC), the Network is controlled through its NMCs by the CC’s Central Message Controller (CMC). For the description of the CC, see 297-1001-101.

* With DMS-SuperNode, the CC is replaced by a Computing Module (CM) and the CMC is replaced by a Message Switch (MS). For the descriptions of the CM and the MS, see 297-5001-100. GS9X04 respectively.

  With a DMS-Supernode, data table NETWORK may require updating (see 297-1001-451).

1.03 The structure and the terminology of Networks are described in Part 2 on page 8. The operation of the Networks is described in Part 3 on page 14.

TYPES OF NETWORKS

1.04 The types of NM are identified by their Northern Telecom (NT) product codes:

NT0X48
NT5X13
NT7X27
NT7X40
NT8X11.

The descriptions of the individual Networks occur in:

Part 4 on page 25, for the NT0X48
Part 5 on page 33, for the NT5X13
Description of NT7X27 on page 40
Description of NT7X40 on page 40
Part 7 on page 41, for the NT8X11.

<u>Note:</u> All abbreviations used in this Practice are listed alphabetically in Part 10 on page 55.

REASON FOR REISSUE

1.05 To indicate the text that has been changed or added throughout the Practice, revision bars (|) are placed in the left margin. A bar beside a heading indicates that all of the text is included up to the next heading of its kind. Text that has been deleted is not indicated by the bars, but is stated in this paragraph. If you do not have the previous issue of the Practice, ignore the revision bars.

This Practice is reissued to correct the descriptions in:

* Intra-Junctor on page 20
* Inter-Junctor on page 22
* Fault Analysis on page 22
* Maintenance by Test Code Insertion and Extraction on page 23
* Figure 6 on page 35
* NT8X11 NM Cards on page 43 to remove the Note
* NT8X11 NMC Cards on page 48
* Junctor Hardware on page 53
* Speech Link Hardware on page 53

and to simplify Figure 10 on page 50.

SOFTWARE IDENTIFICATION

1.06 Software applicable to a specific DMS-100 Family office is identified by a BCS release number and by Northern Telecom (NT) Product Engineering Codes (PEC). The significance of the BCS number and the PEC is described in 297-1001-450 (section 450/32) and in the Office Feature Record D-190.

1.07 A display of the BCS number and PEC for the NT feature packages available in a specific office can be obtained by entering the command string:

PATCHER;INFORM LIST;LEAVE

at a Maintenance and Administration Position (MAP[1]).

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[1] MAP is a trademark of Northern Telecom.

REFERENCES

1.08 References listed as prerequisites are essential for an understanding of this Practice. Those listed as informative contain detailed information concerning other items mentioned in this Practice, but are not essential. References are inserted at the appropriate places in the text.

<u>Note:</u> The documents listed may exist in more than one version. See 297-1001-001 to determine the release code of the version compatible with a specific release of software.

Prerequisite References

DOCUMENT NUMBER	TITLE
297-1001-100	System Description

Informative References

DOCUMENT NUMBER	TITLE
297-1001-001	Master Index of Practices
297-1001-101	Central Control Complex Description
297-1001-103	Peripheral Modules
297-1001-106	Maintenance System DMS-100/-200
297-1001-110	Maintenance and Administration Position (MAP)
297-1001-120	Equipment Identification
297-1001-156	Power Distribution and Grounding Systems
297-1001-451	Customer Data Schema
297-1001-510	Log Report Manual BCS23 through BC25
297-1001-514	Network Module Maintenance and Man-Machine Interface Reference Manual
GS0X18	Digital Network Interface (DNI) Frame
GS0X28	Frame Supervisory Panel (FSP)
GS0X56	Speech Link Connecting (SLC) Frame

2. DESCRIPTION OF THE COMPONENTS OF THE NETWORK

GENERAL

2.01 Figure 1 on page 10 is a simplified block diagram of the basic DMS system, showing the relationship of the Switching Network to the DMS. The duplicated halves of the Network are referred to as planes, designated plane-0 and plane-1. Each plane contains up to 32 Network Modules (NM). In this Practice, only the operation of plane-0 is described in detail; plane-1 operates identically and in parallel. Each of the 32 NMs in plane-0 has a corresponding mate in plane-1. The two corresponding NMs are referred to as "a Network pair."

NETWORK MODULES

2.02 The Network Modules (NMs) are the major components of the Network. An NM establishes and maintains two-way (4-wire) speech and signaling paths between itself and the Peripheral Modules (PM) for the duration of the call. (For the descriptions of the PMs, see 297-1001-103.)

2.03 Each NM has the same configuration of 64 incoming ports and 64 outgoing ports to and from the PMs. There is more than one type of NM which accomplishes the same switching function, but they have different frame and card configurations. The frame and card configurations are described in the respective Network descriptions.

DUPLICATION OF OPERATION

2.04 The two planes of the Network provide reliability for all call connections by duplicating the operation of the switching. Every active connection in one plane is backed-up by a corresponding inactive connection in the other plane. If any channel of the connection fails, the back-up channel is automatically made active, and takes over the call (see 297-1001-100). A caller detects no loss of service when a back-up takes over.

2.05 The duplicated operation is supported by per-channel fault detection and parity checking, and the Network maintenance subsystem. (For the description of Network maintenance, see 297-1001-514.) (The duplication of the operation of an active component by an inactive component on standby is also referred to as "redundancy.") Each NM has 64 by 64 ports to handle the switching of calls, that is, to establish call connections.

NETWORK MODULE CONTROLLERS

2.06 Each NM contains a Network Message Controller (NMC) that handles communications with the CC or DMS-Core and the PM. When control messages for the switching connections are handled, the NMC translates the messages into Network connections. The NMC contains a pair of microprocessors that control the switching in the Network and the test cards, and control communications with the PM and the CC or the Computing Module.

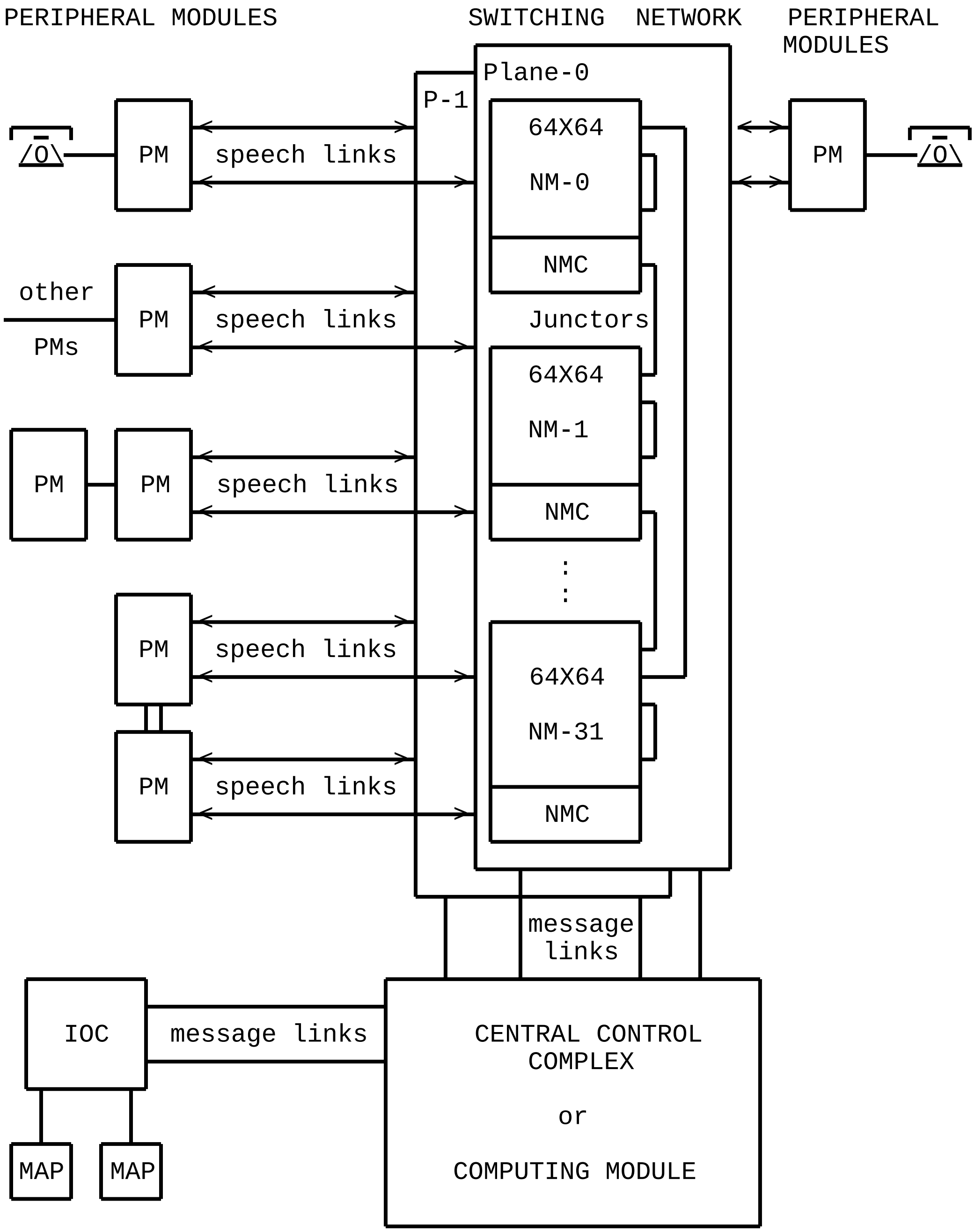

Fig. 1 - Block Diagram of Simplified DMS-100 Configuration

NETWORK TERMINOLOGY

2.07 The terms that are used to describe the function of an NM are defined as follows. They are listed in logical sequence (not alphabetically).

Sides — Each NM has two sides, a Receive (side-A) and a Transmit (side-B). Side-A receives inputs from the PMs and switches outputs to Side-B of another or the same NM. Side-B receives inputs from Side-A of another or the same NM and transmits switched outputs to the PM.

Faces — Each side has two faces: the peripheral and the junctor. The peripheral face of side-A is connected to incoming channels from the PM and the peripheral face of side-B is connected to outgoing channels to the PM. The junctor face of side-A transmits outgoing channels from side-A to the side-B junctor face of another or the same NM.

Junctors — are the connections that carry data from side-A to side-B of the same or another NM. Junctors exist in two forms: serial and parallel. If the office has more than five Network pairs, all junctors are serial.

- Serial — carry 32 channels per junctor in serial data format between the junctor faces of sides-A and -B through the speech interfaces. Junctor patterns are adjustable to meet Network traffic requirements. Serial junctors are used by the NT0X48, NT5X13, NT7X40, and NT8X11. The NT7X27 has no serial junctors because half of one Network is hard-wired to half of the other.

- Parallel — are used by the NMs of the NT5X13 and consist of internal parallel buses from the outgoing time switches of side-A to the incoming time switches of side-B within the same NM. The parallel junctors carry from 32 to 512 channels in increments of 32 in parallel data format, and connect directly between time switches. Parallel junctors are used only if the total number of Network pairs (planes-0 and -1) in an office is less than five.

  The NT7X27 has only parallel junctors.

  In the NT8X11 the parallel junctors occur in groups of 16 ports. Special cabling is required for the backplane.

Time Switches Except for the NT8X11, for each side of an NM there are pairs of digital crosspoint Time Switches (TS), one incoming (IC) and one outgoing (OG), forming two stages of time switching per NM. Each TS has a number of incoming and outgoing ports. The switching capability of an NM is expressed by the quantity of ports and channels.

The NT8X11 has only one TS.

Crosspoints are the connections between the incoming and outgoing paths of a time switch.

Ports are the entry and exit points on the peripheral faces and junctor faces. Each port on the peripheral face carries 32 channels (30 voice, 1 signaling, and 1 used for system testing). The voice channels carry speech signals that are encoded into multiplexed Pulse Code Modulated (PCM) encoded serial data samples. Each port on the junctor face carries 30 voice channels and two unused channels.

The sum of all the ports on all the TS is 64 ports incoming and 64 ports outgoing, per side, per NM. The ports are identified by an "absolute" port number in the range of 0-63.

Channels There are 30 speech channels and 1 signaling channel per port, therefore, 64 ports gives 1920 speech channels and 64 signaling channels per side. One channel per port is used for testing the peripheral ports, but they can also be used for connections within the NM and on the junctors. The total channel capacity per side is:

1920 + 64 + 64 = 2048.

Interswitch Links The first- and second-stage crosspoints (IC and OG) are connected by interswitch link buses within each side of an NM. The crosspoints provide flexible (programmable) channel connectivity between each of the first stage and each of the second stage of time switching. Access to the interswitch link buses is controlled by timing so that the link between two TSs exists only during the appropriate instant of the time switching. There are 2048 possible combinations of interswitch link buses. The buses are selected by messages from the CMC or the Computing Module, which maintain the busy or free status of the interswitch link buses.

Memories Within each TS there is a Data Memory (DM) and a Connection Memory (CM[2]). The DM is used to store PCM speech samples during the time switching, and the CM is used to store the addresses of the outgoing speech samples that are to be moved into specific timeslots by the switching process. Both the DM and the CM store one word of data for each channel entering the TS. Since each TS accepts 16 ports at 32 channels per port, the memories have a capacity of 512 words each per TS (16x32=512). The words are identified as 0 through 511. For one side, the memory capacity of a single stage is 2048 words (4x512=2048). Therefore, there are 2048 words per face per side for both the DM and the CM.

