Meridian 1

Succession 1000M

Succession 3.0 Software

Large System

Planning and Engineering

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October 2003

Standard 1.00. This document is a new NTP for Succession 3.0. It was created to support a restructuring of the Documentation Library, which resulted in the merging of multiple legacy NTPs. This new document consolidates information previously contained in the following legacy documents, now retired:

- *Installation Planning* (553-3001-120)
- *Capacity Engineering* (553-3001-149)
- *System Engineering* (553-3001-151)
- *Power Engineering* (553-3001-152)

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Introduction

A switch must be engineered upon initial installation, during upgrades, and when traffic loads change significantly, or increase beyond the bounds anticipated when the switch was last engineered. A properly engineered switch is one in which all components work within their capacity limits during the busy hour.

This document does not discuss major features, such as Automatic Call Distribution (ACD) or Network Automatic Call Distribution (NACD), and of auxiliary processors and their applications, such as Meridian Mail, CallPilot and Meridian Link Module. Guidelines for feature and auxiliary platform engineering are given in documents relating to the specific applications involved. Sufficient information is given in this document to determine and account for the impact of such features and applications upon the capacities of the system itself.

Engineering a new system

Figure 1 on page 19 illustrates a typical process for installing a new system. The agent expected to perform each step of the process is listed to the right of the block. The highlighted block is the subject of this document. It is further illustrated in Figure 2 on page 20.

Engineering a system upgrade

In cases of major upgrades, or if current resource usage levels are not known, it is recommended that the complete engineering process be followed, as described in the previous section.

If minor changes are being made, the incremental capacity impacts can be calculated and added to the current resource usage levels. The resulting values can then be compared to the capacity chart to determine whether the corresponding capacity has been exceeded.

Figure 1
Engineering a new system

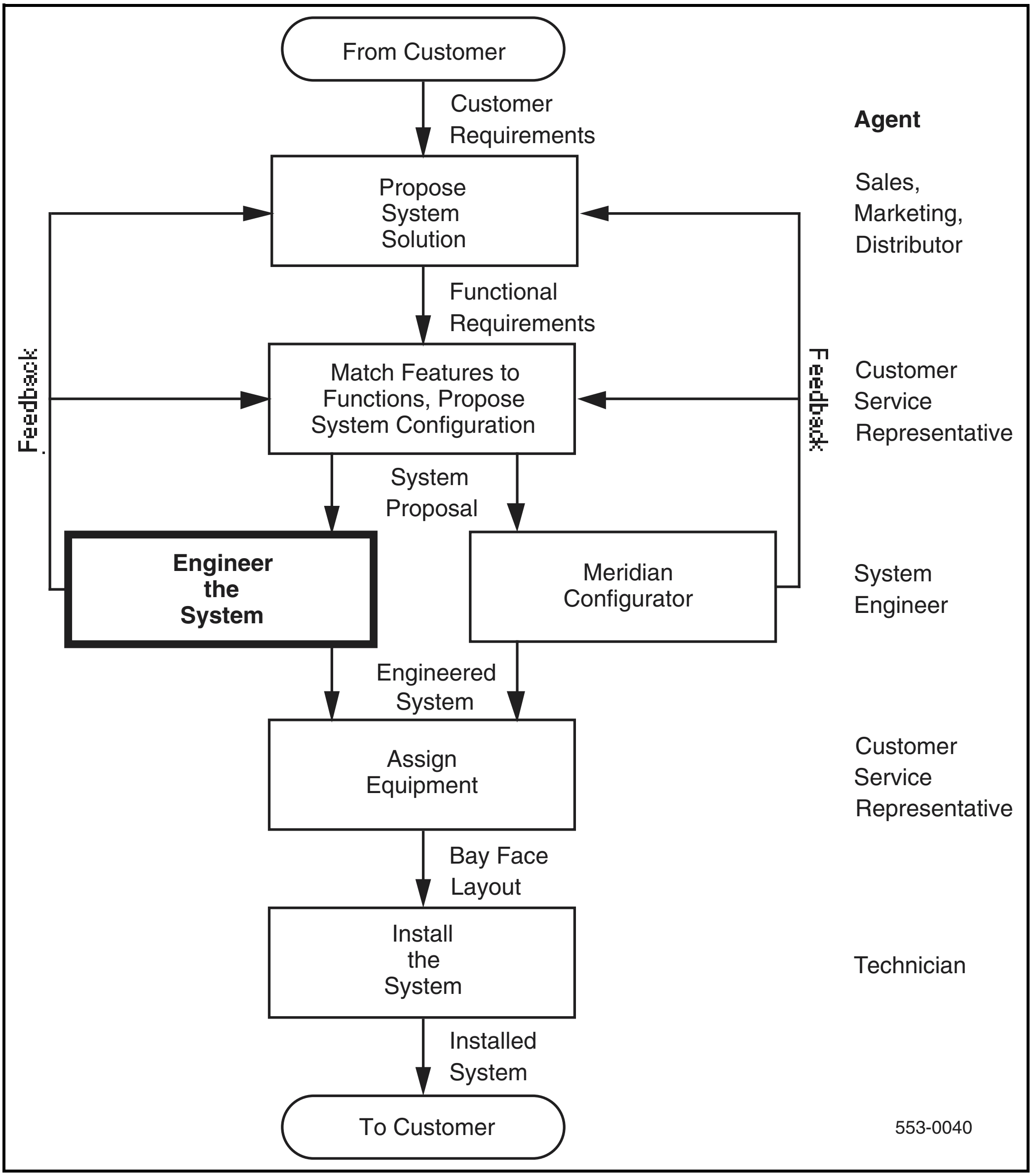
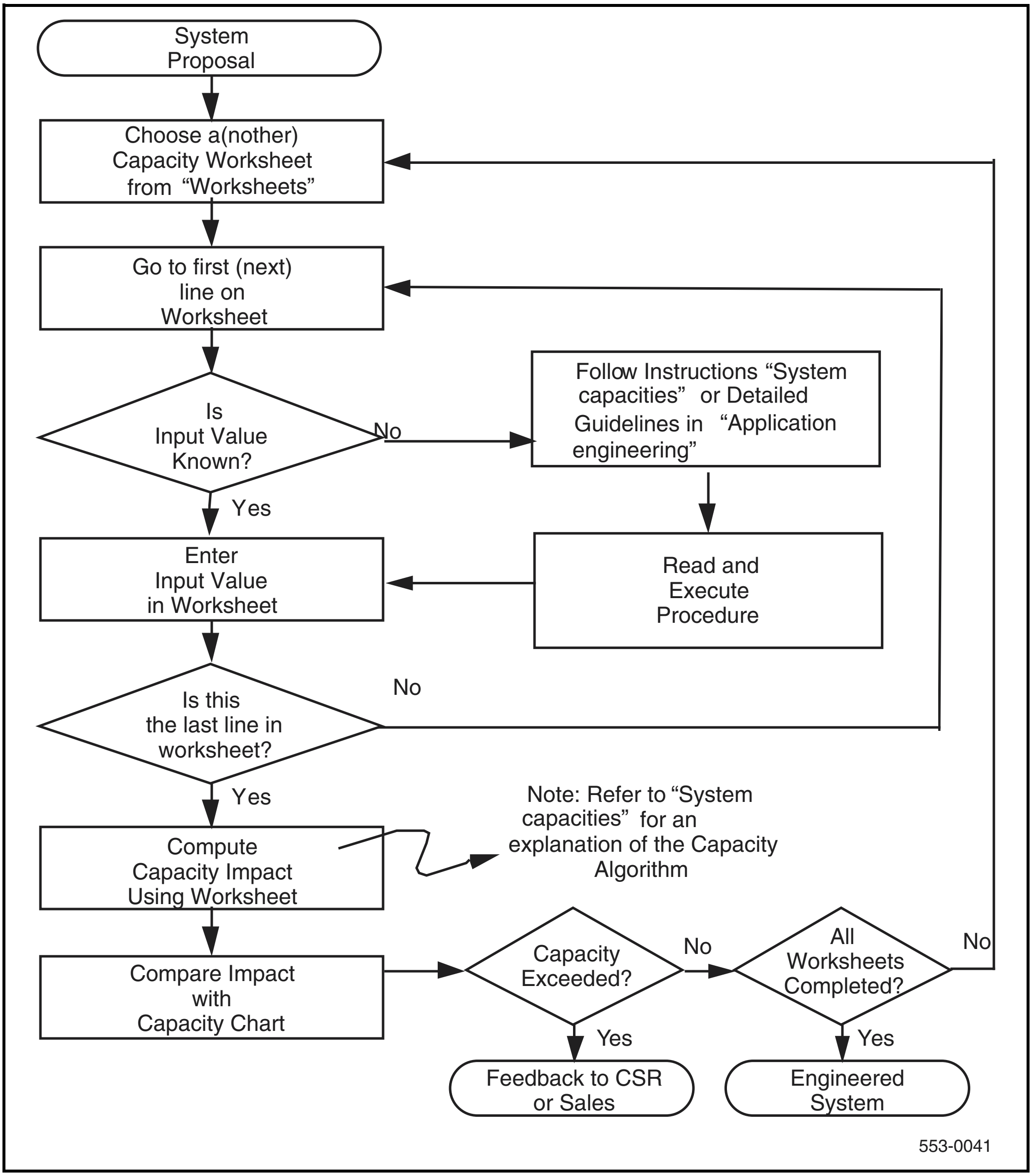


Figure 2
Engineering a new system



Other resources

This section briefly describes the tools available to assist the site engineer, sales person, and/or customer in engineering the switch. Differences between the tools, their platforms and implementation and usage are described.

Meridian Configurator

The Meridian Configurator allows users to prepare quotes for a new system. Meridian Configurator supports Succession 1000M and Meridian 1 sales by analyzing input specifications for a digital PBX to produce a full range of pricing, engineering reports, and graphics. These reports include a complete equipment list, part numbers, software listing, engineering capacities, and pricing for currently available Succession 1000M and Meridian 1 configurations.

Meridian Configurator runs on the user's own DOS/Windows-based personal computer. Specific Succession 1000M and Meridian 1 requirements depend on the version of Meridian Configurator. For details, contact the Nortel Networks account team or Nortel Networks DSM.

