NTP 297-3601-450

DMS-10 Family

600-Series Generics

Provisioning

08.01
For Generic 602.20 Standard August 2006

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Contents

Section 1: Introduction

General information

Traffic provisioning is the process by which the DMS-10 Digital Switching System is equipped with hardware required to provide switching capability for a given traffic load. The process is based on the modular design of the DMS-10 system. This modularity is evidenced by the provisioning of plug-in circuitry as required and by the system architecture: control, network, and peripheral equipment.

The traffic provisioning process consists of:

- provisioning sufficient control, network, and line and trunk (peripheral) equipment to meet the operating company's requirements for the job interval
- provisioning circuit packs to meet the operating company's initial requirements at cutover and requirements for the job interval. In the latter case, the circuit packs required for the rest of the job interval are purchased from Nortel and installed by the operating company as required. They are provisioned according to the rules detailed in the “Provisioning Rules and Methods” section of this NTP.

Buffer allocation is the process by which buffers are assigned to accommodate changes in traffic load. Buffers are areas of memory that hold information until it is transmitted to another device. Some buffers, such as Automatic Message Accounting buffers, should be allocated according to traffic considerations, as detailed in the “Buffer Allocation” section of this NTP.

Physical provisioning is the process by which the DMS-10 switch is equipped with hardware to provide testing, efficient line concentration, and other capabilities not directly influenced by traffic conditions.

Scope and purpose of this publication

This Nortel technical publication (NTP) describes the traffic provisioning, buffer allocation, and physical provisioning processes. The purpose of this NTP is:

- to assist telco personnel in verifying that the system capacity is adequate for the current level of traffic
- to provide telco personnel with basic hardware provisioning guidelines for upgrading their switching equipment
- to provide telco personnel with a general description of how to maximize the traffic-carrying capacity and the network termination capacity of a DMS-10 switch
- to familiarize telco personnel with engineering requirements for new system capabilities and features

Organization

The first three sections of this NTP contain introductory information, traffic definitions, grade-of-service objectives, and DMS-10 system capacity information. The fourth section is an introduction to provisioning rules and methods. Section 5 contains a discussion of buffers and the rules for allocating them. Section 6 provides information necessary to prepare the DMS-10 switch for the Advanced Intelligent Network (AIN) feature. Section 7 provides ISDN U-loop engineering information. Section 8 is an index for the NTP.

Complete descriptions of the hardware components mentioned in this NTP are found in NTP 297-3601-150, *Equipment Identification*. Complete descriptions of DMS-10 system hardware, software, and operation are found in NTP 297-3601-100, *General Description*.

Section 2: Traffic definitions and grades of service

Definitions

The basic traffic provisioning terms are:

Hundred Call Second (CCS).
A Hundred Call Second is the unit in which amounts of telephone traffic are measured. One call that lasts 100 s constitutes 1 ccs.

Busy Season.
Busy Season is that portion of the year composed of the business days of three 4-week periods having the highest average busy hour ccs per main station. Each 4-week period is made up of consecutive weeks, but the three 4-week periods of the Busy Season are not necessarily consecutive. The busy hour is the same hour for each day.

Average Busy Season Busy Hour (ABSBH).
Average Busy Season Busy Hour is the hour, not necessarily a clock hour, that has the average ccs per main station for all of the Busy Season.

High Day Busy Hour (HDBH).
High Day Busy Hour is the busiest hour of the hours comprising the10 HDBH average.

TDM Grade-of-service objectives

The DMS-10 switch is designed to meet the accepted North American standards for grade-of-service. The grade-of-service measurements are:

Incoming Matching Loss (IML).
Incoming Matching Loss (IML) is the percentage of incoming calls that are lost because of network blockage while attempting to connect to a subscriber.

Outgoing Matching Loss (OML).
Outgoing Matching Loss is the percentage of outgoing calls that are lost because of network blockage while attempting to connect to an outgoing trunk.

Intraoffice Matching Loss (IAML).

Intraoffice Matching Loss is the percentage of intraoffice calls that are lost because of network blockage while attempting to connect a subscriber.

Dial Tone Delay (DTD).

Dial Tone Delay is the percentage of originating calls that do not receive dial tone within 3 seconds.

The grade-of-service objectives, expressed in maximum percentage loss or delay, are shown in Table 2-A.

Table 2-A:
TDM Grade-of-service objectives

Grade of Service	Traffic Load	
	ABSBH	HDBH
IML	2.0%	7.0%
OML	1.0%	2.0%
IAML	2.0%	12.0%
DTD	1.5%	20.0%

VoIP Performance Monitoring objectives

Nortel recommends that the Wide Area Network (WAN) that the Packet Gateway Interface (PGI) is connected meet the accepted North American guidelines for VoIP performance. The performance measurements are:

Jitter.

Jitter is the variance of delay when packets do not arrive at the destination address in consecutive order or on a timely basis and the signal varies from its original reference timing. This distortion is particularly damaging to multimedia traffic. For example, the playback of audio or video data may have a jittery or shaky quality.

Packet Loss.

Packet Loss can be expressed as a percentage of packets, which could be dropped over a specified interval. Note that packet loss must be kept at a minimum in order to deliver effective IP telephony and IP video services. Specifically with IP Telephony, the selection of CODEC compression algorithm is important with respect to packet loss. For example, G.729 is more susceptible to the service impairment with packet loss than the G.711 algorithm.

Delay.

Also referred to as latency, delay represents the time between a node sending a message and receipt of the message by another node.

The performance objectives, expressed as a combination of packet loss and network delay, are shown in Table 2-B.

Table 2-B:
VoIP Performance objectives

Packet Loss	Network delay (msec)
0.5%	137
0.75%	127
1.0%	117
1.5%	112
2.0%	103

Section 3: System capacity

System organization

The DMS-10 system is organized into three functional blocks:

- control equipment, which provides overall control of the system, provides interface circuitry for logical units, and stores resident programs, office data, and call data
- network equipment, which performs the digital switching function of the system and provides the interface between the control equipment and the line and trunk equipment
- peripheral equipment, which provides the interface between the Network Equipment and subscriber lines and analog and digital trunks.

For traffic provisioning purposes, each of these equipment areas is broken down into its components. The rules for provisioning traffic-related equipment are given in the "Provisioning rules and methods" section. Provisioning rules for other equipment are given in the NTP entitled *Equipment Identification* (297-3601-150). The NTP entitled *General Description* (297-3601-100) includes a comprehensive description of the DMS-10 system.

System limitations

The capacity of the DMS-10 switch is determined by five factors. Any one of these factors may limit the size of a given system:

- network termination capacity
- network traffic capacity
- memory capacity
- real-time capacity
- configuration limits

Network termination capacity

Analog peripheral shelf termination

An analog peripheral shelf accommodates a maximum of 13 trunk or service packs. Each pack provides one to four circuits, depending upon pack type.

Each multiplex loop can interface with either one or two analog shelves on a primary basis. Thus, the termination capacity of a multiplex loop can be either 26 trunks or 52 trunks (2 shelves X 13 packs per shelf X 2 trunks per pack). In the event of a primary loop failure, the loop that is the mate of the failed loop will serve two or four analog shelves, giving a maximum total of 104 trunks (2 X 52) per multiplex loop.

Digital Carrier Module (DCM) termination

Each multiplex loop serves a maximum of one DCM. Each DCM interfaces with one DS-1 carrier line, which consists of up to 24 communication channels.

Digital Signal Interface (DSI) termination

Two multiplex loops serve one DSI in simplex mode. Each DSI interfaces with two DS-1 carrier lines, each of which contains 24 communication channels.

Office Carrier Module (OCM) termination.

Two or four multiplex loops serve one OCM. Each OCM interfaces with two or four DS-1 carrier lines, having up to 24 channels each. Therefore, the terminating capacity of a multiplex loop connected to an OCM is 24 carrier channels.

Subscriber Carrier Module (SCM) termination.

Two dedicated multiplex loops connect one SCM with DMS-10 network equipment. Each multiplex loop connects to half of one Network shelf. The SCM interfaces with two working DS-1 carrier lines of 24 channels each. (A third DS-1 line is used for sparing.) Thus, the Network terminating capacity of a multiplex loop from an SCM is 24 carrier channels. Multiplex loop sparing is not provided.

Remote Line Concentrating Module, Outside Plant Module, and Outside Plant Access Cabinet (RLCM/OPM/OPAC) terminations.

Two, four, or six multiplex DS-1 loops serve each RLCM, OPAC, and OPM, depending on traffic load.

Remote Subscriber Line Equipment (RSLE) termination.

Two, four, six, or eight multiplex DS-1 loops serve each RSLE bay, depending on the number of RSLE shelves provisioned and the traffic load.

Remote Subscriber Line Module and Outside Plant Subscriber Module (RSLM/OPSM) terminations.

Two multiplex DS-1 loops serve each RSLM shelf, whether it is in an RSLM bay or in an OPSM. If an RSLM bay is provisioned with two RSLM shelves, the bay is served by four multiplex DS-1 loops.

Line Concentrating Module (LCM) termination.

Four or six DS-30A loops are required to serve one LCM. Each LCM supports 640 lines.

SCM-10S termination.

Two or four multiplex loops serve one SCM-10S. Each SCM-10S interfaces with up to 20 DS-1 carrier lines in either Mode I or Mode II operation. Mode I operation employs 5 primary DS-1 lines per SLC (4 lines for traffic and a protection line), with one loop per shelf. In Mode I operation up to four SLCs can be configured per SCM-10S, with a capacity of 384 lines. Mode II operation employs 3 primary DS-1 lines per SLC (2 lines for traffic and a protection line). In Mode II operation up to six SLCs can be configured per SCM-10S, with a capacity of 576 lines.

SCM-10U termination.

The SCM-10U interfaces with the DMS-10 network through DS-30A peripheral equipment loops (PELP). The number of PELPs configured affects the traffic-carrying capacity of the SCM-10U.

The SCM-10U Port Expansion feature, which requires NT8X18BB or later version packs, enables the DMS-10 switch to support up to 16 DS-30A PELPs.

Up to five DS-1 Interface packs (NT6X85) may be equipped in an SCM-10U shelf. Each pack provides two DS-1 links. Therefore, up to 20 DS-1 links connect the SCM-10U module with up to eight RCUs.

RSC-S termination

The RSC-S interfaces with the DMS-10 network through DS-30A peripheral equipment loops (PELP). The number of PELPS configured affects the traffic carrying capacity of the RSC-S. From 2 to 16 PELPS can be connected to a RSC-S and channels on two of these loops are used for signaling. The rest are used for speech. An RSC-S will support up to 7 LCMs and RLCM, OPSM, RSLM, RSLE, OPM, OPAC remotes for a total of ten devices (including LCMs). Backdoor trunking is also supported on an RSC-S. An RSC-S will support up to 4400 LCM and remote lines.

SCM-10A termination

The SCM-10A (ESMA) interfaces with the DMS-10 network through DS-30A peripheral equipment loops (PELP). The SCM-10A interface uses the MVIE or MVDD frame and will connect from 2 to 16 PELPs and up 7 GR-303 Remote Digital Terminals (RDT) supporting a maximum of 4110 lines.

Star Hub termination

The Star Hub is interfaced to the DMS-10 through DS-30A peripheral equipment loops (PELP). It uses from 2 to 16 PELPS with 2 channels on these loops used for signaling and the remaining channels used for speech. A Star Hub will support up to 1152 lines.

PGI termination

The PGI is interfaced to the DMS-10 through DS-30A peripheral equipment loops (PELP). It uses from 2 to 16 PELPS with 2 channels on these loops used for signaling and the remaining channels used for speech. A PGI will support up to 3428 lines.

Network traffic capacity

The DMS-10 switch uses two types of multiplex loops: Multiplex Loop Interface (MLI) loops and DS-30A loops. Each MLI loop can carry approximately 740 ccs of combined line and trunk traffic during the ABSBH. Each DS-30A loop can carry approximately 830 ccs of traffic during the ABSBH. To stay within the traffic limit for each type of loop, peripheral shelves are provisioned with circuit packs according to a peripheral pack assignment algorithm.

Memory capacity

In a 500 CPU-equipped 500-Series DMS-10 switch, 128 Mb of physical memory residing on the CPU circuit pack provides up to 4 GigaBytes of virtual memory for each process. Virtual memory is managed by the CPU and RTOS which translate virtual addresses into physical addresses.

Real-time capacity

The real-time capacity of the DMS-10 system is calculated by determining the average real-time required by the processor to completely process a call. The average real-time depends on the call mix in the office and the CPU real-time required for each call type. CPU real time is, however, only one of several factors that may limit system capacity.

A typical POTS model for CPU capacity considers a traffic mix which includes the following:

- ineffective attempts
- intra-office calls
- originating/outgoing calls
- incoming/terminating calls
- DP and DT lines
- DP, MF, and CCS7 trunks
- EAS and toll trunks
- CLASS features

In addition to the base POTS model, adjustments must be made for various features, such as:

- Meridian Business Sets
- ISDN
- AIN
- LNP
- VoIP Lines

LNP call timings may vary depending on whether an office is configured with LRN or Query on Release.

Configuration limits

The configuration limits of the DMS-10 switch are listed in Table 3-A.

Table 3-A:
DMS-10 switch configuration limits

Item	Limits
Announcement trunks	388
Call handling capacity	110000 ABSBH attempts
Cluster configuration: SSOs per HSO SSOs per LCC Data links per DCM shelf Data links per DSI shelf	 16 16 6 20
Destinations	512
Digit translators: Address Prefix Screening	 32 64 512
Directory numbers	1025000
Directory number hunt groups	2047
Directory numbers per directory number hunt group	256
Emergency regions	16

Table 3-A: (Continued)
DMS-10 switch configuration limits

Item	Limits
ESMA capacity: 7 small RDTs 4 medium RDTs, 2 large RDTs,	 672 lines per RDT 1344 lines per RDT 2048 lines per RDT ***Note:*** *The number of lines that can be assigned varies depending upon traffic requirements.*
ISDN lines	28 per LCM drawer 480 per ESMA
PGI capacity: PGIs	255 ***Note:*** *The number of PGIs that can be connected to the Ethernet Switch is 9.*
VoIP Gateways (GW)	30,720
VoIP Gateway lines (GWL)	2048
Home number plan areas	32
Line capacity	26880
Line capacity in an office with ISDN POTS lines ISDN lines	 26880 1120
Memory capacity	128 mbyte
Multiplex loops per Network shelf	36 speech 4 service circuits
Network capacity per Network module in DMS-10 Classic Network configuration: lines trunks	 6400 600
Network loops per Network Interface pack (NT8T04) for lines or trunks	28 ports (with service channels) 32 ports (without service channels)
Network loops per Network Interface pack (NT8T04) for service channels	4
NXX codes	1024
P-phones (MBS sets)	5 MBS sets per MADN group per LCM
POTS lines per Network module in a DMS-10 Classic Network configuration one network module two network modules	 6400 12800
PRI spans	312
Rate centers	256

Table 3-A: (Continued)
DMS-10 switch configuration limits

Item	Limits
Rate Treatment Packages per rate center	16
Remotes supported per DMS-10 switch	127
Routes	2047
Secondary MADN members for all MADN groups within an LCM Secondary MADN members for all MADN groups within an office	average number should not exceed 4 (total average of 5 members, that is, Primary and Secondary) average number should not exceed 4 (total average of 5 members, that is, Primary and Secondary)
Thousands groups	2048 ***Note:*** *A maximum of 64 thousands groups can be used in an LCM-based remote (RSC-S, RSLE, RSLM, Star Hub) with ESA.*
Toll regions	256
Trunk groups: Incoming Outgoing Two-way	 2047 2047 Each two-way trunk group is considered as one incoming and one outgoing trunk group. With each two-way trunk group provisioned, the maximum number of incoming and outgoing trunk groups is decreased accordingly.
Trunks per trunk group	1023

Section 4: Provisioning rules and methods

General provisioning rules

The number of traffic-dependent hardware and software components required in a given system is determined from provisioning and buffer allocation rules. Where the rules involve an arithmetic calculation, the calculation is written to one decimal place and then, based on risk management, rounded to a whole number. Usually, the amount is rounded up to the next whole digit so that the system is provisioned adequately.

Peripheral equipment

Peripheral equipment in the DMS-10 switch consists of Peripheral Equipment (PE) bays, Line Concentrating Equipment (LCE) bays, Subscriber Carrier Equipment (SCE) bays, and their associated components. In addition, peripheral equipment can include Remote Equipment Modules (REMs), Subscriber Carrier Modules (SCMs), remote Line Concentrating Equipment, and Messaging shelves.

Quantities of peripheral equipment must be determined in the order given in the “Provisioning Rules and Methods” section. This section contains the rules and formulas used to provision peripheral equipment. The information is presented in the order in which the items should be provisioned.

Line packs

The following paragraphs provide an overview of peripheral packs, the provisioning rules that apply to the traffic-related peripheral packs, and the formulas for determining the required quantity of each traffic-related peripheral pack.

LCE line packs

The LCE line packs include:

- Type A Line (NT6X17)
- Type B (Coin) Line (NT6X18AA/BA)
- Type B (+48 V Coin) Line (NT6X18AB)
- P-phone Line (NT6X21AC/AD)

- Data Line Card (NT6X71AB/BA)
- ISDN Line Card (NTBX271)

Refer to the NTP entitled *Equipment Identification* (297-3601-150) for a description of LCE line packs and their application in the DMS-10 switch. Refer to the NTP entitled *Circuit Interfaces for Lines, Trunks, and Test Trunks* (297-3601-184) for functions and characteristics of the LCE line packs.

P-phone line card

The NT6X21AC supports the M5000-Series business set. The NT6X21 can be assigned in the DMS-10 host LCM, RLCM, OPM, OPAC, RSLE, RSLM, and HUB. Although the maximum number of M5000-Series business sets that can be supported in an LCM or remote is limited only by the maximum number of line card slots (640), for a satisfactory grade of service the LCM capacity should be engineered so that peak traffic remains below 1.5 call originations per second per LCM; if the sets are equipped with display units, the allowable peak traffic is 1.2 call originations per second per LCM.

PE line packs

The PE line packs include:

- Single-Party Line (2-dB) (NT2T00)
- Two-Party Line (2-dB) (NT2T01)
- Miscellaneous Line (2-dB) (NT2T03)
- Prepay Coin Line (2-dB) (NT2T04)
- Eight-Party Line (2-dB) (NT2T05)
- MF Ringing Two-Party Line (2-dB) (NT2T07)
- Extended Range Two-Party Line (2-dB) (NT2T08)
- Extended Range Eight-Party Line (2-dB) (NT2T09)
- Two-Party Line (0-dB) (NT2T43)
- Miscellaneous Line (0-dB) (NT2T44)
- Prepay Coin Line (0-dB) (NT2T45)
- Superimposed Ringing Line (0-dB) (NT2T67)
- Single-Party Line (0-dB) (NT2T69)
- MF 8-Party Line (0-dB) (NT2T75)

Refer to the NTP entitled *Equipment Identification* (297-3601-150) for a description of PE line packs and their application in the DMS-10 switch. Refer to the NTP entitled *Circuit Interfaces for Lines, Trunks, and Test Trunks* (297-3601-184) for functions and characteristics of the PE line packs.

Line Load Control line pack assignment

When assigning line packs, “designated essential users” must be considered. Subscribers designated as essential users for the purpose of the Line Load Control feature must be assigned to specific line circuits. For a complete description of the Line Load Control feature and allowable line circuit assignments, see the “Administrative features” section of NTP 297-3601-105, *Features and Services Description*.

Standby line circuit assignment

When provisioning line packs, the provisioning of circuits for use as standby line circuits must be considered. Standby lines can be provisioned for PE bays; the standby line feature is not available for LCE or SCE bays. The number and type of standby line circuits required for PE bays are given below.

When assigning standby line circuits, the following restrictions must be observed:

- A PE shelf that contains a Line and Trunk Test pack (NT2T19) should not contain any standby line circuits. A Line and Trunk Test pack is always located in PE Bay 1, shelf 1, position 5.
- Only line circuits on circuit packs located in positions 12, 13, or 14 of a PE shelf should be assigned as standby line circuits.
- A maximum of one line circuit per PE shelf should be assigned as a standby line circuit.

2-dB Line Packs NT2T03 circuits can serve as standby line circuits for NT2T00, NT2T01, NT2T05, and NT2T07 line circuits. Therefore, the type of line circuits assigned as standby depends on whether or not a particular office is equipped with NT2T03 circuit packs.

In an office equipped with NT2T03 packs, four circuits (two odd-numbered and two even-numbered) of each of the following packs are required, if the office is equipped with these packs:

- NT2T03
- NT2T04
- NT2T08

In an office not equipped with NT2T03 packs, four circuits (two odd-numbered and two even-numbered) of each of the following packs are required, if the office is equipped with these packs:

- NT2T04
- NT2T07
- NT2T08

- NT2T01
- NT2T05

0-db line packs NT2T44 circuits can serve as standby line circuits for NT2T43, NT2T67, NT2T69, and NT2T75 line circuits. Therefore, the type of line circuits assigned as standby depends on whether or not a particular office is equipped with NT2T44 circuit packs.

In an office equipped with NT2T44 packs, four circuits (two odd-numbered and two even-numbered) of each of the following packs are required, if the office is equipped with these packs:

- NT2T08
- NT2T44
- NT2T45

In an office not equipped with NT2T44 packs, four circuits (two odd-numbered and two even-numbered) of each of the following packs are required, if the office is equipped with these packs:

- NT2T08
- NT2T43
- NT2T45
- NT2T67
- NT2T75

SLE line packs

The SLC-96 line cards include:

- Single-Party, Key Line (S203)
- Multiparty, Superimposed-Ringing Line (S221)
- Coin, PBX Line (S233)

For a description of SLC-96 line cards, the Subscriber Loop Equipment (SLE) used in conjunction with Subscriber Carrier Equipment (SCE), refer to the Bell System Practices (BSPs).

Trunk packs

The Trunk packs include:

- Four-Wire E&M Trunk (NT2T20)
- Two-Wire E&M Trunk (NT2T21)

- Miscellaneous Loop Trunk (NT2T23)
- Outgoing Loop Trunk (NT2T24)
- Four-Wire E&M with Pad Switching Trunk (NT2T27)
- CAMA Position Signaling Circuit Trunk (NT2T48)
- Digital Recorded Announcement Trunk (NT2T85)

Refer to NTP 297-3601-150, *Equipment Identification*, for a description of trunk packs and their application in the DMS-10 switch. Refer to the NTP entitled *Circuit Interfaces for Lines, Trunks, and Test Trunks* (297-3601-184) for functions and characteristics of the trunk packs.

Service packs

Service packs include Digitone Receivers (NT2T11), Multifrequency Receivers (NT2T10), and GTS hardware on NT8T04 network interface packs (DMS-10EN only).

Note: VoIP lines should not be used in the calculation of service packs.

GTS Calculation (DMS-10EN only)

Activation of four Global Tone Services on NT8T04 packs is sufficient to handle 20,000 lines at heavy usage. Additional NT2T10 and NT2T11 packs can also be provisioned to provide greater capacity.

Digitone Receiver (NT2T11) pack calculation

Digitone Receivers are provisioned in quantities sufficient to satisfy the grade-of-service objectives listed in the “Traffic Definitions and Grades of Service” section. The equations given in Table 4-A are based on ABSBH traffic loads.

Table 4-A:
Digitone Receiver pack calculation

Step	Procedure
1	Calculate the total number of completed originating Digitone calls ABSBH: A = completed originating Digitone calls $= \frac{100 \times \text{Number of Digitone lines} \times \text{originating ccs per line ABSBH}}{\text{Average call holding time in seconds}}$
2	Calculate the total number of completed terminating Digitone calls ABSBH: B = completed terminating Digitone calls $= \frac{100 \times \text{Number of Digitone lines} \times \text{terminating ccs per line ABSBH}}{\text{Average call holding time in seconds}}$

Table 4-A: (Continued)
Digitone Receiver pack calculation

Step	Procedure
3	Calculate the number of ineffective Digitone attempts: C = ineffective Digitone attempts = A X ineffective ratio[2]
4	Calculate the number of CLASS (ACB, AR, SLE) and AIN calls that perform additional digit collection in response to announcements: D = CLASS and AIN announcement calls = A X (ratio CLASS + ratio AIN) X ratio announcements
5	Calculate the number of terminating SCWID Digitone calls: E = terminating SCWID Digitone calls = B X ratio SCWID
6	Calculate the number of calls using a receiver due to Office-wide ACB: F = A X ratio busy
7	Calculate the total Digitone Receiver ccs ABSBH: G = (A + C + D + E + F) X average Digitone receiver holding time for all call types / 100
8	Refer to Table 4-B. In the ABSBH column, find the number that is equal to or next larger than quantity G from Step 7. The number of Digitone Receiver circuit packs required can then be read from the leftmost column.

Alternatively, Universal Tone Receiver (UTR) packs may be provisioned.

Use 25% if ineffective ratio is not available.

Use 5% if ratio announcements is not available.

Use 10% if ratio busy is not available.

Use 10 sec if average Digitone receiver holding time is not available.

Table 4-B:
Classic Network Digitone Receiver provisioning

Digitone Receiver Packs (two circuits per pack)	Digitone Receiver Usage (ccs) - ABSBH	Digitone Receiver Usage (ccs) - HDBH
2	26	47
3	62	91
4	104	139
5	149	190
6	196	243
7	246	298
8	297	354
9	349	410
10	402	468

Table 4-B: (Continued)
Classic Network Digitone Receiver provisioning

Digitone Receiver Packs (two circuits per pack)	Digitone Receiver Usage (ccs) - ABSBH	Digitone Receiver Usage (ccs) - HDBH
11	456	526
12	513	585
13	569	644
14	624	704
15	681	765
16	739	825
17	798	887
18	856	948
19	915	1010
20	974	1072
21	1033	1134
22	1093	1196
23	1153	1259
24	1213	1322
25	1273	1385
26	1334	1448
27	1395	1511
28	1456	1575
29	1517	1639
30	1577	1702

Multifrequency Receiver (NT2T10) pack calculation

Multifrequency Receivers are provisioned in quantities sufficient to satisfy the grade-of-service objectives listed in the “Traffic Definitions and Grades of Service” section. The equations given in Table 4-C are based on ABSBH traffic loads, estimated voice loop traffic.