Speech Interface Data passing to and from the PM, the junctors, and other Networks is transmitted in the DS-30 format so that the PCM data and the clock and frame pulse may be sent over a single wire-pair. The speech interfaces contain encoding and decoding logic for clock and frame pulse data alignment buffers, and for balanced AC data driving and receiving circuits.

NETWORK MOUNTING FRAMES

2.08 For the descriptions of the frames, see:

NT0X48 Mounting Frame on page 25
NT5X13 Mounting Frame on page 33
NT8X11 Mounting Frame on page 41.

The frame configuration for the NT7X40 is the same as for the NT5X13. The difference between the NT5X13 and the package switches is the type and slot location of the cards. The NT7X27 is a single backplane version of the NT5X13 Network with no junctor cards.

NT0X48 AND NT5X13 FRAMES MOUNTED TOGETHER

2.09 In an office having both NT0X48 and NT5X13 mounting frames, the frame discrimination number is used in a continuous sequence, regardless of NET frame type. In Figure 4 on page 26 the second frame is identified as NETC 01, and the associated NM shelves are NET0 01 (plane-0) and NET1 01.

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[2] To avoid confusion between the terms "Computing Module" and "Connection Memory," "CM" is used for the "Connection Memory" and "Computing Module" is used only in expanded form.

3. NETWORK OPERATION

GENERAL

3.01 The Network types operate differently, but all types have the same function for the DMS system. The differences in the handling of signals are described in Frame, Channel, and Bit Times. The differences in the uses of the link buses are described in:

Interswitch Link Buses (NT0X48) on page 15
Interswitch Link Buses (NT5X13) on page 16.
Interswitch Link Buses (NT8X11) on page 17.

The differences in the operation of the time switching is described in Time Switching on page 17.

FRAME, CHANNEL, AND BIT TIMES

3.02 For the NT0X48, the signals arriving at the incoming ports of the crosspoint card consist of serial data streams.

For all other types of networks, the signals arriving at the incoming ports of the crosspoint cards consist of parallel data streams.

3.03 For all types of Networks, analog speech signals are encoded in 8-bit PCM and sampled at a rate of 8 kHz, or every 125 microseconds (us). The 125us are referred to as the frame-time.

3.04 During the frame-time, 32 different analog signals are sampled, which divides the 125us frame-time into 32 periods of 3.9us each. The 3.9us are called channel-times. The sample is coded by the PCM circuitry into an 8-bit number representing the binary value of the speech or signaling at that instant. This 8-bit value is part of a 10-bit word that also contains a parity bit and a Channel Supervision Bit (CSB). The CSB is used to form a Channel Supervision Message (CSM) between connected PM. These 10 bits subdivide each channel-time into 10 periods of 390 nanoseconds (ns) each, referred to as bit-times.

INCOMING AND OUTGOING FORMATTERS (NT0X48)

3.05 For the NT0X48 only, the incoming formatter is a dual-rank shift register with serial data entering the input rank while parallel data is leaving the output rank. The serial data is converted to parallel data. A mass transfer of the data accumulated in the input rank during one channel-time occurs at the end of that channel-time.

3.06 At the end of that channel-time, all data are transferred to the incoming formatter, second rank, while the data for the next channel enters the first rank. The parallel data words pass from the second rank incoming formatter to the DM where they are simultaneously written into word locations. From the DM the data continues through the time-switching process.

3.07 The cards that do the data conversion are as follows for the respective Network type:

NT0X48 Serial to parallel conversion is done in the NT3X27 incoming crosspoint card.

Parallel to serial conversion is done in the NT3X27 outgoing crosspoint card.

NT5X13 Serial to parallel conversion is done in the NT3X73 card.

Parallel to serial conversion is done in the NT3X86 card.

NT8X11 Both serial to parallel and parallel to serial conversions are done in the NT8X12 port interface card.

INTERSWITCH LINK BUSES (NT0X48)

3.08 In the Serial-to-Parallel (SP) conversion of the Formatters, the 10-bit samples are written into permanently-assigned locations in the DM of the ICXPTs. During the time-switching that follows the formatting, the contents of any ICXPT DM is transferred over an interswitch link bus to any other OGXPT DM.

3.09 Each interswitch link bus provides ten parallel paths, one path for each of the ten bits of the parallel data. Since there are only ten physical connections between each of the eight pairs of ICXPT and OGXPT, and there are a total of 2048 samples to move, timing is used to obtain the number of unique paths required. With 64 interswitch link buses, there are 2048 unique paths that allow data to be transferred to a specific location in the DM of a particular OGXPT.

3.10 Selection of the links is controlled by the CC or the Computing Module software for the Network. The 2048 interswitch links are identified by:

* the absolute link port number (0-63), representing one of the 64 interswitch link buses

* the link channel number (0-31), representing the channel-time that existed when the link was designated for the path.

INTERSWITCH LINK BUSES (NT5X13)

3.11 Following the SP conversion process, the 10-bit samples are written into permanently-assigned locations in the DM of the first-stage TS. After the first-stage time switching operation, the contents of any first-stage DM location is transferred to any second-stage DM over an interswitch link bus.

3.12 Each interswitch link bus provides ten parallel paths, one path for each of the ten bits of the parallel data. Since there are only ten physical connections between each of the four pairs of first- and second-stage TS and there are a total of 2048 samples to move, timing is used to obtain the number of unique paths required.

3.13 The multiplexer (MUX) consists of ten paths, one for each DM bit. Each channel-time (3.9us) was used to build up a set of sixteen 10-bit data words which were written into locations 0 through 15 in the DM. Each 195ns time slot within a channel-time represents the word from a particular channel and port (for example, time slot 0 during channel-time 0 represents the sample from port-0, channel-0). This same timing is used to enable the multiplexer to make a connection to the ten bits of a specific channel, port, and DM of the first-stage TS.

3.14 The interswitch link bus enables the 10-bit connection between the first- and second-stage TS DMs at word location 0. This interswitch link only exists during a 195ns time slot because, during the next time slot, the multiplexer moves on to access another channel-0 on the next port and switch. The selection by the multiplexer is controlled by the contents of the first-stage CM.

3.15 However, three other first- and second-stage TS memories are involved so that the 10-bit link buses are paralleled, making all four first-stage TS DMs equally accessible to all multiplexers and second-stage TS memories. For example, during time slot 0 of channel-time 0, while the interswitch link bus between ICXPT-0 and OGXPT-0 exists, three other interswitch link buses between the other pairs of switches also exist. The timing of the four multiplexers is offset so that interswitch link buses are always unique. The set of four multiplexers is referred to as the commutator.

3.16 Following the set of four interswitch link buses occurring during time slot 0 are fifteen other sets of four interswitch link buses during time slot 1 through 15 of channel-time 0. Time slots 16, 17, 18, and 19 are the unused dead times. Channel timing is arranged to cover the 4-slot gap. When channel-time 0 ends there will have existed 16 sets of 4 interswitch link buses for a total of 64. This pattern of 64 interswitch link buses is referred to as one link channel and since it existed during channel-time 0, is referred to as link channel 0. Likewise, the patterns of 64 interswitch link buses occurring during channel-times 1 through 31 are designated link channels 1 through 31. The 64 link buses existing during each channel-time are identified individually by a link port number in the range of 0-63.

3.17 With 64 interswitch link buses, repeated during 32 channel-times, there are 2048 unique paths required to move the data over the links to a specific location in the DM of a particular second-stage TS. Selection of the links is controlled by the CC or the Computing Module through the first-stage CM. The 2048 interswitch links are identified by:

* the absolute link port number (0-63), representing one of the 64 interswitch link buses

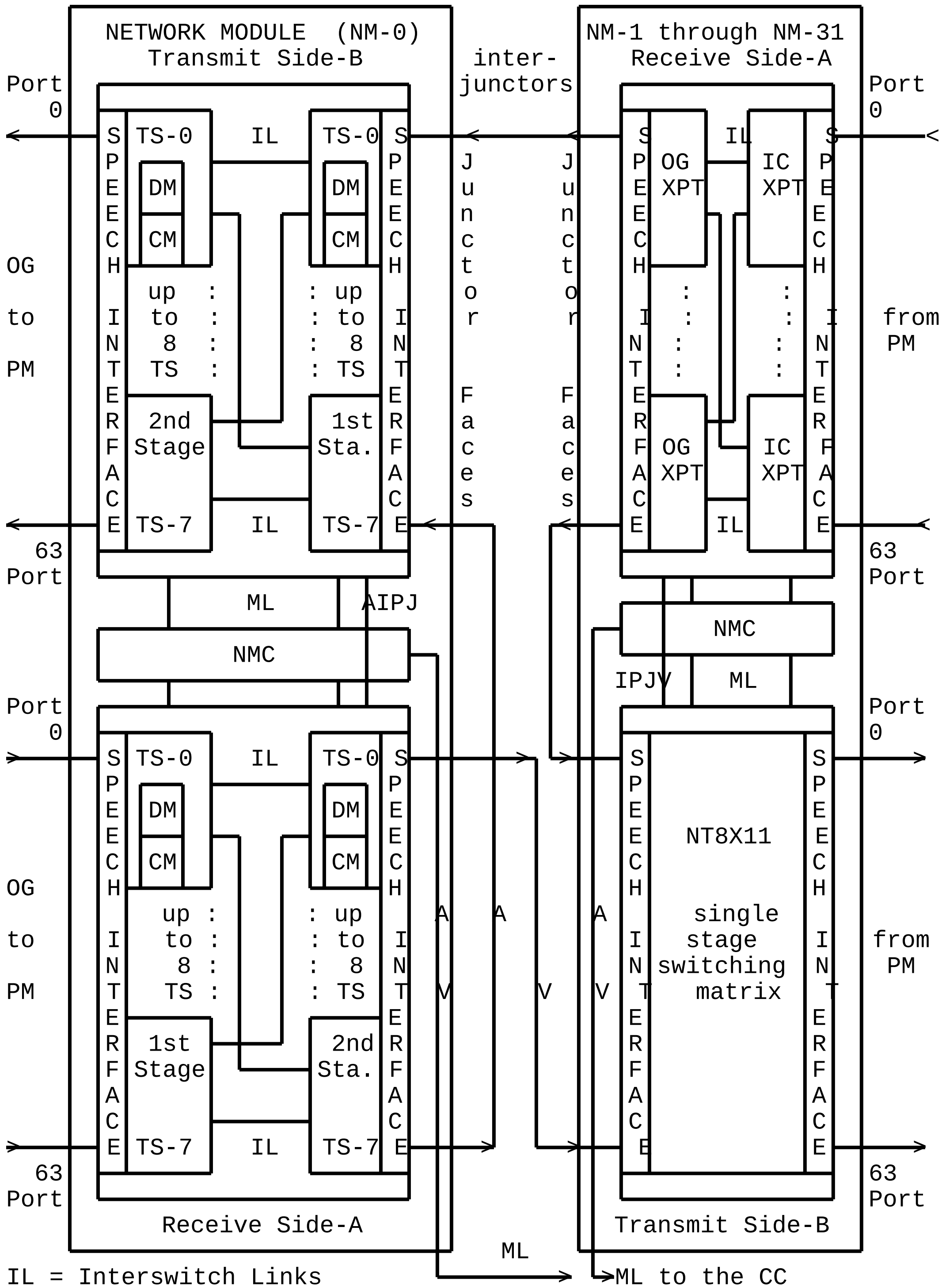
* the link channel number (0-31), representing the channel-time during which the designated link bus existed.

INTERSWITCH LINK BUSES (NT8X11)

3.18 The NT8X11 does not have interswitch link buses. Each of the two crosspoint cards gets 2048 channels in the DM so that 1024 outgoing channels can be switched.

TIME SWITCHING

3.19 The activities of time switching for the NT0X48, NT5X13, and NT8X11 Networks occur as follows (refer to Figure 2 on page 18).



IL = Interswitch Links
ML = Message Links
IPJ = Internal Parallel Junctors

Fig. 2 - Block Diagram of NM Functional Units

1. The calling party has dialed the digits of the directory number and the CC or the Computing Module has translated the digits of the called party into port and channel numbers on the peripheral face of:

   * an outgoing TS for all Network types except NT8X11

   * the B-side TS (output bus) for NT8X11 (which has only one TS).

2. The identification of the calling party in terms of a port and channel number on the peripheral face of:

   * an incoming TS for all Network types except NT8X11

   * the A-side TS (input bus) for NT8X11

   was determined by the CC or the Computing Module when the calling party went off-hook (for example, port-0, channel-2).

3. The CC or the Computing Module selects a path between:

   * the incoming and outgoing TSs for all Network types except NT8X11

   * the input and output buses of the NT8X11

   through a free interswitch link (NT5X13, NT7X27, NT7X40) or a free junctor between sides-A and -B (NT8X11).

4. After the call path is established, each speech sample arriving at the incoming peripheral face on side-A of an NM progresses to its exit at the outgoing junctor face, or through an interswitch link enroute to side-B.

5. After decoding the speech sample in an interface card, data enters the DM of:

   * the incoming TS for all Network types except NT8X11

   * the A-side (input bus) TS for NT8X11.

6. The relationship between ports, channels, and word locations applies to:

   * incoming XPT ports for NT0X48

   * first-stage TS ports for NT5X13, NT7X27, and NT7X40.

   The junctor port word locations are calculated by the NMC to adjust internal timing. The DM and CM word locations are actual numbers calculated by the NMC when the CC or the Computing Module assigns the Network connection.