Meridian Configurator implements the algorithms specified in this document for real time, memory, and physical capacities. It is the official tool for determining whether a proposed configuration will meet the customer's capacity requirements.

Where applicable, in this document, references are made to the Meridian Configurator inputs which correspond to parameters being described.

1-Up

The Meridian 1 Upgrade Configuration Tool (1-Up) provides an efficient means to engineer Succession 1000M and Meridian 1 upgrades. It incorporates the engineering rules and pricing data required to upgrade an existing system to the latest hardware/software platform. It also includes the Autoquote algorithms used for new systems to permit port expansion and application add-ons as part of the upgrade proposal.

1-Up is a Windows™ PC application.

Notice for United States installations

Succession 1000M and Meridian 1 Large System equipment complies with Part 68 of the United States Federal Communications Commission (FCC) rules. On the rear of the pedestal unit in each switching equipment column is a label that contains, among other information, the FCC registration numbers and Ringer Equivalence Number (REN) for the equipment. If requested, you must provide this information to the telephone company.

Regulatory labels include:

- FCC registration: AB6982-14234-MF-E
- FCC registration: AB6982-62937-PF-E
- FCC registration: AB6CAN-61117-MF-E
- FCC registration: AB6CAN-61116-PF-E
- Service Code: 9.0F Ringer equivalent: 1.1B (1.0A)

The REN specifies the number of devices that you can connect to the telephone line. Excessive RENs on the telephone line can prevent devices from ringing in response to an incoming call. In most areas, the sum of the RENs must not exceed five. To find out how many devices you can connect to the line (as determined by the total RENs) contact the telephone company to determine the maximum REN for the calling area.

If your equipment interfaces with the telephone network, the telephone company will notify you in advance that your service may be discontinued temporarily. If advance notice is impractical, the telephone company will notify you as soon as possible. Also, you will be advised of your right to file a complaint with the FCC.

The telephone company can make changes in its facilities, equipment, operations, or procedures that could affect the proper operation of your equipment. If this happens, the telephone company will provide advance notice so you can make the necessary modifications to maintain uninterrupted service.

If you experience trouble with the Succession 1000M and Meridian 1 Large System equipment, contact your authorized distributor or service center.

You cannot use the equipment on public coin service provided by the telephone company. Connection to party line service is subject to state tariffs. Contact the state public utility commission, public service commission, or corporation commission for information.

The system is hearing aid compatible.

If you allow the system to operate in a manner that does not provide proper answer supervision signaling, it is a violation of Part 68 of the FCC Rules.

1 This equipment returns proper answer supervision signals to the Public Switched Telephone Network (PSTN) when calls are:

- **a** answered by the called station
- **b** answered by the attendant
- **c** routed to a recorded announcement that can be administered by the Customer Premises Equipment (CPE) user
- **d** routed to a dial prompt

2 This equipment returns answer supervision on all Direct Inward Dial (DID) calls forwarded back to the PSTN. Exceptions are permissible if:

- **a** a call is unanswered
- **b** a busy tone is received
- **c** a reorder tone is received

The equipment can provide access to interstate providers of operator services through the use of Equal Access codes. Failure to provide Equal Access capabilities is a violation of the Telephone Operator Consumer Services Improvement Act of 1990 and Part 68 of the FCC Rules.

Table 2 lists all applicable network jack Uniform Service Order Codes (USOCs), Facility Interface Codes (FIC), and Service Order Codes (SOC) associated with the services to which the system is connected.

Table 2
Network connection information (Part 1 of 2)

MFRS port ID	MTS/WATS FIC	REN	Network jacks	Port
NT8D14	02LS2	2.7A	RJ21X	2-wire, local switched access (LSA), loop start
NT8D14	02GS2	2.7A	RJ21X	2-wire, LSA, ground start
NT8D14	02RV2-T	0.0B	RJ21X	2-wire, LSA, reverse battery
NT6P03	02LS2	2.7A	RJ21X	2-wire, LSA, loop start
NT4R04AB	02LS2	0.4B	RJ21X	2-wire, LSA, loop start
NT4R04AB	02GS2	0.4B	RJ21X	2-wire, LSA, ground start
A0351167	02LS2	0.4B	RJ21X	2-wire, LSA, loop start
	Analog PL FIC	**SOC**		
NT8D15	TL11M	9.0F	RJ2EX	2-wire E&M tie trunk
NT8D15	TL31M	9.0F	RJ2GX	4-wire dial repeating tie line
NT8D15	TL32M	9.0F	RJ2HX	4-wire dial repeating tie line
NT8D03/09 NTAK92	OL13C	9.0F	RJ21X	Off premise

Table 2
Network connection information (Part 2 of 2)

MFRS port ID	MTS/WATS FIC	REN	Network jacks	Port
	Digital FIC	**SOC**		
QPC472	04DU9-BN	6.0P	N/A	1.544 Mbps superframe
QPC720	04DU9-BN	6.0P	N/A	1.544 Mbps superframe
QPC720	04DU9-1KN	6.0P	N/A	1.544 Mbps extended superframe
NTAK09AA	04DU9-BN	6.0P	N/A	1.544 Mbps superframe
NTAK09AA	04DU9-1KN	6.0P	N/A	1.544 Mbps extended superframe
RPE	04DU9-BN	6.0P	N/A	1.544 Mbps superframe

Notice for Canadian installations

Equipment regulatory labels include “Department of Communications (CS03): 332 404 A.”

This Canadian Department of Communications label identifies certified equipment, which means that the equipment meets certain telecommunications network protective, operational, and safety requirements. The Department does not guarantee that the equipment will operate to the user’s satisfaction.

Before installing the equipment, you must have permission to connect to the facilities of the local telecommunications company. You must also install the equipment using an acceptable method of connection. In some cases, you can extend the company’s inside wiring associated with a single line individual service by using a certified connector assembly (telephone extension cord). Note that compliance with the above conditions may not prevent service degradation.

Repairs to certified equipment must be made by an authorized Canadian maintenance facility designated by the supplier. If you make any repairs or alterations to this equipment, or if equipment malfunctions occur, the telecommunications company may ask you to disconnect the equipment.

To protect personnel, ensure that the electrical ground connections of the power utility, telephone lines, and internal metallic water pipe system (if present) are interconnected. This is particularly important in rural areas.

CAUTION

Damage to Equipment

Do not attempt to make electrical ground connections; contact the appropriate electrical inspection authority or an electrician.

Notice for international installations

If there is not enough planning or technical information available for your country of operation, contact your regional distributor or authority for help.

European compliance information

The equipment meets the following European technical regulations: CTR 1, CTR 2, CTR 3, CTR 4, CTR 6, CTR 10, CTR 12, CTR 13, CTR 15, CTR 17, CTR 22, CTR 24, and the I-ETS 300 131.

Supported interfaces

Analog interfaces are approved based on national or European specifications. Digital interfaces are approved based on European specifications.

Safety specifications

The equipment meets the following European safety specifications: EN 60825, EN 60950, EN 41003.

About this document

This document is a global document. Contact your system supplier or your Nortel Networks representative to verify that the hardware and software described are supported in your area.

Subject

This document provides guidelines for selecting a site, planning a site, and planning the system. It includes information on setting up the equipment area, establishing grounding and power, and meeting cabling requirements. If there is a conflict between information in this document and a local or national code, follow the code.

Note on legacy products and releases

This NTP contains information about systems, components, and features that are compatible with Succession 3.0 Software. For more information on legacy products and releases, click the **Technical Documentation** link under **Support** on the Nortel Networks home page:

http://www.nortelnetworks.com/

Applicable systems

This document applies to the following systems:

- Meridian 1 Option 51C
- Meridian 1 Option 61
- Meridian 1 Option 61C
- Meridian 1 Option 61C CP PII

- Meridian 1 Option 81
- Meridian 1 Option 81C
- Meridian 1 Option 81C CP PII
- Succession 1000M Half Group
- Succession 1000M Single Group
- Succession 1000M Multi Group

Note that memory upgrades may be required to run Succession 3.0 Software on CP3 or CP4 systems (Options 51C, 61, 61C, 81, 81C).

System migration

When particular Meridian 1 systems are upgraded to run Succession 3.0 Software and configured to include a Succession Signaling Server, they become Succession 1000M systems. Table 1 lists each Meridian 1 Large System that supports an upgrade path to a Succession 1000M Large System.

Table 1
Meridian 1 systems to Succession 1000M systems

This Meridian 1 system...	Maps to this Succession 1000M system
Meridian 1 Option 51C	Succession 1000M Half Group
Meridian 1 Option 61	Succession 1000M Single Group
Meridian 1 Option 61C	Succession 1000M Single Group
Meridian 1 Option 61C CP PII	Succession 1000M Single Group
Meridian 1 Option 81	Succession 1000M Multi Group
Meridian 1 Option 81C	Succession 1000M Multi Group
Meridian 1 Option 81C CP PII	Succession 1000M Multi Group

For more information, see *Large System: Upgrade Procedures* (553-3021-258).

Intended audience

This document is intended for individuals responsible for engineering the switch. The engineer may be an employee of the end-user customer, a third party consultant, or a distributor.

Other persons who may be interested in this information, or find it useful, are Sales and Marketing, Service Managers, Account Managers, Field Support, Product Management, and Development.

Conventions

Terminology

In this document, the following systems are referred to generically as "system":

- Meridian 1
- Succession 1000M

The following systems are referred to generically as "Large System":

- Meridian 1 Option 51C
- Meridian 1 Option 61
- Meridian 1 Option 61C
- Meridian 1 Option 61C CP PII
- Meridian 1 Option 81
- Meridian 1 Option 81C
- Meridian 1 Option 81C CP PII
- Succession 1000M Half Group
- Succession 1000M Single Group
- Succession 1000M Multi Group

In North America, there are a number of branch circuit wiring methods recognized by the U.S. National Electrical Code (NEC) and the Canadian Electrical Code (CEC). Among them are:

- 208/120 V, three-phase, four-wire, “wye” service
- 240/120 V, three-phase, four-wire, “delta” service
- 240/120 V, single-phase, three-wire service

Sometimes nomenclature is confusing. For example, the third method (240/120 V, single-phase, three-wire, service) is often referred to as 220/110, 230/115, 240/120, or 250/125 V. This is because, as a result of voltage drops, the nominal voltage varies from region to region, utility to utility, and even within the same distribution network. In addition, the ratings of the plugs and receptacles used are 250 and 125 V, although the nominal voltages are usually lower than this.