Table 4-C: Multifrequency Receiver pack calculation	
Step	**Procedure**
1	Calculate the total Multifrequency Receiver ccs ABSBH, excluding AMA ONI/ANI-fail calls: A = Multifrequency Receiver ccs ABSBH = Total incoming MF trunk ccs ABSBH X average MF Receiver holding time / Average incoming call holding time in seconds
2	Calculate the total Multifrequency Receiver ABSBH for AMA ONI/ANI-fail calls, if any. This includes both incoming CAMA and locally originated LAMA calls: B = Multifrequency Receiver ABSBH seconds = Total AMA ONI/ANI-fail calls ABSBH X average AMA ONI/ANI -fail MF Receiver holding time
3	Convert total Multifrequency Receiver ABSBH into *ccs*: C = Total Multifrequency Receiver ccs ABSBH = B / 100
4	Calculate total Multifrequency Receiver *ccs* ABSBH: D = Total Multifrequency Receiver ccs ABSBH = A + C
5	Locate quantity D from Step 4 (rounding up if D is not a whole number) in Table 4-D. The number of required receiver packs is given in the adjacent column.

Alternatively, Universal Tone Receiver (UTR) packs may be provisioned.

Use 2.1 s if this holding time is unavailable.

Use 12 s if this holding time is unavailable.

Table 4-D: Classic Network Multifrequency Receiver provisioning-ABSBH traffic	
Number of MF Receiver Packs	**Total MF Receiver ccs (D from Step 4 of Table 4-C)**
2	18
3	45
4	79
5	119
6	158
7	209
8	259

Table 4-D: (Continued) Classic Network Multifrequency Receiver provisioning-ABSBH traffic	
Number of MF Receiver Packs	**Total MF Receiver ccs (D from Step 4 of Table 4-C)**
9	309
10	356
11	414

Each pack has two frequency receivers.

Test and test equipment interface packs

The following paragraphs describe test and test equipment interface pack provisioning rules.

Peripheral Maintenance Access (PMA) (NT2T14)

One pack is provided per PE frame and one pack is provided per LCE bay. The pack works in conjunction with the Noller Test Trunk pack or Incoming Test Trunk pack to provide test access to line and trunk circuits. See Table 4-E for formulas used to calculate the number of PMA packs required in addition to the PMA packs provided with the PE and LCE bays. For complete information about remote testing using the PMA pack, see “Remote equipment test access” in section 7 of NTP 297-3601-500, *General Maintenance Information*.

> ***Note 1:*** The PMA is not required in bays where a Peripheral Maintenance System (PMS) is installed.
>
> ***Note 2:*** One PMA pack can serve up to four Remote Maintenance Modules (RMMs). Since a single RMM can serve up to four RLCMs, one PMA can serve up to 16 RLCMs. However, one RMM shelf is required to support each RLCM that is configured for Emergency Stand-Alone (ESA) mode. RLCMs, OPACs, and OPMs can be served by the same PMA pack.

Table 4-E: Peripheral Maintenance Access pack calculation	
Step	**Procedure**
1	Calculate the total number of PMAs required to service remote Line Concentrating Equipment (OPMs, OPACs, OPSMs, RLCMs, RSLEs, and RSLMs): A $= \frac{\text{Number of RMMs serving all RLCMs and OPMs}}{4}$
2	Calculate the total number of PMAs required to serve SLC-96 sites. One PMA pack can serve either four metallic bypass pairs, or four Digital Remote Test Units (DRTU), with each DRTU or metallic bypass pair capable of serving up to eight co-located SLC-96s . B $= \frac{\text{Number of metallic bypass pairs serving all SLC-96s}}{4}$

Table 4-E: (Continued) Peripheral Maintenance Access pack calculation	
Step	**Procedure**
3	Calculate the total number of PMAs required to serve DMS-1 Urban (DMS-1U) sites: 1 PMA pack can serve four metallic bypass pairs or four Digital Remote Test Units (DRTU) with each DRTU or metallic bypass pair capable of serving up to eight co-located DMS-1Us. C = Number of PMAs serving DMS-1Us
4	The total number of PMAs required in addition to PMAs supplied for the PE and LCE bays = A + B + C

Incoming Test Trunk (NT2T16)

One pack is provided for each No. 14 Local Test Desk and/or No. 3 Local Test Cabinet serving the DMS-10 switch.

Noller Test Trunk (NT2T17)

One pack is provided for each Noller NP612 Remote Station serving the DMS-10 switch. The pack works in conjunction with an Auxiliary Ringing and Tone pack and a Miscellaneous Line pack.

Line and Trunk Test (NT2T19)

One pack is required for each DMS-10 switch. A second pack may be provisioned as a standby pack. See the NTP entitled *General Maintenance Information* (297-3601-500).

Auxiliary Ringing and Tone (NT2T40)

One pack is provided with each Noller Test Trunk pack.

Peripheral Processor (NT2T46)

Two packs are recommended for redundancy.

Peripheral Maintenance System (PMS) (NT2T70, NT2T71, NT2T72)

These packs are provisioned on a Dual Equipment/Peripheral Maintenance System shelf. One of each of the three packs can be provisioned per bay. The Peripheral Circuit Test pack (NT2T71) is provisioned in position 1. The Peripheral Maintenance Processor pack (NT2T70) is provisioned in position 2. The Facility Test pack (NT2T72) is provisioned in position 3.

ac Tester (NT2T71, NT2T73, NT2T74)

These packs are provisioned on a Dual Equipment/Peripheral Maintenance System shelf. One of each of the three packs can be provisioned per bay. The Peripheral Circuit Test pack (NT2T71) is provisioned in position 1. The Control Processor pack (NT2T74) is provisioned in position 2. The Signaling Processor pack (NT2T73) is provisioned in position 3.

Remote Maintenance Module

The Remote Maintenance Module (RMM) feature performs a variety of tests on remote Line Concentrating Equipment. The RMM configuration for the Outside Plant Module (OPM), or Outside Plant Access Cabinet (OPAC) is standardized while the RMM configuration for the Remote Line Concentrating Module (RLCM) allows for the sharing of several subscriber line testing packs between two to four RLCMs located within the same site.

Line Test Unit (LTU) (NT2X10AC/NT2X11AD)

The LTU consists of a pair of circuit packs, the LTU analog pack (NT2X10AC) and the LTU digital pack (NT2X11AD). Both are required to provide ac and dc voltage measurements, loop start and ground start tests, and resistance and capacitance measurements.

Metallic Test Access (MTA) pack (NT3X09AA/BA)

The MTA pack provides a metallic connection between LCM maintenance busses and trunk circuits. The BA version provides an 8 X 8 matrix required for RLCM subscriber loop testing, for supporting subscriber line testing for up to four RLCMs, or for battery maintenance functions and subscriber loop testing in the OPM or OPAC. The AA version provides a 4 X 8 matrix required for OPM/OPAC battery control functions.

Incoming/Outgoing Test Trunk pack (NT2X90)

The I/O Test Trunk interfaces the RLCM with CALRS, #14 Local Test Desk, and #3 Local Test Cabinet external test equipment to provide the same level of testing as is supported by this equipment at the DMS-10 switch.

Scan point and signal distribution equipment

Scan points and signal distribution points are provided to allow automatic monitoring and reporting, respectively, of critical system conditions. An abnormal condition can be detected by a scan point and an alarm can be activated by a signal distribution point associated with that scan detection point. The provisioning of scan point and signal distribution equipment is determined by the operating company.

Miscellaneous Scan Detection pack (NT0X10) Each Miscellaneous Scan Detection pack can monitor up to fourteen conditions. The OPM and OPAC are equipped with one Miscellaneous Scan Detection pack, prewired to support 14 battery and environmental alarms. If additional OPM/OPAC monitoring is required, up to three additional Miscellaneous Scan Detection packs can be provisioned. An RLCM can be equipped with up to four optional Miscellaneous Scan Detection packs.

Miscellaneous Signal Distribution pack (NT2X57) The Miscellaneous Signal Distribution pack provides access to 14 relay switches. These relay switches can be wired to customer supplied equipment (for example, alarms, maintenance equipment). The RLCM can be provisioned with up to four Miscellaneous Signal Distribution packs.

Line Concentrating Modules

Each Line Concentrating Module (LCM) consists of two shelves or Line Concentrating Arrays (LCAs). Each LCA contains five drawers. Each drawer contains two subgroups and each POTS subgroup contains 32 line cards (NT6X17, NT6X18, NT6X21, and NT6X71). If configured for ISDN, one drawer in each shelf can support up to 28 ISDN line cards (NTBX27). Consequently, each POTS-only LCM contains 20 subgroups of 32 lines each, while each combined ISDN/POTS LCM contains up to 16 subgroups of 32 POTS lines and up to 4 subgroups of 14 ISDN lines. The formulas for determining the number of Line Concentrating Modules (LCMs) required for an office is given below.

For POTS-only LCMs:

Number of LCMs required = Total number of lines required / (640 x % fill)

Since the DMS-10 switch does not support LCA load sharing, lines must be provisioned evenly across the LCAs in an LCM based on offered traffic load. Each LCM is configured with four or six DS-30A loops, that is, two or three loops per LCA shelf. If all of the time-slots on the DS-30A loops serving one LCA are busy when the LCM is operating in normal mode, calls are not sent over the other LCA's DS-30A loops but are, instead, blocked. When one of the LCAs is in failure mode and half of the network loops are unavailable for service, the DS-30A loops of the remaining LCA handle all of the traffic for all lines (640 X % fill) configured in the LCM.

> ***Note:*** *The LCAs are arranged by even and odd line subgroups (LSG). The 0, 2, 4, 6, 8, 10, 12, 14, 16, and 18 LSGs are controlled by one LCA and the traffic offered is routed to the DS-30A loops associated with the even Network shelf. The 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19 LSGs are controlled by the other LCA and the traffic offered is routed to the DS-30A loops associated with the odd Network shelf.*

To assist with LCA load balancing, the Long Duration Call Reporting (LDCR) feature provides a mechanism for identifying lines that make connections that exceed a pre-programmed length of time (between 15 and 240 minutes). Thus, lines that make long duration calls can be identified so that they can be moved, if necessary, to provide load balancing. For complete information about the LDCR feature, see Section 8 of NTP 297-3601-105, *Features and Services Description*.

> ***Note:*** *Load balancing must be performed between odd and even LSGs of the LCM because traffic from the even LSGs is routed over one group of DS-30A loops and traffic from the odd LSGs is routed over the other group of DS-30A loops.*

Line Concentrating Equipment bays

Line Concentrating Equipment (LCE) bays are provisioned according to the total number of LCMs required. One LCE bay can accommodate two LCMs. The formula for determining the number of LCE bays required is given below.

Number of LCE bays required = Number of LCMs required \ 2

For combined ISDN and POTS LCMs:

A = Total number of POTS lines required \ 512

> ***Note:*** *The divisor of 512 assumes the maximum of two ISDN drawers. Replace the divisor with 576 if only one ISDN drawer is installed.*

B = Total number of ISDN lines required \ 56

> ***Note:*** *The divisor of 56 assumes the maximum of two ISDN drawers. Replace the divisor with 28 if only one ISDN drawer is installed.*

Number of LCMs required = The larger value of A and B

> ***Note:*** *A minimum of one LCE bay is required per system, except for LCC offices. LCCs cannot be configured with Line Concentrating Equipment.*

ISDN and POTS traffic provisioning

Traffic usage must be considered for both ISDN and POTS lines when provisioning for acceptable call blocking parameters. Traffic is determined using CCS (hundred call seconds), or, a measure of the number of seconds per hour a line is in use. The maximum CCS value for one channel is 36, which is 3600 seconds, or 1 hour. Although a POTS line uses a single channel, an ISDN line uses two B-channels. Since each B-channel can remain active up to the full 36 CCS, the maximum traffic for an ISDN line is 64 CCS.

Table 4-F shows the relationship between POTS and ISDN line drawer traffic usage based on the maximum line configuration (64 POTS and 28 ISDN). The table provides values for 4-loop LCMs and 4-span RLCMs configured with either one or two ISDN drawers. A POTS line at 2.0 CCS indicates that the line is used 200 seconds (2.0 X 100) for each hour. An ISDN line at 38.0 CCS means that the combined B-channels are used 3800 seconds for each hour, out of a possible 6400 seconds. As indicated in Table 4-F, a POTS line at 4.2 CCS or greater, exceeds the 1% call blocking limit for an RLCM. Table 4-F can be used to determine acceptable ISDN or POTS traffic levels, depending on which variable is known and measured.

Table 4-F: ISDN/POTS Traffic Provisioning

CCS per POTS line	CCS per ISDN line			
	4 loop LCM			
	4 loop LCM		4 span RLCM	
	1 ISDN drawer	2 ISDN drawers	1 ISDN drawer	2 ISDN drawers
2.0	38.0	34.2	38.0	19.7
2.2	38.0	32.3	34.0	17.9
2.4	38.0	30.5	29.9	16.0
2.6	38.0	28.7	25.8	14.2
2.8	38.0	26.8	21.7	12.4
3.0	38.0	25.0	17.5	10.6
3.2	38.0	23.2	13.4	8.7
3.4	38.0	21.4	9.3	6.9
3.6	34.2	19.5	5.2	5.1
3.8	30.1	17.7	1.1	3.2
4.0	26.0	15.9	exceeds blocking	1.4
4.2	21.9	14.0	exceeds blocking	exceeds blocking
4.4	17.8	12.2	exceeds blocking	exceeds blocking
4.6	13.6	10.4	exceeds blocking	exceeds blocking
4.8	9.5	8.6	exceeds blocking	exceeds blocking
5.0	5.4	6.7	exceeds blocking	exceeds blocking

Note: *Assumes 1% blocking with the maximum 64 POTS lines and 28 ISDN lines for each drawer. CCS values are the maximum CCS before blocking is exceeded.*

The steps shown in Table 4-G may be used to calculate the maximum CCS per ISDN line in order to determine the impact from adding up to ten ISDN line drawers to the engineered load of the LCM/RLCM.

Table 4-G: Calculate impact of ISDN line drawer provisioning on engineered LCM/RLCM load

Step	Procedure
1	Let the number of ISDN lines required = A
2	Let the number of ISDN lines installed per drawer = B
3	Calculate the number of ISDN drawers required, C = A / B (rounded up)
4	Let the entry in Table 4-H for the required configuration = D

Table 4-G: (Continued) **Calculate impact of ISDN line drawer provisioning on engineered LCM/RLCM load**	
Step	**Procedure**
5	Let E = number of POTS lines (which must be ≤ 64 X (10 - C), that is, maximum of 64 per drawer)
6	Let F = CCS per POTS line (select F ≤ 1064 X (10 - C) / E, to avoid POTS drawer blocking, assuming the load is distributed evenly among the subgroups)
7	Let G = D X (56 X C + 64 X (10 - C)) - E X F (if G < 0, reduce the value of E or F)
8	Calculate the maximum CCS allowed per ISDN line: H = G / A (limit H ≤ 1064 X C / A, to avoid ISDN drawer blocking, assuming the load is distributed evenly among the subgroups) To increase the value of H, reduce the values of A, B, E, or F and perform steps 1 through 8 again.

Table 4-H: **ISDN/POTS lines load limits**						
ISDN Drawers per LCM/RLCM	**Average Carried CCS per ISDN B Channel or POTS Line on a Fully-Equipped LCM/RLCM**					
	LCM			**RLCM**		
	2 loops			2 spans		
0	2.08	5.03	8.11	1.43	3.72	6.15
1	1.96	4.94	8.05	1.31	3.62	6.07
2	1.84	4.84	8.00	1.19	3.51	5.99
3	1.72	4.75	7.94	1.07	3.41	5.91
4	1.60	4.65	7.88	0.95	3.30	5.82
5	1.48	4.56	7.82	0.83	3.19	5.74
6	1.35	4.46	7.76	0.71	3.07	5.65
7	1.23	4.35	7.69	0.59	2.95	5.56
8	1.10	4.25	7.63	0.47	2.83	5.47
9	0.97	4.14	7.56	0.35	2.71	5.38
10	0.84	4.03	7.49	0.24	2.59	5.28

1% blocking criterion

64 POTS lines per drawer or 28 ISDN lines per drawer

Remote Line Concentrating Equipment

Remote Line Concentrating Equipment consists of Outside Plant Modules (OPMs), Outside Plant Access Cabinets (OPACs), Outside Plant Subscriber Modules (OPSMs), Remote Line Concentrating Modules (RLCMs), Remote Subscriber Line Equipment (RSLE) bays, and Remote Subscriber Line Modules (RSLMs). They are provisioned according to the number of remote lines required and the facilities available. Each OPM, OPAC, and RLCM can be provisioned with up to 640 lines. Each OPSM and RSLM shelf can be provisioned with up to 192 lines or 256 lines, depending upon the type of RSLM shelf used. Each RSLE bay can be provisioned for up to 1,024 lines, or a maximum of 512 lines per each of two RSLE D shelves. (An RSLE D shelf consists of one RSLE Control shelf and one RSLE Line Drawer shelf.) Additionally, an RSLM bay may be provisioned with one or two RSLM shelves.

The selection of an OPM (or OPAC) or an OPSM instead of an RLCM or an RSLM, respectively, depends on the physical facilities available. The OPM (and OPAC) and OPSM are free-standing environmentally-controlled enclosures that do not require additional facilities; the RLCM and RSLM bays require housing to protect them from environmental conditions.

Analog peripheral shelves

In the provisioning of analog peripheral shelves, the following two factors are considered:

- Total peripheral equipment ccs: on average, each analog trunk shelf is configured with one MLI loop and can carry a maximum traffic load of 740 ccs ABSBH
- Total number of peripheral packs required (each shelf can accommodate a maximum of 14 packs, in addition to the Peripheral shelf Controller and Peripheral shelf Converter packs).

In any given system, one of these two factors dictates the number of analog peripheral shelves required. To determine which factor applies in a particular system, both calculations are made. Each calculation gives the number of shelves required, based on one of the two factors. The number of shelves required is the greater of the two quantities calculated.

The calculations given in Tables 4-I and 4-J are used to determine the number of analog shelves required in a given system. To allow for the ongoing provisioning of peripheral packs by the operating company, additional peripheral shelf space must be provisioned initially. The number of analog shelves required to accommodate growth is determined using the same two factors used for initial installation, but is based on the projected increase in the number of installed peripheral packs during the job interval, rather than the actual number of installed packs at the beginning of the job interval.

Table 4-I:
Analog peripheral shelf calculation by peripheral equipment *ccs* for ABSBH

Step	Procedure
1	Total peripheral equipment ccs is the sum of:
	Originating ccs per line X total number of lines installed in an analog shelf
	Terminating ccs per line X total number of lines installed in an analog shelf
	Total incoming trunk ccs
	Total outgoing trunk ccs
	Digitone Receivers ccs, determined from Tables 4-A and 4-B
	Multifrequency Receivers ccs, determined from Tables 4-C and 4-D
2	Number of analog peripheral shelves required = $\frac{\text{Total peripheral equipment ccs}}{740}$ (A minimum of two analog peripheral shelves is required per system.)

Table 4-J:
Analog peripheral shelf calculation by number of peripheral packs required (constant number of PE bays)

Step	Procedure
1	Refer to NTP 297-3601-184 to determine the number of line packs required for PE shelves. Let the number of line packs required = A
2	Refer to NTP 297-3601-184 to determine the number of trunk packs required. Let the number of trunk packs required = B
3	Determine the number of miscellaneous test packs required (refer to “Test and Test Equipment Interface Packs” in this section and to the NTP entitled *Equipment Identification*; 297-3601-150). Note that the Line and Trunk Test pack (NT2T19) occupies two pack positions. Let the number of miscellaneous test pack appearances required = C
4	Refer to Table 4-A to determine the number of Digitone Receiver packs required. Let the number of Digitone receiver packs required = D
5	Refer to Table 4-C to determine the number of Multifrequency Receiver packs required. Let the number of Multifrequency Receiver packs required = E
6	The number of analog peripheral shelves required = $\frac{A + B + C + D + E}{13}$ (A minimum of two analog peripheral shelves is required per system.)

Digital peripheral shelves

Digital shelves are provisioned according to the number of DS-1 digital carrier lines required. Each carrier line interfaces with the DMS-10 switch through a Digital Carrier Module (DCM), an Office Carrier Module (OCM), a Subscriber Carrier Module (SCM), an SCM-10S Subscriber Carrier Module (SCM-10S), an Subscriber Carrier Module 10U (SCM-10U), or a Digital Carrier Interface (DCI). The calculation for the number of required digital shelves is given in Table 4-N.

Digital Carrier Modules

Digital Carrier Modules support the digital interface between digital switching systems, including the interface between cluster hosts (HSOs) and Satellite Switching Offices (SSOs).

Digital Carrier Modules in the cluster environment In the cluster environment, DCMs may be provisioned only in positions 2, 5, 12, and 15 (positions 8 and 18 are dedicated to trunking application). Thus, each DCM shelf provides a maximum of four links for interface between the host office and its associated SSOs. Table 4-K provides DCM shelf provisioning calculations for simplex and duplex cluster applications. For additional information concerning DCMs in the cluster environment, see NTP 297-3601-100, *General Description*.

Office Carrier Modules

Office Carrier Modules are required to support the digital interface between a DMS-10 switch and the Remote Carrier Module (RCM) of a Remote Equipment Module (REM). Each REM requires an OCM in the DMS-10 switch supporting it. Each OCM shelf accommodates a maximum of four OCMs.

Subscriber Carrier Modules

Subscriber Carrier Modules are required to support the digital interface between a DMS-10 switch and a DMS-1. Each SCM shelf supports 48 digital transmission channels of up to 251 subscriber lines. Up to 16 SCMs can be provisioned in a DMS-10 switch. Each SCM shelf accommodates a maximum of two SCMs.

SCM-10S

SCM-10S Subscriber Carrier Modules are required to support the digital interface between a DMS-10 switch and a SLC-96 remote terminal. Each Controller Array shelf supports four SLC-96s in Mode I operation (4 DS-1 traffic lines and one protection line per SLC-96) and six SLC-96s in Mode II operation (2 DS-1 traffic lines and one protection line per SLC-96). The paragraphs under the heading “Subscriber carrier equipment” provide further information about SCM-10S provisioning.

SCM-10U

Subscriber Carrier Module 10U (SCM-10U) modules are required to support the digital interface between a DMS-1 Urban (DMS-1U) and the DMS-10 switch. Each SCU module can serve up to eight DMS-1Us. The paragraphs under the heading “Subscriber carrier equipment” provide further information about SCU provisioning.

Digital Carrier Interface

Digital Carrier Interfaces (DCI) are required to support the digital interface between remote Line Concentrating Equipment (OPMs, OPACs, OPSMs, RLCMs, RSLEs, and RSLMs) and the DMS-10 switch supporting it, or, when configured as a Digital Signal Interface (DSI), to support the digital interface between digital switching systems.

Subscriber remote interface On a DCI shelf, each Subscriber Remote Interface (SRI) pack supports two DS-1 loops. A single 2-loop remote requires 2 SRI packs, with one circuit from each pack used. Combinations of remotes from a DMS-10 switch can be provisioned to maximize traffic handling capabilities and to minimize costs. A maximum of 10 SRI packs can be provisioned on a Digital Carrier Interface (DCI) shelf. Table 4-M provides SRI pack provisioning calculations for the base site DMS-10 switch.

Digital Signal Interface The Digital Signal Interface (DSI) is a digital trunk interface that replaces the DCM and Subscriber Remote Interface (SRI). A DSI module comprises the following circuit packs: Span Interface Controller (NT4T24) or CALEA Interface pack (NT4T50) and DS-1 Interface pack (NT6X50). DSI modules are housed on Digital Carrier Interface (DCI) shelves located in CE-1, CE-2, CE-3, or CE-4 bays. A single Digital Carrier Interface shelf can accommodate up to 10 DSI modules, with two DS-1 links supported per module. A DSI module may be used either as a digital trunk interface or as a remote interface, although the module cannot be used for both types of interface at the same time. For more information about the DSI module packs and Digital Carrier Interface shelf, see NTP 297-3601-150, *Equipment Identification*, and NTP 297-3601-100, *General Description*.

Digital Signal Interface in the cluster environment In the cluster environment, each DCI shelf provides a maximum of 20 spans for interface between the host office and its associated SSOs. Table 4-L provides DCI shelf provisioning calculations for simplex and duplex cluster applications.

Table 4-K:
Digital Carrier Module shelf provisioning for cluster applications

SSOs in configuration	Total DCM Shelves Required		
		Host DCM shelves required	
	SSO DCM shelves required	Simplex link configuration (1 link per SSO)	Duplex link configuration (2 links per SSO)
1	1	1	1
2	2	1	1
3	3	1	2
4	4	1	2
5	5	2	3
6	6	2	3

Table 4-K: (Continued)
Digital Carrier Module shelf provisioning for cluster applications

SSOs in configuration	Total DCM Shelves Required		
		Host DCM shelves required	
	SSO DCM shelves required	Simplex link configuration (1 link per SSO)	Duplex link configuration (2 links per SSO)
7	7	2	4
8	8	2	4
9	9	3	5
10	10	3	5
11	11	3	6
12	12	3	6
13	13	4	7
14	14	4	7
15	15	4	8
16	16	4	8

Table 4-L:
Digital Carrier Interface shelf provisioning for cluster applications

SSOs in configuration	Total DCI Shelves Required		
		Host DCI shelves required	
	SSO DCI shelves required	Simplex link configuration (1 link per SSO)	Duplex link configuration (2 links per SSO)
1 through 10	1 per SSO	1	1
11 through 16	1 per SSO	1	2

Table 4-M: SRI pack provisioning per base site	
Step	**Procedure**
1	Calculate the number of DS-1 loops that service remotes: A = sum of (*n* X number of n-loop remotes) where *n* can be even values from 2 through 16
2	Calculate the total number of SRI packs required to service all remote Line Concentrating Equipment: C = A / 2

Table 4-N: Digital shelf calculation	
Step	**Procedure**
1	Determine the number of DCM shelves required by using the following formula: A = Number of DCM shelves = $\frac{\text{Number of DCMs}}{6}$
2	Determine the number of OCM shelves required by using the following formula: B = Number of OCM shelves = $\frac{\text{Number of REMs}}{4}$
3	Determine the number of SCM shelves required by using the following formula: C = Number of SCM shelves = $\frac{\text{Number of SCMs}}{2}$
4	Determine the number of DCI shelves required by using the following formula: D = Number of DCI shelves = $\frac{\text{Number of SRIs (C from Table 4-M)}}{10}$
5	Number of digital shelves = A + B + C + D

CALEA Traffic Provisioning

The traffic provisioning process for the Communications Assistance for Law Enforcement Agencies (CALEA) feature consists of providing sufficient network and digital trunk (peripheral) equipment to satisfy both the operating company's and the Law Enforcement Agency's (LEA) requirements for:

- Call Content Channels (CCC) resources
- Dialed Digit Extraction (DDE) resources

Call Content Channel resources

The Digital Carrier Module (DCM) and Digital Signal Interface (DSI) are digital trunk modules that can be used to provide call content channels. In generic 501, either DCM or DSI modules can be used. In 502.10 and later generics, the new DSI (i.e. NT4T50/NT6X50) can be used, and the DSI must be assigned as the CALEA application. The NT4T50 CALEA Interface pack is used to provide the Dialed Digit Extraction (DDE) capability. If DDE is **not** required for a given surveillance, as specified in a court or other authorization, then standard digital trunk facilities may be used.