PARALLEL JUNCTORS

For NT5X13, NT7X27, NT7X40

3.20 The direct connections of the outgoing TS of side-A to the incoming TS of side-B provide sixteen parallel-data 32-channel junctor port connections between the DM of the first- and second-stage TSs in opposite sides of the same Network Crosspoint shelf. The advantage of the parallel junctor is that data between sides of the same NM need not be changed back to serial format through the PS formatter, but can be switched directly in parallel format between word locations in the respective DM. The requirements for serial interface cards and junctor cables are reduced, and in offices having a single NM pair, it is not necessary to have PS formatters or serial interface cards on the junctor face.

3.21 In Figure 3 on page 21, parallel junctors are implemented by a multiplexer (MUX) on the crosspoint card, which is connected between the SP formatter and the input to the DM of the first-stage TS. The MUX normally passes speech samples (parallel data) from the SP formatter to the first-stage TS DM. If that junctor is a parallel junctor, a connection is made to permit data to enter the appropriate word location in the side-B DM.

3.22 All crosspoint cards are equipped with the MUX, which is only activated when the card is used in side-B. When used as a side-A crosspoint card, data from the second-stage TS DM is available to the MUX in side-B, but is only transferred to the side-B DM when the path through the MUX exists during the timeslot representing the assigned parallel junctor port and channel.

For NT8X11

3.23 There are two kinds of junctors for the NT8X11 Network, called parallel intra-junctors and serial inter-junctors.

Intra-Junctor

3.24 In an NM there are four intra-junctors, each of which is a 10-bit parallel bus running at 5.12 MHz. Their function is to interconnect two crosspoint cards within the same NM. However, to reduce the quantity of junctor port cards, the parallel intra-junctors can also be used to connect up to three other Network shelves provided the overall loop length is within 10 feet.

3.25 Using parallel junctors to interconnect NMs of the same Network is possible only if the difference of the length between the links from the CMC or the Message Switch (MS) to the NMs is less than 200 feet. The differential phase between the Network's shelf clock or frame pulse is within 90 nanoseconds. This is based on the assumption that the incoming PCM data from different NMs are latched in a register at the falling edge of

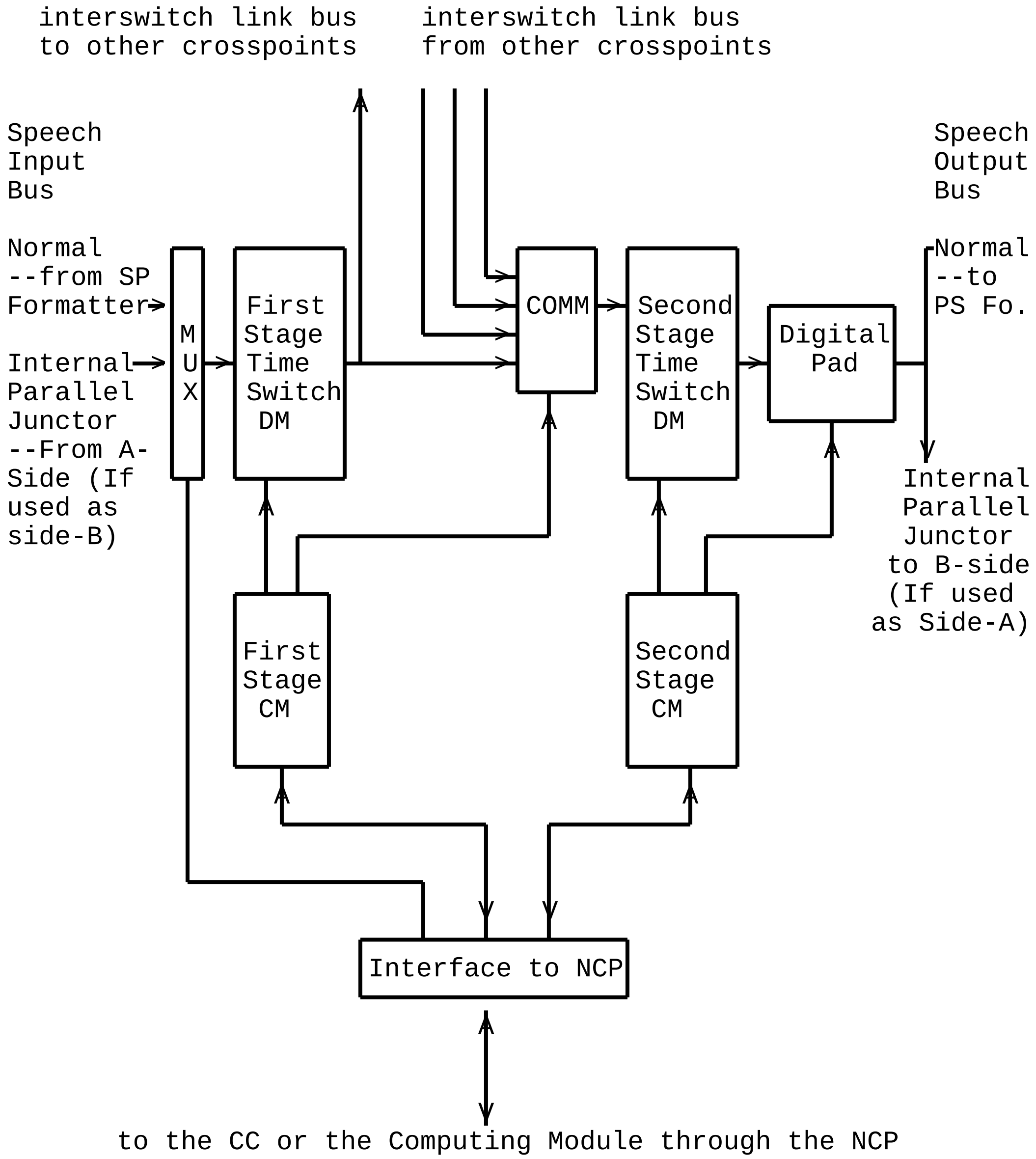


Fig. 3 - Block Diagram of Crosspoint Card Using Parallel Junctors for the NT5X13, NT7X27, and NT7X40

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the C195 clock in the crosspoint card before being written to the DM.

3.26 Data alignment of the frame pulse between Network shelves may be required for parallel junctoring. For the NT core only, a phase alignment circuit is in the clock card and can be manually adjusted during office commissioning.

Inter-Junctor

3.27 When the Network size grows beyond one Network, inter-junctors are required to connect two Networks.

3.28 The parallel output port buses from the TS are input into the serial port cards within the NM. The serial port cards converts the parallel data into serial data. Since an inter-junctor port has the same DS-30 format as a PM port, the interface provided in the port card allows the serial inter-junctor.

3.29 On the other side of the TS, the port cards convert the serial PCM data before transferring it to the parallel input of the crosspoint card.

3.30 For an NT8X11, both P-side and junctor side use the same port card.

COMPARISON OF PORT QUANTITIES

3.31 The main difference between the NT7X27 and the other types of Networks is in the quantity of ports per shelf.

* The NT5X13 and NT7X40 have eight interface cards at eight ports per card for a total of 64 ports per shelf (8x8).

* The NT7X27 has seven interface cards at eight ports per card for a total of 56 ports per shelf (7x8).

* The NT8X11 has four interface cards at sixteen ports per card for a total of 64 ports per shelf (4x16).

3.32 For the description of the cards for the NT7X27, refer to the cards described in Part 5 on page 33.

MAINTENANCE

Fault Analysis

3.33 A fault in the Network may affect the function of any hardware connected to it, for example, a PM or the CC or a Computing Module. By knowing the function(s) of cards, a fault can identify a specific card that is likely to be responsible for a problem.

3.34 At the Network level of a MAP, the links, junctors, crosspoints, and integrity can be tested at separate levels. All levels except for the integrity level are supported by the test code card. The integrity level of the MAP is a self-checking level which monitors the integrity bytes and therefore monitors individual call connections through the Network.

In General

3.35 Personnel engaged in fault detection and other maintenance procedures for a Network can communicate with the DMS through the Maintenance and Administration Position (MAP). The MAP is used to monitor and maintain the status of the various parts of the NM, for tracing faults, and for manually applying tests. Instructions for using the MAP are in 297-1001-110. The description of Network maintenance and the commands that are used at the MAP are in 297-1001-514.

MAINTENANCE BY TEST CODE INSERTION AND EXTRACTION

3.36 Maintenance by Test Code (TC) is used for all Network types to test the continuity of path connections. By checking for the presence of the TC at successive locations along a path, the card(s) where a fault might be occurring is identified. The insertion and extraction of TC is done automatically by the system. The card that uses the TC depends on the type of Network:

NT0X48: card NT3X20 (in NT0X48 NMC Cards on page 31)
NT5X13: card NT3X71 (in NT5X13 NMC Cards on page 38)
NT7X27: card NT3X71 (in NT5X13 NMC Cards on page 38)
NT7X40: card NT3X71 (in NT5X13 NMC Cards on page 38)
NT8X11: card NT8X14 (in NT8X11 NMC Cards on page 48).

3.37 TC insertion and extraction points appear at connector pins on the backplane of the shelf and are connected to the following circuits:

* decoder inputs to speech IF buffer (TC insert)

* speech IF buffer outputs (TC extract)

* interswitch link bus terminations on test access card (TC extract)

* NT0X48: output from outgoing formatter cards on outgoing XPT cards (TC extract)

  NT5X13: output from a PS formatter card (TC extract)

* speech IF buffer inputs to encoder (TC extract)

* NT5X13: crosspoint input (TC insert and extract); Crosspoint output (TC extract).

3.38 The TCs are used by maintenance programs for troubleshooting. Tests are done by inserting a test pattern at the TC insertion location in place of the speech samples. Checks are then made at the various TC extract points for the presence of the test pattern. If successive frames of correctly alternating words are detected, the test requirements are satisfied. The test pattern may be sent from one NM and detected in another, thus checking the interface cards and the junctors between the NM. The test access cards are controlled by the CC and the Computing Module.

3.39 It is the function of the TC card to control the timing and application of TC to a particular path. Selection of a specific channel occurs when the card applies an "enable" signal during the applicable time slot.

3.40 If a fault is detected in a link or a junctor, the link or junctor is removed from service by being made system busy and its status SysB is displayed at the MAP. For information on the displays for the Network at the MAP, see 297-1001-514.

4. DESCRIPTION OF NT0X48

GENERAL

4.01 This part describes the configuration of the frame, the types of cards, and the function of the NT0X48. The NT0X48 has a single-bay Network (NET) frame, as shown in Figure 4 on page 26.

4.02 The functions are performed by cards (Printed Circuit Boards) that are plugged into the four NET shelves. All shelves are equipped with power converters which are fed from the -48V office battery through the Power Distribution Center (PDC) (described in 297-1001-156) and the Frame Supervisory Panel (FSP) (described in GS0X28). The functions of the cards are described in NT0X48 NM Cards on page 27.

NT0X48 MOUNTING FRAME

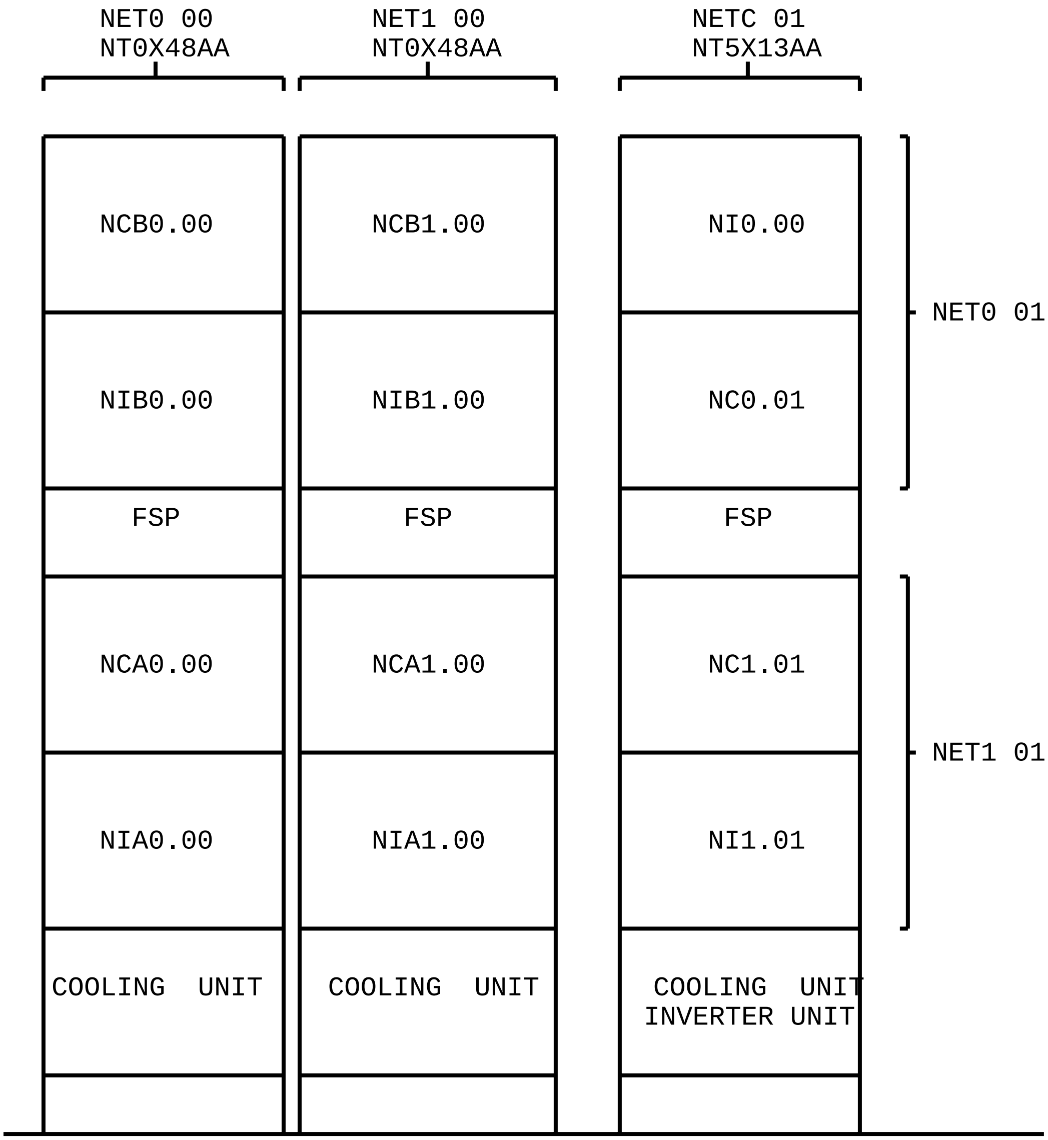
4.03 Each single-bay frame of the NT0X48 contains one NM. Therefore, each Network plane requires from 1 to 32 frames to accommodate a complete set of NMs. Figure 4 on page 26 shows an arrangement of one NM (frame) per plane.