Related information

This section lists information sources that relate to this document.

NTPs

The following NTPs are referenced in this document:

- *Dialing Plans: Description* (553-3001-183)
- *Features and Services* (553-3001-306)
- *Software Input/Output: Administration* (553-3001-311)
- *Telephones and Consoles: Description* (553-3001-367)
- *Traffic Measurement: Formats and Output* (553-3001-450)
- *Large System: Overview* (553-3021-010)
- *Large System: Installation and Configuration* (553-3021-210)
- *Large System: Upgrade Procedures* (553-3021-258)
- *Meridian MAX Installation* (553-4001-111)
- *Site and Installation Planning* (553-7011-200)

- *Candeo Power System User Guide* (P0914425)
- *Candeo Power System Installation Guide* (P0914426)

Online

To access Nortel Networks documentation online, click the **Technical Documentation** link under **Support** on the Nortel Networks home page:

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CD-ROM

To obtain Nortel Networks documentation on CD-ROM, contact your Nortel Networks customer representative.

System equipment

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Introduction

This section gives a high level description of system architecture, emphasizing components of the Succession 1000M and Meridian 1 that have capacity limitations or impacts. The hardware of these systems is divided into six functional areas:

1 Common equipment (Core) – Provides the processor control, software execution, and memory functions of the system.

2 Common equipment (Network) – Performs switching functions between the processor and peripheral equipment cards.

3 Peripheral equipment – Provides the interface between the network and connected devices, including terminal equipment and trunks.

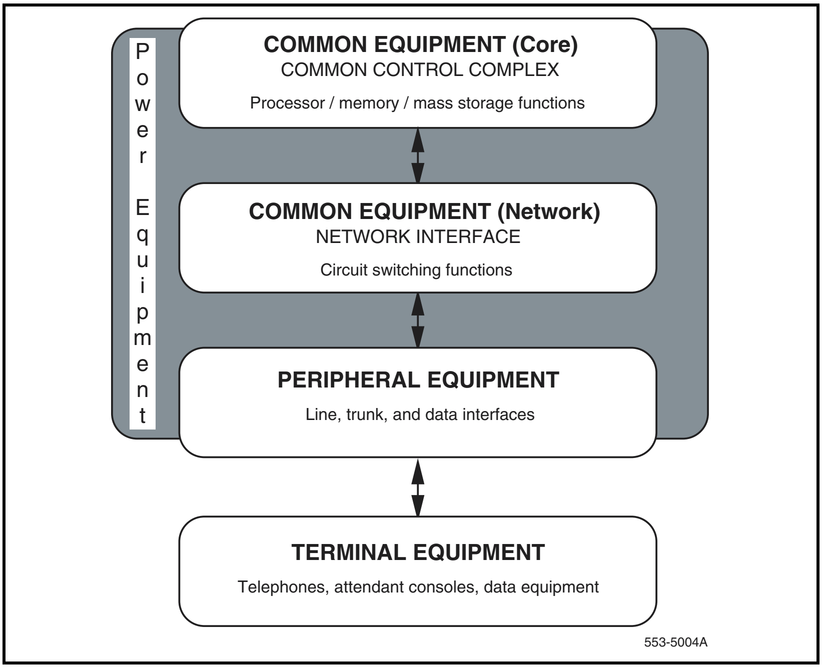
4 Terminal equipment –Includes telephones and attendant consoles (and may include equipment such as data terminals, printers, and modems).

5 Power equipment – Provides the electrical voltages required for system operation, and cooling and sensor equipment for system protection.

6 Auxiliary equipment – Includes separate computing platforms that provide additional functionality which interfaces with and sometimes controls the activities of the switch's main processor.

Note: As shown in Figure 3 on page 28, the network interface function is generally considered a subset of the common equipment functions.

Figure 3
Basic system architecture



This section provides guidelines for system configuration. The worksheets referenced in this section can be found in Appendix A: “Worksheets” on page 405.

Universal Equipment Modules – UEMs

Universal Equipment Modules (UEMs) are the building blocks of the communications system. Each UEM is a self-contained unit with power, a card cage, I/O panels, and cable routing channels. It is a generic case containing sets of equipment used in system operations (see Figure 4 on page 30).

UEMs are stacked in columns

UEMs are stacked in columns, up to four modules high. These UEMs are numbered 0 to 3 from the bottom up (see Figure 4 on page 30). Cables connect cards in the same module, between two modules and between cards and the I/O panel in the same module.

Column components

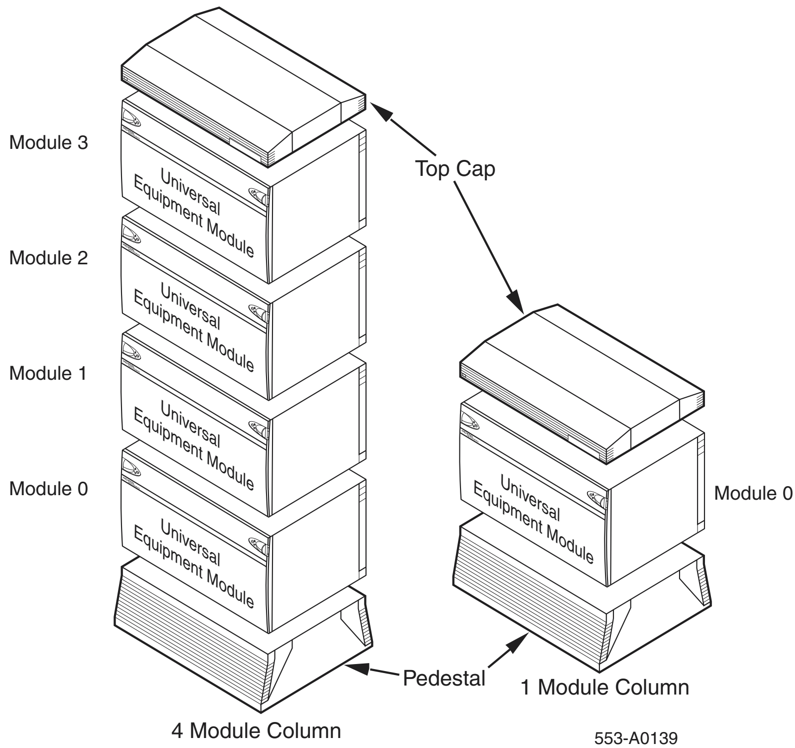
Each column contains a pedestal base, a top cap, and up to four modules.

Pedestals

Each column sits on a pedestal. The pedestal contains power, cooling, and monitoring equipment.

- A Power Distribution Unit (PDU) in the back of the pedestal supplies either ac or dc power to the column.
- A System Monitor checks the column’s cooling and power systems.
- A blower unit (accessible from the front of the pedestal) forces air up through the modules to cool the circuit cards.

Figure 4
Universal Equipment Modules



Top Caps

A top cap is mounted on the top module of each column. It contains:

- Air exhaust grills in the cap that release air from the blowers in the pedestal.
- A heat sensor that monitors the temperature of the column.
- A red LED in the front of the cap's exhaust grill that lights if the system overheats or if a power outage occurs.
- Ladder racks for routing cables can also be fitted to the top caps.

Modules

Up to four modules can be included in a column. The modules can include:

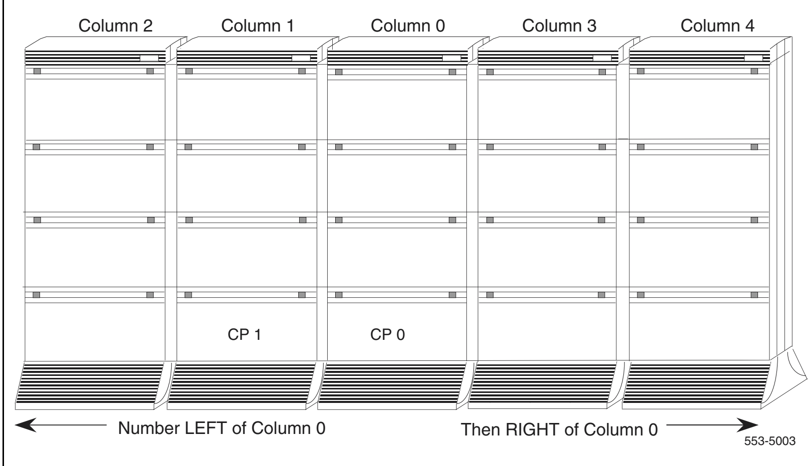
- NT4N41 CompactPCI® (cCPI) Core/Network Module – required for all Large Systems
- NT8D35 Network Module – required for Meridian 1 Option 81C CP PII and Succession 1000M Multi Group
- NT8D37 Intelligent Peripheral Equipment (IPE) Module – required for all Large Systems

In addition, modules that house application-specific equipment, such as Meridian Mail and Meridian Link modules, can be included in a column.

Columns are grouped in rows

A system can have one column or multiple columns. Columns are attached in rows. Column 0 is always the column containing the "Core/Net 0" module. Column 1 is placed to the left of Column 0 and ALWAYS contains the "Core/Net 1" module.

Figure 5
Column numbering



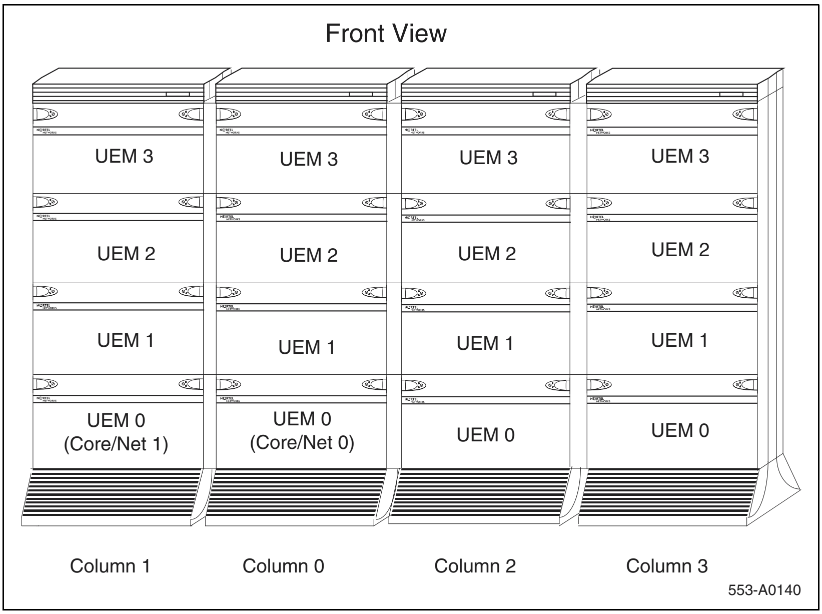
> ***Note:*** Modules containing the CP equipment should always be placed in the first two tiers of system columns.