Sufficient digital trunks must be assigned to satisfy each LEA's requirements. In generic 501 any unused channels in digital trunk facilities (T1 carrier systems) used for CALEA can be assigned as regular digital trunks. However, in 502.10 and later generics when the NT4T50 CALEA Interface pack is used, any unused channels cannot be used as digital trunks.

Include CCCs in any digital peripheral shelf calculations and in the calculations for the number of peripheral loops, network interface packs, network packs, and networks shelves.

Dialed Digit Extraction resources

DDE capability is available only in 502.10 and later generics. DSI digital trunks on the NT4T50 CALEA Interface pack can be used as DDE resources. Dialed digit extraction is required for all outgoing calls under surveillance (intra-office as well as inter-office). When call content is required for a surveillance, the DSI equipment provisioned for CCCs is also used to provide the DDE capability.

When call content is not required, DSI digital trunks must be assigned to a Call Content Group (CCG) which will be used for DDE purposes only. CCGs can be dedicated to a specific surveillance or they can be shared by multiple surveillances. It is recommended that one CCG be used for DDE purposes and that it be shared by all surveillances (for a given LEA) that do not require call content.

The number of DDE resources (i.e. digital trunks) required may be calculated as shown in Table 4-O. The DDE resources are limited and are accessed on a first-come, first-served basis. The number of DDE resources assigned to the CCG should be such that a DDE resource is available at virtually all times.

Each DSI module has two DS1 digital spans yielding a total of 48 channels available as DDE resources. Channel 1 of the first DS1 span must be assigned in order for the DSI module to perform DDE. It is used to initialize DDE functionality when the DSI module is returned to service. More than one LEA may be assigned DDE resources from the same DSI module but they cannot share the same resources. When more than 48 DDE resources are needed, a new DSI (NT4T50/NT6X50) module must be assigned.

Table 4-O: Number of digital trunks required for DDE	
Number of intercept subject DNs per LEA	**Number of DDE resources per LEA**
1 to 4	6
5 to 10	12
11 to 30	18
31 to 50	24
more than 50	30

Note 1: When an intercept subject's DN can have multiple “originating” call appearances, such as with an ISDN BRI terminal, additional DDE resources may be required. Count each key appearance that can originate a call as one DN in the above calculations.

Note 2: These calculations do not apply to MBS sets because these sets do not generate DTMF tones and will be handled differently by the system processor's high-level software. When the intercept subject's DN is assigned only to an MBS set, do not include it in the above calculations.

Note 3: Multiple Appearance Directory Numbers (MADN) count as 1 intercept subject DN. Only one MADN line may originate a call at a time.

Note that this is a recommendation. Sufficient resources should be assigned to satisfy all active surveillances. If a DDE resource is needed and none is available, an indication is provided to law enforcement in the release cause parameter of the Release message.

Peripheral Equipment bays

Peripheral Equipment (PE) bays are provisioned according to the total number of peripheral shelves required. The J0T30E-1 PE-1 bay accommodates four shelves. Additional PE bays accommodate five shelves. Analog shelves may be provisioned in Shelves 1 through 4 of the J0T30E-1 PE bay. DCM, OCM, SCM, or DCI shelves may be provisioned in shelf 4 of a J0T30E-1 PE-1 and shelves 2, 4 and 5 of additional J0T30E-1 PE bays. Messaging shelves may be provisioned in shelves 2, 4, and 5 of additional J0T30E-1 PE bays. The calculation for determining the number of J0T30E-1 PE bays required is given in Table 4-P.

Table 4-P: Peripheral Equipment bay (J0T30E-1) calculation	
Step	**Procedure**
1	Refer to Tables 4-I and 4-J and use the larger value to determine the number of analog peripheral shelves required. Let the number of analog peripheral shelves required = A
2	Refer to Tables 4-I and 4-J to determine the number of analog peripheral shelves required for growth. Let the number of analog peripheral shelves required for growth = B
3	Refer to Table 4-N to determine the number of digital peripheral shelves required. Let the number of digital peripheral shelves required = C
4	The calculation for the number of required Messaging shelves to be provisioned in CE bays is: Number of Messaging shelves = (2 + (Number of SNLs)) / 20 The calculation for the number of required Messaging shelves to be provisioned in PE bays is: Number of Messaging shelves = (2 + (Number of SNLs)) / 12 Let the number of Messaging shelves required = D
5	Number of PE bays = (A + B + C + D) ÷ 3 (A minimum of one PE bay is required per system.)

Subscriber Carrier Equipment

The following information describes how to provision SCM-10S modules, SCM-10U modules, and Subscriber Equipment bays.

SCM-10S modules

Each SLC-96 channel bank consists of four shelves, which are logically divided into two shelf groups (AB and CD). Each shelf group can be configured independently for Mode I or Mode II operation. In Mode I, each shelf connects to an SCM-10S through one DS-1 link; in Mode II, each shelf shares the same DS-1 link; that is, one link per shelf group.

Each SCM-10S subscriber carrier module is composed of two shelves. Each shelf can be provisioned with five DS-1 Interface packs, with each pack providing two DS-1 links. Hence, a maximum of ten packs or 20 DS-1 links can be provisioned per SCM-10S module. Each of the two ports on a DS-1 Interface pack should interface to a different SLC-96 in order to prevent the loss of an entire SLC-96 or SLC-96 shelf group because of a DS-1 Interface pack failure.

SCM-10S modules are provisioned to interface with SLCs in either a Mode I or Mode II configuration. In a typical Mode I configuration, the SCM-10S serves four SLCs. In a typical Mode II configuration, the SCM-10S serves six SLCs. Various combinations of the two modes may be configured on an SCM-10S. However, all links to a SLC must terminate on the same SCM-10S.

SCM-10U modules

An SCM-10U module comprises two shelves, each provisioned with five DS-1 Interface packs. Each DS-1 pack terminates two T1 links. A DMS-1U in a minimal configuration serves up to 96 subscribers and connects to the SCM-10U with two T1 links. A DMS-1U in a maximal configuration can serve up to 528 subscribers and connects to the SCM-10U with up to eight T1 links.

Subscriber Carrier Equipment bay

SCE bays are provisioned according to the total number of SCM-10S or SCM-10U modules required. One SCE bay can accommodate either two SCM-10S modules or two SCM-10U modules, or one of each type module. Thus:

Number of SCE bays required = Number of SCM-10S and/or SCM-10U modules required \ 2

> ***Note:*** *A minimum one SCE bay is required when configuring the system to interface with either SLC lines or DMS-1U lines.*

Remote Switching Center (RSC-S) Equipment

The RSC-S is a remote switching system comprised of a family of DMS-100 remote peripherals, based on Common Peripheral Module (CPM) architecture. The RSC-S provides an alternative to HSO/SSO configurations and increased DMS-10 line capacity as a result of line concentration and Intraswitching. The primary system components include:

- Remote Cluster Controller 2 (RCC2) shelf, which contains the central processing equipment and circuitry for the RSC-S
- Line Concentrating Modules (LCM), which serve as the subscriber interface for the RSC-S for up to 640 lines per LCM
- Remote Maintenance Module (RMM) shelf, which is used for maintenance and line or trunk diagnostics

These components are provisioned in the following two cabinets:

- Cabinetized Remote Switching Center (CRSC), which houses the RCC2, the RMM and an LCM, and provides control for associated LCMs and RMMs as directed by the host, maintenance and service circuits provided by the RMM, and up to 20 DS-1 links which can be used for digital trunks
- Cabinetized Line Concentrating Equipment (CLCE), which houses up to two LCMs, each of which can contain 640 line cards; up to three CLCEs can be supported in a single RSC-S configuration

The RSC-S configuration also includes, for configurations supporting more than 640 lines, a Cabinetized Remote Maintenance Equipment cabinet (CRME) (NTRX31) which houses two circuit breaker shelves, each with 20 A feeds and 20 B feeds, and miscellaneous customer-provided equipment for the RSC-S.

RSC-S cabinets are configured in lineups for most efficient operation and economical installation. Cabinet positions and arrangements are standardized for simplicity of engineering and installation. Aisle width is a minimum of 3 feet in the front and rear of the cabinet.

Lines, trunks, and channels

C-side provisioning

The RSC-S is connected to the host by way of 2 to 16 DS-1, or Subscriber Remote Interface (SRLK), links provided by from 2 to 8 NT4T09 Subscriber Remote Interface (SRI) packs or Digital Signal Interface (DSI) modules. The minimum configuration consists of two SRI packs (or DSI modules), each supporting one SRLK used for signaling. Each SRLK is connected to a different RSC-S unit. The maximum configuration includes eight SRI packs (or DSI modules) supporting 16 SRLKs, with two SRLKs used for signaling.

P-Side provisioning

P-side provisioning depends upon the number of DS-30A links used and the number of Dual DS-1 Interface (NTMX81AA) packlets provisioned. Table 4-Q shows possible pack configurations and the capacity for each configuration.

Table 4-Q:
P-Side provisioning and capacity

Circuit pack configuration (number of packs and pack type)	DS-30A ports	DS-1 ports	Channels to LCM	Channels to DS-1
2 NTMX74 DS-30A Interface 1 NTMX87 PCM Carrier	32	8	1024	192
2 NTMX74 DS-30A Interface 2 NTMX87 PCM Carrier	32	16	1024	384
2 NTMX74 DS-30A Interface 3 NTMX87 PCM Carrier	32	22	1024	528

20 assignable for trunking

Line Concentrating Equipment in the RSC-S

An RSC-S configuration can support up to 4480 lines: 640 lines in the Cabinetized Remote Switching Center (CRSC) cabinet and up to three Cabinetized Line Concentrating Equipment (CLCE) cabinets, each of which houses up to 1280 lines.

Carried-CCS and line/trunk capacity

Tables 4-R and 4-S provide an example of the CCS capacities of the RSC-S and of the line/trunk quantities that each CCS capacity can support. Assumptions used in these calculations include:

- 20% intra RSC-S line traffic (Tables 4-R and 4-S); 50% intra RSC-S trunk traffic (Table 4-S)
- 3 CCS carried High Day Busy Hour (HDBH) / POTS line
- 511 call header blocks
- 25 CCS carried HDBH / trunk

The following restrictions must be remembered when configuring an RSC-S:

- An RSC-S can support a maximum of 382 trunks when it is in ESA mode.
- An NT4T04AK enables one RSC-S to be configured off of each DS-30A pair; an NT4T04AL enables two RSC-Ss to be configured off of each DS-30A pair.

Table 4-R: Carried-CCS and line-only capacity

C-side DS-1 ports	Switched C-side channels	C-side channels capacity CCS	Total RSC-S traffic CCS	POTS lines
2	46	1242	1537	512
4	94	2813	3481	1160
6	142	4432	5485	1828
8	190	6074	7518	2505
10	238	7731	9568	3189
12	286	9397	11630	3876
14	334	11071	13701	4480
16	382	12749	15779	4480

Note: *Maximum number call attempts per hour for this model: 10518*

Table 4-S: Carried-CCS and line/trunk capacity

C-side DS-1 ports	Switched C-side channels	C-side channels capacity CCS	Total RSC-S traffic CCS	POTS lines	Trunks
2	46	1242	1800	494	12
4	94	2813	4078	1119	28
6	142	4432	6426	1764	45
8	190	6074	8807	2418	62
10	238	7731	11209	3078	78

Table 4-S: Carried-CCS and line/trunk capacity					
C-side DS-1 ports	**Switched C-side channels**	**C-side channels capacity CCS**	**Total RSC-S traffic CCS**	**POTS lines**	**Trunks**
12	286	9397	13625	3742	95
14	334	11071	16051	4407	113
16	382	12749	17281	4425	114

Note: *Maximum number call attempts per hour for this model: lines, 8850; trunks, 1585. Average holding time is 180 seconds.*

Remote Maintenance Module

An RSC-S can be configured with one Remote Maintenance Module (RMM) in the CRSC cabinet. The Remote Maintenance Module (RMM) feature performs a variety of tests on remote Line Concentrating Equipment. The RMM subscriber line testing packs utilized by the RSC-S include:

- *Line Test Unit (LTU) (NT2X10AC/NT2X11AD)*. The LTU consists of a pair of circuit packs, the LTU analog pack (NT2X10AC) and the LTU digital pack (NT2X11AD). Both are required to provide ac and dc voltage measurements, loop start and ground start tests, and resistance and capacitance measurements.
- *Metallic Test Access (MTA) pack (NT3X09AA/BA).* The MTA pack provides a metallic connection between LCM maintenance busses and trunk circuits. The BA version provides an 8 X 8 matrix required for RSC-S subscriber loop testing.
- *Incoming/Outgoing Test Trunk pack (NT2X90).* The I/O Test Trunk interfaces the remote LCM with CALRS, #14 Local Test Desk, and #3 Local Test Cabinet external test equipment to provide the same level of testing as is supported by this equipment at the DMS-10 switch.

Scan points and signal distribution points are provided to allow automatic monitoring and reporting, respectively, of critical system conditions. An abnormal condition can be detected by a scan point and an alarm can be activated by a signal distribution point associated with that scan detection point. The provisioning of scan point and signal distribution equipment is determined by the operating company. The scan point and signal distribution packs include:

- *Miscellaneous Scan Detection pack (NT0X10).* Each Miscellaneous Scan Detection pack can monitor up to fourteen conditions. The RSC-S is equipped with one Miscellaneous Scan Detection pack but can be equipped with up to four (the RSC-S may be provisioned with one NT0X10 pack, one NT2X57 pack, and up to three additional NT0X10 or NT2X57 packs in any combination).

- *Miscellaneous Signal Distribution pack (NT2X57).* The Miscellaneous Signal Distribution pack provides access to 14 relay switches. These relay switches can be wired to customer supplied equipment (for example, alarms, maintenance equipment). The RSC-S is equipped with one Miscellaneous Signal Distribution pack but can be equipped with up to four (the RSC-S may be provisioned with one NT0X10 pack, one NT2X57 pack, and up to three additional NT0X10 or NT2X57 packs in any combination).

Network equipment

The following paragraphs describe the different types of network equipment required or provisionable and the formulas for determining the quantities required of each.

Peripheral loops

There are two kinds of peripheral loops: Multiplex Loop Interface (MLI) loops and DS-30A loops. Each loop contains 32 channels: 30 for speech and 2 for signaling. The total number of peripheral loops required in a system is dictated by the number of analog peripheral shelves required, the number of digital shelves required, and the number of LCMs, SCM-10Ss, SCM-10Us, and LCE-based remotes required in the system.

Analog shelves

One MLI loop can serve one or two shelves on a primary basis and two or four shelves on a secondary basis for low traffic usage (less than 365 ccs per shelf). For higher traffic, each analog trunk shelf should be configured with one MLI loop.

Digital shelves

One MLI loop serves one digital module. The calculation for determining the number of loops required for digital shelves is given in Table 4-T.

LCMs

Four DS-30A loops (two pairs) serve one LCM. One pair of loops can act as a spare for the other pair. The formula for determining the number of DS-30A loops required for LCMs is: Number of DS-30A loops required = number of LCMs required X 4.

SCM-10S

Two or four DS-30A loops serve one SCM-10S. In the two-loop configuration, both loops serve each Controller Array shelf, with 1 channel per loop used for signaling and 31 channels per loop used for voice. In the four-loop configuration, two loops are configured per shelf, with 1 channel per two loops used for signaling and 63 channels per two loops used for voice. The calculations for determining the number of DS-30A packs required to support SCM-10Ss are given in Tables 4-U and 4-V.

SCM-10U

Two through sixteen DS-30A loops serve one SCM-10U. In this configuration, each SCM-10U can support eight RCUs and 13280 ccs of traffic.

PGI

Two through sixteen DS-30A loops serve one PGI. The calculations for determining the number of DS-30A loops are given on page 4-66.

LCE-based remotes

Two, four, or six DS-30A loops serve one OPM, OPAC, OPSM, RLCM, or RSLM, up to eight DS-30A loops serve one RSLE, and up to sixteen DS-30A loops serve one RSC-S, depending on traffic considerations.

The calculations for determining the number of DS-30A packs are given in Table 4-AD.

Table 4-T:
Multiplex Loop Interface calculation-digital shelf

Step	Procedure
1	Let the number of DCMs/DSLKs = A
2	Let the number of OCMs = B
3	Each SCM shelf is served by two MLI loops. Let the number of SCM shelves = C
4	Number of MLI loops for digital shelves = (A) + (B) + (2 X C)

Table 4-U:
DS-30A calculation for SCM-10S (assuming 1% blocking and 50% originating, 50% terminating traffic)

Step	Procedure
1	Let the total number of lines per SLC-96 = A
2	Calculate the total calling traffic for the SLC-96 in ccs: B = ccs/line X A
3	Locate the total traffic in Table 4-V to determine the number of DS-30A loops required.

Table 4-V:
DS-30A provisioning per SCM-10S (assuming 1% blocking)

Total ccs Capacity (Figure B from Table 4-U)	DS-30A loops required	ccs per SLC-96 line	ccs per channel
> 1555 (Mode II)	2	2.70 (Mode II)	25.08 (Mode II)
> 1567 (Mode I)		4.08 (Mode I)	25.27 (Mode I)
1555 < and < 3529 (Mode II)	4	6.13 (Mode II)	28.01 (Mode II)
1567 < and < 3570 (Mode I)		9.30 (Mode I)	28.33 (Mode I)

Basic Network or CNI shelf function packs

The Input/Output Bus Extender (IOBE) pack, 5/12 Volt Converter (Power) pack, and Bus Terminator pack enable the DMS-10 Classic Network and CPU/Network shelves, and the DMS-10EN CNI shelves to function. The following paragraphs describe the packs and their provisioning rules.

Input/Output Bus Extender (IOBE) pack (NT3T72)

IOBE packs extend the CPU's I/O bus to the DMS-10 Classic Network shelves, to the DMS-10EN CNI shelves, and to the General-Purpose Input/Output (GPIO) shelves. IOBE packs are not provisionable: two IOBE packs are provided per Network shelf, two IOBE packs are provided for each half of the GPIO shelf, three IOBE packs are provided per CPU/Network shelf, and three IOBE packs are provided per CNI shelf.

5/12 Volt Converter (Power) pack (NT3T19)

In a DMS-10 Classic Network, Power packs provide the Network with both +5 and ±12 volts. The Network pack (NT4T06) uses only +5 volts; the ±12 volts are distributed throughout the general-purpose I/O locations (positions 4 through 7). When the power load on a shelf does not justify both power supplies, a single power supply may be used, in which case a strap must be installed at the rear of position 21 to connect the two power buses. A maximum of two power packs may be configured per Network or CPU/Network shelf. One power pack is always configured in position 21; a second power pack may be provisioned in position 1.

In a DMS-10EN network, power feeds of the dual Power packs are spread throughout the shelf, ensuring that the failure of single power pack does not eliminate the functional capability of all packs of a given type. The left power supply feeds power to slot positions 2-9, 14, 17, and 18. The right power supply feeds power to slot positions 12, 13, 15, 16, and 19-21. The powering arrangement for slots 10 and 11 (NT3T72 pack positions) ensures that the network side of the I/O bus is powered even if the processor on that shelf is not.

Bus Terminator pack (Classic Network only) (NT4T00 and NT4T07)

In the DMS-10 Classic Network, Bus Terminator packs are not provisionable. Two Bus Terminator packs are provided per Network shelf: NT4T00 is configured in position 8 and NT4T07 is configured in position 20.

General-Purpose Input/Output (GPIO) packs

General-Purpose Input Output packs provide interface between the network and specific devices; for example, maintenance terminals.

To provide sparing, identical GPIO packs must be configured in identical positions on a pair of shelves in the Network (CE-1) bay.

In the DMS-10 Classic Network configuration, four pack positions (4 through 7) on the Network shelf are for general-purpose I/O packs. These positions will accept such packs as the Serial Data Interface (SDI) pack, Dual Serial Data Interface (Dual SDI) pack, Data Link Controller (DLC) pack, Magnetic Tape Controller (MTC) pack, Input/Output Interface (IOI) pack, and LAN/CPU Interface (LCI) pack. The MTC pack may be provisioned in position 4 only. The DLC pack may be provisioned in position 5, 6, or 7 only. Other general-purpose I/O packs are provisioned as required by the operating company.

In a DMS-10EN network, positions 13 and 19 of the CNI shelves can be provisioned with the DSDI pack. Slot 21 of the CNI shelves can be provisioned with DSDI, DLC, or LCI packs.

The GPIO shelf provides 15 pack positions (4 through 18) for general-purpose I/O packs. These positions will accept such packs as the Dual SDI, DLC, and MTC. In a DMS-10 Classic Network, positions 11 and 12 on the GPIO shelf can only be provisioned with SDI and DSDI packs.

Serial Data Interface (SDI) pack (NT3T09)

The SDI pack enables the interchange of data between the processor and data communication or terminal equipment, and between the processor and the Ethernet Switch. For additional information about provisioning the NT3T09 pack, see SOP 0101 in NTP 297-3601-311, entitled *Data Modification Manual*.

> ***Note:*** *Usually, devices are assigned to port numbers 0 and 1, and the Maintenance Interface pack (NT3T71) is used instead of the SDI pack.*

Dual Serial Data Interface (Dual SDI) pack (NT3T80)

The SDI pack enables the interchange of data between the processor and data communication or terminal equipment, and between the processor and the Ethernet Switch. The Dual SDI pack can be provisioned in the Control (CE-3) bay as well as a network (CE-1) bay. For additional information about provisioning the NT3T80AA/BA pack, see SOP 0101 in NTP 297-3601-311, entitled *Data Modification Manual*.

Data Link Controller (DLC) pack (NT3T50)

The DLC pack provides up to two data links between a Host Satellite Office (HSO) and up to two Satellite Switching Offices (SSOs) in a DMS-10 cluster.

Magnetic Tape Controller (MTC) pack (NT3T10)

The MTC pack controls the nine-track tape drives and BMC or other tape emulation billing storage devices required by the Local Automatic Message Accounting (LAMA) feature. In switches configured with a 1600-bpi AMA bay, the MTC is replaced with two I/O Interface packs (NT3T90).

Magneto-Optical Mini-Disk (NT4T32BA)

The NT4T32BA must reside on the GPIO shelf in position 10, in the DMS-10EN network configuration.

Input/Output Interface (IOI) pack (NT3T90)

The IOI pack on the Network shelf provides the interface with the AMA disk drives in the 1600-bpi AMA configuration.

LAN/CPU Interface (LCI) pack (NT4T16)

The LCI pack provides the interface between the CPU I/O busses and one Local Area Network (LAN) on a Messaging shelf. Two LCI packs are required, one for each LAN in the DMS-10 switch.

Service circuit packs

In the DMS-10 Classic Network configuration, Service circuit packs interface with the network in call processing functions. Identical service circuit packs must be configured in identical positions on two Network or CPU/Network shelves. The two service circuit packs and their provisioning rules follow.

Tone and Digit Sender (TDS) pack (NT4T01)

The TDS pack is a general-purpose service circuit pack that provides tone and digit sending for the DMS-10 Classic Network. Each network module may be provisioned with two TDS packs. One TDS pack is always configured in position 9 of each of the two shelves in the module. Another TDS pack may be provisioned in position 11 of each of the two shelves, if required by the operating company. One TDS pack may be provisioned on each CPU/Network shelf. Tables 4-W and 4-X provide calculations for determining the number of TDS packs required to support a given level of traffic.