4.04 The NT0X48 frames are identified, first by the plane, as NET0 or NET1, and then by the individual frame discrimination number; in this example: NET0 00 and NET1 00. For a complete Network, these identifications range up to NET0 31 and NET1 31. For details of the complete DMS-100 Family equipment identification scheme, see 297-1001-120.

4.05 The NM cards occupy four shelves in the frame. The FSP, which handles power distribution and alarms, occupies the center postion. See GS0X28 for details of the FSP.

4.06 Figure 5 on page 28 shows a front view of the NM frame and identifies the card PECs and their slots. The shelves in the NT0X48 NET frame are identified according to the DMS-100 Family equipment location scheme. Each shelf is allotted a base mounting position number representing the location of the lowest mounting screws supporting the shelf in the frame. The range of base mounting holes is 00 to 77, with 00 at the bottom of the frame.

4.07 The shelves containing the cards for side-A of the NM are located in base mounting positions 18 and 32. The shelves containing the side-B components are in base mounting positions 51 and 65.




```
0 or 1 for the plane of the shelf   Each shelf serves A & B sides

NT0X48 Frame:                       NT5X13 Frame:
   NET0 NET Shelves, Plane-0           NET0 NET Frame, Plane-0
   NET1 NET Shelves, Plane-1           NET1 NET Frame, Plane-1

Shelves:                            Shelves:
   NCA NET Crosspoint, Side-A          NI0 NET Crosspoint, Plane-0
   NIA NET Interface,  Side-A          NC0 NET Interface,  Plane-0
   NCB NET Crosspoint, Side-B          NC1 NET Crosspoint, Plane-1
   NIB NET Interface,  Side-B          NI1 NET Interface,  Plane-1
```

Fig. 4 - Nomenclature for Frames of NT0X48 and NT5X13

4.08 Shelves 32 and 65 contain the crosspoint cards which perform the TS functions. These shelves are referred to as the Network Crosspoint (NC) shelves, while shelves 18 and 32 contain the speech interface cards and are referred to as the Network Interface (NI) shelves. The NC shelf (32) for side-A is identified as NCA, followed by its plane and frame reference (for example, NCA0: 00). Similarly, the NI shelf for the same plane and side is identified as NIA0: 00. The same principle applies to the corresponding shelves in side-B and plane-1.

4.09 Network Crosspoint Shelf: contains the incoming (IC) and outgoing (OG) crosspoint (XPT) time switch cards. There are eight IC XPT cards, identified as ICXPT-0 through ICXPT-7 and eight OG XPT cards, identified as OGXPT-0 through OGXPT-7, per shelf. Each ICXPT card accepts a total of eight inputs from two IF cards (2x4), and each OGXPT card provides eight outputs to two IF cards. The eight ICXPT and eight OGXPT cards occupy sixteen locations in the center of the shelf. At the left end of the shelf is located the test access card, and at the right end of the shelf, a bus card which interfaces with the NMC circuits.

4.10 The configuration of the NC shelf is the same for both sides-A and -B. Shelf 32 is the NC shelf for side-A, while shelf 65 is the NC shelf for side-B.

4.11 Network Interface Shelf A: is occupied mainly by the Speech Interface (IF) cards, of which there are sixteen, identified as IF-0 through IF-15 (see Figure 5 on page 28). Each IF card accepts four ports from the PM, giving a total of 64 ports (4x16) for the shelf. At the left end of the shelf a bus card interfaces with the test circuits and provides proper termination. At the right end of the shelf another bus card interfaces with the NMC circuits.

4.12 Network Interface Shelf B: The arrangement of the Speech Interface cards in this shelf is the same as in the NIA shelf, except that there is only one bus card at the left end of the shelf. The right end of the shelf contains the four cards which perform the NMC function (see NT0X48 NMC Cards on page 31).

NT0X48 NM CARDS

4.13 The main cards for a fully-equipped NM of an NT0X48 Network are:

NT3X17AA (ICXPT cards)
NT3X18AA (OGXPT cards)
NT3X19AA (Speech Interface cards).

For an example of the card positioning, see Figure 5 on page 28.

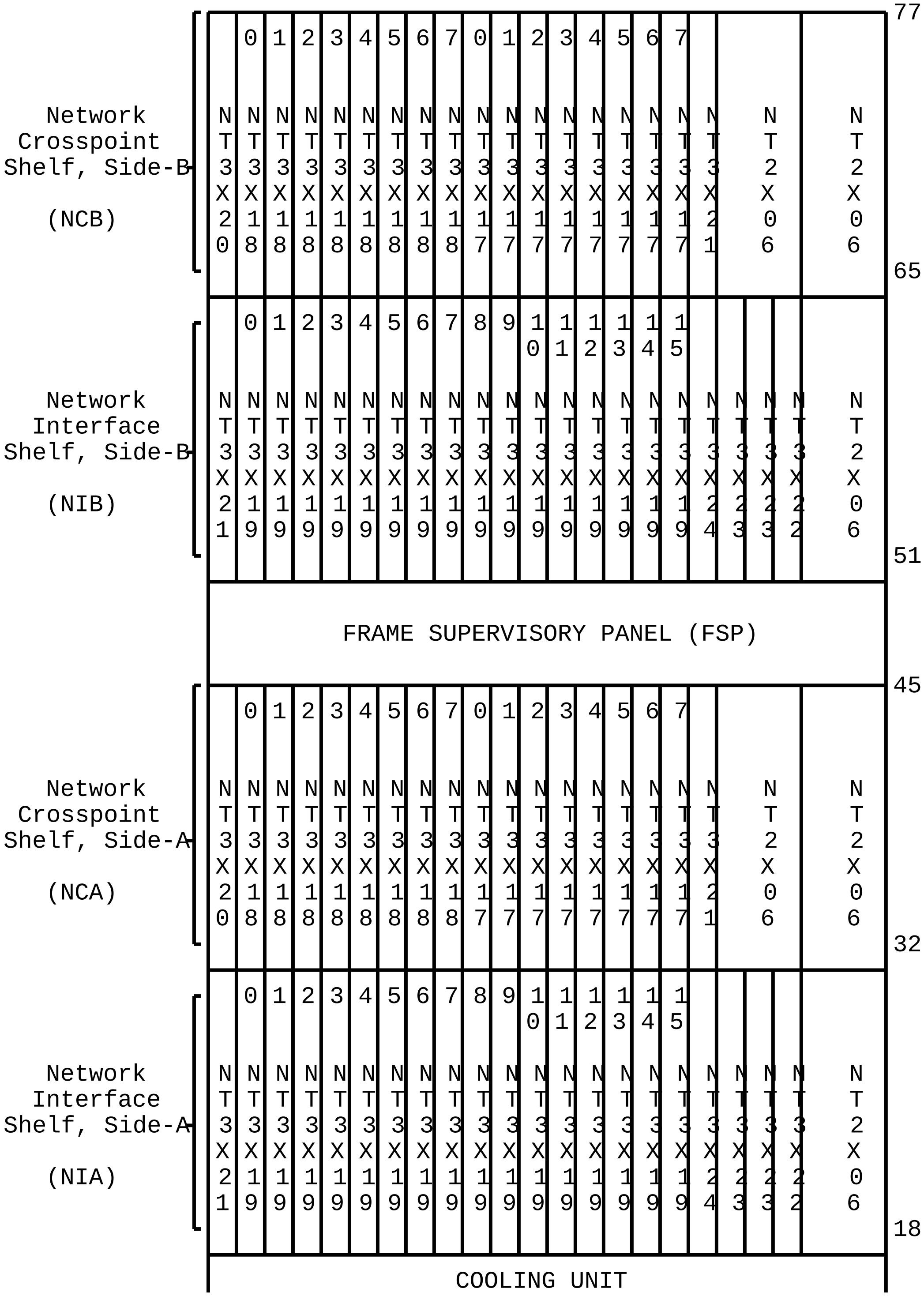


Fig. 5 - NT0X48 NM Frame and Cards

4.14 The following descriptions of the function of the cards apply to the receive side-A and the transmit side-B. The only difference is that in side-B the inputs arrive from another NM, or side-A of the same NM through the junctors, and the outputs connect to the PM. In side-A, the inputs arrive from the PM, and the outputs connect to the junctors.

NT3X17AA The eight outputs from IF-0 and IF-1, each representing 32 channels of serial data, enter the incoming formatter and are converted to 32 sets of parallel data words, 10-bits per word, having 8 words per set.

NT3X18AA An NM contains eight OGXPT numbered 0 through 7, each containing:

- a multiplexer (MUX)
- a DM
- a CM
- an outgoing formatter (OFM).

All eight interswitch link buses from ICXPT-0 through -7 are connected to inputs -0 through -7 of the eight multiplexers. The bus from each ICXPT card is connected to the corresponding inputs on all of the OGXPT cards. That is, output from ICXPT-0 is connected to the 0 inputs on OGXPT-1 through -7, and so on for the outputs from ICXPT -1 through -7. The set of 8 multiplexers is referred to as the commutator. Each multiplexer output connects to a 256-word DM where each word is permanently assigned to one interswitch link port and channel. Samples are read out of the ICXPT DM and written into the OGXPT DM at the appropriate word location (address) and time that coincides with the existence of the assigned interswitch link bus.

The CM similarly has 256-word storage capacity where each word location is permanently assigned to a particular junctor port and channel. The CM is manipulated by a control message from the CC or the MS which assigns a free junctor and channel to the sample in the DM by writing the address of that sample into the free CM storage location. At the appropriate times, co-incident with the assigned junctor ports and channels, the samples are read out of the DM and enter the outgoing formatter, where the parallel data is converted back to serial format, for transmission to the outgoing circuits of an IF card.

NT3X19AA contains decoders and buffers for the incoming circuits, and buffers and encoders for the outgoing circuits.

Incoming Circuits

The decoders can accommodate four 32-channel ports (0-3) of incoming serial PCM at 2.56Mb/s, therefore, for the 64-port NM, 16 speech IF cards are required (designated IF-0 through IF-15). Each IF outputs four sets of 32-channel PCM samples which have been changed from the incoming pulse trains to serial data format by the decoder circuits. Test codes (TC) for maintenance are inserted and extracted at the IC buffers before the samples leave the speech card. All 16 IF cards operate similarly.

Outgoing Circuits

Speech samples, in serial data format, re-enter the speech card from OGXPT-0. Internal messages are inserted at the OG buffers before the data passes to the encoder to be changed into a pulse train for outgoing transmission. Similar action occurs between OGXPT-1 through -7, and IF-1 through IF-15.

Activity of NT3X17AA

* After leaving the incoming formatter, the parallel data is written into the DM. The DM stores up to 256 10-bit words, with each word location permanently assigned to a particular port and channel (the address). DM locations are identified by numbers 0 through 255. Thus, DM location 0 is assigned to port-0, channel-0, while location 255 is for port 7 channel 31.

* The CM also has storage for 256 10-bit words (8 bits for data, 1 for busy/idle bit, 1 bit unused). Each storage location is permanently assigned to one of 256 10-bit parallel interswitch link buses to the OGXPT. A free interswitch link bus is assigned to any DM word through a control message from the CC or the MS. The address of the DM word (IC port and channel number) is written into the CM word location, representing the assigned interswitch link bus.

* The complete NM of eight XPT can therefore accommodate 8 X 256 = 2048 speech channels and can switch them over the same number of interswitch link buses. The ICXPTs are identified as ICXPT-0 through -7. Internal messages (2 per port) are extracted before the data leaves the DM.

* Ports are identified by the absolute port number in the range of 0-63. Port-0 on ICXPT-0 has absolute port number -0, while Port-7 on ICXPT-7 has absolute port number-63. All other port references are numbered accordingly.

NT0X48 NMC CARDS

4.15 All signaling and control messages between the CC or the MS and the NM pass through the NMC. The NMC is positioned on shelf 51 of the NET frame, and serves both the receive (A) and transmit (B) sides of the NM. The NMC cards of the NT0X48 are:

NT3X20 (Test Access cards)
NT3X21 (Bus cards)
NT3X22 (Input/Output Interface (IF) cards)
NT3X23 (Input/Output Processor cards)
NT3X24 (Clock card).

4.16 They have the following functions.

NT3X20 tests the backplanes of NCB shelf 65 and NCA shelf 32, which are terminated at their distant ends. Each side of the NM contains an NT3X20 test access card. The side-A test access card is located on NCA shelf 32, and the side-B test card is on NCB shelf 65. The test access cards act as interswitch link bus terminators. One card provides the test access to the receive side and the other to the transmit side.