Column 0 and Column 1 are placed at the far left of the row (front view). Column numbering continues to the right of Core 0 (see Figure 6 on page 32).

Additional rows are configured with the lowest numbered column on the far left and the highest numbered column on the far right (front view).

For compliance with Electromagnetic interference/radio frequency interference (EMI/RFI) standards, spacer kits are provided to interconnect the columns in a multiple-column system.

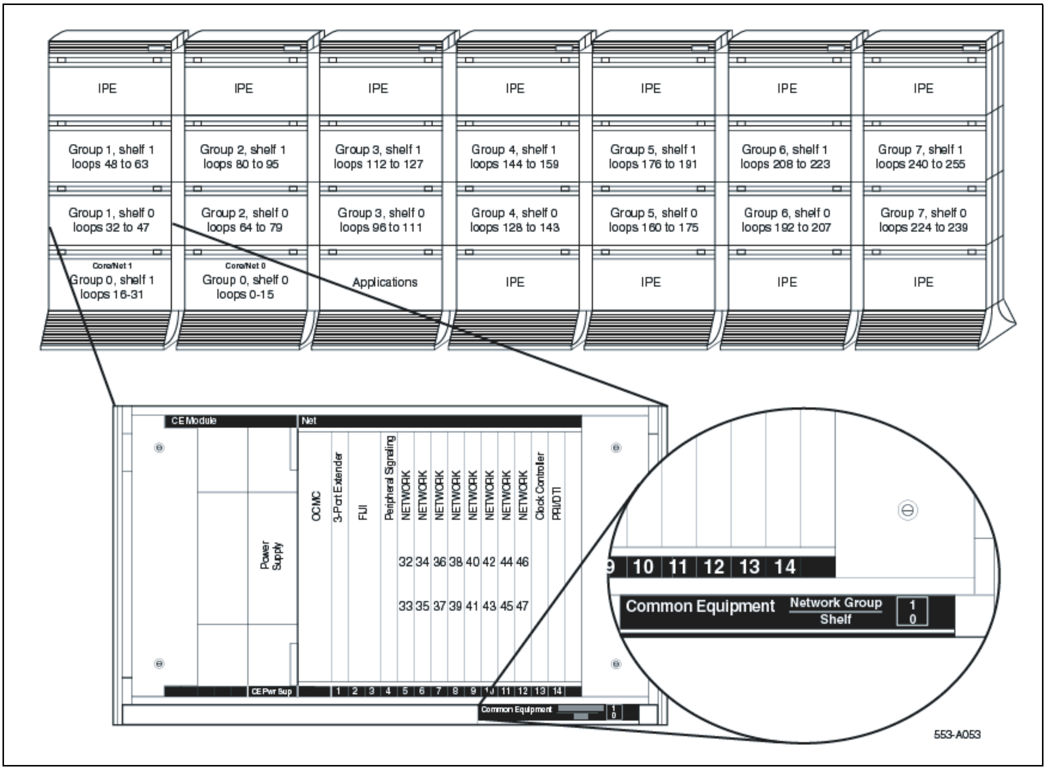
Figure 6
Example of Large System column row



UEMs are identified by function

Each UEM contains a specialized set of equipment to digitalize, process, and route phone calls and voice messages (see Figure 7).

Figure 7
UEMs identified by function



Card cage

Inside each UEM is a metal card cage. This card cage holds the circuit cards, power card, and related equipment for that module. UEMs are named for the function of that card cage.

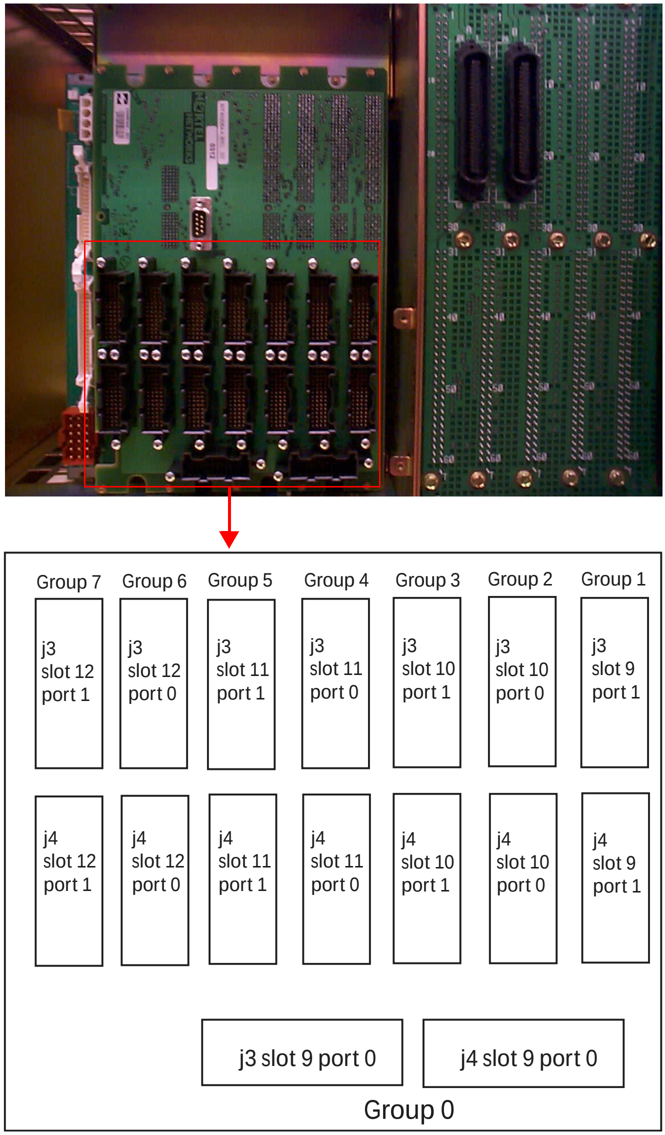
Card cages are bolted inside the UEM case. Card cages can be removed and replaced for repairs or upgrades.

Core/Net module

Meridian 1 Large Systems feature the NT4N41 Core/Net module. The Core/Net module provides a unified hardware platform for single group and multi-group configurations. The NT4N41 Core/Net module supports:

- Two CD-ROMs for all systems.
- An integrated cPCI shelf.
- A NT4N48AA System Utility card that incorporates the functionality of the System Utility Transition card, LCD display, and the security device holder.
- An LCD display on the System Utility card (formerly located on the front chassis).
- A fanout panel (see Figure 8 on page 35) to replace Transition cards (cCNI Transition card and System Utility Transition card) and provide connectivity to the network shelf.
- Upgrades from single group to multi-group configurations (requiring a new keycode file and any additional hardware necessary for a multi-group system).

Figure 8
NT4N41 Core/Net shelf fanout panel (backplane)



Common equipment (Core)

The central processor is the common control complex of any system. It executes the sequences which process voice and data connections, monitor call activity, and perform system administration and maintenance.

The processor communicates with the network interface over a common control bus that carries the flow of information.

The common control complex consists of:

1 The processor card or cards that provide the computing power for system operation.

2 System memory that stores all operating software programs and data unique to each system.

3 The disk drive unit that provides mass storage for operating programs and data.

4 I/O interfaces that provide an information exchange between the user and the system.

Core Processor (CP)

At system power-up, pre-stored instructions are executed by the CP to begin the process of loading programs from the system’s mass storage device into memory. The program’s first activity is to read in the site’s configuration database from mass storage. Once the system loading and initialization process is complete, the program enters its normal operational state.

During normal operation, the CP performs control and switching sequences required for call processing, system administration and maintenance, and processes input/output messages which provide interfaces to auxiliary processors and the system administrator. Each of these activities is controlled by a preprogrammed sequence of instructions. The CP is capable of executing a limited number of these instructions in a given time period. This number depends on the processing power of the CP.

Some system options provide redundant CP and memory components. The active CP writes status changes to both memories and each CP can read from either memory. If the active CP fails, the backup CP is activated. If the active memory fails, the same CP continues to operate, but operates using the backup memory.

System memory

System memory contains all software programs and data required by the main processor. Four types of solid-state memory are used: Flash Electronically Programmable Read-Only Memory (Flash EPROM), Read-Only Memory (ROM), and Dynamic Random-Access Memory (DRAM).

ROM is permanently programmed memory (firmware) housed on a CP daughterboard. This memory stores basic instruction interpreters, firmware procedures for operating system functions such as arithmetic and memory access, and the bootstrap procedures necessary to initialize the system and bring it into a working state. ROM also stores the recovery, or trap, sequence which is automatically activated at power-up, system reload, or when certain faults are detected.

Flash EPROM is used to store code (such as bootstrap code, OS code, call processing code, and other application code).

DRAM is dynamic writable memory contained in chips which may be located on a separate memory board, or, for some systems, on the CP board itself. It is volatile, that is, its contents are lost when power is disconnected. Therefore, its contents must be restored from nonvolatile memory (mass storage) whenever power is lost, the system is reloaded, or certain faults occur.

On the CPV5350 (CP PII), DRAM is divided into five functional areas.

1. Unprotected data store (UDATA) holds constantly changing, unprotected data (such as call registers, call connection, and traffic data) required during call processing.
2. Protected data store (PDATA or office data) holds protected customer-specific information (such as trunk configuration and speed call data).
3. Program store holds call processing programs, input/output procedures, programmed features and options (such as conference and call transfer), and diagnostic and maintenance programs.