Table 4-W: Tone and Digit Sender traffic calculation

Step	Procedure
1	Calculate the amount of ABSBH outgoing trunk traffic requiring Dial Pulse (DP) outpulsing: A = ABSBH outgoing DP trunk traffic = Total outgoing DP trunks X $\frac{ccs}{trunk}$
2	Calculate the amount of ABSBH outgoing trunk traffic requiring Multifrequency (MF) outpulsing: B = ABSBH outgoing MF trunk traffic = Total outgoing MF trunks X $\frac{ccs}{trunk}$
3	Calculate the amount of ABSBH outgoing trunk traffic requiring Dual Tone Multi-Frequency (DTMF) outpulsing: C = ABSBH outgoing DTMF trunk traffic = Total outgoing DTMF trunks X $\frac{ccs}{trunk}$
4	Calculate the amount of ABSBH terminating CND, CNAM, and SCWID traffic receiving caller identification information: D = ABSBH terminating CND, CNAM, and SCWID traffic receiving caller identification information = (ratio CND + ratio CNAM + ratio SCWID) X number of lines X terminating ccs/line ABSBH
5	Calculate the amount of THDBH outgoing traffic requiring DP outpulsing: E = (THDBH / ABSBH ratio) X A

Table 4-W: (Continued)
Tone and Digit Sender traffic calculation

Step	Procedure
6	Calculate the amount of THDBH outgoing traffic requiring MF outpulsing: F = (THDBH / ABSBH ratio) X B
7	Calculate the amount of THDBH outgoing traffic requiring DTMF outpulsing: G = (THDBH / ABSBH ratio) X C
8	Calculate the amount of THDBH terminating CND, CNAM, and SCWID traffic receiving caller identification information: H = (THDBH / ABSBH ratio) X D
9	Calculate the DP outpulsing traffic the TDS must support: $I = E \times \frac{\text{Average DP sender hold time}}{\text{Average call hold time}}$
10	Calculate the MF outpulsing traffic the TDS must support: $J = F \times \frac{\text{Average MF sender hold time}}{\text{Average call hold time}}$
11	Calculate the DTMF outpulsing traffic the TDS must support: $K = G \times \frac{\text{Average DTMF sender hold time}}{\text{Average call hold time}}$
12	Calculate the CND, CNAM, and SCWID traffic that the TDS must support: $L = H \times \frac{\text{Average DTMF sender hold time}}{\text{Average call hold time}}$
13	Calculate the total digit sender traffic: M = I + J + K + L
14	Refer to Table 4-X. In the total digit sender traffic column, find the number that is equal to or next larger than quantity M from Step 13. The number of Tone and Digit Sender circuit packs required can then be read from the rightmost column.

Use HDBH/ABSBH ratio figures if THDBH/ABSBH ratio figure is not available.

Use 8 seconds for average DP sender hold time and 2.5 seconds for average MF and DTMF average sender hold times, if figures are not available

.

Table 4-X:
Tone and Digit Sender pack provisioning (assuming 1% blocking of busy hour traffic)

Total Digit Sender Traffic (ccs) from Step 13 of Table 4-W	Number of Required TDS Packs
1822	2
2891	3
3982	4

Universal Tone Receiver (UTR) pack (NT4T02)

The UTR pack receives digital multi-frequency tones from the DMS-10 Classic Network (via the TDS) for up to 32 channels simultaneously. A UTR pack may be provisioned in position 10 and position 12 in each of the two shelves in the module, if required by the operating company. One UTR pack is provisioned on each CPU/ Network shelf. Tables 4-Y, 4-Z, and 4-AA provide calculations for determining the number of UTR packs required to support a given level of traffic.

Table 4-Y: Universal Tone Receiver pack traffic calculation

Step	Procedure
1	Calculate total digitone receiver ccs ABSBH by performing steps 1 - 3 of Table 4-A.
2	Calculate total multifrequency receiver ABSBH by performing steps 1 - 4 of Table 4-C.
3	Calculate total UTR traffic by adding the total digitone receiver ccs ABSBH to the total multifrequency receiver ccs ABSBH.
4	Refer to Table 4-Z and Table 4-AA. In the Total UTR Traffic column, find the number that is equal to or next larger than the quantity from step 3. The number of UTR packs required can then be read from the right-hand column.

Table 4-Z: Universal Tone Receiver pack provisioning (assuming 5% blocking of HDBH)

Total UTR Traffic (ccs)	UTR Packs Required
1767	2
2754	3
3741	4

Table 4-AA: Universal Tone Receiver pack provisioning (assuming 1% blocking of ABSBH)

Total UTR traffic (ccs)	UTR packs required
1616	2
2557	3
3497	4

Conference pack (NT4T03)

Each Conference pack provides switch and control circuitry for one conference loop in the DMS-10 Classic Network configuration. Each conference pack contains 10 conference circuits. The DMS-10 conference call capability is used for operator verification calls, for the Three-Way Calling feature, and for wireless call hand-offs. One Conference pack is required for operator verification calls (two packs may be provisioned). One Conference pack will accommodate 10 three-way conferences (30 conferees). To calculate the required number of Conference packs, sum the total three-way calls ccs, operator verification ccs, and wireless call hand-off ccs, and locate this value, or the next highest value if the value is not listed, in column 1 of Table 4-AB. The adjacent value in column 2 gives the required number of conference packs.

ABSBH wireless call hand-off ccs is calculated using the following formula:

A X B X C X D / E

where: A = Number of wireless subscribers
B = Number of ccs per wireless subscriber
C = Number of hand-offs per wireless call
D = Conference Pack holding time for wireless call hand-off (assume 7 seconds)
E = Wireless call holding time (seconds)

Table 4-AB:
Conference pack provisioning (assuming 0.1% blocking of ABSBH)

Three-Way call ccs, operator verification ccs, and Wireless Call Hand-off ccs	Conference packs required
339	2
600	3
880	4
1170	5
1469	6
1771	7
2081	8

Services provided in the DMS-10EN network configuration

The Network Interface pack (NT8T04) provides up to 128 channels of tone, receiver, and conference services in the DMS-10EN network. The circuitry that provides these services consists of two separate digital signal processors (DSP), called Global Tone Services banks (GTSB). Each GTSB provides 64 service channels. The GTSBs perform the following functions:

- DTMF digit sending and reception
- Multi-frequency (MF) sending and reception
- Call processing tones
- Calling number/name delivery to customer premises equipment (CPE)
- 3-way conference
- Dial-pulse (DP) sending
- Coin services
- ISUP continuity test

Network interface packs in the DMS-10 Classic Network configuration

In the DMS-10 Classic Network configuration, the two types of interface packs are the Multiplex Loop Interface (MLI) pack (NT4T05) and the DS-30A Interface pack (NT4T04). The MLI can interface with eight MLI loops. The DS-30A can interface with eight DS-30A loops.

The network interface packs are provisioned as required, up to a maximum of five interface packs per J1T31 Network shelf, and up to two interface packs per J1T72 CPU/Network shelf. Identical network interface packs must be configured in identical positions on a pair of Network or CPU/Network shelves. Table 4-AC shows the calculation for determining the number of MLI packs required. Table 4-AD shows the calculation for determining the number of DS-30A packs required.

Table 4-AC: MLI pack calculation	
Step	**Procedure**
1	One MLI loop can serve one or two shelves on a primary basis and two or four shelves on a secondary basis for low traffic usage (less than 365 ccs per shelf). For higher traffic, each analog trunk shelf should be configured with one MLI loop. Let the number of MLI loops for analog shelves = A
2	Refer to Table 4-T to determine the number of MLI loops required for digital shelves. Let the number of MLI loops for digital shelves = B
3	Number of MLI packs in system (Classic Network **only**) = $\frac{A + B}{8}$ **OR** Number of NT8T04 (MLI) packs in system (DMS-10EN **only**) = $\frac{A + B}{32}$

Table 4-AD: DS-30A pack calculation	
Step	**Procedure**
1	Calculate the number of DS-30A loops required for LCE by multiplying the number of LCMs by four or six. Let the number of DS-30A loops for LCMs = A
2	Calculate the number of DS-30A loops required for 2-loop SCM-10Ss by multiplying the number of 2-loop SCM-10Ss by two. Let the number of DS-30A loops for two-loop SCM-10Ss = B
3	Calculate the number of DS-30A loops required for 4-loop SCM-10Ss by multiplying the number of 4-loop SCM-10Ss by four. Let the number of DS-30A loops for 4-loop SCM-10Ss = C
4	Calculate the number of DS-30A loops required for LCE-based remotes (OPM, OPAC, OPSM, RLCM, RSLE, RSLM, RSC-S) by multiplying the number of SRI packs required (as determined in Table 4-M) by two. Let the number of DS-30A loops for LCE-based remotes = D
5	Calculate the number of DS-30A loops required for PGIs. Let the number of DS-30A loops for PGIs = E. Number of DS-30A packs in system (Classic Network **only**)= $\frac{A + B + C + D + E}{8}$ **OR** Number of NT8T04 packs (DS-30A) in system (DMS-10EN **only**) = $\frac{A + B + C + D + E}{32}$

Rules for provisioning a network interface pack in position 13

Provisioning a network interface pack in position 13 of a Network shelf requires careful attention to traffic loading. Position 13 has access to only one-half of the network di-loop timeslots that positions 14, 15, 16, and 17 each have in a two network pack (NT4T06) configuration, and to only one-fourth of the network di-loop timeslots that positions 16/17 or 14/15 each have in a single network pack configuration. The service circuits (Tone and Digit Sender, Conference, and Universal Tone Receiver) share the network di-loop timeslots with position 13.

In order to ensure network availability at the same grade of service as positions 14, 15, 16, and 17, only four (two network packs) or two (one network pack) of the eight peripheral loops on this interface pack should be assigned if traffic levels are at the recommended maximum ccs per peripheral loop.

Provisioning equipment capable of producing high levels of traffic load (that is, remotes) should also be avoided.

When all eight peripheral loops are provisioned on an interface pack located in position 13, with one network pack configured, each peripheral loop can handle a traffic load of 207 ccs, as a general rule. For 3.6 ccs lines, this is equivalent to 57 lines per loop. For 27 ccs trunks, this is equivalent to seven trunks. The maximum traffic load of the interface pack to the network di-loops is 1660 ccs.

When all eight peripheral loops are provisioned on an interface pack located in position 13, with two network packs configured, each peripheral loop can handle a traffic load of 415 ccs, as a general rule. For 3.6 ccs lines, this is equivalent to 115 lines per loop. For 27 ccs trunks, this is equivalent to seven trunks. The maximum traffic load of the interface pack to the network di-loops is 3320 ccs.

When provisioning of peripheral loops on an interface pack in position 13 is being performed without the direction of Nortel Customer Engineering personnel, it is recommended that it be implemented incrementally, with checks for network blockage or delays using OPMs before additional traffic load is added.

Network interface packs in the DMS-10EN network configuration

In the DMS-10EN network configuration, the NT8T04 Network Interface pack serves as the interface to both the Multiplex Loop Interface (MLI) and DS-30A Interface (DS-30A) families of DMS-10 peripherals. A single NT8T04 can support only one application, either MLI or DS-30A, at a time. Each NT8T04 provides up to 32 peripheral loops (PELP). Thus, each CNI shelf can provide up to 160 PELPs. Each NT8T04 is mated with an NT8T04 provisioned in the same slot on the other CNI shelf, for sparing purposes.

The number of NT8T04 packs required depends on the number of MLI and DS-30A loops required.

Network packs in the DMS-10 Classic Network configuration

Each Network pack (NT4T06) performs both time and space switching in the DMS-10 Classic Network. Network packs are provisioned according to the number of peripheral loops required.

> ***Note:*** *In a regular network module, Network packs are configured in positions 18 and 19 of the Network shelf. One Network pack is required in position 18. A Network pack is required in position 19 if the value of D in Table 4-AE is 4 or 8.*

Table 4-AE:
Classic Network - Network pack calculation

Step	Procedure
1	Refer to Table 4-AC to determine the number of MLI packs required. Let the number of MLI packs required = A
2	Refer to Table 4-AD to determine the number of DS-30A packs required. Let the number of DS-30A packs required = B
3	The number of diloops in system = (A + B - number of Network modules) X 4 = C
4	Let the number of Network packs in system = D If C < 20, then D = 2 If C > 20 but < 36, then D = 4 If C > 36, then D = 8

A diloop has 64 channels and connects the network interface packs with the network packs.

Network packs in the DMS-10EN network configuration

In the DMS-10EN network configuration, each Network pack (NT8T06) performs both time and space switching. Four Network packs are provisioned in the CNI module.

Network shelves

In the DMS-10 Classic Network, Network shelves are provisioned in pairs. The calculation is given in Table 4-AF.

Table 4-AF:
Classic Network - Network shelf calculation

Step	Procedure
1	Refer to Table 4-AE to determine the number of Network packs provisioned. Let the number of Network packs provisioned = A
2	If A = 2 or 4, the number of Network shelves required = 2 If A = 8, the number of Network shelves required = 4

CPU / Network shelves

In the DMS-10 Classic Network configuration, CPU/Network shelves are provisioned in pairs, one pair per three-bay configuration.

Network modules

To provide a redundant switching network to serve lines and trunks, each Network shelf is paired with another Network shelf. A pair of Network shelves comprises a Network Module in the DMS-10 Classic Network configuration. Each module serves as a unit during sparing. The maximum network size is two modules. The formula for determining the number of Network Modules required for an office is:

number of Network Modules = number of Network shelves \ 2

CNI modules

In the DMS-10EN network configuration, each CNI shelf is paired with another CNI shelf. A pair of CNI shelves comprises a CNI module. The DMS-10EN network operates in a dual-plane network plane architecture. The DMS-10EN provides hot-standby equipment redundancy as each call is switched simultaneously in parallel in both network planes.

Network (CE-1) bay in a DMS-10 Classic Network configuration

In a typical DMS-10 Classic Network configuration, the bay consists of either one or two Network Modules and a Power and Cooling Module. If only one Network Module is provisioned, it is located on shelves 4 and 5. If two Network Modules are provisioned, they are located on shelves 2 through 5. Shelf 1 can be provisioned with a Messaging shelf, GPIO shelf, or DCI shelf.

Network (CE-1) bay in a DMS-10EN network configuration

In the DMS-10EN network configuration, the CE-1 Network Expansion frame houses one CNI module, a Power and Cooling Module, up to two GPIO shelves, a Digital Carrier Interface shelf, and a Messaging shelf. A J1T93A-1 CE-3 Common Equipment frame can house digital trunks, CCS7 equipment, and one GPIO shelf. A PE-01 frame provides power distribution and metallic maintenance facilities.

A DMS-10EN system can have GPIO shelves provisioned in locations CE 1-3, CE 1-2, and CE 3-1. However, not all of these positions can be provisioned at the same time. Only a maximum of two GPIO shelves are allowed.

Control equipment

The Control equipment packs are listed below. For the locations of these packs on the Control and CPU/Network shelves, refer to the NTP entitled *Equipment Identification* (297-3601-150).

Basic shelf function packs

The following packs enable the Control or CPU/Network shelf to function:

- I/O Bus Extender pack (NT3T72)
- 5/12 Volt Converter (Power) packs (NT3T19)
- CPU Bus Terminator, Type 1 pack (NT3T34) (400 CPU only)

System Processor

The CPU, memory, and clock functions are all built into the NT3T98 System Processor circuit pack. The NT3T98 circuit pack requires an NT3T84 paddleboard to provide connectivity to two physical ethernet links.

CPU-associated packs

Associated with each CPU are the following required packs:

- Maintenance Interface pack (NT3T71)
- System Bus Controller (SBC) pack (NT3T70)
- Input/Output Interface pack (NT3T90)

The Maintenance Interface packs (NT3T71) are dedicated to maintenance terminals 0 and 1. The pack on the CPU 0 shelf is dedicated to maintenance terminal 0, and the pack on the CPU 1 shelf is dedicated to maintenance terminal 1.

Optional Control Equipment packs

The following packs may be provisioned as required:

- Dual Serial Data Interface (SDI) pack (NT3T80)

  Note: *This pack may be provisioned in positions 12 through 14 of the Control shelf. Because the Input/Output Interface pack is located in position 12, the Dual SDI pack usually is located in position 13 or 14.*

- Synchronous Clock pack (NT3T47), if the system requires clock synchronization
- General Purpose Input/Output packs

Control (CE-3) bay

The CE-3, or Control, bay is always provisioned in a full-sized DMS-10 switch configuration. Normally the Control bay consists of two fully duplicated Control shelves, each containing a CPU and its associated memory (shelves 2 and 3); an Alarm and Ringing Module (shelf 5); a Power and Cooling Module; the magneto-optical drive or disk drive (shelf 4); and the Vent and Filter Unit/Panel (shelf 1).

CCS7 equipment

Messaging shelf

Up to four Messaging shelves (J1T65A-1) may be provisioned in the DMS-10 switch. The number of Messaging shelves to be provisioned is determined by the number of Common Channel Signaling 7 (CCS7) links required for the system. Up to 38 Signaling Network Links (SNL) may be assigned. One LAC pack is required for each link.

A Messaging shelf configured in a CE bay may be provisioned with up to 20 LAC packs. However, two LAC packs per system must be dedicated to Level 3 network applications. Thus, the calculation for the number of required Messaging shelves to be provisioned in CE bays is:

Number of Messaging shelves = (2 + (Number of SNLs)) / 20.

A Messaging shelf configured in a PE bay should be provisioned only with up to 12 LAC packs. Thus, the calculation for the number of required Messaging shelves to be provisioned in PE bays is:

Number of Messaging shelves = (2 + (Number of SNLs)) / 12.

For more information about provisioning requirements for the J1T65A-1 Messaging shelf, see Section 5, “Shelves, modules, and panels,” in NTP 297-3601-150, *Equipment Identification*.

Service Switching Point, Signaling Relay Point, and Signaling Transfer Point

The Service Switching Point (SSP) is an end-point in the CCS7 network. Thus, the SSP is either a source or a destination for CCS7 signaling messages.

The Signaling Relay Point (SRP) and Signaling Transfer Point (STP) are interfaces between an SSP sub-network and other Signaling Transfer Points (STP). The SRP/STP performs sub-network message routing and controls CCS7 signaling information transfer between the sub-network and the STPs. A DMS-10 SRP can be configured only as a single unit; DMS-10 STPs must be configured in mated pairs. The dual-SRP/STP configuration ensures that all subnetwork data traffic can continue to be processed should one of the mated STP/SRPs fail.

> ***Note:*** *Although the dual DMS-10 STP/SRP configuration allows the number of nodes in the subnetwork to be doubled, the subnetwork must be engineered so that one STP/SRP can handle all of the subnetwork data traffic when its mate is not functioning.*

Link provisioning

Normally, two CCS7 links share the message traffic load unless a failure forces one of the links to handle the entire load. To keep delays to a minimum when a link fails, each link pair is engineered as a single link that can handle 80 percent of the maximum message traffic capacity of the link pair. Table 4-AG shows level 2 message traffic capacity in one direction.

<table>
<tr><th colspan="3">Table 4-AG:
Level 2 message capacity (in one direction)</th></tr>
<tr><th>Link speed (kbps)</th><th colspan="2">Engineered capacity (octets per second)</th></tr>
<tr><td>4.8</td><td colspan="2">460</td></tr>
<tr><td>9.6</td><td colspan="2">940</td></tr>
<tr><td>19.2</td><td colspan="2">1280</td></tr>
<tr><td rowspan="6">56</td><td>Message size (octets)</td><td>Engineered capacity (octets per second)</td></tr>
<tr><td>20 through 29</td><td>2000</td></tr>
<tr><td>30 through 34</td><td>3500</td></tr>
<tr><td>35 through 39</td><td>4300</td></tr>
<tr><td>40 through 44</td><td>5000</td></tr>
<tr><td>45 through 279</td><td>5500</td></tr>
</table>

Links between SSPs and DMS-10 STPs/SRPs

Message traffic between SSPs and DMS-10 STPs/SRPs requires one link pair. The minimum speed of the links must be calculated so that one link can handle the entire load should the mate link fail. The speed of the links connecting SSPs to the DMS-10 STP/SRP may be 4.8 kbps, 9.6 kbps, 19.2 kbps, or 56 kbps.

Links between DMS-10 STPs/SRPs and other STPs

Although this link speed is fixed at 56 kbps, more than one pair of links may be required for larger sub-networks.

Message traffic provisioning

Figure 4-1 is a diagram that shows types of messages carried by CCS7 links in a DMS-10 STP/SRP configuration. When provisioning the STP/SRP, it is necessary to ensure that its capacity to handle Level 3 message traffic is not exceeded. This capacity, shown in Table 4-AH, reflects the STP/SRP's ability to support the total CCS7 message traffic on all SSP and STP links associated with the STP/SRP. The STP/SRP is engineered to handle 80% of its actual message traffic capacity in order to keep delays to minimum.

Figure 4-1: Types of messages carried by CCS7 links in the DMS-10 STP/SRP configuration

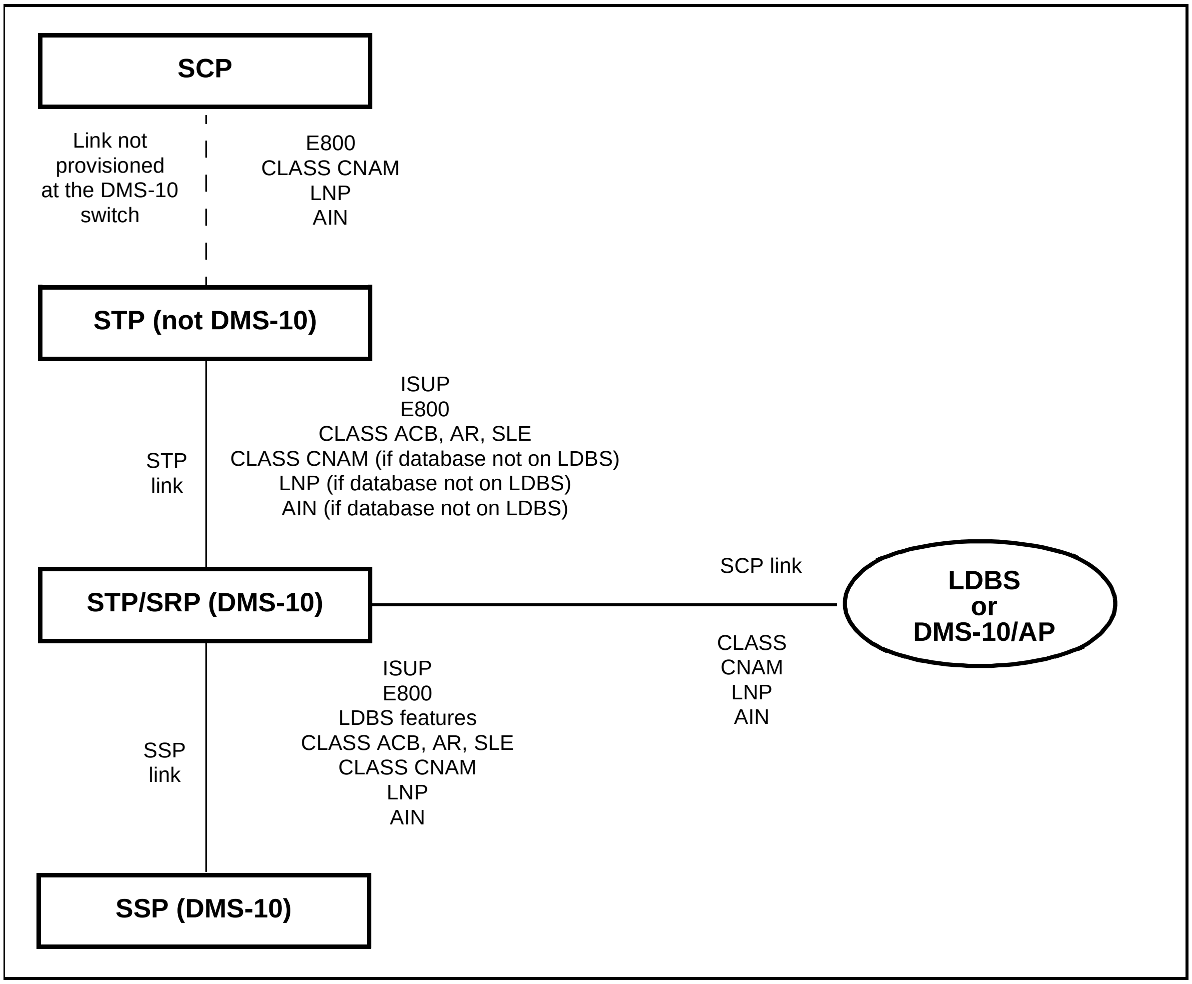


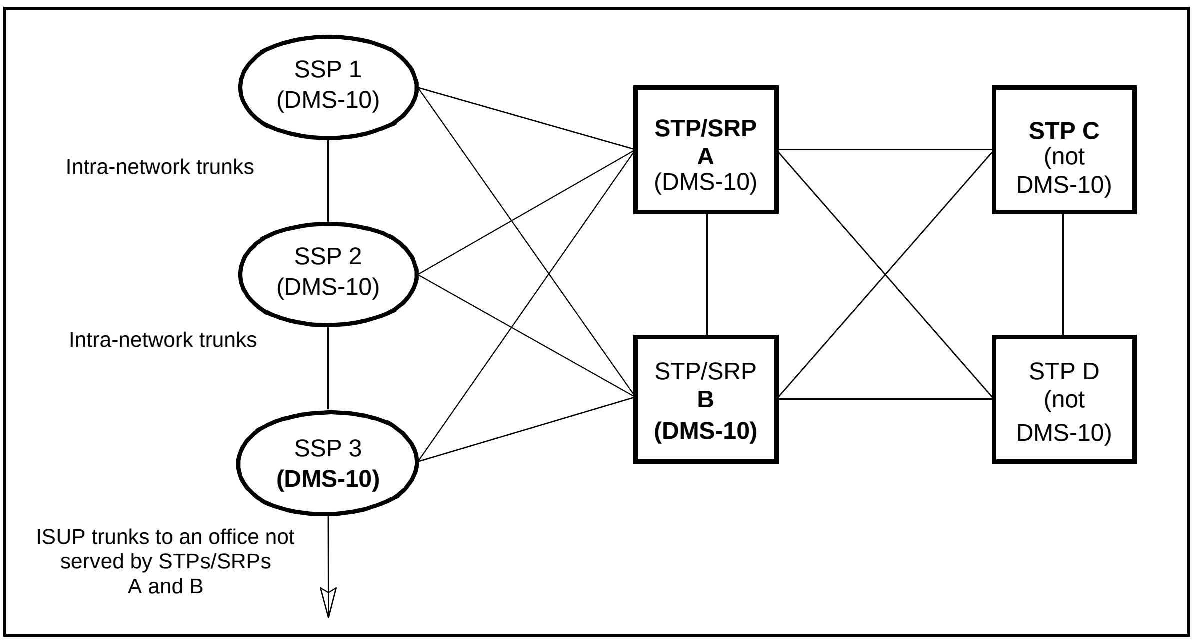
Table 4-AH:
Level 3 message engineered capacity

Message size (octets)	Message per second without Gateway Screening	Messages per second with Gateway Screening
88 through 183	167	131
184 through 279	132	111

DMS-10 Signaling Transfer Point (STP) and Signaling Relay Point (SRP) configuration

Figure 4-2 shows a sample DMS-10 STP/SRP configuration. The DMS-10 STP/SRP comprises a DMS-10 switch and a Martin and Associates CNAM-DB, LDBS 2000, or DMS-10/AP (DMS-10 Application Peripheral) unit with Global Title Translations capability. (Mated pairs of CNAM-DB, LDBS 2000, or DMS-10/AP units may be installed for increased performance and reliability). The DMS-10 STP/SRP can be deployed as an independent element within the CCS7 network to provide connectivity for multiple signaling points. The DMS-10 STP/SRP can also serve as a natural extension of the DMS-10 cluster configuration to serve nodes in a DMS-10 subnetwork. Also, the DMS-10 STP/SRP can serve as an addition to a fully-provisioned DMS-10 switch to extend CCS7 signaling further into the public network. The DMS-10 STP/SRP serves to decrease the number of external network database queries required for CCS7 call processing.