NT3X21 distributes to the NIA, NIB, and NCA, NCB shelf back planes the control signals generated by the Input/Output processor cards. The NT3X21 cards are located on shelves 65, 32, and 18. Shelf 51 receives control and timing signals directly. Two other NT3X21 bus cards are used at the far ends of shelves 51 and 18 for proper termination of the shelf backplanes.

NT3X22 interfaces the transmission of signaling and control messages to and from the CMC in the CCC or the MS in the DMS-SuperNode, and the two processors in the NMC. In the DMS-100 message handling system, "handshake" protocol is used. That is, no message sequence is initiated without receiving an acknowledgement from the receiver that it is ready to receive, and no sequence is completed without another acknowledgement after transmission that the reception is error-free.

NT3X23 communicates with the CC or the MS through the NT3X22 IF card. There are two processor cards. The processors manipulate the message data by routing the message to destinations, either within the NM (such as link or junctor connection commands), or to the address of a particular PM, instructing it to perform a call-processing or maintenance task.

One processor (NT3X23AA) handles all messages from the CMC or the MS, and is referred to as the C-side processor. Internal messages from the C-side processor, destined to the NM, are translated into control signals and routed to the NCA and NCB crosspoint cards. The C-side processor also receives internal messages from the PM which are extracted at the NT3X17 incoming XPT cards. Messages destined to a PM are routed to the P-side processor.

The other processor (NT3X23AB), referred to as the P-side processor, handles messages destined for a PM, which have been routed to it by the C-side processor. Messages destined to a PM are inserted into channel-0 of the appropriate outgoing port of the NT3X19 IF card, located on the NIA and NIB shelves to which the addressed PM is connected.

NT3X24 derives a 10.24 MHz Network clock pulse and a frame pulse (125 us) of data incoming from the CMC. All timing within the NM is controlled by the clock, and is also passed through the IF cards to the PM.

The CMC clock provides the common clock source for all Networks. This allows the Networks to align their channels and firmware so that data can be switched across interswitch link buses going to and from the connecting DMs. Timing is also required in the PMs for similar reasons of synchronization.

5. DESCRIPTION OF NT5X13

GENERAL

5.01 This part describes the configuration of the frame, the types of cards, and the function of the NT5X13. The NT5X13 has a single-bay Network (NET) frame, as shown in Figure 4 on page 26.

5.02 The functions are performed by cards that are plugged into the four NET shelves. All shelves are equipped with power converters which are fed from the -48V office battery through the PDC and the FSP (described in 297-1001-156 and in GS0X28 respectively).

NT5X13 MOUNTING FRAME

5.03 Each single-bay frame of the NT5X13 contains two NMs as plane-0 and plane-1 respectively. A complete set of NM for both planes is accommodated in 32 frames (half the number required for NT0X48). Figure 7 on page 42 shows an arrangement of one NM per plane.

5.04 The combined Network frame is identified first as NETC, and then by the individual frame discrimination number, ranging from NETC 00 to NETC 31. In Figure 4 on page 26, the NT5X13 frame is identified as NETC 01.

5.05 The upper two shelves in the frame contain the NM cards for plane-0, while the lower two shelves contain the cards for plane-1. The FSP occupies the center position. Identification of NT5X13 is similar to that used for Network NT0X48.

5.06 In Figure 6 on page 35 the shelves in the NT5X13 NET frame are identified according to the DMS-100 Family equipment location scheme. Each shelf is allotted a base mounting number representing the location of the lowest mounting screws supporting the shelf in the frame. The range of base mounting holes is 00 to 77, with 00 at the bottom of the frame.

5.07 The NT5X13 frame contains equipment for two complete NM, one for plane-0 and the other for plane-1. The shelves containing the components for plane-0 are located in shelves 51 and 65. The plane-1 components are in shelves 18 and 32.

5.08 Shelves 65 and 18 contain the speech interface cards for planes-0 and -1, respectively. Shelf 65 is identified as the Network Interface shelf for plane-0 (NI0), while shelf 18 is the Network Interface shelf for plane-1 (NI1). Similarly, shelves 51 and 32 contain the Network crosspoint cards for planes -0 and -1, respectively. Shelf 51 is identified as the Network Crosspoint shelf for plane-0 (NC0), while shelf 32 is the Network Crosspoint shelf for plane-1 (NC1).

5.09 Network Interface Shelf: Each NI shelf contains two sets of eight speech IF cards. Shelves NI0 (65) and NI1 (18) have identical configurations. One set interfaces with the junctors and the other set interfaces with the PMs by the P-side links. Both sets of cards are identified as IF-0 through IF-7. Each IF card accepts eight ports from the PM or junctors, giving a total of 64 ports (8x8) for the shelf. Each side has an associated SP formatter and a PS formatter card. These cards are located between the IF cards for the two sides. The shelf also contains a P-side processor card which handles part of the NMC function involving messages between the NET and its associated PM.

5.10 Network Crosspoint Shelf: Shelf 51 contains two sets of four crosspoint (XPT) cards, each performing both the incoming and outgoing crosspoint TS functions. The set at the left is used for side-A of an NM, and the set to the right is used for side-B. Both sets of cards are identified as XPT-0 through XPT-3. Each XPT accepts 16 inputs from two IF cards, and provides 16 switched outputs to two IF cards. Inputs from the IF cards enter through the SP formatter, and outputs leave through the PS formatter. The total number of inputs and outputs for the four XPT cards is 64 (16x4).

5.11 The card positions for shelf 51, from left to right, are shown in Figure 6 on page 35. The remainder of the input side of the shelf is unused. Shelf 32 contains corresponding cards for plane-1 which are located in right to left configuration.

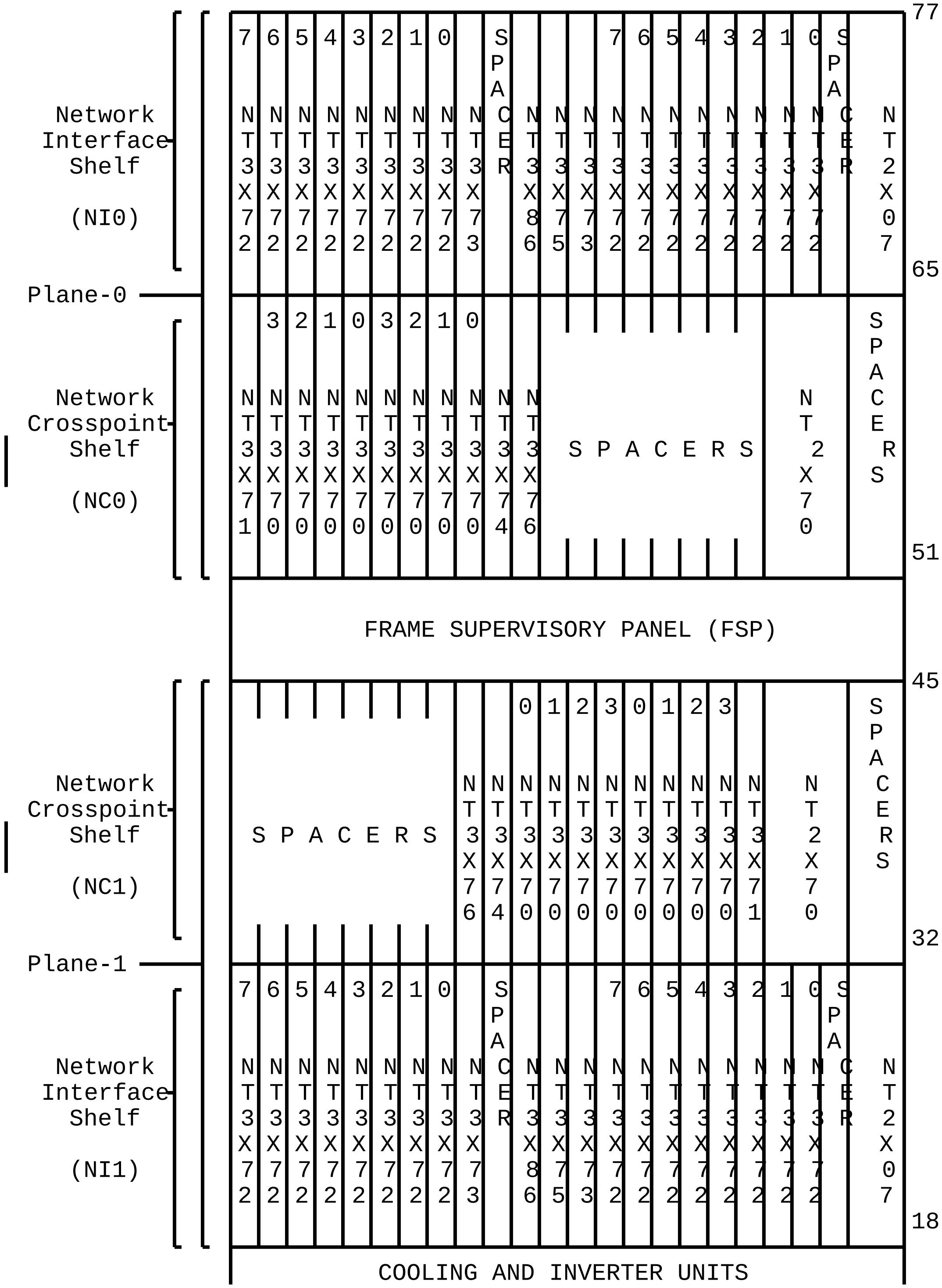


Fig. 6 - NT5X13 NM Frame and Cards -- Fully Equipped

NT5X13 NM CARDS

5.12 The main cards for a fully-equipped NM of an NT5X13 Network are:

NT3X70 (Crosspoint cards)
NT3X71 (Test Code cards)
NT3X72 (Serial port (speech) interface cards)
NT3X73 (Serial-to-Parallel (SP) formatter cards)
NT3X86 (Parallel-to-Serial formatter (PS) cards).

5.13 The following description applies to the receive side-A and the transmit side-B. The only difference is that in side-B the inputs arrive from another NM, or side-A of the same NM, through the junctors, and the outputs connect to the PM. In side-A, the inputs arrive from the PM, and the outputs connect to the junctors.

NT3X70 contains the TS for 512 channels (one quarter) of one side of an NM. Speech data enters the XPT card in parallel format on a 10-bit wide bus carrying 512 channels. Since the format is parallel, the ports are separated in time, not in space. The data on this bus is written into the DM of the first-stage TS. The data in the DM is subsequently distributed to its own second-stage TS and to those on its three mate XPT cards through the interswitch link buses. A space switching circuit known as a commutator is an integral part of the interswitch link buses. It creates a new 512-channel bus for the second-stage TS by selecting channels from its own first-stage TS and channels from each of the three mate XPT cards. The second-stage TS is identical to the first-stage TS. Speech data leaves the XPT card on a 10-bit wide bus.

Each TS has a DM and a CM. The DM does the actual time switching. During the instant assigned to the interswitch link bus, a speech sample is written into the DM at an address specified by a counter which repetitively cycles through the 512 active addresses of the memory, and a sample is read from the DM at an address supplied by the CM. It is this process which relocates the position of the channels in time on the parallel bus thereby performing a time switch function.

The CM holds information which sets the switching pattern. It is written by the NCP in response to a control message from the CC or the Computing Module

In addition to controlling the DM, the CM also:

* controls the space switching commutator on the interswitch links

* selects a digital pad which controls the level of the speech path following the outgoing time switch.

One of eight loss values (from 0-7 db) is selected automatically by the system. Adjusting the loss value in the Network means that attenuation is centrally done for the system (instead of by each PM), and is done for lines that do not have attenuation capabilities.

NT3X71 interfaces with a Network Control Processor card (NT3X74) to allow the insertion and extraction of Test Code (TC) (see Maintenance by Test Code Insertion and Extraction on page 23).

NT3X72 provides eight bi-directional, 2.56 Mb/s serial port interfaces on shelf 18. Each card interface contains decoders and data alignment buffers for the incoming circuits, and encoders and buffers for the outgoing circuits.

Insertion of TC occurs only on the incoming speech path, while extraction occurs on either path.

Incoming Circuit

The decoders can accommodate eight 32-channel ports (0-7) of incoming serial PCM at 2.56 Mb/s from the PM, therefore, for a 64-port NM, 8 speech interface cards are required (designated IF-0 through IF-7). Each IF outputs eight sets of 32-channel PCM samples which have been changed from the incoming pulse trains to 10-bit serial data format by the decoder circuits. The serial data stream from each decoder is paired with that from another port (for example, port-0 and port-1), and each pair of data streams is interleaved onto a 5.12 Mb/s serial (1 pair) bus to the SP formatter. Four 5.12 Mb/s serial buses (1 pair each) are used to carry the total of eight streams (four pairs) from IF-0 (ports 0-7) to the SP formatter. A similar arrangement of four-pair 5.12 M b/s serial buses carries data from IF-1 (ports 8-15) making a total of sixteen data streams (8 pairs) per couple of IF cards (IF-0, IF-1). The other ports (16-63) on IF-2 through IF-7 are similarly paired and also output 16 data streams per couple of IF cards.

Ports are identified by the absolute port number in the range of 0-63. Port-0 on IF-0 has absolute port number-0, while port-7 on IF-7 has absolute port number-63. All other port references are numbered accordingly.

Outgoing Circuit

In the outgoing direction each IF card receives four 5.12 Mb/s binary serial speech buses, each carrying a pair of data streams from the PS formatter. It demultiplexes these speech buses to the 2.56 Mb/s format and inserts internal messages. The data streams pass to the encoders to be changed into pulse trains for outgoing transmission through the appropriate ports.