4 OS Heap is an area from which features can allocate memory during run time by means of VxWorks memory allocation function calls. Features that are relatively self-contained and have taken advantage of the VxWorks C/C++ development environment are the heap users and include QSIG, message-based buffering, Taurus, MMIH, SMP. On the Meridian 1 Option 61C CP PII and Meridian 1 Option 81C CP PII systems, the patch storage area is included in the OS heap area.

5 Miscellaneous fixed OS requirements.

On the NT5D10 and NT5D03 (CP 3, CP 4) cards, DRAM is divided into five functional areas.

1 Unprotected data store (UDATA) holds constantly changing, unprotected data (such as call registers, call connection, and traffic data) required during call processing.

2 Protected data store (PDATA or office data) holds protected customer-specific information (such as trunk configuration and speed call data).

3 Dynamic OS Heap space for OS and for certain system features (OTM, MMIH, QSIG, PRI) to allocate as needed during run time.

4 Patching area.

5 Miscellaneous fixed OS requirements.

Program store holds call processing programs, input/output procedures, programmed features and options (such as conference and call transfer), and diagnostic and maintenance programs.

Mass storage

Customer data storage

Mass storage devices (floppy disks and fixed head rotating disks) are used to permanently store customer database information required by the main processor and peripherals. The floppy disk medium to save site-specific data periodically as it is updated. On some systems a hard disk is used as a back up for floppies, and as a time saving mechanism.

System software delivery

System software is delivered to a customer on a CD-ROM disk.

Floppy use on a live system

At system power-up or during a system reload, protected customer data, program store information, and peripheral device software are automatically transferred from the disk drive unit to the system memory or peripheral devices. During regular operation, the CP accesses information from the memory.

If information in protected data store is changed (such as a change in a telephone configuration), the information on the disk drive unit must be updated. Transferring data from the system memory to the disk drive unit is called a data dump. Data dumps can occur automatically or manually (through software program commands).

The NT5D61 Input/Output Disk Unit with CD-ROM (IODU/C) is used on the CP3 or CP4 systems. It includes:

- One 3.5-inch floppy disk drive with a formatted capacity of 1.44 MB.
- One 3.5-inch SCSI hard disk to store the system database and software.
- One CD-ROM drive (the NT5D61BA vintage does not have a CD-ROM drive).

The NT4N43 Multi-Media Disk Unit (MMDU) card is used on the Large Systems. This card includes:

- One IDE hard disk to store the system database and software.
- One floppy disk to install software or back up databases.
- One CD-ROM to install system software.

One MMDU card is installed in the far right of each Core/Net module.

Input/output interfaces

Input/output (I/O) ports provide an interface between the system and external devices, such as terminals and teletypewriters, and application module link

(AML) applications, including Meridian Mail and Meridian Link. The I/O devices may be located at local or remote sites.

With the NT6D80 Multi-purpose Serial Data Link (MSDL) Cards, a maximum of 64 I/O ports is supported (there are four ports per card; up to 16 cards can be configured). However, the maximum number of AML ports supported remains at 16.

Several types of I/O ports are available, each with its own unique protocol and bandwidth characteristics. The bandwidth of an I/O port may constrain the amount of information which can be exchanged over that link.

IPE Modules

The distance allowed between a network card and the peripheral equipment module it serves is limited to a maximum network cable length of 13.7 m (45 ft). A peripheral equipment module can be placed anywhere in the system, as long as it is within the range of the network cable.

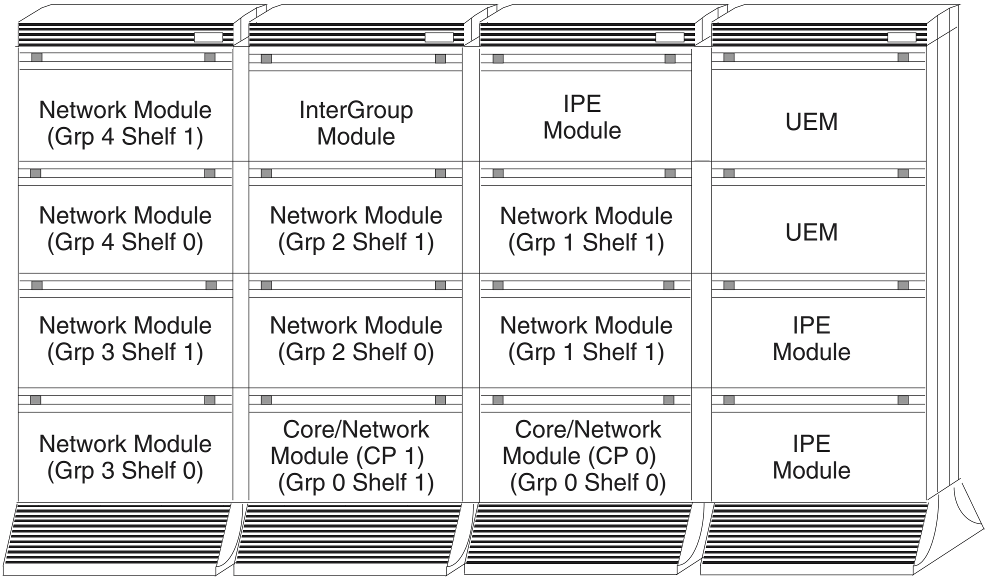
Network Modules

The modules for each network group must be located together and in the same column (see Figure 9 on page 41):

- The two modules that house each full network group are placed one on top of the other, with the module for Shelf 0 on the bottom.
- The modules that house Group 0 are located in column 0; the modules that house Group 1 are located in column 1.
- Additional network groups are added to the left of the CP columns.

Figure 9 on page 41 shows a Meridian 1 Option 81C CP PII. This Large System provides one network group (Group 0) in the two Core/ Network Modules.

Figure 9
Meridian 1 Option 81C CP PII with network groups



Note: Modules labeled "UEM" can be application modules (such as Meridian Mail), Network Modules configured for PRI/DTI , PE Modules, RPE Modules, or additional IPE Modules.

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Intergroup Module NT8D36

The Intergroup switch (IGS) card provides speech path switching between network groups for the Meridian 1 Option 81C CP PII.

Fibre Network Fabric

Fibre Network Fabric allows the expansion of Meridian 1 Option 81C CP PII system from five network groups to eight network groups, a 60% increase in port and trunk capacity.

The Intergroup cards and Intergroup module in current systems are replaced by a Dual Ring fiber optic network. The Fibre Network Fabric provides complete non-blocking communication between the network groups, eliminating the incidence of busy signals for calls switched between groups.

A fiber network of eight network groups provides 7680 timeslots for 3840 simultaneous conversations.

Upgrades are achieved by replacing the Intergroup cards in the Core/Net and Network modules with Fiber Junctor Interface (FIJI) cards. These FIJI cards are connected with fiber optic cable to form a Dual Ring Fiber Network. In this new configuration, the Intergroup module is no longer used. The module can be left in place, or removed. The Intergroup module can also be converted into an IPE module with the IPE Expansion kit.

In CP3 and CP4 systems existing cCNI cards are replaced with CNI-3 cards to increase the maximum number of network groups to eight. Each CNI-3 card connects to a maximum of three network groups. A combination of two port cCNI cards and three port CNI-3 cards can be used in a system. Large system CP PII systems need to add additional NT4N65 cCNI cards as required for additional network loops.

Software Package 365 must be activated.

Succession Signaling Server

Succession 1000M systems use a Succession Signaling Server. The Succession Signaling Server provides a central processor to drive the signaling for Internet Telephones and IP Peer Networking. The Succession Signaling Server is an industry-standard, PC-based server. It provides signaling interfaces to the IP network using software components that operate on the VxWorks™ real-time operating system.

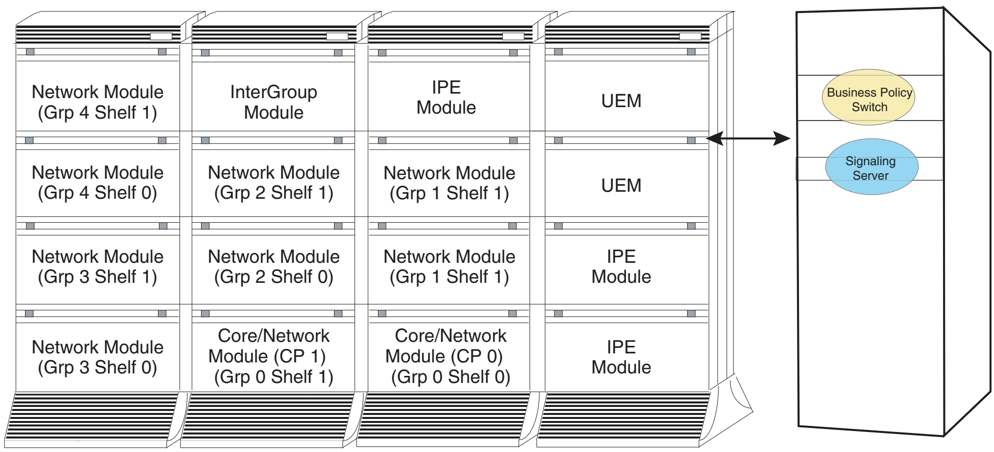
The Succession Signaling Server can be installed in a load-sharing redundant configuration for higher scalability and reliability. The following software components can operate on the Succession Signaling Server:

- Terminal Proxy Server (TPS)
- H.323 Gateway Signaling software

- H.323 Gatekeeper software (optionally redundant)
- Succession 1000 Element Manager web server

Signaling Server is an application server which houses any combination of Gatekeeper, H.323 Gateway, Line Terminal Proxy Server and Element Manager. The signaling server is mounted in a 19" rack. (See Figure 10.)

Figure 10
Succession 1000M Large System



Note: Modules labeled "UEM" can be application modules (such as Meridian Mail), Network Modules configured for PRI/DTI , PE Modules, RPE Modules, or additional IPE Modules.

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Element Manager is negligible in system impact, and can reside with any other element. This section therefore concentrates on the first three software elements of the Succession Signaling Server.

The TPS, Gatekeeper, and Gateway can co-exist on one Succession Signaling Server or reside individually on separate Succession Signaling Servers, depending on traffic and redundancy requirement. A brief description of each element’s function and engineering requirement follows.