Figure 4-2: DMS-10 STP/SRP configuration



To maximize network availability to users:

- A single-node SRP configuration should be avoided. Two 56 kbps C-links interconnect the mated STPs/SRPs to provide network reliability.
- Each DMS-10 STP/SRP should be equipped with at least two diversely-routed signaling links to adjoining STPs or databases.
- Each subnetwork member should be equipped with at least two diversely-routed signaling data links. If these links home on a non-mated DMS-10 SRP, they should terminate on separate power feeds of the SRP.

DMS-10 STP/SRP provisioning procedure

The number of messages that can be transmitted per second in each connection determines the number of links and Level 3 throughput capacity required. It is important to engineer offices in an STP/SRP configuration for maximum possible message processing capacity. The procedure for provisioning an STP/SRP is outlined in Table 4-AI.

Table 4-AI:
STP/SRP provisioning procedure

Step	Procedure
1	Perform the procedure shown in Table 6-A for each SSP associated with the STP/SRP to be engineered in order to determine the number of messages/sec between each SSP and the STP/SRP. For example, Both SSP 1 and SSP 2 are identical to the example shown in Table 6-A. Links between each SSP and STP/SRP's A/B are 9.6 kbps. STP/SRP's A/B have Gateway Screening. Links between STP/SRP's A/B and STP's C/D are 56 kbps. Calculations are shown only for STP/SRP A since the calculations for STP/SRP B are identical. Number of 25-octet ISUP messages/sec between SSP 1 and STP/SRP A = 16.2 Number of 25-octet ISUP messages/sec between SSP 2 and STP/SRP A = 16.2 Number of 80-octet TCAP messages/sec between SSP 1 and STP/SRP A = 6.3 Number of 80-octet TCAP messages/sec between SSP 2 and STP/SRP A = 6.3 Number of 100-octet TCAP messages/sec between SSP 1 and STP/SRP A = 1.9 Number of 100-octet TCAP messages/sec between SSP 2 and STP/SRP A = 1.9
2	Calculate the total number of STP/SRP-to-STP ISUP messages (25 octets long) per second as the sum of the 25-octet ISUP messages/sec for each SSP. For example, Total number of ISUP messages (25 octets long) per second between STP/SRP A and STP C/D pair = 16.2 msg/sec for SSP 1 + 16.2 msg/sec for SSP 2 = 32.4 msg/sec

Table 4-AI: (Continued) STP/SRP provisioning procedure	
Step	**Procedure**
3	Calculate the total number of STP/SRP-to-STP TCAP messages (80 octets long) per second as the sum of the 80-octet TCAP messages/sec for each SSP. For example, Total number of TCAP messages (80 octets long) per second between STP/SRP A and STP C/D pair = 6.3 msg/sec for SSP 1 + 6.3 msg/sec for SSP 2 = 12.6 msg/sec
4	Calculate the total number of STP/SRP-to-STP TCAP messages (100 octets long) per second as the sum of the 100-octet TCAP messages/sec for each SSP. For example, Total number of TCAP messages (100 octets long) per second between STP/SRP A and the STP C/D pair = 1.9 msg/sec for SSP 1 + 1.9 msg/sec for SSP 2 = 3.8 msg/sec
5	Determine the number of required link pairs, if link speed is less than 56 kbps: 0.5 x [# 25-octet messages per second x 25) + (# 80-octet messages per second x 80) + (# 100-octet messages per second x 100)] / engineered capacity from Table 4-AG Determine the number of required link pairs, if link speed is 56 kbps: (0.5 x # messages per second) / [(ratio of 25-octet messages per second x 80) + (ratio of 80-octet messages per second x 68) + (ratio of 100-octet messages per second x 55)] ***Note:*** The denominator of the 56 kbps equation is a weighted average of the engineered capacities shown in Table 4-AG that have been converted from octets/sec into messages/sec. For example: From Table 6-A: Between SSP 1 and STP/SRP A: 24.4 msg/sec and one 9.6-kbps link pair Between SSP 2 and STP/SRP A: 24.4 msg/sec and one 9.6-kbps link pair Between STP/SRP A and STP C/D pair: 32.4 ISUP messages (25 octets long) per second + 12.6 TCAP message (80 octets long) per second + 3.8 TCAP message (100 octets long) per second = 48.8 total messages per second, of which 66% are 25 octets long, 26% are 80 octets long, and 8% are 100 octets long. Between STP/SRP A and STP C: (0.5 X 48.8) / [(0.66 X 80) + (0.26 X 68) + (0.08 X 55)] = 0.326, requires one 56-kbps link pair Between STP/SRP A and STP D: (0.5 X 48.8) / [(0.66 X 80) + (0.26 X 68) + (0.08 X 55)] = 0.326, requires one 56-kbps link pair

Table 4-AI: (Continued) STP/SRP provisioning procedure	
Step	**Procedure**
6	Determine whether Level 3 message capacity of the STP/SRP, without Gateway Screening, is exceeded: (0.5 x # messages per second) / [(ratio of 25-octet messages per second x 221) + (ratio of 80-octet messages per second x 221) + (ratio of 100-octet messages per second x 167)] Determine whether Level 3 message capacity of the STP/SRP, with Gateway Screening, is exceeded: (0.5 x # messages per second) / [(ratio of 25-octet messages per second x 150) + (ratio of 80-octet messages per second x 150) + (ratio of 100-octet messages per second x 131)] ***Note :*** In either case, if the calculated value is greater than 1, Level 3 message capacity of the STP/SRP has been exceeded and message traffic must be reduced. ***Note :*** The denominators are a weighted average of the engineered capacities shown in Table 4-AH. For example, Level 3 of STP/SRP A handles 48.8 msg/sec between itself and the STP C/D pair + 24.4 msg/sec between itself and SSP 1 + 24.4 msg/sec between itself and SSP 2 = 97.6 msg/sec. Of these messages, 66% are 25 octets long, 26% are 80 octets long, and 8% are 100 octets long. (0.5 X 97.6 messages/sec) / [(0.66 X 150) + (0.26 X 150) + (0.08 X 131)] = 0.329 < 1, thus, Level 3 message capacity of STP/SRP A is not exceeded.

SCM-10A equipment

ESMA shelf provisioning

A maximum of 40 ESMA shelves can be provisioned in a single DMS-10 switch. An ESMA shelf must be physically located within 38 feet (length of the DS-30A link) of the controlling CE frame.

ESMA shelf capacity model

Using Tables 4-AJ and 4-AK, the ESMA shelf CCS and line capacity can be calculated.

Table 4-AJ: GR-303 Office Model Service Mix and Traffic				
Service Type	**Business**	**Residence**	**ISDN only**	**CCS per line**
Residential POTS	25%	40%	0	1.85
Business POTS	25%	10%	0	3.2
CENTREX	25%	10%	0	6.1
CLASS	10%	35%	0	1.85

Table 4-AJ: (Continued) GR-303 Office Model Service Mix and Traffic				
Service Type	**Business**	**Residence**	**ISDN only**	**CCS per line**
ISDN BRI	10%	5%	100%	13
Switched Specials	5%	0	0	36

The figures in Table 4-AK are calculated given the following factors:

- 1% blocking at ESMA stage (leaving 1% blocking at DMS-10 network)
- Line model is the same as that shown in Table 4-AJ
- 1.3 HDBH/ABSBH ratio
- Mixed loss-delay model
- 55% originating traffic

Table 4-AK: ESMA CCS and Line Capacity							
Links to network	**Channels to network**	**CCS/ ESMA**	**Business Model Line Capacity (lines)**			**Residential Model Line Capacity (lines)**	**ISDN-only Loop Capacity (loops) (see note)**
			Total	**Dialup**	**Nailed up**		
2	56	1558	218	207	11	403	92
4	116	3510	488	464	24	909	207
6	176	5523	763	725	38	1430	326
8	236	7565	1042	990	52	1959	447
10	296	9626	1324	1258	66	2493	569
12	356	11699	1607	1527	80	3030	692
14	416	13782	1892	1798	94	3569	815
16	476	15872	2178	2070	108	4110	939

Note: *A maximum of 480 ISDN loops is supported per ESMA (with extension shelf); a maximum of 83 ISDN loops is supported per ESMA (without extension shelf).*

ESMA shelf P-side port capacity

Tables 4-AL and 4-AM summarize the possible configuration options available for ESMA shelf P-side EDCH and DS-1 ports with regard to various levels of ISDN penetration.

Table 4-AL: ESMA capacity (with extension shelf)

EDCH	DS-1	Total ports
10	24	34
9	32	41
8	40	48
0	48	48

Table 4-AM: ESMA capacity (without extension shelf)

EDCH	DS-1	Total ports
2	8	10
0	24	24

P-side provisioning order

The following provisioning guidelines help to ensure that future ESMA shelf upgrades are not limited and that service-affecting changes are avoided.

Main shelf provisioning Main shelf (NTMX8504) provisioning guidelines are as follows:

- All three main shelf P-side slots can be used for DS-1.
- Slot 12 is not available for EDCH. EDCH can be declared only in slots 14 and 16.
- If an extension shelf is required, slots 14 and 16 should be left unused until all other slots have been utilized either for DS-1 ports or for EDCH packs.
- If an extension shelf is not required, DS-1 ports should be defined from 0 through 23 (slots 12, 14, 16 starting from the top packlet and working downwards), and the EDCH packs as 17 (slot 14) followed by 9 (slot 16).

Extension shelf provisioning Extension shelf (NTMX8604) provisioning guidelines are as follows:

- The DS-1 P-side slots in the extension shelf should be provisioned in the following order: 4, 6 for left extension half (connected to the lower ESMA shelf), or 23, 21 for the right extension half (connected to the upper ESMA shelf). Slot 8 (slot 19 in the right half) should not be used for DS-1 ports unless there is a requirement for 48 DS-1 ports.
- Slots 4, 6, 21, and 23 are not available for EDCH packs.
- EDCH slots should be provisioned in the following order: 3, 5, 7, 11, 9, 10, 12, 8 for the left extension half, or 24, 22, 20, 16, 18, 17, 15,19 for the right extension half.
- If the main shelf contains two EDCH packs and one DS-1 frame, and three extra DS-1 frames are required, at lease one of the EDCH packs should be moved from the main shelf to the extension shelf and at least one of the DS-1 frames should be installed in the main shelf.

DS-30A Interface pack provisioning (Classic Network)

The DS-30A Interface pack (NT4T04) is restricted to providing the interface for up to eight DS-30A links. These links can be used by the ESMA shelf in the maximum configurations shown in Table 4-AN.

Table 4-AN: ESMA configurations

Number of ESMAs/RSC-Ss	Maximum number of LCM/RLCMs
2	0
1	3

CMR pack provisioning The NT6X78 CLASS Modem Resource card should be provisioned in slot 5 (unit 0) and slot 23 (unit 1).

UTR pack provisioning Two UTR packs (NT6X92) should be provisioned per ESMA unit.

C-side provisioning Two through 16 ports can be provisioned per ESMA shelf depending on the number of lines provisioned and the traffic on these lines. Table 4-AO shows the number of C-side channels required for traffic (dynamic calls), based on 1% blocking HDBH at the ESMA, due to the limited number of C-side channels from the ESMA to the DMS-10 network. Table 4-AP shows the number of channels required for non-dynamic traffic (nailed-up connections). To determine the number DS-30A links to be provisioned, the sum of the channels required (from the two tables) should be divided by 30 and the dividend then rounded up to the next even integer.

Table 4-AO:
Carried CCS HDBH versus C-side channels

CCS	Channels	CCS	Channels	CCS	Channels
29	4	5049	164	10523	324
107	8	5184	168	10661	328
200	12	5319	172	10799	332
303	16	5455	176	10937	336
412	20	5590	180	11076	340
524	24	5725	184	11214	344
639	28	5861	188	11353	348
757	32	5997	192	11491	352
877	36	6133	196	11630	356
998	40	6269	200	11768	360
1120	44	6405	204	11907	364
1244	48	6541	208	12045	368
1369	52	6677	212	12184	372
1494	56	6813	216	12323	376
1621	60	6950	220	12462	380
1748	64	7086	224	12600	384
1875	68	7223	228	12739	388
2004	72	7360	232	12878	392
2133	76	7496	236	13017	396
2262	80	7633	240	13156	400
2392	84	7770	244	13295	404
2522	88	7907	248	13434	408
2653	92	8044	252	13573	412
2784	96	8181	256	13712	416
2915	100	8319	260	13851	420
3047	104	8456	264	13990	424
3178	108	8593	268	14130	428
3311	112	8731	272	14269	432
3443	116	8868	276	14408	436
3576	120	9006	280	14547	440
3709	124	9143	284	14687	444
3842	128	9281	288	14826	448
3975	132	9419	292	14965	452
4109	136	9557	296	15105	456
4243	140	9694	300	15244	460

Table 4-AO: (Continued)
Carried CCS HDBH versus C-side channels

CCS	Channels	CCS	Channels	CCS	Channels
4377	144	9832	304	15383	464
4511	148	9970	308	15523	468
4645	152	10108	312	15662	472
4780	156	10246	316	15802	476
4915	160	10385	320	15872	480

Table 4-AP:
Number of C-side channels for non-dynamic traffic

Resource	Number of channels required
DMSX Messaging	2
Packet Handler Connections	1 per connection
Special Service Connections (hairpinning)	1 per connection

ESMA shelf port assignment

Table 4-AQ shows the port assignments for the ESMA shelf. The port column shows the address in the matrix. The DS-1 slot column shows which slot and packlet is required, where the packlet number starts from the top to the bottom of the NTMX87 frame.

When declaring the ESMA P-side ports, the port number is used to identify the service the port uses.

Table 4-AQ:
ESMA Time Switch pack (NTMX75) matrix configurations

Port	DS-1 slot	EDCH slot
0	12, 0	
1	12, 0	
2	12, 1	
3	12, 1	
4	12, 2	
5	12, 2	
6	12, 3	
7	12, 3	
8	16, 0	
9	16, 0	16

Table 4-AQ: (Continued)
ESMA Time Switch pack (NTMX75) matrix configurations

Port	DS-1 slot	EDCH slot
10	16, 1	
11	16, 1	
12	16, 2	
13	16, 2	
14	16, 3	
15	16, 3	
16	14, 0	
17	14, 0	14
18	14, 1	
19	14, 1	
20	14, 2	
21	14, 2	
22	14, 3	
23	14, 3	
24	EXT 4, 0	
25	EXT 4, 0	
26	EXT 4, 1	
27	EXT 4, 1	
28	EXT 4, 2	
29	EXT 4, 2	
30	EXT 4, 3	
31	EXT 4, 3	
32	EXT 6, 0	
33	EXT 6, 0	
34	EXT 6, 1	
35	EXT 6, 1	
36	EXT 6, 2	
37	EXT 6, 2	
38	EXT 6, 3	
39	EXT 6, 3	
40	EXT 8, 0	EXT 3
41	EXT 8, 0	EXT 5
42	EXT 8, 1	EXT 7
43	EXT 8, 1	EXT 8
44	EXT 8, 2	EXT 9
45	EXT 8, 2	EXT 10

Table 4-AQ: (Continued)
ESMA Time Switch pack (NTMX75) matrix configurations

Port	DS-1 slot	EDCH slot
46	EXT 8, 3	EXT 11
47	EXT 8, 3	EXT 12
48		EXT 3
49		EXT 5
50		EXT 11
51		EXT 7
52		
53		

The following guidelines pertain to data assignment:

- At least one DS-1 port from extension slot 4 must be declared before any DS-1 ports can be declared in slot 6.
- At least one DS-1 port from extension slot 6 must be datafilled before any DS-1 ports can be declared in slot 8.
- DS-1 ports in extension slot 8 cannot be declared if any of EDCH ports 40 through 47 are declared.
- EDCH ports 48 through 51 can only be used if extension slots 4, 6, and 8 all contain at least one DS-1 port.
- EDCH and DS-1 ports that use the same physical slot cannot be datafilled simultaneously.
- Ports 48 through 51 can only be used for the special configuration of 48 DS-1s and 4 EDCHs.

EDCH provisioning

The Enhanced D-channel Handler (NTBX02) is required only if ISDN loops are configured. Typically, channels 1 through 27 of the pack are used for ISDN lines and channels 28 through 31 are used for Bd connections. Because each channel supports four ISDN loops, each NTBX02 supports up to 108 ISDN loops.

A maximum of 10 EDCH packs can be supported. At lease one of the EDCH packs must be declared a spare in order to back up all of the other EDCH packs.

Since both EDCH packs and RDTs compete for the 32 available Enhanced ISDN Processor (EISP) pack (NTBX01) channels, the provisioning rules presented in Table 4-AR should be followed.

Table 4-AR: RDT versus EDCH provisioning

Number of EDCH packs	Maximum number of RDTs
0	7
1-4	7
5-8	7
9-10	7

ISDN loop provisioning

Each ISDN line requires one-fourth of an EDCH channel: four D-channels are multiplexed together on each EDCH channel. A maximum of 124 ISDN lines are supported by each EDCH pack.

Bd connections

Each Bd (low-speed packet terminal on the D-channel) line is routed from an external packet handler, through a DS0 channel on a DS-1 link, to a specific channel on the EDCH pack. Each channel supports a maximum of 64 multiplexed Bd channels. Since four EDCH channels are normally used as Bd channels, a maximum of 256 Bd channels can be declared per EDCH pack.

Load distribution

EDCH packs should be monitored, through OPMs, to ensure that they are being loaded equally. Lines should be moved from one EDCH to another, whenever necessary to balance the load.

Lines and channels

RDT Line capacity and ESMA support capability

Each ESMA shelf can support up to seven Integrated Digital Terminals (IDT), without ISDN, and up to seven IDTs, with ISDN. Three pre-defined RDT sizes - small, medium and large - determine the number of RDTs that an ESMA can support. Table 4-AS shows the relationship between the RDT line configuration and the number of RDTs that can be supported by an ESMA.

Table 4-AS: RDT and ESMA size relationship

ESMA size	RDT line size	Number of RDTs that an ESMA can support
small	up to 672 lines	up to 7 (POTS lines only) up to 7 (POTS and ISDN lines)
medium	up to 1344 lines	up to 4
large	up to 2048 lines	up to 2

Channels

For each RDT, four DS-0 channels are reserved for messaging: one channel for the Time Slot Management Channel (TMC), used for call processing, one for the Embedded Operations Channel (EOC), used for provisioning and maintenance purposes, and two backup channels (one channel each for the TMC and the EOC). All channels not used for messaging are available for traffic.

RDT provisioning

Up to 280 RDTs can be provisioned per DMS-10 (7 RDTS per ESMA and 40 ESMAs per DMS-10 switch). Up to 128 remote sites, including RDT sites, can be provisioned per DMS-10 switch and up to 32 RDTs can be provisioned per site.

The number of DS-1 links required by an RDT depends on the number of lines on that RDT, the traffic through the RDT, and the blocking allowed.

Distance between ESMA shelf and an RDT

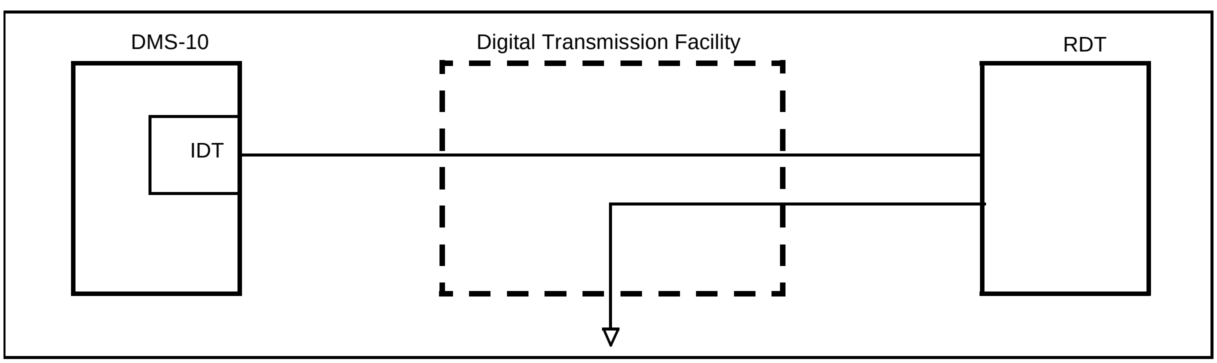
The maximum allowable distance between an ESMA shelf and an RDT is 68 miles (0.548 ms one-way transmission delay).

ESMA shelf to RDT network configurations supported

The DMS-10 supports the standard network configuration in which the DMS-10 switch is connected directly to an RDT. The DMS-10 can also support configurations that include intermediate network equipment, provided that the intermediate network equipment is “transparent,” that is, the physical-layer payload is transported unchanged and adds no additional delay. The DMS-10 ESMA shelf supports two Integrated Network Access (INA) techniques: field-groomed; and fully-integrated.

Field-groomed Using this technique, illustrated in Figure 4-3, the DS-0 is groomed before it reaches the IDT. Since the DMS-10 switch is unaware of this action, this technique can be supported.

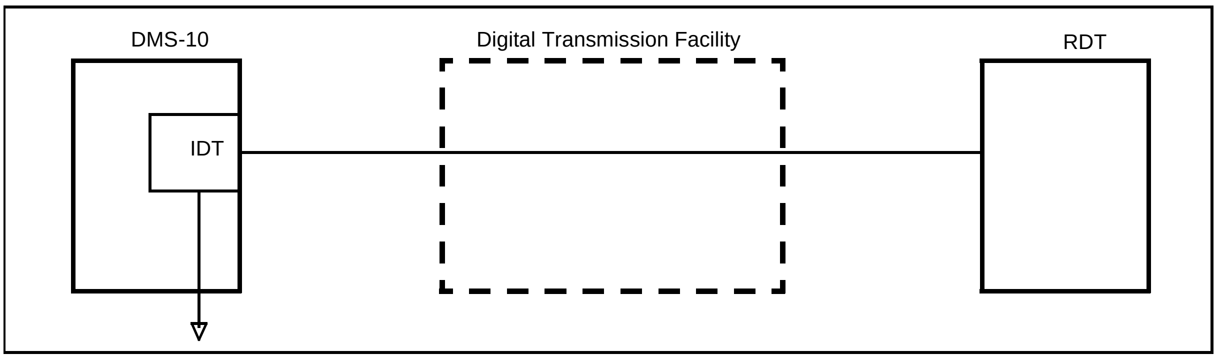
Figure 4-3: Field-groomed network configuration



Fully-integrated Using this technique, illustrated in Figure 4-4, grooming is performed through the GR-303 interface. Single, or multiple, DS-0 channels are routed, or hairpinned, through the IDT to a DS-0 channel. This technique is used when the DMS-10 switch is not required to switch the connection and acts as a pipeline to transfer all data from the RDT out of the DMS-10 switch without having to deal with the contents of the data or signaling. This technique is supported, with 2 limitations:

- Only single DS-0 grooming is supported
- Non-switched and non-locally switched facility UNICODE treatment is not supported

Figure 4-4: Fully-integrated network configuration



Echo management

GR-303 specifications indicate that the total round-trip delay between two RDTs should not exceed 6.5 ms. This delay is split between the RDTs (2.5 ms, with grooming, and 2 ms, without grooming), the transmission environment (2.6 ms, with grooming, and 3.1 ms, without grooming), and the DMS-10 switch (1.4 ms). This allows the one-way transmission delay to be 0.65 ms, or approximately 81 miles, with grooming, or 0.775 ms, or approximately 97 miles, without grooming.

The DMS-10 switch does not meet the criteria of 1.4 ms. The DMS-10 network one-way delay is 0.5 ms (4 frames), and the ESMA delay is 0.258 ms in the transmit direction, 0.396 ms in the receive direction for DS-1 links on the main shelf, and 0.521 ms in the receive direction for DS-1 links on the ESMA extension shelf.

The DMS-10 switch delay, the maximum one-way transmission delay, and the allowable distance between the ESMA shelf and the RDT is shown in Table 4-AT.

Table 4-AT:
Delays and distances between the ESMA shelf and an RDT

DS-0 Grooming in RDT	DS-1 Location	DMS Delay (ms)	One-way DS-1 Delay (ms)	Maximum Distance (miles)
No grooming	main shelf	2.308	0.548	68 (see Note 1)
	extension shelf	2.558	0.485	60 (see Note 1)
Grooming	main shelf	2.308	0.425	53 (see Note 1)
	extension shelf	2.558	0.36	45 (see Note 1)

Note 1: The distances shown in Table 4-AT are based on the GR-303 requirement that total round trip delay may not exceed 6.5 msec and RDT round trip delay is 2.0 msec. The distances can be extended, however, if the GR-303 0dB model is not used, RDT round trip delay is less than 2.0 msec, or total round trip delay is increased. Using the model described in ANSI T1 508a, “Network Performance - Supplement to Loss Plan for Evolving Digital Networks, 1993,” which allows for 0dB through 6dB insertion loss, the round trip delay can be increased up to 12 msec, thus extending the distances shown in Table 4-AT by an additional 687 miles. Note, however, that DMS-10 ESMA lines can be provisioned with a maximum of 2dB of insertion loss - any additional insertion loss must be provided by the RDT.

Note 2: In this table RDT round trip delay is assumed to be 2.0 msec long.