NT3X73 converts the incoming serial data received from the speech interface cards to the parallel format required for the crosspoint cards. The SP formatter consists of four identical sections. Each section is responsible for converting 16 ports (8 pairs) of speech data into a 512-channel, 10-bit parallel bus. Thirty-two (4 sections X 8 pairs) dual-port (1-pair) serial data buses from eight serial interface cards are received by the four SP formatter sections. It outputs four 10-bit parallel buses, one to each of the four crosspoint cards which comprise one side of an NM.

NT3X86 converts parallel speech buses from the XPT cards to the serial format required by the serial port IF cards. The PS formatter consists of four identical sections. Each section is responsible for converting a 512-channel 10-bit parallel bus into sixteen (8-pairs) serial buses. Four parallel buses are received by the PS formatter, one from each of the four XPT cards which comprise one side of an NM. It outputs thirty-two (4 sections x 8 pairs) dual port (1-pair) serial data buses to eight serial IF cards.

NT5X13 NMC CARDS

5.14 All signaling and control messages between the CC or the Computing Module and the NM pass through the NMC. The NMC consists of three cards, which are located on the NI and NC shelves, and serve both sides of their associated Network plane. The NMC cards for plane-0 are on shelves 65 and 51, while the NMC cards for plane-1 are on shelves 32 and 18.

5.15 The NMC cards for the NT5X13 Network are:

NT3X74 (Network Control Processor (NCP) card)
NT3X75 (P-side Processor card)
NT3X76 (Network Clock card).

The functions of the NMC cards are as follows.

NT3X74 handles all messages from the CMC or the Computing Module, and performs the C-side processor function. Messages for the Network are acted upon by the NCP itself, which has control buses to the XPT cards, the TC card, the clock card, and the P-side message processor. Network connections are established by writing DM addresses into the first- and second-stage TS CMs of both the A- and B-sides of the Network.

The control bus to the TC card is used to specify the word locations and channels for TC insertion and extraction, and to return the extracted data to the control processor. Extracted TCs are held in registers in the TC card for access by the NCP. The NCP then reads the registers to check if a valid TC has been extracted.

The control bus to the clock card (NT3X76) performs various clock maintenance operations and accesses the Network's transmission interface to the CC or the Computing Module.

The bus to the P-side message processor exchanges peripheral messages between the two processors. Messages addressed to the PM are routed to the P-side processor card for insertion into channel-0 of the appropriate port of the card to which the addressed PM is connected.

NT3X75 handles message exchanges between an NM and its PM. The P-side of the processor is connected across the four parallel buses between the formatters and the XPT cards on the A- and B-sides of their peripheral faces. Messages from a PM are extracted at the output of the SP formatter, while messages to a PM are inserted at the input to the PS formatter. The processor is thus able to access all the channel-zero's going to and coming from the PM. Four simultaneous message transactions can be handled, but only one at a time on each parallel bus. On its Network side, the processor has access to a message buffer on the NCP card (NT3X74). Messages received from peripherals are deposited in this buffer to be relayed by the NCP to the CC or the Computing Module. The P-side processor also scans this buffer for outgoing messages. These are sent to the PM specified in the message headers.

NT3X76 interfaces the transmission of signaling and control messages to and from the CMS in the CC or the Computing Module in the DMS-SuperNode, and the two processors in the NMC. In the DMS-100 Family message handling system, "handshake" protocol is used. That is, no message sequence is initiated without receiving an acknowledgement from the receiver that it is ready to receive, and no sequence is completed without another acknowledgement after transmission that the reception is error-free. CMC or Computing Module messages carry only control data in serial format.

The Network clock card for NT5X13 contains a circuit that generates a 10.24 MHz clock pulse and a frame pulse (125us). The clock circuit periodically synchronizes itself with the frame pulse received from the incoming data from the CMC or the Computing Module. These clock and frame pulses control timing within the NM and, through the interface cards, to the PM.

6. DESCRIPTIONS OF NT7X27 AND NT7X40

GENERAL

6.01 The NT7X27 and NT7X40 are specially packaged Networks. They use similar types and cards but the cards are placed in different slots in their respective frames.

DESCRIPTION OF NT7X27

6.02 The NT7X27 has similarities to the NT5X13 but is mounted on only one shelf. The cards of the NT7X27 have the same function as the cards of the NT5X13 except that they are located in different slots in the shelves. Unlike the NT5X13, the NT7X27 cannot be expanded in the same manner. The NT7X27 has seven interface cards (numbered 0 to 6) at eight ports per card, therefore the quantity of ports per shelf is fifty-six (7x8). All of the ports are connected to P-side links. Also, the NT7X27 has a serial to parallel formatter for the A-side and a parallel to serial formatter for the B-side. All the junctors are parallel intra-junctors and inter-junctors. The NT7X27 has only two Network configurations.

DESCRIPTION OF NT7X40

6.03 The NT7X40 is very similar to the NT5X13. It has two shelves per Network plane and is used for SL-100.

6.04 For the description of the cards for the NT7X40, refer to the cards described in Part 5 on page 33.

7. DESCRIPTION OF NT8X11

GENERAL

7.01 This part describes the configuration of the frame, the types of cards, and the function of the NT8X11. The NT8X11 has a single-bay Network (NET) frame, as shown in Figure 7 on page 42.

NT8X10 AND DSNE

7.02 When two NT8X11 Networks are mounted in the same equipment frame, the frame is referred to as the NT8X10 or the Double Shelf Network Equipment (DSNE).

7.03 The functions are performed by cards that are plugged into the four NET shelves. All shelves are equipped with power converters which are fed from the -48V office battery through the PDC and the FSP (described in 297-1001-156 and in GS0X28 respectively).

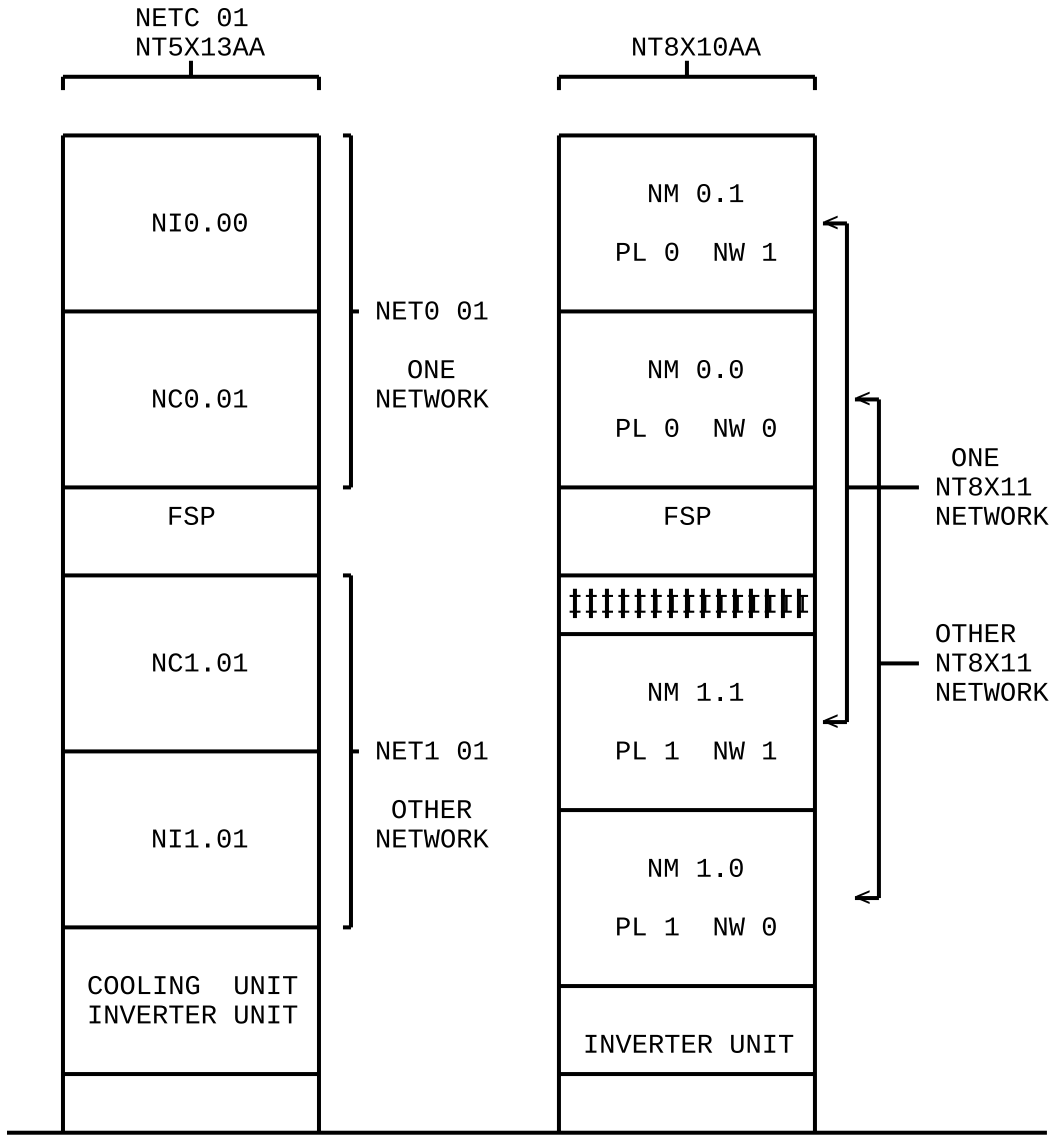
NT8X11 MOUNTING FRAME

7.04 One single-bay frame of the NT8X11 contains two NMs as plane-0 and plane-1 respectively. A complete set of NMs for both planes is accommodated in 16 frames (half the number required for NT5X13). Figure 7 on page 42 shows an arrangement of one NM per plane per shelf. The combination of two NT8X11 Networks, the baffle, the different mounting positions, and the Inverter Unit in one frame is called the NT8X10 frame.

7.05 The Network halves are identified as NET0 01 and NET1 01. NET0 01 has one shelf and NET1 1 has one half. For a comparison of the NT8X11 frame and the NT5X13 frame, see Figure 7 on page 42. The upper two shelves in the frame contain the NM cards for plane-0, while the lower two shelves contain the cards for plane-1. The FSP occupies the center position.

7.06 In Figure 8 on page 44 the shelves in the NT8X11 NET frame are identified according to the DMS-100 Family equipment location scheme (described in 297-1001-120). Each shelf is allotted a base mounting number representing the location of the lowest mounting screws supporting the shelf in the frame. The range of base mounting holes is 00 to 77, with 00 at the bottom of the frame.

7.07 The NT8X10 frame contains equipment for four complete NMs, two for plane-0 and two for plane-1. The shelves containing the components for two plane-1s are located in shelves 51 and 65. The plane-0 components are in shelves 18 and 32.



0 or 1 for the plane of the shelf   Each shelf serves A & B sides

NT5X13 Frame:	NT8X11 Frame:
NETC01 NET Frame, Plane-0	two Networks
NETC01 NET Frame, Plane-1	
Shelves:	Shelves:
NI0 NET Crosspoint, Plane-0	NM 0.1 Plane-0, Network 1
NC0 NET Interface, Plane-0	NM 0.0 Plane-0, Network 0
NC1 NET Crosspoint, Plane-1	NM 1.1 Plane-1, Network 1
NI1 NET Interface, Plane-1	NM 1.0 Plane-1, Network 0

Fig. 7 - Nomenclature for Frames of NT5X13 and NT8X11

7.08 Both the crosspoint and the interface cards are contained in one shelf, and each shelf contains one complete Network. Therefore, one frame can contain two fully equipped Network pairs.

7.09 The card positions for shelf 51, from left to right, are shown in Figure 8 on page 44. The remainder of the input side of the shelf is unused, however, it allows heat to dissipate from the frame’s equipment. Shelf 32 contains corresponding cards for plane-0 which are located in right to left configuration.

NT8X11 NM CARDS

7.10 The main cards for a fully-equipped NM of an NT8X11 Network are:

NT8X12AA (Interface cards)
NT8X13AA (Crosspoint cards)
NT8X14AA (Test Code cards).

7.11 The following description of the card functions applies to the receive side-A and the transmit side-B. The only difference is that in side-B the inputs arrive from another NM, or side-A of the same NM, through the junctors, and the outputs connect to the PM. In side-A, the inputs arrive from the PM, and the outputs connect to the junctors.

NT8X12AA provides sixteen bi-directional, 2.56 Mb/s port interfaces for the DS-30 format of NMs or PMs and also provides the serial to parallel and parallel to serial formatter functions for interfacing with the NT8X13 crosspoint card. Each card has a W87 chip for the DS-30 conversion and a W72 chip for the serial and parallel conversions (see Figure 9 on page 46).

The W87 has a 32-bit elastic buffer which allows a sufficient delay compensation so that a port card can be used on the peripheral side and the junctor side. The W87 also detects and decodes the clock, frame pulse, and data from the biphase signal. The sixteen serial data outputs from the W87s are multiplexed and input to the W72 chip, which formats and shifts the serial data into parallel format.