Terminal Proxy Server (TPS)

A TPS handles initial signaling exchanges between an Internet Telephone and the Succession Signaling Server. TPS capacity is limited by a software parameter limit of 5000 Internet Telephones. The TPS hardware processor capacity limit is unknown at time of publication, but is expected to be higher than the software limit.

The redundancy of TPS is under the mode of N+1. Therefore one extra Succession Signaling Server can be provided to cover TPS functions from N other servers.

Gatekeeper

The capacity of the Gatekeeper is limited by the endpoints it serves and the number of entries at each endpoint. Any potential hardware limits are the Succession Signaling Server processing power and memory limits.

Since a Gatekeeper is a network resource, its capacity is a function of the network configuration and network traffic (IP calls). Some basic network information is required to engineer a Gatekeeper.

The redundancy of the Gatekeeper is in a mode of $2 \times N$. Therefore an alternate Gatekeeper can only serve the Gatekeeper it is duplicating.

Gateway

The IP Peer H.323 Gateway trunk, or H.323 Trunk, provides the function of a trunk route without a physical presence in the hardware.

The H.323 Trunk is limited by a software limitation of 382 virtual trunks per route. Beyond that, a second Succession Signaling Server is required.

In addition, deciding to combine the Terminal Proxy Server, Gatekeeper, and H.323 Trunk is determined by traffic associated with each element, and the required redundancy of each function.

The redundancy mode of the Gateway is $2 \times N$. Two Gateways handling the same route can provide redundancy for each other, but not other routes.

For detailed Succession Signaling Server engineering rules and guidelines see “Succession Signaling Server Algorithm” on page 357.

Network equipment

The network is a collection of paths over which voice and data information can be transmitted. A Succession 1000M or Meridian 1 network is digital, meaning that the voice and data information is encoded in digital form for transmission. These digital signals are multiplexed together on a physical entity called a “loop.” Each path or “channel” on a loop is identified by its “time slot,” which signifies the order in which the data is placed on the loop during the multiplexing operation.

Loops transmit voice, data, and signaling information over bidirectional paths between the network and peripheral ports (that is, two channels are allocated for each conversation, one in each direction). The network is designed so that any terminal can be connected, through proper assignment of time slots, to any other (functionally compatible) terminal on the system. The technology used is called space switching and time division multiplexing.

The use of transmission channels in the switch is known as “traffic.” Traffic is generated by terminals (sets and trunks). Each loop or superloop has a capacity for traffic which is a function of the number of time slots available, and the blocking level which the user is willing to accept. Blocking is the probability that a caller will not be able to complete a call because there is no time slot available at the particular time it is needed. The higher the traffic, the higher the blocking. A typical acceptable level of network blocking is P.01, which means 1% of all calls (1 in 100) will be blocked, on the average.

Network cards

Network cards are the physical devices which digitally transmit voice and data signals. Network switching also requires service loops (such as conference and Tone and Digit Switch [TDS] loops) that provide call progress tones and outpulsing.

Five cards provide basic network switching control.

1. The NT8D04 Superloop Network Card provides switching for four loops grouped together in an entity called a superloop.
2. The QPC414 Network Card provides switching for two loops.
3. NT5D12 and NT5D97 Digital Trunk Card replace the functionality of the QPC720 DT/PRI and QPC414 Network card.
4. NT5D12 has two DTI/PRI loops and take one network slot.
5. NT5D97 has two DTI2/PRI2 loops and take one network slot.

cCNI configuration Meridian 1 Option 61C and Meridian 1 Option 81C CP PII)

In the NT4N41 Core/Net Module, port 0 on the NT6D65 Core to Network Interface (cCNI) Card in slot 12, supports a half-group. This half-group does not have to be group 0 however in a new system it is normally configured as group 0. Communication between the cCNI and 3PE cards for group 0 is accomplished through the backplane; no cable is required.

There are two ports on each cCNI card. cCNI cards are added when additional Network groups are required.

The default (factory) cCNI port assignments are shown in Table 3 on page 47. cCNI cards provide ports for two Network groups each. These connections are made from the backplane of the Core/Net modules.

Network groups configuration is flexible. Any cCNI port may support any given network group, however, for ease of maintenance, associate network groups and cCNI ports in a logical sequence. Refer to Table 3 on page 47 for a typical cCNI port assignment and the associated network group. Port 0 of the cCNI in slot 12 and the 3PE card are hard wired at the module's backplane.

The NT4N41 Core/Network Module is also used in Meridian 1 Option 61C CP PII. Again, port 0 is dedicated to group 0 and the cCNI card must be installed in slot 9. Port 1 is not used because the Meridian 1 Option 61C CP PII is a single group system.

Table 3
Typical cCNI configurations with Meridian 1 Option 81C CP PII

cCNI card slot / port	Network group supported
cCNI 9 / Port 0	Group 0
cCNI 9 / Port 1	Group 1
cCNI 10 / Port 0	Group 2
cCNI 10 / Port 1	Group 3
cCNI 11 / Port 0	Group 4
cCNI 11 / Port 1	Group 5
cCNI 12 / Port 0	Group 6
cCNI 12 / Port 1	Group 7
Note: You do not have to configure both ports on a cCNI card.	

Network organization

On most systems, network loops are organized into groups.

- A Succession 1000M Half Group system provides up to 16 loops
- A Succession 1000M Single Group system provides up to 32 loops
- A Succession 1000M Multi Group system with IGS provides up to 160 loops
- A Succession 1000M Multi Group system with the Fibre Network Fabric (FNF) feature provides up to 256 loops

FNF offers an improved architecture in which intergroup traffic is carried on two counter-rotating fiber-optic SONET rings with enough capacity to prevent blocking.

Network configuration

Network switching cards digitally transmit voice and data signals. Network switching also requires service loops (such as conference and TDS loops), which provide call progress tones and outpulsing. The NT8D04 Superloop Network Card provides four loops per card. It is grouped together in an entity called a superloop.

The system network loops are organized into groups. A system is generally configured as a:

1. Half-group system which provides up to 16 loops.
2. Full-group system which provides up to 32 loops.
3. Multiple-group system which provides up to 256 loops.

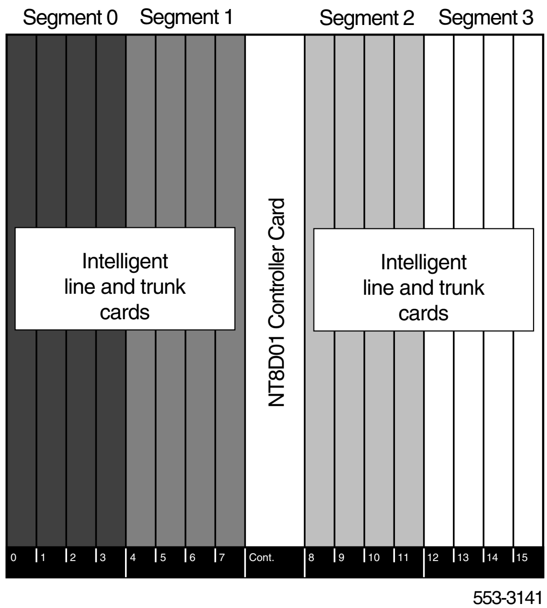
An additional switching stage is required for switching to be performed between groups in multiple-group configurations. This switching stage, an extension of the originating and terminating network loops, is provided by intergroup switch cards and the junction board in the InterGroup Module.

Superloop network configurations

By combining four network loops, the superloop network card makes 120 traffic timeslots available to IPE cards. The increased bandwidth and larger pool of timeslots provided by a superloop increases network traffic capacity for each 120-timeslot bundle by 25 percent (at a P0.1 grade of service).

The NT8D37 IPE Module is divided into segments of four card slots numbered 0-3 (see Figure 11 on page 49). Segment 0 consists of slots 0-3, segment 1 consists of slots 4-7, segment 2 consists of slots 8-11, and segment 3 consists of slots 12-15. A superloop can be assigned from one to eight IPE segments.

Figure 11
Superloop segments in the IPE Module



A superloop is made up of NT8D04 Superloop Network Cards, NT8D01 Controller Cards, and from one to eight IPE segments. The NT8D01BC Controller-4 Card interfaces with up to four superloop network cards. The NT8D01BD Controller-2 Card interfaces with up to two superloop network cards.

The following superloop-to-segment configurations are supported:

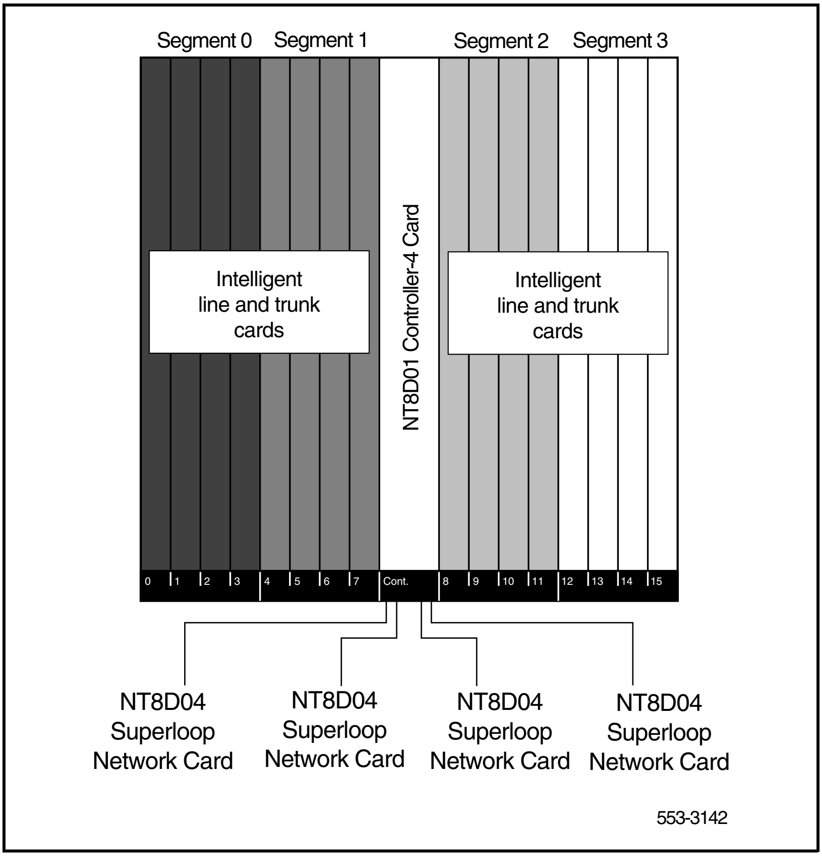
- One segment per superloop
- Two segments per superloop
- Four segments per superloop
- Eight segments per superloop
- One segment per superloop/three segments per another superloop
- Two segments per superloop/six segments per another superloop

One segment per superloop

A configuration of one segment per superloop requires four superloop network cards and one NT8D01 Controller-4 Card (see Figure 12).