In the calculations used to derive the values in the table, shown below, the one-way propagation speed is assumed to be 0.008 ms/mile:

- DMS round trip = 2 X (one-way network delay) + 2 X (ESMA transmit + receive delay)
- One-way DS-1 transmission delay = (6.5 - (RDT round trip) - (DMS round trip)) / 4
- Maximum distance = one-way DS-1 transmission delay / 0.008

As shown in the table, an ESMA extension shelf reduces the allowable distance between ESMA and RDT by 8 miles and DS-0 grooming reduces the allowable distance by 16 miles.

Voice over Internet Protocol (VOIP)

The following information describes how to provision the Ethernet Switch (ES), Packet Gateway Interface (PGI), Gateway (GW), and Gateway Lines (GWL)

Ethernet Switch (ES)

The following sections describe the cables and their associsted ports used to provision the VoIP ES.

Ethernet Switch Location

Two Ethernet Switches will be mounted in a Miscellaneous Equipment frame that has the physical space, appropriate power sources, and air flow. For convenience, they may be mounted next to the PGIs.

Cables

Table 4-AU: "Cables required for two Ethernet Switches" identifies the ethernet cables needed to install two (2) Ethernet Switches on the DMS-10 CO LAN.

Table 4-AU: Cables required for two Ethernet Switches

Ethernet Cables	No. of Cables
Ethernet cables for PGI connections	4 per PGI
Ethernet cables for System Processor pack connections	4
Ethernet cable for cross-connection	2
Ethernet cables for OAM&P VLAN connection	1 or 2[1]

1. Either one (1) when the existing OAM&P VLAN is currently connected to the System Processor pack via a hub, or two (2) when the OAM&P VLAN is connected via an Ethernet switch.

Ethernet Switch 470 Port Numbering and Assignment

Each Ethernet Switch will have the cables allocated in a custom manner for the DMS-10 CO LAN application. This will allow the switches to use a pre-defined configuration file that sets up each port's attributes. Figure 4-5: shows the port numbering scheme of an Ethernet Switch, and Table 4-AV: and Table 4-AW: define the ports assignment.

Figure 4-5: Ethernet Switch 470 RJ-45 Port Numbering

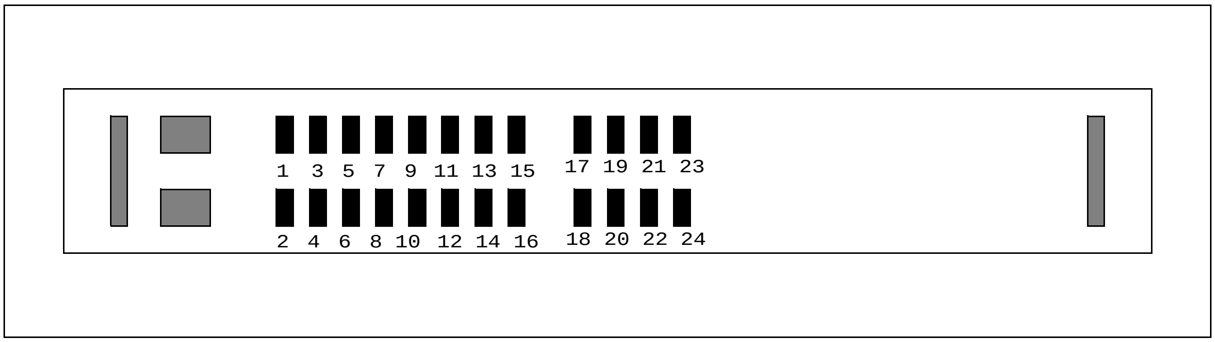


Table 4-AV: Ethernet Switch 470 Unit 0 Port Assignment

Port #	Application	
1	Connect to existing hub/switch (OAM&P VLAN)	
2	Interconnect to other Ethernet Switch Unit 1	
3	Connect to System Processor pack 0 ENET 0	
4	Not used	
5	Connect to PGI A, Controller 1 LAN 0	
6	Connect to PGI A, Controller 2 LAN 0	
7	Connect to PGI B, Controller 1 LAN 0	Optional
8	Connect to PGI B, Controller 2 LAN 0	
9	Connect to PGI C, Controller 1 LAN 0	Optional
10	Connect to PGI C, Controller 2 LAN 0	
11	Connect to PGI D, Controller 1 LAN 0	Optional
12	Connect to PGI D, Controller 2 LAN 0	
13	Connect to PGI E, Controller 1 LAN 0	Optional
14	Connect to PGI E, Controller 2 LAN 0	

Table 4-AV: Ethernet Switch 470 Unit 0 Port Assignment (Continued)

15	Connect to PGI F, Controller 1 LAN 0	Optional
16	Connect to PGI F, Controller 2 LAN 0	
17	Connect to PGI G, Controller 1 LAN 0	Optional
18	Connect to PGI G, Controller 2 LAN 0	
19	Connect to PGI H, Controller 1 LAN 0	Optional
20	Connect to PGI H, Controller 2 LAN 0	
21	Connect to PGI I, Controller 1 LAN 0	Optional
22	Connect to PGI I, Controller 2 LAN 0	
23	Connect to System Processor pack 1ENET 0	
24	Not used	

Note: The character "A" through "I" after "PGI" represents the PGI number 1 to 255.

Table 4-AW: Ethernet Switch 470 Unit 1 Port Assignment

Port #	Application	
1	Connect to existing ethernet switch (OAM&P VLAN) -or- Not assigned when a hub is used.	
2	Interconnect to other Ethernet Switch Unit 0	
3	Connect to System Processor pack 0 ENET 1	
4	Not used	
5	Connect to PGI A, Controller 1 LAN 1	
6	Connect to PGI A, Controller 2 LAN 1	
7	Connect to PGI B, Controller 1 LAN 1	Optional
8	Connect to PGI B, Controller 2 LAN 1	
9	Connect to PGI C, Controller 1 LAN 1	Optional
10	Connect to PGI C, Controller 2 LAN 1	
11	Connect to PGI D, Controller 1 LAN 1	Optional
12	Connect to PGI D, Controller 2 LAN 1	

Table 4-AW: Ethernet Switch 470 Unit 1 Port Assignment (Continued)

Port #	Application	
13	Connect to PGI E, Controller 1 LAN 1	Optional
14	Connect to PGI E, Controller 2 LAN 1	
15	Connect to PGI F, Controller 1 LAN 1	Optional
16	Connect to PGI F, Controller 2 LAN 1	
17	Connect to PGI G, Controller 1 LAN 1	Optional
18	Connect to PGI G, Controller 2 LAN 1	
19	Connect to PGI H, Controller 1 LAN 1	Optional
20	Connect to PGI H, Controller 2 LAN 1	
21	Connect to PGI I, Controller 1 LAN 1	Optional
22	Connect to PGI I, Controller 2 LAN 1	
23	Connect to System Processor pack 1ENET 1	
24	Not used	

PGI

Each PGI consists of two Packet Gateway Interface Controlers (PGIC). Two to sixteen PELPs are interfaced to each PGI. PGIs and their associated Ethernet Switches (ES) are provisioned in a ME bay and must be located within 38 feet of their associated DS30A packs.

Software Control

The Voice over IP (VoIP) Session Initiation Protocol (SIP) service will introduce a count of the maximum number of SIP subscriber line and trunk appearances that can be assigned on a per-office basis. Nortel will set the count when the service is purchased. Access to the data modification overlay prompting sequences required to provision SIP will be controlled by this count.

Configurable Hardware

Packet Gateway Interface (PGI) Provisioning

There are two steps to provisioning the PGI. Step one is to determine how many PGIs are required based upon expected traffic. Step 2 is to determine how many DS-30A loops are required for the PGI to support the expected traffic.

Determine Number of PGIs

The PGI has two resources that must be considered in determining the traffic carrying capacity: media portal channels and inter-working channels. A media portal channel is used to connect two VoIP endpoints. An inter-working channel is used to connect an IP endpoint to a traditional TDM endpoint. For purposes of this discussion, a VoIP endpoint is an IP line or trunk. A TDM endpoint is a legacy circuit on the DMS-10 such as an LCM line or a DSI trunk. The overall capacity of the PGI is 510 inter-working channels and 256 media portal channels. These limits are exclusive of one another and both pools of resources are available for simultaneous use.

When this resource limitation is expressed as traffic capacity at 0.1% blocking probability in the ErlangB model the following limits result:

Inter-working traffic limit = 458 equivalent bearer paths.

Media portal traffic limit = 218 equivalent brearer paths.

The PGI capacity is then 458 Erlang or 16488 Hundred Call Seconds (CCS) of inter-working traffic and 218 Erlang or 7848 CCS of media portal traffic.

Simplified Capacity Calculation (50% or greater inter-working)

The usual situation is that most of the VoIP traffic will be inter-working between a VoIP endpoint and a TDM endpoint. For this situation a simple and conservative method of calculating capacity is to simply ignore the media portal capacity and calculate for the inter-working limit. This method yields correct results for any traffic mixtures that consist of 50% or greater inter-working calls.

Using this method, the general formula for determining the number of PGIs required to service the VoIP lines and trunks in the office is given as follows:

L = average traffic load per VoIP line expressed in Erlangs

T = average traffic load per VoIP trunk expressed in Erlangs

The values for L and T depend upon subscriber calling patterns. These should be chosen by the traffic engineer at the telephone company. Some typical values may be:

L = 0.14 Erlangs (equivalent to 5 CCS)

T = 0.8 Erlangs (equivalent to 28.8 CCS)

Number of PGIs = ((VoIP lines * L) + (VoIP trunks * T)) / 458

The number of PGIs required is the number calculated above rounded up to the nearest integer value.

For a single PGI that is operating at greater than 50% inter-working, some allowable mixtures of lines and trunks at T=0.8 Erlang and L = 0.14 Erlang are given in table 4-AX.

Table 4-AX: Line and Trunk capacity mixtures for 50% or more inter-working

Trunks	Lines
0	3298
50	3010
100	2722
150	2434
200	2146
250	1858
300	1570
350	1282
400	994
450	706
500	418
550	130
572	0

Detailed Capacity Calculation (50% or less inter-working)

For situations where the VoIP traffic mixture will be comprised of less than 50% inter-working traffic a more detailed calculation must be made that considers the traffic mixture. This calculation method should only be used for situations where less than 50% of the VoIP traffic will consist of a VoIP endpoint connected to a TDM endpoint.

%iwl = percentage of inter-working line traffic. This is the percentage of traffic that a VoIP line generates where the other endpoint is a TDM line or trunk.

%iwt = percentage of inter-working trunk traffic. This is the percentage of traffic that a VoIP trunk generates where the other endpoint is a TDM line or trunk.

PGIs = ((VoIP lines * (1- %iwl) * L) + (VoIP trunks * (1 - %iwt) * T)) / 218

The number of PGIs required is the number calculated above rounded up to the nearest integer value.

The total traffic availability for a single PGI is given in table 2. This table represents the carrying capacity of the PGI for any mixture of inter-working traffic vs media portal traffic. The traffic must be divided between the expected trunk traffic and line traffic.

Table 4-AY: Traffic capacity for various inter-working mixtures

% I-W Traffic	Total Channels Avail	Total Erlangs Avail @ 0.1%	Recommended Traffic Capacity Erlangs
0%	256	218	218
10%	284	244	244
20%	320	277	277
30%	366	321	321
40%	427	379	379
50%	512	460	458
60%	640	582	458
70%	729	668	458
80%	638	580	458
90%	567	512	458
100%	510	458	458

For the circuit-to-packet gateway interface, a PGI must be connected to at least two DS-30A loops. The PGI can accomodate from two up to sixteen DS-30A loops, with two 'primary' loops carrying the DMSX signaling.

Cable Provisioning

For PGI, cable provisioning guidelines include:

- Two cables connecting the PGI with two DS-30A (NT4T04/NT8T04) are required. Each cable will connect from one to eight DS-30A loops.
- Six ethernet cables per PGI are required. Two cables connect the two PGI external WAN interfaces to the subscriber access WAN, and four cables connect the PGI internal LAN interfaces to the two Ethernet Switches, one cable from each PGI controller pack to one Ethernet Switch.

Calculating the number of DS-30A loops

This section may be used to calculate the number of DS-30A loops per PGI that are required to support a given number of gateway subscriber lines and trunks.

Assumptions:

The calculations in this section are based on the ErlangB model for the number of DS-30A channels per PGI, as shown in Table 4-AZ. This calculation is based on 0.1% blocking.

Table 4-AZ: Calculating CCS per loop

Number of DS-30A loops per PGI	Number of DS-30A channels	Total Erlangs	Erlangs per loop
n	**(n * 32) - 2**	**E**	**E / n**
2	62	42.4	21.2
4	126	98.3	24.6
6	190	156.4	26.1
8	254	215.6	27.0
10	318	275.6	27.6
12	382	335.9	28.0
14	446	396.7	28.3
16	510	457.7	28.6

Formula:

The number of loops for a given traffic load of lines and trunks can be calculated as follows:

L = average traffic load per VoIP line expressed in Erlangs

T = average traffic load per VoIP trunk expressed in Erlangs

The values for L and T depend upon subscriber calling patterns. These should be chosen by the traffic engineer at the telephone company. Some typical values may be:

L = 0.14 Erlangs (equivalent to 5 CCS)

T = 0.8 Erlangs (equivalent to 28.8 CCS)

%iwl = percentage of inter-working line traffic. This is the percentage of traffic that a VoIP line generates where the other endpoint is a TDM line or trunk. Nortel recommends that %iwl be set to 100% for this calculation. This is a conservative simplification of the formula that is generous in allocating capacity.

%iwt = percentage of inter-working trunk traffic. This is the percentage of traffic that a VoIP trunk generates where the other endpoint is a TDM line or trunk. Nortel recommends that %iwt be set to 100% for this calculation. This is a conservative simplification of the formula that is generous in allocating capacity.

Total IW traffic in Erlangs = (# lines * L * %iwl) + (#trunks * T * %iwt)

If multiple PGIs are required, they should be fully equipped with 16 DS30A loops each except for the last PGI which may be equipped by allocating loops to cover the remainder of: (Total IW traffic in Erlangs)/458. Table 4-AZ provides a range of values for the number of loops required for a single PGI at different IW traffic levels.

For a single PGI, the same method is used.

Total IW traffic in Erlangs = (# lines * L * %iwl) + (#trunks * T * %iwt)

Solve for the number of loops required by choosing the appropriate value from Table 4-AZ.

Table 4-BA summarizes the number of DS-30a peripheral loops, channel allocation, and LAN connections.

Table 4-BA: Packet Gateway Interface Summary

	PGI controller pack	1 PGI	2 PGIs	3 PGIs	4 PGIs
Number of PGI controller packs	1	2	4	6	8
Number of DS-30a peripheral loops	1 to 8	2 to 16	18 to 32	34 to 48	50 to 64
Number of signaling channels	1	2	4	6	8
Inter-working traffic capacity in Erlangs @0.1% blocking	217	458	950	1447	1947
Number of internal LAN connections	2	4	8	12	16
Number of external WAN connections	1	2	4	6	8

It may be noted that the traffic capacity does not progress in a purely linear relationship as PGIs are added. This is because of the increase in efficiency as resource groups become larger. However, this effect is not large and for estimation purposes, one may simply assume that every fully equipped PGI can carry 458 Erlangs of inter-working traffic. When more than 4 PGIs are to be assigned in a DMS-10 switch, then the items listed in Table 4-BA can be calculated as follows:

Let "n" be the number of PGIs to be assigned, then:

Number of PGI controller packs = 2 * n
Number of DS-30a peripheral loops = (2 * n) to (16 * n)
Number of signaling channels = 2 * n
Maximum number of bearer channels= 458 * n
Number of internal LAN connections= 4 * n
Number of external WAN connections= 2 * n

Gateways (GW)

Software will allow up to 30720 VoIP gateways to be provisioned. However, the actual number of lines that can be supported is dependant upon the switch’s call model. VoIP GWs do not increase the total line capacity of a DMS-10.

Gateway Lines (GWL)

Software will allow up to 2048 VoIP gateway lines to be provisioned per GW. However, the actual number of lines that can be supported is dependant upon the switch’s call model. VoIP GWLs do not increase the total line capacity of a DMS-10.

Section 5: Buffer allocation

Introduction

Buffers are areas of memory that are used to store information until it can be transmitted to another device. For example, Maintenance Teletype (MTTY) buffers queue output messages until they can be printed.

Some buffers can be increased or decreased in size, based on traffic requirements and other considerations. Other buffers, such as network input and output buffers, are fixed in size. This section focuses on buffers that can be changed and are traffic dependent. It explains what the buffers are used for, and provides instructions for calculating appropriate buffer sizes. The following types of buffers are addressed in this section:

- Call Registers (CR)
- Line Registers (LR)
- Billing Registers (BR)
- Maintenance Teletype buffers (MTTY)
- Emergency I/O buffers (EIOB)
- Digit buffers (DIGB)
- Data Link Controller Message buffers (MDLC)
- Automatic Message Accounting buffers (AMAB)
- Satellite Switching Office buffers (SSOB)
- ISDN Q.931 buffers (Q931)
- ISDN CPE buffers (CPEB)
- Small Feature buffers (SFTR)
- Large Feature buffers (LFTR)
- Extra Large Feature buffers (XFTR)

These buffers are assigned in Overlay CNFG (BUFF and AMA prompting sequences). Refer to the NTP entitled *Data Modification Manual* (297-3601-311).

Meridian Business Sets (MBS) impact on buffer allocation

Meridian Business Sets in a DMS-10 system increases traffic load on various system resources due to the higher traffic-per-line expected for MBS M5000-Series set lines and the introduction of new features. Call register and line register load increases because the MBS M5000-Series sets have a higher ccs/line than POTS lines. In addition, MBS M5000-Series sets can use multiple call registers simultaneously. Digit buffer load increases due to the MBS Voice Mail, calling card, and banking functions. Large and small feature buffer load increases due to the Call Park and Camp-On features, and due to the MBS M5000-Series set display.

ISDN and AIN impact on buffer allocation

ISDN B-channels in a DMS-10 system increase traffic load on various system resources due to the higher traffic-per-channel expected for ISDN. Call register load increases because the ISDN BRI and PRI B-channels have a higher ccs/channel than POTS lines. ISDN PRI ccs/B-channel is expected to be similar to ccs/trunk. Usage of multiple ISDN BRI B-channels also implies additional line register usage. B-channel usage may also affect feature buffers, and ISDN Q.931 buffers.

The percentage of billable calls may increase with the usage of AIN features. Digit buffer usage may also increase. Calling Name Delivery, AIN, and ISDN all affect feature buffer usage.

Wireless impact on buffer allocation

Wireless in a DMS-10 system may have a significant impact on traffic load on various system resources. Traffic per Wireless subscriber may differ significantly from ccs per POTS subscriber. In addition, billing register load may increase due to collection of air-time information for terminating and originating Wireless subscribers. Line register usage, large feature buffer usage, and extra-large feature buffer usage may increase due to hand-offs and NCAS messaging.

Call registers (CR)

Call registers store data associated with a call (for example, address information, dialed digits). One register is required for each call. Table 5-A contains the procedures used to calculate the number of call registers to allocate.

Table 5-A: Call Register calculation	
Step	**Procedure**
1	Calculate peak ratio: A = HDBH ccs / ABSBH ccs
2	Calculate total traffic: B = (ccs/trunk X number of trunks) + (3 X number of MBS subscribers X ccs/MBS subscriber) + (number of Wireless subscribers X ccs/Wireless subscriber) + (number of POTS subscribers X ccs/POTS subscriber) + (3 X number of ISDN BRI lines X ccs/ISDN BRI line) + (number of ISDN PRI B-channels X ccs/ISDN PRI B-channel) + (number of SIP subscribers X ccs/SIP subscriber) where: ccs/ISDN BRI line = 1st B-channel ccs + 2nd B-channel ccs 3 = assumed number of DN/special function keys
3	Calculate the number of Call Registers: C = ((A X 0.62 X B X (1 + hand-offs/call)) / 34.4) + 30 If Wireless is not configured, then number of hand-offs/call = 0

Line registers (LR)

Line registers store information associated with a particular peripheral circuit (for example, talking, ringing, or dialing status). One line register is required per active peripheral circuit. Table 5-B contains the procedures used to calculate the number of line registers to allocate.

Table 5-B: Line Register calculation	
Step	**Procedure**
1	Calculate Peak Ratio: A = HDBH ccs / ABSBH ccs
2	Calculate the number of line registers: LR = [A X [(3 X number of MBS subscribers X ccs/MBS subscriber) + (1.25 X number of Wireless subscribers X ccs/Wireless subscriber) + (number of POTS subscribers X ccs/POTS subscriber) + (3 X number of ISDN BRI lines X ccs/ISDN BRI line) + (number of SIP subscribers X ccs/SIP subscriber)] X [1+ hand-offs/call] / 34.4] + 40 where 3 = assumed number of DN/special function keys If Wireless is not configured, then number of hand-offs/call = 0

Billing registers (BR)

Billing registers store billing information for chargeable calls. The following formula is used to calculate the number of billing registers required:

BR = (1.1 X number of bills per call X number of call registers X 2.6) + 10

Maintenance teletype buffers (MTTY)

Maintenance teletype buffers queue teletype (TTY) output messages. Under normal operating conditions, the TTY output system can keep up with the output requirements of the switch, but external events can occur which will cause the switch to generate output messages faster than the physical output devices can process the data. When this occurs, the MTTY buffers are used to store the output messages until the physical output devices can accept the data.

If the buffers are overrun, the message sequence numbers will not be in sequence and some messages will end in four periods (. . . .). Each line of TTY output requires approximately 1.5 MTTY buffers. Each printed page (66 lines) of buffered output requires approximately 100 MTTY buffers.

Note: *The recommended MTTY allocation is 500.*

Emergency I/O buffers (EIOB)

Emergency I/O buffers are reserved so that operating company personnel can communicate with the DMS-10 switch when a system overload or emergency leaves no available MTTY buffers. Although two hundred buffers is the system default allocation, the number of these buffers can be increased up to a maximum of 500.

Digit buffers (DIGB)

Digit buffers store the digits required for end-to-end signaling, call forwarding, and for local calls placed using the coin overtime and hotel/motel features. The required number of buffers is computed by determining the number of call ccs that will be used. This number and the desired blocking factor is then used with an Erlang B table to compute the DIGB number. Table 5-C lists the functions that use digit buffers, typical holding times, and the nominal percentages of calls. Table 5-D contains the procedures used to calculate the number of digit buffers to allocate.

Table 5-C:
Digit Buffer functions

Function	Buffer Holding Time (in seconds)	Percent of Calls
Activate Call Forwarding (CFW)	120	2.5
Don't Answer Transfer	15	2.5
Automatic Number Identification (ANI)	2	5.0
Traffic Separation Measurement System (TSMS) Buffer	10	100

Table 5-C: (Continued) Digit Buffer functions		
Function	**Buffer Holding Time (in seconds)**	**Percent of Calls**
Local Coin Overtime	420	0.5
Remote Register	360	5.0
Voice Mail (due to MBS)	6.5	8.0
Calling Card (due to MBS)	6.5	0.8
Banking (due to MBS)	6.5	0.8
Advanced Intelligent Network (AIN) Announcement	75	5.0

Table 5-D: Digit Buffer calculation	
Step	**Procedure**
1	Calculate peak ratio: A = HDBH ccs / ABSBH ccs
2	Calculate total traffic: B = (ccs/trunk X number of trunks) + (3 X number of MBS subscribers X ccs/MBS subscriber) + (number of Wireless subscribers X ccs/Wireless subscriber) + (number of POTS subscribers X ccs/POTS subscriber) + (3 X number of ISDN BRI lines X ccs/ISDN BRI line) + (number of ISDN PRI B-channels X ccs/ISDN PRI B-channel) + (number of SIP subscribers X ccs/SIP subscriber) where: ccs/ISDN BRI line = 1st B-channel ccs + 2nd B-channel ccs 3 = assumed number of DN/special function keys
3	Calculate the number of calls in 1 second: C = A X 0.5 X B / (36 X sec call holding time)
4	Calculate buffer load for each function shown in Table 5-C: B = A X (% calls / 100) X buffer holding time in seconds ***Note:*** Use the values in Table 5-C if the percentage of calls and buffer holding time values cannot be obtained from traffic information from the office.
5	Calculate total buffer load: Total buffer load = sum of B for each function used
6	Determine the DIGB buffer size. Consult Table 5-F to find the erlang load and the corresponding buffer size. If the exact load does not appear in the table, use the next-highest increment that is closest to it.

Data Link Controller message buffers (MDLC)

Data Link Controller message buffers are used in the cluster configuration to queue messages between the link transport functions in the host or Satellite Switching Office (SSO) and the following applications: billing; alarm/maintenance; satellite access functions; and operational measurements (OPMs). The host may be a Host Switching Office (HSO) or a Large Cluster Controller (LCC). The queue allows processing and formatting of data concurrently with data transmission.

The MDLC size is 300 for SSO, HSO, and LCC applications and 0 for standalone applications. The MDLC size can be adjusted up to a maximum of 500.

Automatic Message Accounting buffers (AMAB)

Automatic Message Accounting buffers are host (HSO or LCC) buffers that queue formatted SSO billing registers awaiting output to the Automatic Message Accounting (AMA) device. The buffers are divided equally among the SSOs.

When an SSO's AMA process has transmitted the flow-controlled number of messages to the host, it stops transmitting messages until the host indicates the buffers have been emptied. When this notification is received, more AMA messages will be transmitted to the host by the SSO's AMA application.

The number of AMAB for HSO and LCC applications is equal to the number of SSOs X 25, with a minimum of 50. The number of AMAB for SSO and standalone applications is 0. The number of AMAB can be adjusted up to a maximum of 500.

Satellite Switching Office buffers (SSOB)

Satellite Switching Office buffers are used in the host (HSO or LCC) for holding SSO output. The output is generated in the SSOs for output on the host's teletype input/output (TTY I/O) devices by the Line Insulation Test (LIT), operational measurement (OPM) and satellite access function applications.

When an application has transmitted the flow-controlled number of messages, it stops transmitting messages until the host sends a message to the SSO that indicates the buffers have been emptied. When this notification is received, more messages will be transmitted by the SSO applications to the host. This affects cluster operation by introducing application output delays.