For the transmitting path, the 10-bit parallel data at 5.12 MHz that is received from the crosspoint card is applied to the W72 chip. The W72 reformats and shifts the data into 8-bit serial data stream, each of which carries 64 PCM channels at 5.12 MHz. The W87 demultiplexes the serial transmitting data from 5.12 to 2.56 MHz. The transmitted data is then passed to the biphase encoder where framing information is encoded into a DS-30 biphase format. The output of the biphase

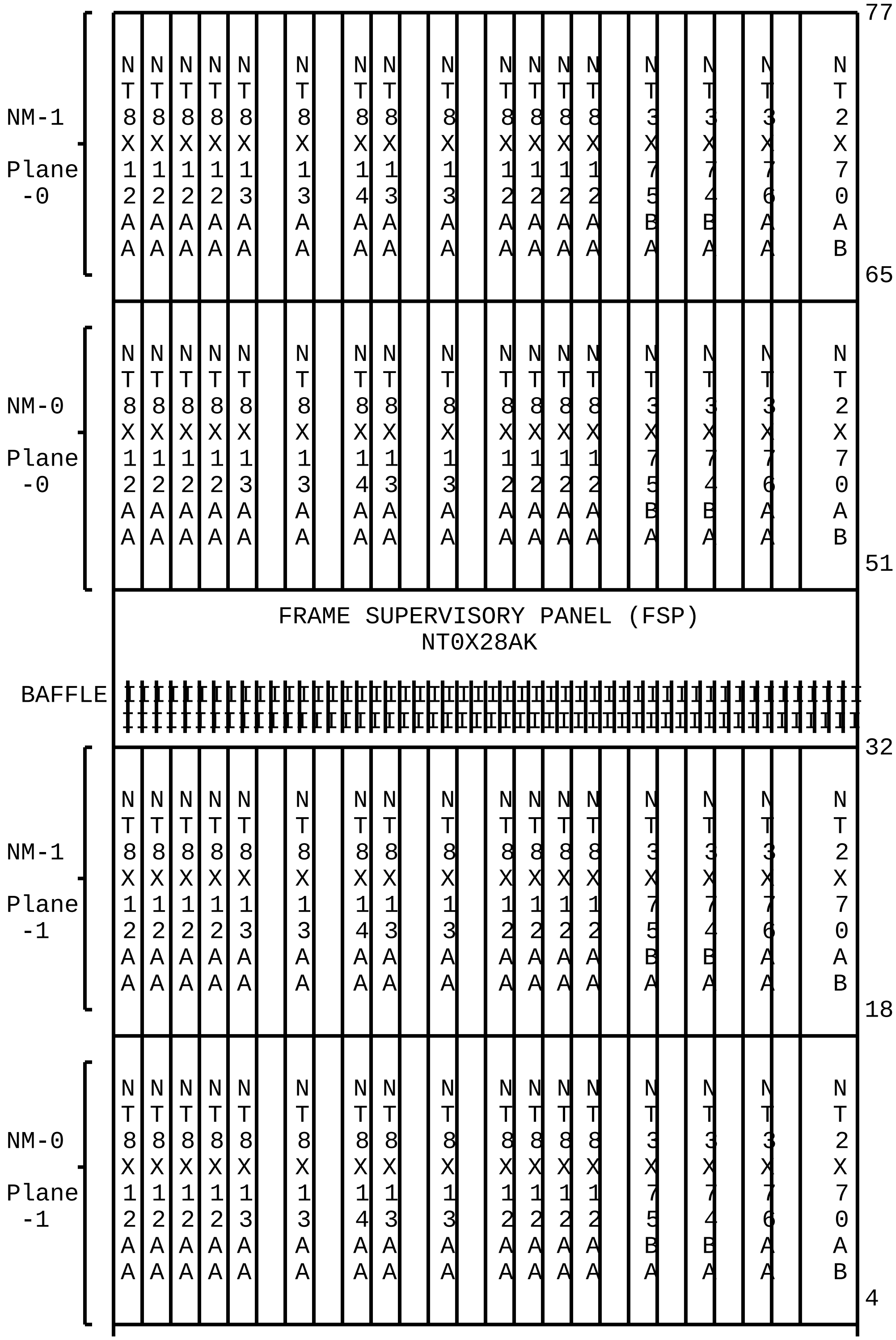


Fig. 8 - NT8X11 NM Frame and Cards--two fully equipped Networks

encoder is transmitted by a different line driver in the W87. A transformer provides DC isolation and rejects common mode signals.

The card provides sixteen ports and in a set of four provides sixty-four ports per NM. The NT8X12 card of the NT8X11 Network replaces the functions of the NT3X72, NT3X73, and NT3X86 cards of the NT5X13 Network.

Test Code

The card also handles the insertion and extraction of Test Code (TC) from card NT8X14. TC is inserted only on the port card in the speech channel immediately after the outgoing circuit. When TC is inserted, the speech bus is disabled for the involved port and channel.

TC is extracted from a port card:

* on the incoming side immediately after insertion

* on the outgoing side immediately before the W87 chips.

Incoming Circuit

On each card, two formatter chips (W72) each converts sixteen serial ports to parallel or sixteen parallel ports to serial. The main function of these circuits is:

* to convert incoming data in the DS-30 format of transmission and convert it into PCM data, then send it to a NT8X13 crosspoint card

* to receive and to re-align incoming biphase data.

Outgoing Circuit

On each card, eight DS-30 chips (W87) each provides two bidirectional interfaces to the DS-30 links that connect the NMs to the PMs. The main function of these circuits is to convert outgoing PCM data from an NT8X13 crosspoint card into the DS-30 format for transmission over the DS-30 links.

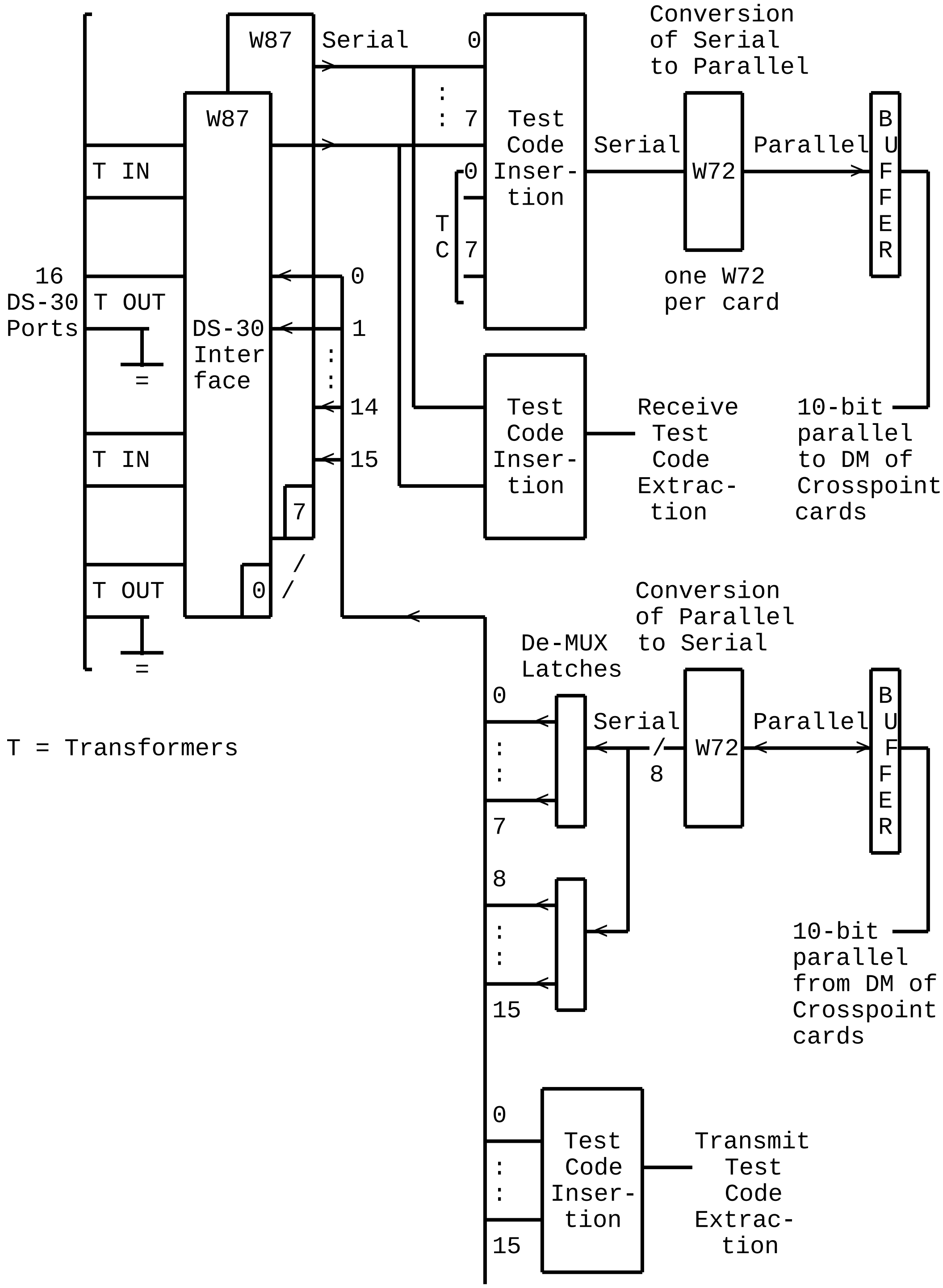


Fig. 9 - NT8X12 Port Card Block Diagram

NT8X13AA contains the TS for 2048 input channels and 1024 output channels. Two pairs of cards are required, one pair for switching from the peripheral input channels to the junctor output channels on the A-side, and one pair for switching from the junctor input channels to the peripheral output channels on the B-side. The NT8X13 is identical for A- and B-side functions. When used in a time-slot for an A-side function, it outputs to the junctor cards; when used in a time-slot for a B-side function, its input is from the junctor cards. When only parallel junctors are used, the signal is sent directly from an A-side crosspoint card to a B-side crosspoint card.

Unlike the NT3X70 cards of the NT5X13 Network, the NT8X13 crosspoint cards do not block the time switching. Any of the input channels are switched to any of the output channels without restrictions. The NT8X13 card is a single stage TS.

Each TS is a 2-way commutated, 2-way matrix that switches any one of the 2048 input channels to any one of the 2048 output channels. Each TS has two DMs with a capacity of one frame (125us) of PCM samples from each of two input buses. The DM does the actual time switching. During the instant assigned to the interswitch link bus, a speech sample is written into the DM at an address specified by a counter which repetitively cycles through the 512 active addresses of the memory, and a sample is read from the DM at an address supplied by the CM.

The size of a DM is 1K at 10-bits wide and uses the same memory size as the NT5X13 (55 nanosecond 1K times 4 static RAMs) to construct the DM and CM.

Each DM is controlled by a CM which supplies its DM with the read addresses. The CM holds information which sets the switching pattern. It is written by the NCP in response to a control message from the CC or the Computing Module.

In addition to controlling the DM, the CM also:

* controls the space switching commutator on the interswitch links

* selects a digital pad which controls the level of the speech path following the outgoing time switch.

One of eight loss values can be selected.

NT8X14AA interfaces the NM with the Network Control Processor (NCP) card for the insertion and extraction of Test Code (TC) and for the testing of the digital pads. TC is used by the CC or the Computing Module to check the continuity of a PCM path. If the TC card does not trace the expected test code, the location is read by the NCP and sent to the CC or the Computing Module. A card list of suspected faulty card(s) is displayed at the MAP. See Maintenance by Test Code Insertion and Extraction on page 23.

NT8X11 NMC CARDS

7.12 The NMC cards for the NT8X11 Network are:

NT3X74BA (Network Control Processor (NCP) card)
NT3X75BA (P-side Processor card)
NT3X76AA (Network Clock card)
NT3X76AC (Network Clock card for DMS SuperNode).

The functions of the NMC cards are as follows:

NT3X74BA handles the following:

* all messages from the CMC or the Computing Module

* does the C-side processor function

* controls the Network switching

* inserts or extracts TC in response to the CC or the Computing Module

* provides the message buffer for the P-side processor when a PM is to communicate with the CC or the Computing Module.

Messages for the Network are acted upon by the NCP itself, which has control buses to the crosspoint cards, the TC card, the clock card, and the P-side message processor. Network connections are established by writing DM addresses into CMs of both the A- and B-sides of the Network. The control bus to the TC card is used to specify the word locations and channels for TC insertion and extraction, and to return the extracted data to the control processor. The control bus to the clock card (NT3X76) does various clock maintenance operations and accesses the Network's transmission interface to the CC or the Computing Module. The bus to the P-side message processor exchanges peripheral messages between the two processors. Messages addressed to a PM are routed to the P-side processor card for insertion into channel-0 of the appropriate port of the card to which the addressed PM is connected.

NT3X75BA handles message exchanges between an NM and its PM. The P-side of the processor is connected across the four parallel buses of the crosspoint cards on the A- and B-sides of their peripheral faces. Messages from a PM are extracted at the input of the crosspoint card, while messages to a PM are inserted at the output of the crosspoint card. The processor is thus able to access all the channel-0s going to and coming from the PM. Four simultaneous message transactions can be handled, but only one at a time on each parallel bus. On its Network side, the processor has access to a message buffer on the NCP card (NT3X74). Messages received from peripherals are deposited in this buffer to be relayed by the NCP to the CC or the Computing Module. The P-side processor also scans this buffer for outgoing messages. These are sent to the PM specified in the message headers.

NT3X76AA provides two transmission interfaces for signaling and control messages to and from the CMC in the CC or the Computing Module in the DMS-SuperNode and the two processors in the NMC. In the DMS-100 Family message handling system, "handshake" protocol is used. That is, no message sequence is initiated without receiving an acknowledgement from the receiver that it is ready to receive, and no sequence is completed without another acknowledgement after transmission that the reception is error-free. CMC or Computing Module messages carry only control data in serial format over a DS-30 link. Since the transmission is at 256 Kbytes/second, no PCM data is transmitted over that link.