If the segment is equipped with digital line cards that have all 16 voice and all 16 data terminal numbers (TNs) provisioned, this configuration provides a virtual non-blocking environment (120 traffic timeslots to 128 TNs).

Figure 12
One segment per superloop



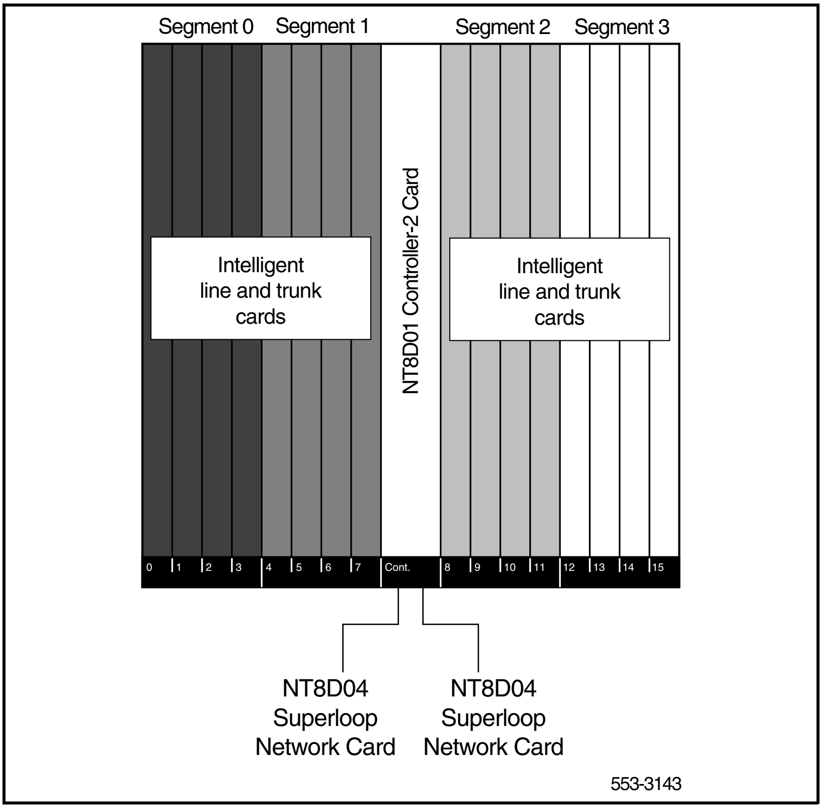
Two segments per superloop

A configuration of two segments per superloop requires two superloop network cards and one NT8D01 Controller-2 Card (see Figure 13).

If the segments are equipped with analog line cards and trunk cards, this configuration provides a virtual non-blocking environment (120 traffic timeslots to 32-128 TNs).

If half of the data TNs on digital line cards are enabled, this configuration still provides a low concentration of TNs to timeslots (120 traffic timeslots to 196 TNs) and a very low probability of blocking.

Figure 13
Two segments per superloop



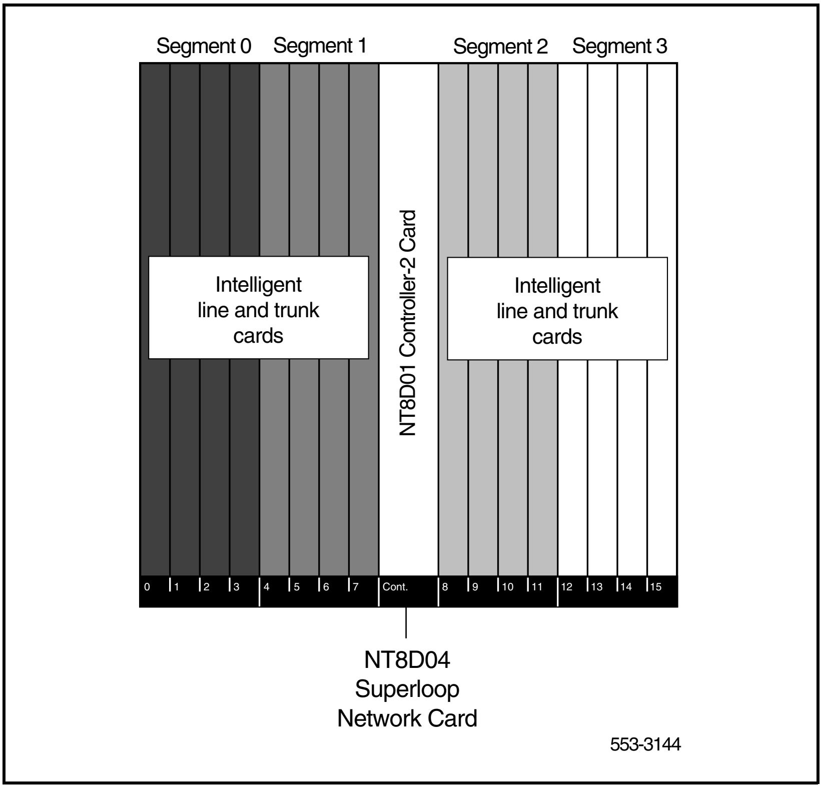
Four segments per superloop

A configuration of four segments per superloop requires one superloop network card and one NT8D01 Controller-2 Card (see Figure 14).

If the segments are equipped with analog line cards and trunk cards, this configuration provides a medium concentration environment (120 traffic timeslots to 64-256 TNs).

If half of the data TNs on digital line cards are enabled, this configuration provides a concentration of 120 traffic timeslots to 384 TNs.

Figure 14
Four segments per superloop



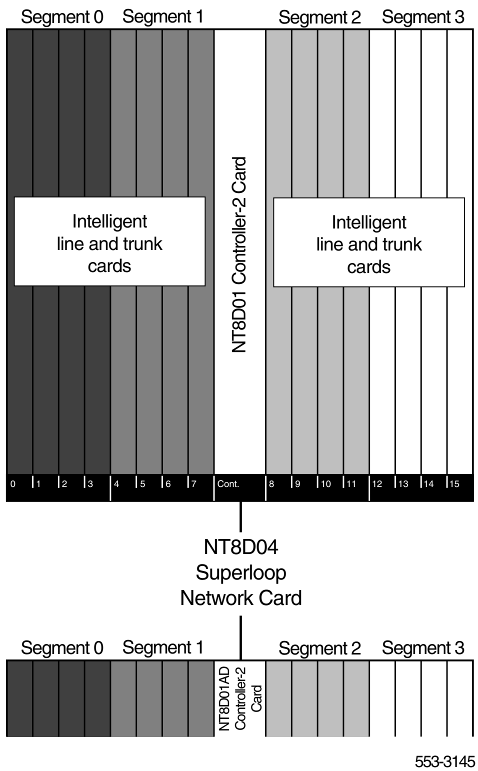
Eight segments per superloop

A configuration of eight segments per superloop requires one superloop network card and two NT8D01 Controller-2 Cards (see Figure 15).

If the segments are equipped with analog line cards and trunk cards, this configuration provides a high concentration environment (120 traffic timeslots to 128-512 TNs).

If half of the data TNs on digital line cards are enabled, this configuration provides a concentration of 120 traffic timeslots to 768 TNs.

Figure 15
Eight segments per superloop



One segment per superloop/three segments per another superloop

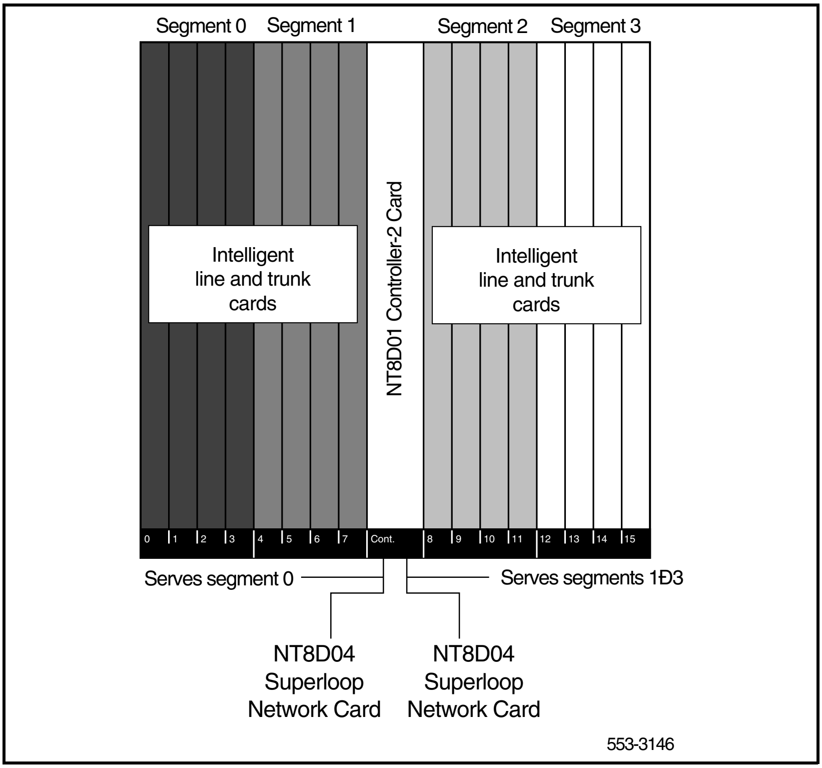
A configuration of one segment per superloop/three segments per another superloop requires two superloop network cards and one NT8D01 Controller-2 Card (see Figure 16).