The number of SSOB for HSO and LCC applications is 300. The number of SSOB for SSO and standalone applications is 0. The number of SSOB can be adjusted up to a maximum of 500.

ISDN Q.931 buffers (Q931)

One buffer is allocated for each end of an ISDN call that requires an ISDN user terminal. The buffer, which is held for the call duration, facilitates the terminal Q.931 protocol control. The buffer equation assumes an average of three simultaneous calls for each B-channel on 25% of the lines, and one call for each B-channel on the remaining 75% of the lines. Table 5-E contains the procedure used to calculate the required number of ISDN Q.931 buffers. The minimum number of Q.931 buffers is 100 for offices with 5000 or fewer lines.

Table 5-E:
ISDN Q.931 buffer allocation

Step	Procedure
1	A = peak ratio (HDBH ccs / ABSBH ccs) B = number of ISDN BRI lines C = ccs for each ISDN BRI line: 1st B-channel ccs + 2nd B-channel ccs D = number of Wireless lines E = ccs for each Wireless line F = number of ISDN PRI B-channels G = ccs per ISDN PRI B-channel
2	Calculate the erlang load due to ISDN Q.931 buffers: A X [(1.5 X B X C) + (D X E) + (F X G)] / 36
3	Determine the buffer size by finding the erlang load size in table 5-F and using the buffer size that corresponds with the load. If the exact load size does not appear in the table, use the next highest increment, closest to the actual load.

ISDN CPE buffers (CPEB)

One buffer is allocated for every download request initiated by a subscriber ISDN terminal. Only one buffer, which is held for the download duration, can occur for an ISDN line drawer at a time, therefore the number of CPE (customer premise equipment) downloads is equal to the number of ISDN line drawers. If no ISDN BRI lines are equipped, the number of buffers is 0. Otherwise, in the DMS-10 Classic network configuration, 20 is the number of buffers recommended for a two-shelf network and 40 is the number of buffers recommended for a four-shelf network. In the DMS-10EN, 40 is the number of buffers that is recommended.

Small Feature buffers (SFTR)

Small feature buffers (SFTR) are general use buffers. The buffer sizes are determined based on the estimates of all features using the feature buffers. The minimum number of feature buffers is 700 for offices with 5000 or fewer lines.

The following formulas are used to calculate the SFTR load size for the Ring Again, Virtual Facilities Group Controls, Call Park, CLASS, and AIN features, and also for the MBS 5000-Series set display. After calculating the sum erlang load size of all appropriate SFTR features, refer to the Feature Buffer Table, table 5-F, to determine the total SFTR buffer size.

SFTR load for Ring Again (RAG):

Refer to the LFTR load for RAG calculation. The SFTR load for RAG = 3/2 X LFTR load for RAG

Virtual Facilities Group Controls (VFGC):

SFTR load for VFGC = 0 (not used).

Call Park:

Load for Call Park = ((A * B * C * D * E * F * G) / 36)

where:

A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of EBS lines with Call Park
C = Traffic per EBS line (or ccs per line) (assume 2 * ABSBH)
D = Ratio: (Incoming EBS traffic + Outgoing EBS traffic) / (Incoming EBS traffic + Outgoing EBS traffic + Intra-group EBS traffic) (assume 0.5)
E = Probability of using Call Park when configured (assume 0.13)
F = Duration of park request as a fraction of average holding time (assume 2.3)
G = Number of large feature buffers used per call (assume 1)

CLASS features:

SFTR load for CLASS = 0 (not used).

Calling Name Delivery (CNAM)

DMS-10 supports two types of implementation for calling name delivery (CNAM), one for the United States of America (USA) and one for Canada. Each implementation is explained and the appropriate calculations provided.

In the USA, when the terminating line has CNAM, a small feature buffer is obtained for intra-office calls; and for either ISUP or non-ISUP trunks, all calls incoming on a trunk and terminating on a line and all trunk-to-line calls. The buffer is obtained on the terminating side.

The USA SFTR CNAM buffer load, in erlangs, is calculated as the sum of two formulas. The first formula is for non-MADN (NM) calls and the second formula is for MADN calls (M):

$$(0.5 * A * B * C * (D / E) / 36) \quad \underline{NM}$$
$$+$$
$$(0.5 * A * F * G / 36) \quad \underline{M}$$

USA CNAM SFTR load

where:

A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of non-MADN group lines configured with CNAM
C = ABSBH ccs per non-MADN group line
D = 20 second buffer holding time
E = Call holding time (seconds)
F = Number of MADN groups configured with the CNAM
G = ABSBH ccs per MADN group

In Canada, a small feature buffer is obtained for most calls including intra-office calls where the terminating line has CNAM, all ISUP calls incoming on a trunk and terminating on a line, all trunk-to-line ISUP calls, all ISUP calls originating on a line and outgoing on a trunk, all line-to-trunk ISUP calls, and tandem ISUP calls. The buffer is obtained on the originating or incoming side.

The Canadian SFTR CNAM buffer load, in erlangs is calculated as the sum of two formulas. The first formula is for non-MADN (NM) calls and the second formula is for MADN calls (M):

$$0.5 * A * (B * C * + (H * I + J * K) * (B * C / (B * C + F * G))) * (D / E) / 36 \quad \underline{NM}$$
$$+$$
$$0.5 * A * (F * G + (H * I + J * K) * (F * G / (B * C + F * G))) / 36 \quad \underline{M}$$

Canadian CNAM SFTR load

where:

A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of non-MADN group lines
C = ABSBH ccs per non-MADN group line
D = 20 second buffer holding time
E = Call holding time (seconds)
F = Number of MADN groups
G = ABSBH ccs per MADN group
H = Number of trunks
I = ABSBH ccs per trunk

J = Number of ISDN PRI B-channels
K = ABSBH ccs per ISDN PRI B-channel

MBS 5000-Series set display:

Load for MBS 5000-Series set display = ((A * B * C * D * E) / 36)

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of MBS M5000-Series set lines
C = Traffic (ccs) per line (assume 2 * ABSBH)
D = Number of simultaneously-active DN/special function keys (assume 3)
E = Duration of request as a fraction of average holding time (assume 1)

Calculate SFTR size:

Calculate the total SFTR erlang load as:

SFTR = (A + B + C + D + E + F)

where:
A = RAG SFTR load
B = VFGC SFTR load
C = Call Park SFTR load
D = CLASS SFTR load
E = CNAM SFTR load
F = MBS 5000-Series set display SFTR load

Determine the SFTR buffer size by finding the erlang load size in table 5-F and using the buffer size that corresponds with the total load. If the exact load size does not appear in the table, use the next highest increment, closest to the actual load.

Note: *If a buffer allocation already exists, after determining a new buffer size from table 5-F, use whichever buffer size is larger.*

Large feature buffers (LFTR)

Large feature buffers (LFTR) are general use buffers for DMS-10 switch call processing features. The buffer sizes are determined based on the estimates of all features using the feature buffers. The minimum number of feature buffers is 400 for offices with 5000 or fewer lines.

The following formulas are used to calculate LFTR load size for the Ring Again, Virtual Facilities Group Controls, Call Park, CLASS, Wireless features, and for the MBS 5000-Series set display and AIN TCAP and LNP TCAP buffers. After calculating the sum erlang load size of all appropriate LFTR features, refer to the Feature Buffer Table, table 5-F, to determine the total LFTR buffer size.

Ring Again (RAG):

LFTR load for RAG = ((A * B * C * D * E * F * G) / 36)

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of lines configured with RAG
C = Traffic per line (or ccs per line) with RAG (assume 2 * ABSBH value)
D = Ratio: Originating line traffic / Total line traffic (assume 0.5)
E = Probability of using RAG when configured (assume 0.15)
F = Duration of the RAG request as a fraction of average holding time (assume 1)
G = Number of buffers per call (assume 2)
36 = Number of ccs per erlang.

Virtual Facilities Group Controls (VFGC):

Load for VFGC = ((A * B * C * D * E) / 36)

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of EBS lines that are affected by VFGC
C = Average number of VFGC legs per VFGC call (use 1.1 if this information is not available)
D = Traffic per EBS line (or ccs per line) (assume 2 * ABSBH)
E = Ratio: (Incoming EBS traffic + Outgoing EBS traffic) / (Incoming EBS traffic + Outgoing EBS traffic + Intra-group EBS traffic) (assume 0.5)
36 = Number of ccs per erlang.

Call Park:

Refer to the SFTR Call Park calculation. The LFTR calculation is identical to the SFTR calculation.

CLASS features:

Automatic Callback (ACB), Automatic Recall (AR), and Screening List Editing (SLE), figured separately for each feature:

LFTR = ((A * B * C * D * E * F * G) / 36)

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of lines configured with feature
C = Traffic (ccs) per line configured with feature (assume 1.8 * ABSBH for ACB and SLE; assume 1.55 * ABSBH for AR)
D = Ratio of originating to total line traffic

(assume 0.5)
E = Probability of using feature when configured (assume 0.15 for ACB, 0.13 for AR, 0.01 for SLE)
F = Duration of request/session as a fraction of average holding time (assume 3 for ACB and AR, and 1 for SLE)
G = Number of large feature buffers used per call (assume 2)
36 = Number of ccs per erlang.

Load for Class = Load for ACB + Load for AR + Load for SLE

MBS 5000-Series set display:

LFTR load for MBS 5000-Series set display = 0 (not used).

AIN TCAP:

Each AIN call uses an AIN TCAP buffer starting from the time the AIN query message is sent, including play and collect session durations, until the response is received.

Load for AIN TCAP = 0.5 * A * ((B * C + D * E + F * G) / 36) * H * (I + J * K) / L

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of lines
C = Number of ccs per line
D = Number of trunks
E = Number of ccs per trunk
F = Number of ISDN PRI B-channels
G = Number of ccs per ISDN PRI B-channel
36 = Number of ccs per erlang
H = Ratio: AIN subscribers / Total subscribers
I = Buffer holding time for query and response (assumes 5 seconds)
J = Ratio: AIN play and collect sessions / Total AIN calls
K = Buffer holding time for play and collect sessions (assumes 70 seconds)
L = Call holding time (seconds)

LNP TCAP:

Each LNP call uses an LNP TCAP buffer starting from the time the AIN query message is sent until the response is received.

Load for LNP TCAP = 0.5 * A * ((B * C + D * E + F * G) / 36) * H * I / J

where: A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of lines
C = Number of ccs per line
D = Number of trunks
E = Number of ccs per trunk
F = Number of ISDN PRI B-channels
G = Number of ccs per ISDN PRI B-channel
36 = Number of ccs per erlang
H = Ratio: LNP query calls / Total calls
I = Buffer holding time (assumes 5 seconds)
J = Call holding time (seconds)

Wireless:

Each Wireless call hand-off uses a large feature buffer during the period that the hand-off is in progress.

LFTR load for Wireless call hand-offs = A * ((B * C) / 36) * D * E / F

where: A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of Wireless subscribers
C = Number of ccs per Wireless subscriber
36 = Number of ccs per erlang
D = Number of hand-offs per Wireless call
E = Buffer holding time (assume 7 seconds)
F = Wireless call holding time (seconds)

Calculate LFTR size:

Calculate the total LFTR erlang load as:

LFTR load = (A + B + C + D + E + F + G + H)

where: A = RAG LFTR load
B = VFGC LFTR load
C = Call Park LFTR load
D = CLASS LFTR load
E = MBS 5000-Series set display LFTR load
F = AIN TCAP LFTR load
G = LNP TCAP LFTR load
H = Wireless Call hand-off LFTR load

Determine the LFTR buffer size by finding the erlang load size in table 5-F and using the buffer size that corresponds with the total load. If the exact load size does not appear in the table, use the next highest increment, closest to the actual load.

Note 1: If a buffer allocation already exists, after determining a new buffer size from table 5-F, use whichever buffer size is larger.

Note 2: If VFGC has the LCE Line Card Monitor feature installed, add 200 to the buffer size obtained from table 5-F.

Extra large feature buffers (XFTR)

Extra large feature buffers (XFTR) are general use buffers for DMS-10 switch call processing features. The buffer sizes are determined based on the estimates of all features using the feature buffers. The minimum number of feature buffers is 200 for offices with 5000 or fewer lines.

The following formulas are used to calculate the XFTR load size for the ISUP auxiliary, AIN registers, AIN LNP registers, AIN display text, ISDN display text, ISDN transport feature, and Wireless feature. After calculating the sum load size of all appropriate XFTR features, refer to the Feature Buffer Table, table 5-F, to determine the total XFTR buffer size.

ISUP auxiliary buffers:

The DMS-10 switch uses ISUP Auxiliary Buffers to store the Initial Address Message (IAM) and Release Message (REL) for offices that handle tandem traffic with CCS7 on incoming and outgoing trunks. These messages are stored in case they must be retransmitted due to a failure condition.

Load for ISUP auxiliary buffers = 0.5 * A * [(B * C + D * E) / 36] * F * G * H / I

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of trunks
C = Number of ccs per trunk
D = Number of ISDN PRI B-channels
E = Number of ccs per ISDN PRI B-channel
36 = Number of ccs per erlang
F = Ratio: Tandem trunk load / Total trunk load
G = Number of buffers per call (assume 2 buffers)
H = Buffer holding time (assume 15 seconds)
I = Call holding time (seconds)

AIN registers:

Every call with AIN features uses an AIN register from the time at which an AIN trigger launches a database query until the call is answered or abandoned.

Load for AIN registers = 0.5 * A * ((B * C + D * E + F * G) / 36) * H * I * J / K

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of lines
C = Number of ccs per line
D = Number of trunks

E = Number of ccs per trunk
F = Number of ISDN PRI B-channels
G = Number of ccs per ISDN PRI B-channel

36=Number of ccs per erlang
H=Ratio: AIN query calls / Total calls
I=Number of AIN triggers per call (assume 1.25 triggers)
J=Buffer holding time (assume 23 seconds)
K=Call holding time (seconds)

AIN LNP registers:

Every LNP call uses an AIN LNP register from the time at which an AIN trigger launches a database query until the call is answered or abandoned.

Load for AIN LNP registers = 0.5 * A * ((B * C + D * E + F * G) / 36) * H * I / J

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of lines
C = Number of ccs per line
D = Number of trunks
E = Number of ccs per trunk
F = Number of ISDN PRI B-channels
G = Number of ccs per ISDN PRI B-channel
36 = Number of ccs per erlang
H = Ratio: LNP query calls / Total calls
I = Buffer holding time (assume 23 seconds)
J = Call holding time (seconds)

AIN display text:

Display text buffers are used by AIN calls that require called party text displays. The buffer is held from the authorize termination response message receipt until the text is displayed.

Load for AIN display text = A * B * (C / 36) * D * E * F / G

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of lines using AIN display text (configure with TA option)
C = Number of ccs per line
36 = Number of ccs per erlang
D = Ratio: Terminating traffic / Total traffic (assume 0.5)
E = AIN display text probability (if configured)
F = Buffer holding time (assume 5 seconds)
G = Call holding time (seconds)

ISDN display text:

Display text buffers are used by each end of an ISDN call that requires ISDN subscriber terminal text display. The buffer is held from the time of the first display until call release.

Load for ISDN display text = 1.5 * A * B * (C / 36) * D

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of ISDN lines
C = Number of ccs per ISDN line
36 = Number of ccs per erlang
D = Ratio: ISDN display text buffer calls / Total ISDN calls

ISDN transport feature:

ISDN calls sometimes use transport feature buffers to hold specific informational parameters during call set-up. These buffers may also be used again during call clearing.

Load for ISDN transport feature = A * {[(1.5 * B * C + D * E) / 36] / (1 + F)} * G * H / I

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of ISDN lines
C = Number of ccs per ISDN line
D = Number of ISDN PRI B-channels
E = Number of ccs per ISDN PRI B-channel
36 = Number of ccs per erlang
F = Ratio: ISDN intra-office calls / Total calls
G = Ratio: ISDN transport feature buffer calls / Total ISDN calls
H = Buffer holding time (assume 28 seconds)
I = ISDN call holding time (seconds)

Wireless NCAS:

When NCAS is configured, each incoming NCAS message received from TCAP uses extra-large feature buffers.

The LFTR load for Wireless NCAS = A * ((B * C) / 36) * (1 + D) * 1.1 * E * F * G / H

where:
A = Peak Ratio (HDBH ccs / ABSBH ccs)
B = Number of Wireless subscribers
C = Number of ccs per Wireless subscriber
36 = Number of ccs per erlang
D = Number of hand-offs per Wireless call
E = Ratio: Terminating calls / Total calls (assume 0.5)
F = Number of buffers used per terminating call (assume 1)

G = Buffer holding time (assume 0.5 seconds)
H = Wireless call holding time (seconds)

Calculate XFTR size:

Calculate the total XFTR erlang load as:

XFTR load = (A + B + C + D + E + F + G)

where: A = ISUP auxiliary XFTR load
B = AIN register XFTR load
C = AIN LNP register XFTR load
D = AIN display text XFTR load
E = ISDN display text XFTR load
F = ISDN transport feature XFTR load
G = Wireless NCAS XFTR load

Determine the XFTR buffer size by finding the load size in table 5-F and using the buffer size that corresponds with the total load. If the exact load size does not appear in the table, use the next highest increment, closest to the actual load.

> ***Note:*** *If a buffer allocation already exists, after determining a new buffer size from table 5-F, use whichever buffer size is larger.*

Table 5-F:
Provisioning of Feature buffers, Digit buffers, and ISDN Q.931 buffers

Erlang load	Buffers Required
32.51	50
75.24	100
119.94	150
165.62	200
211.92	250
258.64	300
305.69	350
352.99	400
400.49	450
448.16	500
495.96	550
543.89	600
591.93	650
640.06	700
688.27	750
736.56	800

Table 5-F: (Continued)
Provisioning of Feature buffers, Digit buffers, and ISDN Q.931 buffers

Erlang load	Buffers Required
784.91	850
833.33	900
881.80	950
930.32	1000
978.89	1050
1027.50	1100
1076.15	1150
1124.84	1200
1173.57	1250
1222.32	1300
1271.11	1350
1319.93	1400
1368.78	1450
1417.65	1500
1466.54	1550
1515.46	1600
1564.40	1650
1613.36	1700
1662.35	1750
1711.35	1800
1760.37	1850
1809.41	1900
1858.46	1950
1907.53	2000
1956.62	2050
2005.72	2100
2054.83	2150
2103.96	2200
2153.10	2250
2202.26	2300
2251.43	2350
2300.61	2400
2349.80	2450
2399.00	2500
2448.21	2550
2497.44	2600

Table 5-F: (Continued)
Provisioning of Feature buffers, Digit buffers, and ISDN Q.931 buffers

Erlang load	Buffers Required
2546.67	2650
2595.92	2700
2645.17	2750
2694.43	2800
2743.70	2850
2792.99	2900
2842.28	2950
2891.57	3000
2940.88	3050
2990.19	3100
3039.51	3150
3088.84	3200
3138.18	3250
3187.52	3300
3236.87	3350
3286.23	3400
3335.59	3450
3384.96	3500
3434.34	3550
3483.72	3600
3533.11	3650
3582.50	3700
3631.90	3750
3681.31	3800
3730.72	3850
3780.14	3900
3829.56	3950
3878.99	4000
3928.42	4050
3977.86	4100
4027.30	4150
4076.75	4200
4126.20	4250
4175.66	4300
4225.12	4350
4274.58	4400

Table 5-F: (Continued)
Provisioning of Feature buffers, Digit buffers, and ISDN Q.931 buffers

Erlang load	Buffers Required
4324.05	4450
4373.53	4500
4423.01	4550
4472.49	4600
4521.98	4650
4571.47	4700
4620.96	4750
4670.46	4800
4719.96	4850
4769.47	4900
4818.98	4950
4868.49	5000

Section 6: Advanced Intelligent Network Engineering

Introduction

Advanced Intelligent Network (AIN) comprises several network elements that interact with switching systems to allow services to be defined outside of the internal call processing logic of the switching systems. With AIN feature development tools, the operating company can design and deploy features to its own specifications and make these features available across private and public networks. New subscriber features can be developed and implemented on the network without major disruption to current software loads of the individual network members.

AIN features enhance switch call processing logic capabilities to recognize calls that require additional processing and to query an application Service Control Point (SCP). Service logic programs at the SCP determine how AIN calls should proceed for further call processing. Queries and responses between offices equipped with AIN features and the SCP use Common Channel Signaling No.7 protocol.

Grade-of-service impact

The DMS-10 switch is designed to meet accepted North American standards for grade-of-service. The following measurements can be affected by the introduction of AIN:

- The average call set up time (measured to the point at which the caller receives ringback tone) may increase slightly. This value can be affected by the number of times that a trigger is activated during a call and the time taken for SCP response messages to be received following a TCAP query.
- The percentage of calls completing (measured to the point at which the caller receives ringback tone) may decrease slightly. This value can be affected by the number of AIN call failures (calls routed to AIN final treatment).
- The percentage of originating calls that do not receive dial tone within three seconds, can be affected if a sufficient number of Digitone Receivers (NT2T11) are not provisioned in the switch.

It is important to note that these measurements are affected by the network response time, which is outside of DMS-10 switch control.

Real-time capacity

The real-time impact of AIN depends on the number of triggers per call and the real-time required by the processor to completely process a trigger. See the “System Capacity” section of this NTP for a discussion of calculations required.

CCS7 Link Provisioning and Message Capacity

The number of signaling links required by an office is calculated from the number of ISUP and TCAP messages per second, which is affected by the introduction of AIN services. In addition, Level 3 message capacity of the SSP must be evaluated.

DMS-10 SSP link provisioning

The procedure used to determine the number of signaling links required is shown in Table 6-A. Additional information is found in Section 4, “Provisioning rules and methods.”

DMS-10 STP link provisioning

The total number of signaling links in a DMS-10 STP is the sum of the number of links from each SSP (as calculated using Table 6-A) plus two links (to accommodate C-links between mated STPs), plus the total number of links to the CCS7 network.

Since the DMS-10 STP also acts as an SSP, its links must also be engineered to accommodate AIN TCAP messages. If the AIN applications reside at a remote SCP in the CCS7 network, then the STP-to-CCS7 network links must be engineered to accommodate this extra traffic. If the SCP is connected directly to the DMS-10 switch (that is, serving the local network), then the DMS-10 STP should be equipped with at least two diversely-routed signaling links to the SCP. Mated pairs of SCP units may be installed for increased performance and reliability.

Table 6-A: DMS-10 with SSP Link Provisioning Calculation	
Step	**Procedure**
1	Calculate peak ratio: A = HDBH ccs / ABSBH ccs For example, A = 1.3
2	Calculate total traffic: B = (ccs/trunk X #trunks) + (3 X #MBS subscribers X ccs/MBS subscriber) + (#Wireless subscribers X ccs/Wireless subscriber) + (#POTS subscribers X ccs/POTS subscriber) + (3 X #ISDN BRI lines X ccs/ISDN BRI line) + (#ISDN PRI B-channels X ccs/ISDN PRI B-channel) where: ccs/ISDN BRI line = 1st B-channel ccs + 2nd B-channel ccs 3 = assumed number of DN/special function keys For example, # trunks = 500 #MBS subscribers = 500 #Wireless subscribers = 0 #POTS subscribers = 4250 #ISDN BRI lines = 250 #ISDN PRI B-channels = 0 ccs/trunk = 25.2 ccs/MBS subscriber = 7.2 ccs/Wireless subscriber = 3.6 ccs/POTS subscriber = 3.6 ccs/ISDN BRI line = 20.0 ccs/ISDN PRI B-channel = 25.2 B = 53,700 ccs
3	Calculate the number of calls in 1 second: C = A X 0.5 X B / (36 X sec call holding time) For example, sec call holding time = 180 C = 5.4 calls/sec

Table 6-A: (Continued)
DMS-10 with SSP Link Provisioning Calculation

Step	Procedure
4	Calculate the number of SSP-to-STP ISUP messages (25 octets long) per second for an SSP: D = C X (1 + number of hand-offs/call) X [6 messages/call X (ratio of originating/outgoing ISUP + ratio of incoming/terminating ISUP) + 12 messages/call X ratio of incoming/outgoing ISUP] where: If Wireless is not configured, number of hand-offs/call = 0; otherwise number of hand-offs/call = 0.05 For example, ratio of originating/outgoing ISUP = 0.25 ratio of incoming/terminating ISUP = 0.25 ratio of incoming/outgoing ISUP = 0.00 D = 16.2 ISUP messages/sec (25-octet)
5	Calculate the number of SSP-to-STP TCAP messages (80 octets long) per second for an SSP: E = C X (1 + number of hand-offs/call) X [2 messages/call X (ratio of E800 calls + ratio of LDBS calls + ratio of AR calls + ratio of CNAM calls) + 12 messages/call X (ratio of ACB calls + ratio of SLE calls) + number of NCAS messages/call X 1.1] where: If Wireless is not configured, number of hand-offs/call = 0; otherwise number of hand-offs/call = 0.05 If Wireless NCAS is not configured, number of NCAS messages/call = 0; otherwise number of NCAS messages/call = 16 For example, ratio of E800 calls = 0.25 ratio of LDBS calls = 0.00 ratio of AR calls = 0.01 ratio of CNAM calls = 0.20 ratio of ACB calls = 0.01 ratio of SLE calls = 0.01 (Does not include SimRing) E = 6.3 TCAP messages/sec (80-octet)

Table 6-A: (Continued) DMS-10 with SSP Link Provisioning Calculation	
Step	**Procedure**
6	Calculate the number of SSP-to-STP TCAP messages (100 octets long) per second for an SSP: F = C X (1 + number of hand-offs/call) X [2 messages/trigger X (ratio of LNP calls X number of triggers/LNP call + ratio of AIN calls X number of triggers/AIN call)] where: If Wireless is not configured, number of hand-offs/call = 0; otherwise number of hand-offs/call = 0.05 All Wireless calls are AIN calls For example, ratio of LNP calls = 0.10 ratio of AIN calls = 0.05 number of triggers/LNP call = 1 number of triggers/AIN call = 1.5 F = 1.9 TCAP messages/sec (100-octet)
7	Determine the number of required link pairs, if link speed is less than 56 kbps: 0.5 x [# 25-octet messages per second x 25) + (# 80-octet messages per second x 80) +(# 100-octet messages per second x 100)] /engineered capacity from Table 4-AG Determine the number of required link pairs, if link speed is 56 kbps: (0.5 x # messages per second) / [(ratio of 25-octet messages per second x 80) +(ratio of 80-octet messages per second x 68) + (ratio of 100-octet messages per second x 55)] ***Note:*** *The denominator of the 56 kbps equation is a weighted average of the engineered capacities shown in Table 4-AG that have been converted from octets/sec into messages/sec (see Section 4, “Provisioning rules and methods”).* For example, Determine the number of 4.8 kbps link pairs required: 0.5 X (D X 25 + E X 80 + F X 100) / 460 = 1.19, thus, two 4.8 kbps link pairs are required. (One link pair of speed 9.6 kbps or higher could be provisioned instead.)