The Network clock card (NT3X76) contains a circuit that generates a 10.24 MHz clock pulse and a frame pulse (125us). The clock circuit synchronizes itself with the frame pulse received from the incoming data from the CMC or the Computing Module. These clock and frame pulses control timing within the NMs and, through the interface cards, to the PMs.

NT3X76AC is the same as the NT3X76AA card except that it is used with DMS SuperNode.

NT8X11 TRANSMIT AND RECEIVE PATHS

7.13 The transmit and receive paths through the cards of the NT8X11 are shown in Figure 10 on page 50.

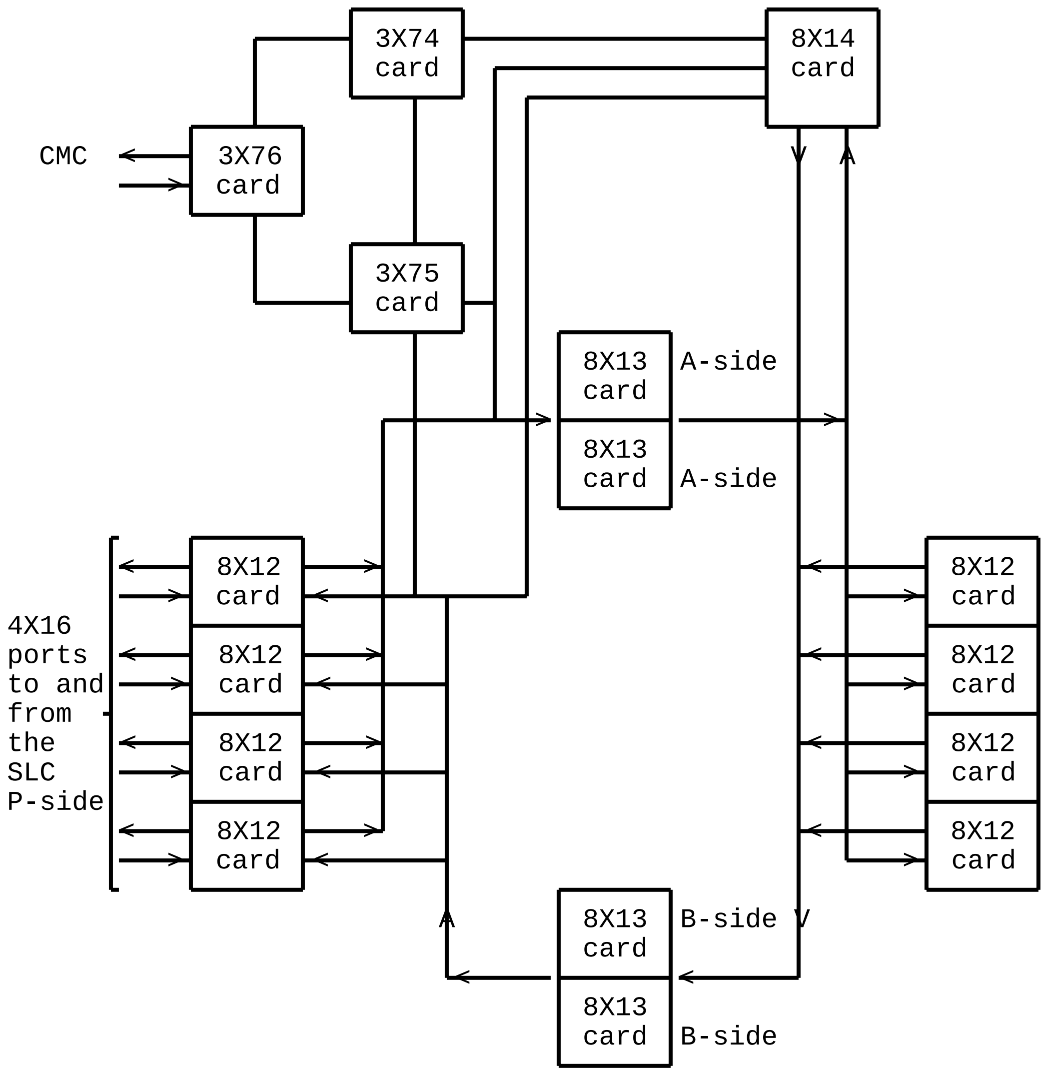


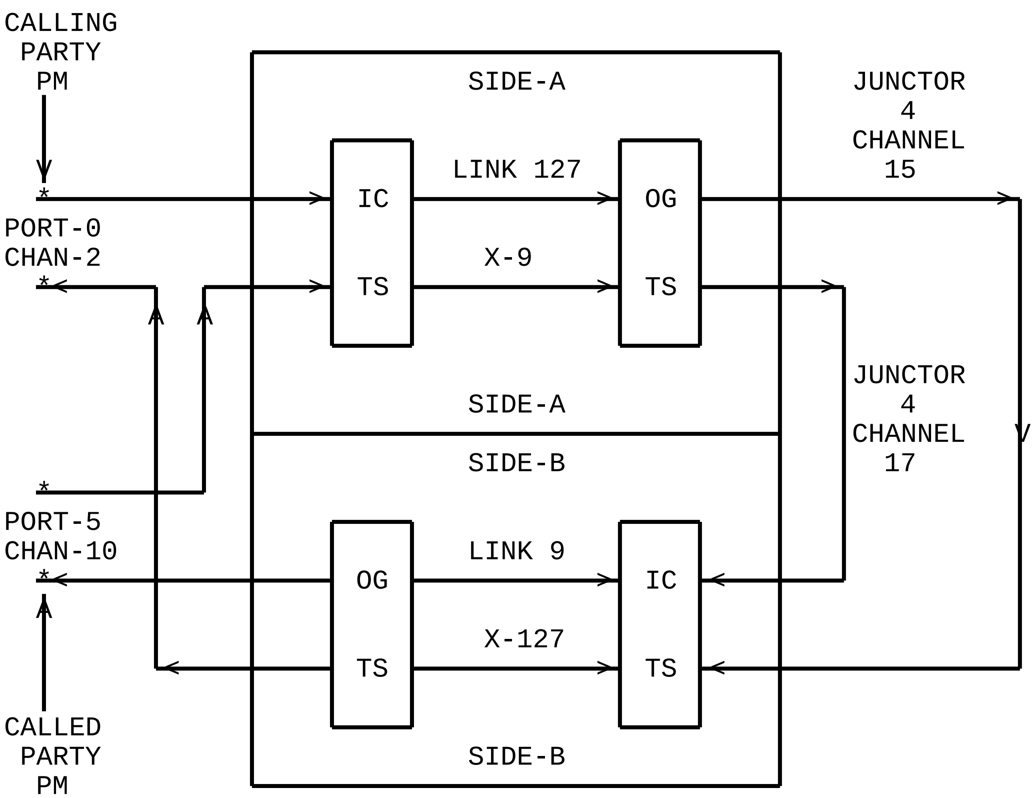
Fig. 10 - NT8X11 Data Transmit and Receive Paths

8. COMMON TRAITS

COMPLEMENTING

8.01 The description of the NM covers one-half of the 4-wire transmission path provided for connections through the DMS-100 Family Network. In this half-path, a 2-wire unidirectional speech path exists from the calling party to the called party through the receive (A) side of an NM and the transmit (B) side of the same, or another NM.

8.02 There also exists concurrently the other path from the called party to the calling party through separate channels on the A- and B-sides of the same, or another NM. Figure 11 shows a 4-wire connection using both sides of the same NM. To minimize round-trip delay, the interswitch link buses and junctor channels for one half of the transmission path are automatically selected by CC or the MS to be the complements of those selected for the other half-path.



Note: For the NT8X11, the four IC and OG TS boxes would be shown as one large box.

Fig. 11 - 4-Wire Paths (Complementing)

8.03 The complement consists of subtracting the link bus and junctor channel number for the calling-to-called party path, from the total number of link bus channels and junctor channels available per TS. The total number of link bus channels available per TS depends on the type of NM, as follows:

NT0X48: Each TS card has 8 ports and 32 channels per port for a total of 256 channels. Two channels per TS are required to carry the two paths needed for each call connection. The total number of available interswitch link channels is therefore 128 (0-127) per TS.

NT5X13, NT7X27, NT7X40: Each TS card has 16 ports and 32 channels per port for a total of 512 channels. On the basis of two interswitch link channels per call, the total number of available interswitch link channels is therefore is 256 (0-255) per TS.

NT8X11: Complementing is not relevant to the NT8X11 because the Network does not have interswitch links for its one-stage TS, but the junctors are still relevant.

8.04 Separate junctors are used to carry each path, so the total number of available junctor ports is 32.

8.05 In the example, it is assumed that the CC or the MS is handling a calling party originating at port-0, on side-A of an NM, and that interswitch link 127 has been selected for the A-side connection. The digits of the called party have been translated as port-5, channel-10 on the B-side of the NM, and interswitch link-9 has been selected for the B-side connection to this port. Junctor-4, channel-15 has been selected to carry this path between sides.

8.06 The total number of available interswitch link channels is represented by n (where n is 127 or 255). The complementary link and junctor channels are assigned by the CC or the MS as follows:

Calling Party	Path	Side	Link	Junctor	Side	Link	Path	Called Party
Pt.0 Ch.2	IC	A	127	4 Ch.15	B	n-9	OG	Pt.5 Ch.10
Pt.0 Ch.2	OG	B	n-127	4 Ch.17 (32-15)	A	9	IC	Pt.5 Ch.10

For the NT8X11, in the same example there are no link assignments:

Calling Party	Path	Side	Junctor	Side	Path	Called Party
Pt.0 Ch.2	IC	A	4 Ch.15	B	OG	Pt.5 Ch.10
Pt.0 Ch.2	OG	B	4 Ch.17 (32-15)	A	IC	Pt.5 Ch.10

8.07 The overall identification of link channels for all the TS in a fully-equipped NM (2048 channels) uses the link port (0-63) number, and link channel (0-31) numbering scheme. This scheme is used for maintenance to identify links on MAP displays and Network Log reports (described in 297-1001-514 and 297-1001-510 respectively).

8.08 The NT8X11 has only one TS per side, but the function is the same.

JUNCTOR HARDWARE

8.09 Connections to the junctor ports are organized by the Digital Network Interconnecting (DNI) frame. The DNI provides patching for the junctor cables from the A-sides of the NM, and for the cables to the B-sides of the NM. The frame houses connector panels mounted horizontally. The DNI frame is to provide means for flexibly arranging the patterns of junctor connections between NM in accordance with traffic requirements, and to enable expansion of the Network to be performed with minimum effect on Network operation. Refer to GS0X18 for a description of the DNI frame.

8.10 The NT7X27 and NT7X40 use special junctor cables to eliminate the need for a DNI.

SPEECH LINK HARDWARE

8.11 Connections between the PM and the NM ports are organized by the Speech Link Connecting (SLC) frame. The SLC provides 4-wire patching for the speech link cables to and from the Network and the peripheral module(s). The frame houses two groups of panels. The assignment of peripheral ports to Network ports can be arranged at the SLC to obtain the most efficient use of the Network, and to enable expansion to be performed with minimum effect on the system. Refer to GS0X56 for a description of the SLC frame.

9. TRAFFIC CAPABILITIES

GRADE OF SERVICE

9.01 The DMS-100 Family Network meets North American grade of service objectives as follows:

Network Matching Loss Objectives

DMS-200: 0.5% matching loss based on 10 HDBH[3]
2.0% matching loss based on HDBH[4]

DMS-100: 1.0% (OG) loss based on 1 ABSBH[5]
2.0% (IC) loss based on 1 ABSBH
20.0% loss based on HDBH

Matching loss is defined as the average probability of a call not being completed due to congestion in the Network and in line concentration.

CAPACITY

9.02 As a Class 5 office, DMS-100 is capable of terminating over 100,000 lines, while DMS-200 provides 60,000 trunk terminations. Network capacity is estimated to be 700,000 ABSBH equivalent Hundred Call Seconds (CCS).

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[3] 10 HBDH = 10 High Day Busy Hours

[4] HBDH = High Day Busy Hour

[5] ABSBH = Average Busy Season Busy Hour

10. ABBREVIATIONS

CC	Central Control
CCC	Central Control Complex
CM	Connection Memory
CMC	Central Message Controller
CPU	Central Processing Unit
CSB	Channel Supervision Bit
CSM	Channel Supervision Message
DC	Device Controller
DM	Data Memory
DMS	Digital Multiplex System
DNI	Digital Network Interface (frame)
DS	Data Store
DSNE	Double Shelf Network Equipment
FSP	Frame Supervisory Panel
ICXPT	Incoming Crosspoint
IF	Interface
IFM	Incoming Formatter
IC	Incoming
I/O	Input/Output
IOC	Input/Output Controller
MUX	Multiplexer
MAP	Maintenance and Administration Position
Mb/s	Megabits per Second
MS	Message Switch
NC	Network Crosspoint (shelf)
NCP	Network Control Processor
NI	Network Interface (shelf)
NM	Network Module
NET	Network (frame)
NMC	Network Message Controller
NETC	Network Combined (frame)
OG	Outgoing
OGXPT	Outgoing Crosspoint
OFM	Outgoing Formatter
PCB	Printed Circuit Board (card)
PCM	Pulse Code Modulation
PDC	Power Distribution Center
PEC	Product Engineering Code
PM	Peripheral Module
PS	Parallel-to-Serial
RAM	Random Access Memory
SLC	Speech Link Connecting (frame)
SP	Serial-to-Parallel
TC	Test Code
TS	Time Switch
XPT	Crosspoint