Table 6-A: (Continued) DMS-10 with SSP Link Provisioning Calculation	
Step	**Procedure**
8	Determine whether Level 3 message capacity of the SSP is exceeded: # messages per second / [(ratio of 25-octet messages per second x 221) + (ratio of 80-octet messages per second x 221) + (ratio of 100-octet messages per second x 167)] ***Note 1:*** If the calculated value is greater than 1, Level 3 message capacity of the SSP has been exceeded and message traffic must be reduced. ***Note 2:*** The denominators are a weighted average of the engineered capacities shown in Table 4-AH (see Section 4, “Provisioning rules and methods”). For example, Number of messages per second = D + E + F = 16.2 + 6.3 + 1.9 = 24.4 messages/sec Ratio of 25-octet messages/sec = 16.2 / 24.4 = 0.66 Ratio of 80-octet messages/sec = 6.3 / 24.4 + 0.26 Ratio of 100-octet messages/sec = 1.9 / 24.4 = 0.08 Determine whether the Level 3 message capacity of the SSP is exceeded: 24.4 messages/sec / [(0.66 X 221) + (0.26 X 221) + (0.08 X 167)] = 0.113 < 1, thus, Level 3 message capacity of the SSP is not exceeded.

AIN buffer engineering

AIN uses both large feature buffers and digit buffers. Information concerning large feature buffers and digit buffers is found in Section 5, “Buffer Allocation.”

Section 7: ISDN U-loop engineering

Introduction

In the ISDN network, the service connection to the ISDN central office (CO) is referred to as the U-loop. This 2-wire access loop connects the NT1 at the customer premises to the ISDN line card. This equipment is designed to adapt to various U-loop configurations, assuming that they are non-loaded (no loading coils) and are within the Operating Loss Limits. The U-loop loss must take into account the total loss of all cabling between the NT1 and the ISDN line card. The cabling also includes CO, outside plant, and customer premises wiring. The loss level is affected by various factors, such as cable type and bridged taps. Loss level may be established by actual measurements at 40 kHz, or by calculation using cable records.

ANSI standards compliance

The ISDN NTBX27 line card and the NT1 comply with the ANSI U-loop performance specifications by meeting the requirements for the null loop and ANSI test loops #4-#15. These loops include mixed gauges and bridged taps which exhibit a U-loop loss within the Application Loss Limit of 40 dB at 40 kHz.

U-loop parameters

The ISDN basic access system provides bidirectional digital information transmission at160 kbps over a single customer 2-wire access loop. The specifications for the main U-loop parameters are listed in Table 7-A.

Table 7-A:
ISDN line card parameters

Parameters	Specifications
Line transmit rate	160 kbps
Information rate (customer data)	144 kbaud (2B + D)
Operating loss limits (with 49 disturbers)	46 dB at 40 kHz (BER = 10^{-7})
Recommended application loss limit	40 dB at 40 kHz (BER = 10^{-7})
Line code	2B1Q (2 binary, 1 quaternary)
Transmitted peak voltage	2.5 V nominal into 135 ohms resistive load
Terminating impedance	135 ohms, +/- 10 % resistive (0 kHz to 160 kHz)

In a 50-wire pair ISDN cable, the other 49 cable pair cause noise, affecting the ISDN cable pair's operating conditions.

The Bit Error Rate (BER) performance objective of 10^{-7} to ensures satisfactory ISDN digital data channel transmission.

See the following text for a recommended loss limit explanation.

Operating loss limit is the maximum loop loss limit with 49 disturbers. The operating loss is reduced by impulse noise and other loop impairments. Do not attempt to engineer an ISDN line to the 46 db operating loss limit unless accurate loop measurements are available. The application loss limit is the recommended loss limit to use in most instances. The application loss limit is obtained by subtracting assumed loop impairment budgets from the operating loss limit. Table 7-B lists the operating loss applicable margin due to noise and other loop impairments. When subtracted from the 46 dB operating loss limit, the total loop impairment loss of 6 dB produces the recommended 40 dB application loss limit.

Table 7-B:
Assumed loop impairment loss budgets

Parameters	Loss
Impulse noise (estimate)	3 dB
Added crosstalk margin for 99 disturbers	2 dB
Other loop impairments	1 dB
Total maximum margin (buried cable)	6 dB

U-loop engineering recommendations

The main recommendations for U-loop engineering include:

- the general loop conditions that must be satisfied to meet 10^{-7} BER
- allowable cable gauges for various bridged tap configurations
- the existing transmission systems that can share the same multi-pair cable with ISDN systems

The selected U-loops should satisfy the general conditions described in this document. As a minimum requirement, a loop should be suitable for POTS deployment. Inductive and capacitive devices, including, loading coils, build-out capacitors, bridge lifters, and induction mitigation devices; are not allowed on ISDN loops. These devices severely attenuate the ISDN signal.

The 2B1Q transmission system was designed to handle any combination of loop and bridged tap gauges. The maximum recommended loop length is engineered to account for the 40 kHz loop loss and the bridged tap 40 kHz loss within the application loss limit.

When calculating the loop loss, add 1.7 dB to the applications loss for every 1 k foot (up to 3 k feet) of a single bridged tap. For bridged taps that are 3 k feet and longer, add 5.1 dB to the application loss. For multiple bridged taps, calculate the loss value by adding the individual losses to the application loss. When no bridged taps exist on the loop, the loop can be made up of any gauge. Engineer the *no bridged tap* cable length for a 40 kHz loop loss that is within the application loss limit of 40 dB.

Table 7-C lists the maximum cable length, by gauge, that can support both application and operating loss limits. Application loss is the recommended limit when engineering a U-loop. Though not recommended, if the conditions of the outside plant permit, cable length can be engineered for a 40 kH loop loss that is within the operating loss limit of 46 dB.

Table 7-C:
Maximum recommended cable length

Cable gauge	**Cable length in km (k feet)**	
(AWG)	Application loss limit (40 dB)	Operating loss limit (46 dB)
26	4.40(14.5)	5.00(16.5)
24	6.55(21.5)	7.60(25.0)
22	8.80(29.0)	9.75(32.0)
mixed	5.50(18.0)	6.20(20.4)

Mixed represents a U-loop consisting of multiple cable gauges. This being the most common loop type, represents the maximum recommended cable length of 18 k feet.

ISDN systems crosstalk compatibility

Two systems sharing the same multi-pair cable are crosstalk compatible if neither system induces or receives an unacceptably high interfering noise to, or from, the other system through electromagnetic coupling.

Within the same cable binder group. the ISDN U-loop is crosstalk compatible with existing systems when they have been deployed according to their respective crosstalk limited reach. Crosstalk compatible systems include POTS, DDS, Datapath, and T1. Certain carrier systems and multi-channel subscribers are not compatible with ISDN, and should not share the same cable. Added Main Line (AML) is an example of an incompatible carrier system. The Anaconda S6A analog carrier system is an example of an incompatible multi-channel subscriber.

U-loop qualification

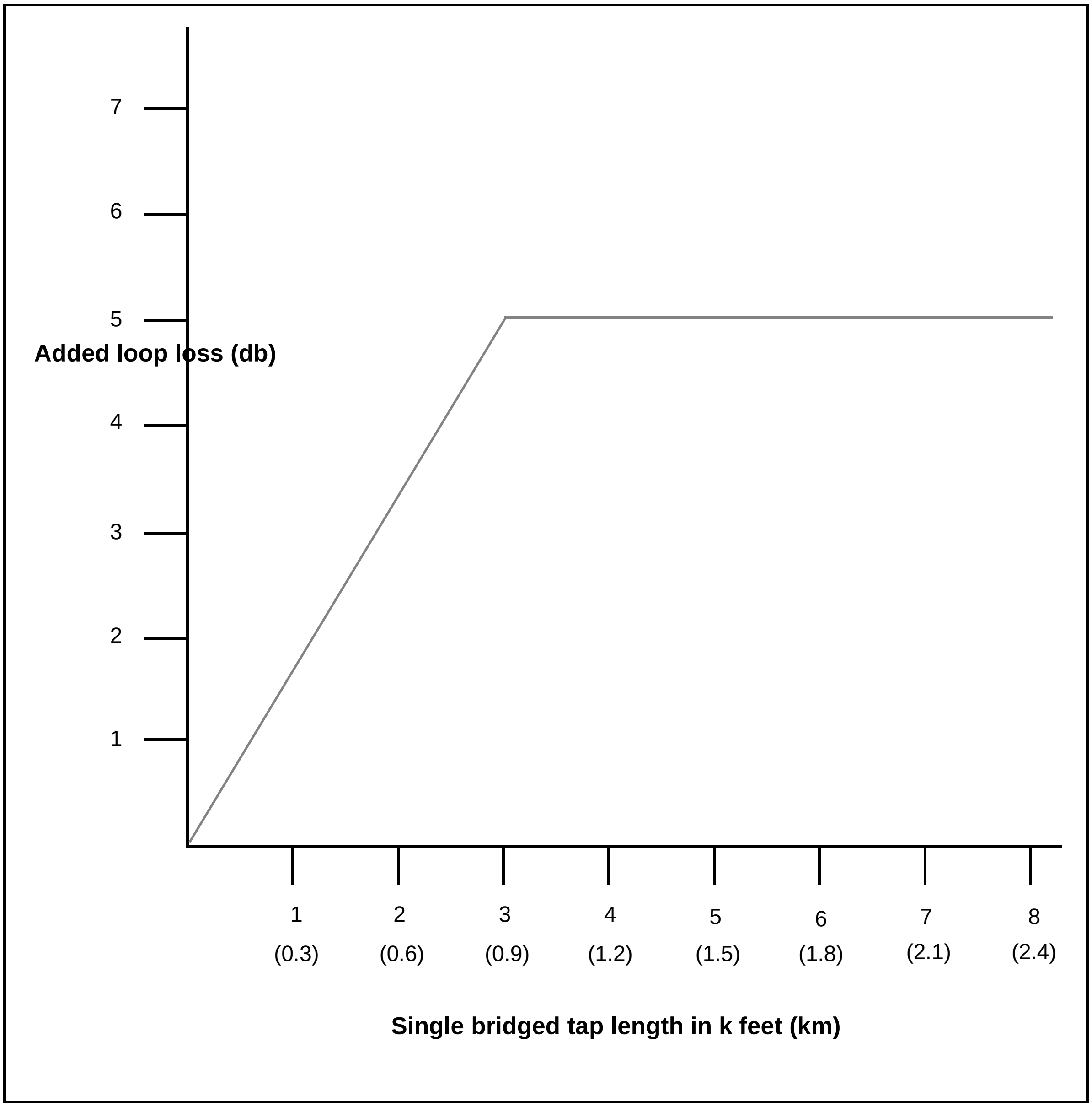
Table 7-D lists a procedure to determine whether a U-loop qualifies for ISDN loop service. The procedures uses a calculation and data sheet presented in Table 7-E, and also a diagram to determine loop loss from bridge taps in Figure 7-1. An example, using the procedure described in Table 7-D follows the supporting data table and figure.

Table 7-D: ISDN loop qualification procedure	
Steps	**Specifications**
Step 1	Select the loop to be used as an ISDN U-loop.
Step 2	Make sure that the loop meets the engineering recommendations.
Step 3	Enter the recommended application loss limit in Table 7-E for cable as 40 dB.
Step 4	Enter the total length of each type of cable that makes up the loop in Table 7-E, and multiply these by the loss constants to determine the total loss for each type of cable.
Step 5	If the loop contains bridged taps, use Figure 7-1 to determine the loss associated with each bridged tap, and enter the values in Table 7-E.
Step 6	Enter the losses associated with central office (CO) wiring and customer premises (CP) wiring in Table 7-E. ***Note:*** This step makes a small contribution to the total loss, and is therefore considered as optional.
Step 7	Using Table 7-E , determine the total loss of the selected loop.
Step 8	If the total loop loss from Table 7-E is less than, or equal to, the recommended application loss, the loop qualifies as an ISDN loop.
Step 9	If the loop qualifies as an ISDN loop, but does not operate with the required BER, refer to U-loop diagnostics in this chapter. If diagnostics do not resolve the BER issue, then select another loop and repeat this procedure.

Table 7-E: ISDN loop loss calculation				
Gauge (AWG)	**Insulation type**	**Unit loss dB/km (dB/k foot)**	**Length k feet**	**Loss (dB)**
19	PIC	3.3 (1.0)		
19	PULP	3.6 (1.1)		
22	PIC	4.6 (1.4)		
22	PIC	4.9 (1.5)		
24	PIC	5.9 (1.8)		
24	PULP	6.3 (1.9)		
26	PIC or PULP	9.2 (2.8)		
Customer premises wiring		5.9 (1.8)		
Central Office wiring		9.2 (2.8)		
Bridged tap 1				
Bridged tap 2				
Bridged tap 3				
Bridged tap 4				
Bridged tap 5				
Bridged tap 6				

Table 7-E: ISDN loop loss calculation				
Gauge (AWG)	**Insulation type**	**Unit loss dB/km (dB/k foot)**	**Length k feet**	**Loss (dB)**
Total loop loss in dB				
Recommended application loss limit for cable = 40 dB				

Figure 7-1: Added loop loss vs single bridged tap length



ISDN loop loss example

The following example illustrates the recommended process for determining if a loop qualifies as an ISDN line as described in Table 7-D. The line used in this example is illustrated in Figure 7-2. The data required to calculate the loop loss is entered into a sample ISDN loop calculation table in Table 7-F. Values created for this example appear in bold typeface.

Step 1 asks to select the loop. For this example, the loop is represented in Figure 7-2. Step two requires that the loop meets engineering recommendations. For this example, these conditions are considered adequate. According to Step 3, the value of 40 db is placed in the last row of the table.

In Step 4, the total length of 24 AWG cable (l1 plus L2) is determined to be 7.5 k feet. The length of 26 AWG cable is 2.7 k feet. Multiplying 7.5 by the 24 AWG loss constant of 1.8 produces a dB loss of 13.5. Likewise, multiplying 2.7 by the 26 AWG loss constant of 2.8, produces a 7.56 dB loss.

In Step 5, according to Figure 7-1, 1.8 km (for BT1) aligns with 3.06 dB. Likewise, for BT2, .7 k feet aligns with 1.2 dB.

In Step 6, the CP wiring of 200 feet (.2 k feet) is multiplied by the 1.8 constant to produce a .36 dB loss. Likewise, the 400 foot (.4 k feet) CO wiring is multiplied by the 2.8 constant to produce a 1.12 dB loss.

In Step 7, all losses in the Loss (dB) column add up to a 26.8 total dB loop loss. This value is within the recommended maximum application loss limit of 40 dB, and therefore the loop qualifies as an ISDN loop.

Figure 7-2: Added loop loss vs single bridged tap length

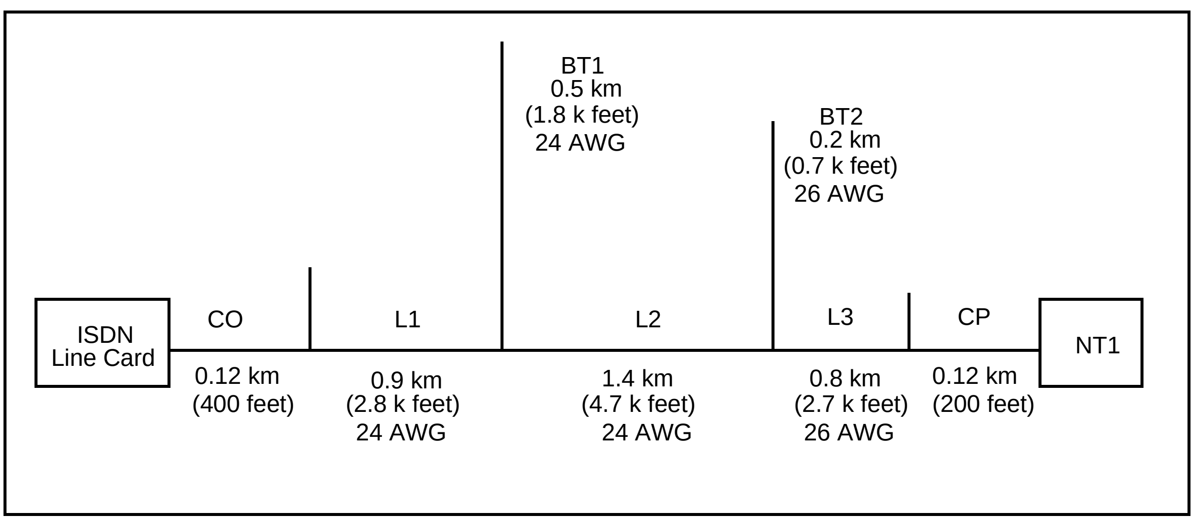


Table 7-F:
ISDN loop loss calculation example

Gauge (AWG)	Insulation type	Unit loss dB/km (dB/k foot)	Length k feet	Loss (dB)
19	PIC	3.3 (1.0)		
19	PULP	3.6 (1.1)		
22	PIC	4.6 (1.4)		
22	PIC	4.9 (1.5)		
24	PIC	5.9 (1.8)	7.5	13.5
24	PULP	6.3 (1.9)		
26	PIC or PULP	9.2 (2.8)	2.7	7.56
Customer premises wiring		5.9 (1.8)	0.2	0.36
Central Office wiring		9.2 (2.8)	0.4	1.12
Bridged tap 1			1.8	3.06
Bridged tap 2			0.7	1.20
Bridged tap 3				
Bridged tap 4				
Bridged tap 5				
Bridged tap 6				
Total loop loss in dB				26.8
Recommended application loss limit for cable = 40 dB				40

U-loop diagnostics

The bit error rate is expressed as an absolute ratio such as 1×10^{-7}, or, one bit error in ten million transmitted bits. If the loop's BER exceeds 10^{-7}, there could be several factors involved: loop loss, background noise, and bridged taps are typically the factors affecting ISDN system performance.

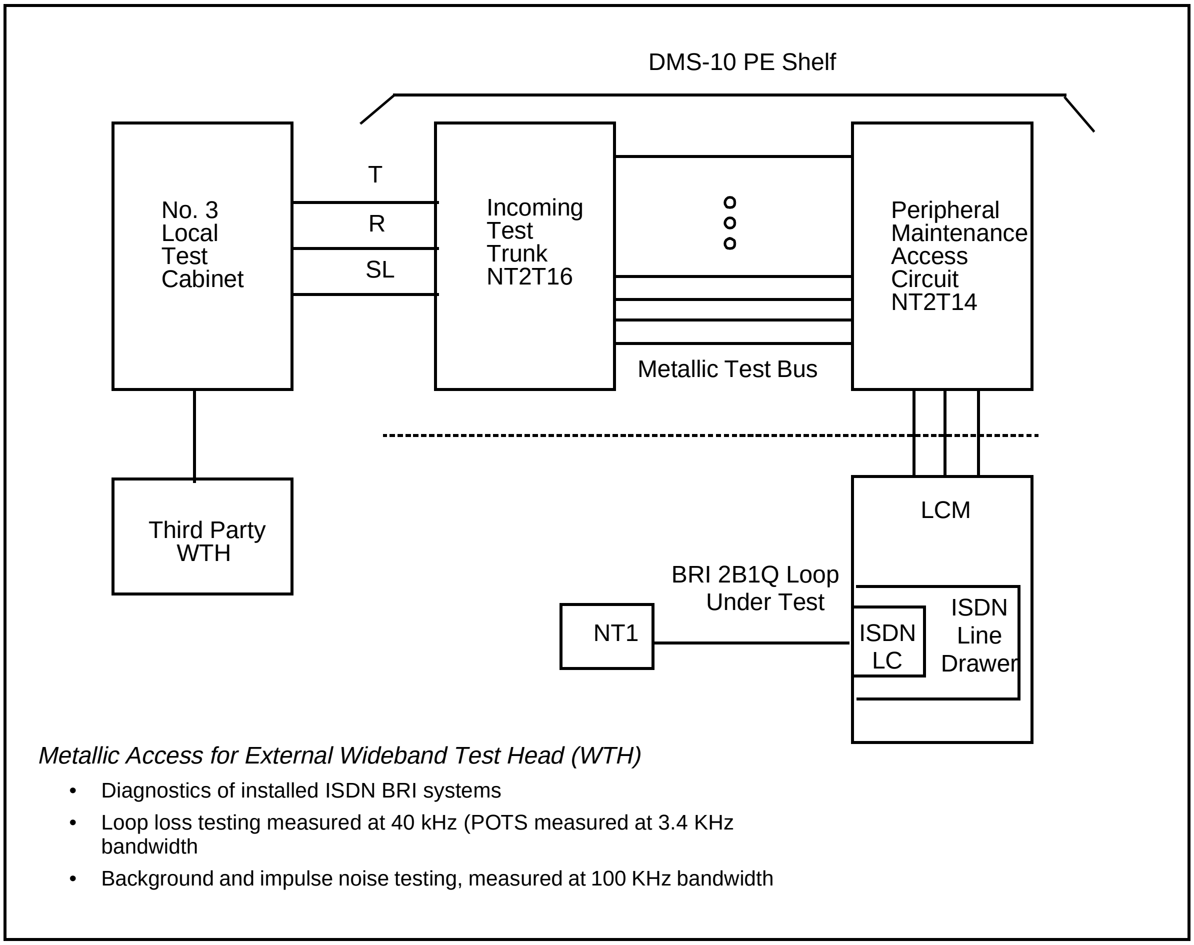
Loop loss

The BER may exceed the specified level if the measured loop loss is higher than the recommended application loss limit (40 dB for buried cable). Loop loss should be measured by applying a continuous wave signal at 40 kHz to one end of the loop, and measuring its level in 135 ohms termination at the other end with a transmission test set. Test equipment should be capable of measuring at a 40 kHz bandwidth, or greater.

To measure the signal propagation and attenuation on the candidate ISDN loops, an external wideband test head can be connected through the DMS-10 metallic access bus. This testing is usually required only where adverse conditions are encountered. For example, where cable records indicate the loop length exceeds 15 kfeet, or other digital carrier systems are present in the same cable sheath as the candidate ISDN cable pair.

Wideband Test Head Access for BRI Loop Qualification and Testing uses the DMS-10 Peripheral Maintenance Access (PMA) system for subscriber loop metallic testing. Wideband test equipment can be used to perform signal attenuation, wideband noise and crosstalk, longitudinal balance, and other specialized measurements. Figure 7-3 provides a block diagram of DMS-10 wideband test access to ISDN loops.

Figure 7-3: Wideband Test Access to ISDN loops



Background noise

The total background noise in a 100 kHz band induced on the loop from all sources of interference should not exceed 65 dBrn (unweighted) for a loop loss of 50 dB to achieve a 10^{-7} BER. If the loop loss is lower, for example by 6 dB, then the allowed background noise is higher by that amount. For example, for a 37 dB loop loss, the value would be 71 dB. The values for background noise versus loop loss are listed in Table.

The total background noise measured in a 50 kHz band induced on the loop from all sources of interference should not exceed 57 dBrn for a loop loss of 40 dB to achieve the required BER. If the loop loss is lower,m for example by 6 dB, the allowed background noise is higher by that amount. For example, for a 34 dB loop loss, the value would be 63 dBrn. Background noise can be measured using a 50 kHz measuring device with a 100 kHz bandwidth and 135 ohms termination impedance.

Impulse noise

To meet a 10^{-7} BER on a loop loss of 40 dB at 40 kHz, the zero count impulse noise threshold is 63 dBrn in a 100 kHz bandwidth, and 62 dBrn in a 50 kHz bandwidth. The zero count impulse noise threshold results in a 2B+D error count of no more than 6 errors/B-channel and 1 error/D-channel in 15 minutes.

The 10^{-7} BER values for impulse noise threshold levels versus loop loss are listed in Table

Bridged taps

Not meeting bridged tap recommendations may prevent the loop from meeting a 10^{-7} BER. Bridged taps could be the cause of unsatisfactory performance if the cable records are incorrect, particularly in cases in which only the total length of the bridged taps is known and no gauge or individual length information is available. In these cases, consider removing the bridged taps, or select another loop.

Table 7-G:
10^{-7} BER Background and impulse noise threshold levels versus loop loss

Loop loss (dB)	Background noise (dBrn) 100 khz50 kHz bandband		Impulse noise threshold level (dBrn) 100/50 khzUsing HP4935A bandband	
40	65	57	63	62
39	66	58	64	63
38	67	59	65	64
37	68	60	66	65
36	69	61	67	66
35	70	62	68	67
34	71	63	69	68
33	72	64	70	69
32	73	65	71	70
31	74	66	72	71
30	75	67	73	72
29	76	68	74	73
28	77	69	75	74

Table 7-G: (Continued) **10 $^{-7}$ BER Background and impulse noise threshold levels versus loop loss**				
Loop loss (dB)	**Background noise (dBrn)** **100 khz50 kHz** **bandband**		**Impulse noise threshold level (dBrn)** **100/50 khzUsing HP4935A** **bandband**	
27	78	70	76	75
26	79	71	77	76
25	80	72	78	77
24	81	73	79	78
23	82	74	80	79
22	83	75	81	80

Section 8: Index

Numbers-

DMS-10 Family

600-Series Generics

Provisioning

NTP number: NTP 297-3601-450
Release: 08.01
For Generic 602.20
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