This configuration provides:

1 A virtual non-blocking environment (120 traffic timeslots to 128 TNs) for the single segment served by the first superloop.

2 A medium concentration of TNs to timeslots for the three segments assigned to the additional superloop.

Figure 16
One segment per superloop/three segments per superloop



Two segments per superloop/six segments per another superloop

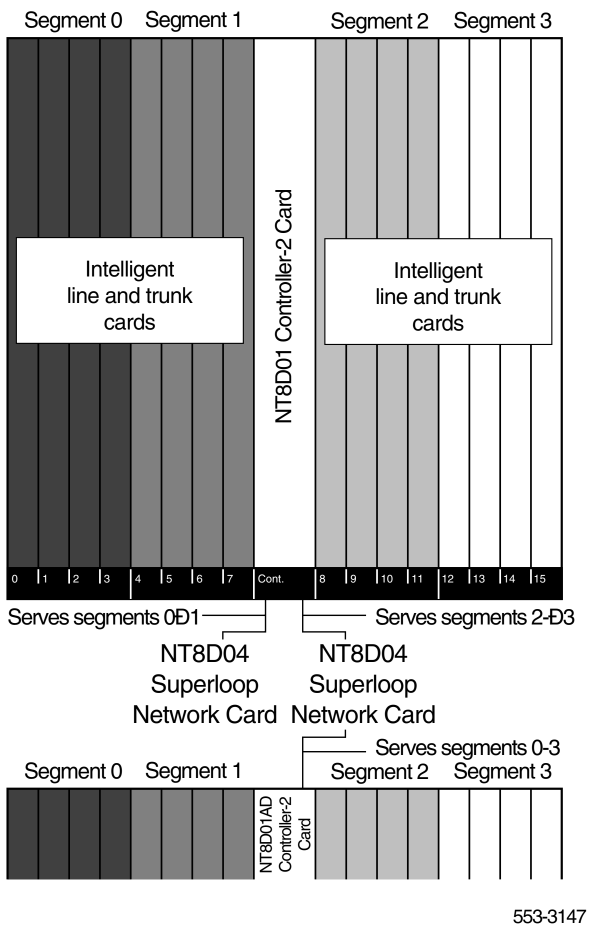
A configuration of two segments per superloop/six segments per another superloop requires two superloop network cards and two NT8D01 Controller-2 Cards (see Figure 17 on page 56).

This configuration provides:

1 A virtual non-blocking environment for the two segments served by the first superloop (or a very low concentration of TNs to timeslots if some data TNs are enabled).

2 A medium concentration of TNs to timeslots for the six segments assigned to the additional superloop.

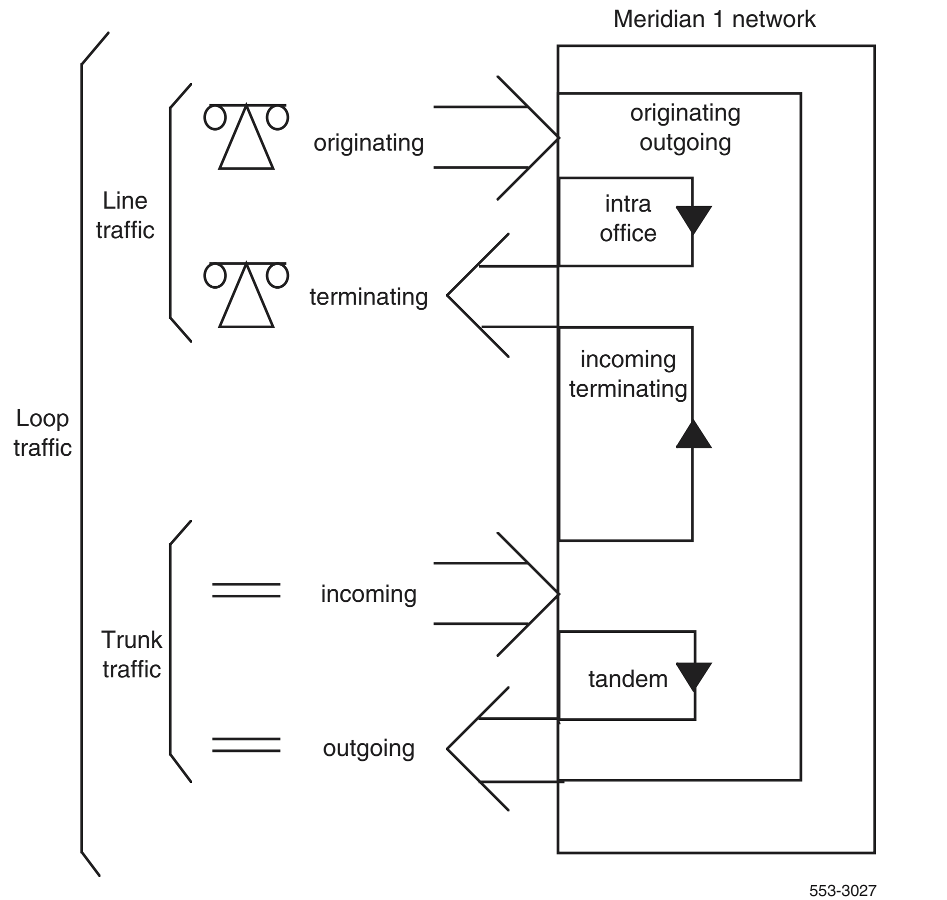
Figure 17
Two segments per superloop/six segments per superloop



Traffic configuration

The traffic distribution when considering individual customer or system traffic is shown in Figure 18.

Figure 18
Traffic distribution



Network loop traffic

Typically, initial equipment is configured at an 85 percent utilization level to leave room for expansion. The traffic level per network loop depends on whether or not the peripheral equipment uses Digitone equipment:

- 3500 CCS is the capacity of a fully loaded superloop
- 2975 CCS is 85 percent utilized
- Digitone traffic is a part of the capacity

Partitioning

The Succession 1000M and Meridian 1 Large System can be configured as a partitioned or non-partitioned system when it serves more than one customer.

A partitioned system dedicates each customer and the customer's associated lines and trunks to actual partitioned segments of the system in terms of loops and modules. Consoles and Digitone receivers are normally spread over all loops and modules in a partitioned system.

In a non-partitioned system, all customers, trunks, lines, consoles, and Digitone receivers are spread over all loops and modules. A non-partitioned system provides the following advantages:

- Fewer traffic loops are required
- Fewer peripheral equipment (IPE) modules and cards are required
- System call-carrying capacity is more easily achieved and maintained
- Customers are distributed evenly over the loops
- Load balancing is more easily accomplished

Network loop assignment

When assigning the loop number in systems equipped with two Network Modules, distribute the load evenly across both modules. Record the loops used in Worksheet 1: Load balancing on page 407.

Distribute the total number of IPE Modules over the total number of voice and data loops. Normally, one IPE Module is assigned to a superloop. However, one IPE Module can be assigned from one to as many as four superloops, depending on the concentration of terminal number-to-timeslot ratio.

Compute the number of network groups based on the total number of loops required (excluding conference/TDS loops). Use Table 4 and the following equation to find the number of network groups required:

> Total number of loops
> = (4 × the number of superloop network cards) + (2 × the number of QPC414 Network Cards)

Table 4
Loop number assignment

Number of groups	Loop assignments
1	28
2	56
3	84
4	112
5	140
6	168
7	196
8	224

Peripheral equipment

Peripheral equipment refers to the hardware devices that connect ports (lines and trunks) to the network (loops). Since most ports have analog voice channels, and the network is digital, peripheral equipment cards must convert the signals received from ports from analog to digital.

A process called pulse code modulation (PCM), is used to convert analog signals to digital signals before switching is performed by the network. This conversion method samples the amplitude of the analog signal at a rate of twice the highest signal frequency, then converts the amplitude into a series of coded pulses. For telecommunications, the PCM-sampling frequency standard is 8 kHz.

Compressing-expanding (companding) PCM is a standard technique for using 8-bit words to efficiently represent the range of voice and data signals. Two standards for companding, A-Law and μ-Law, are recognized worldwide.

Intelligent peripheral equipment (IPE) conforms to both standards. The standard is selected through software. IPE cards are supported by NT8D04 Superloop Network Card loops. IPE cards are housed in the NT8D37 IPE Module.

Intelligent peripheral equipment includes:

- Controller cards that provide timing and control sequences and monitoring capabilities.
- Analog and digital line and trunk cards that provide interfaces to equipment outside the modules (such as telephones, data terminals, and trunks).

Table 5 on page 61 lists the IPE cards and the number of terminations each supports.

Each equipment card contributes traffic to the network. The traffic required by a peripheral equipment card is the sum of the traffic generated by the ports (sets or trunks) serviced by the card. The traffic requirements of all peripheral equipment cards provisioned on a particular network loop must match the traffic capacity of that loop.

IPE configuration

As described in "Superloop network configurations" on page 48, an IPE Module is divided into segments of four card slots that are assigned to superloops. A superloop combines four regular network loops to make 120 traffic timeslots available to the IPE cards. There can be from one to eight segments in a superloop, in a number of configurations. Each configuration is selected based on system traffic requirements and the specific IPE cards used.

Preferably, a superloop should be configured to serve an even number of segments. You should assign full traffic and IPE cards to one superloop before assigning the next superloop. However, there may be empty IPE slots associated with a superloop if the superloop is not assigned to exact multiples of eight cards. As the system grows, more IPE cards can be added to that superloop.

The total number of ringing generators required in a system can be minimized by consolidating analog line cards in as few IPE Modules as possible. However, for traffic and reliability purposes, the analog line cards must not fill more than three-fourths of the IPE Module.

Succession Voice Gateway Media Cards should be configured in IPE segments engineered to be non-blocking. CallPilot 201i should be configured in IPE segments engineered to be non-blocking.

Table 5
Intelligent peripheral equipment

Intelligent peripheral equipment cards	Number of terminations
Controller cards:	
– NT8D01 Controller card - 4	N/A
– NT8D01 Controller card - 2	N/A
Line cards:	
– NT8D02 Digital Line card	16 to 32
– NT8D09 Analog Message Waiting Line card	16
Trunk cards:	
– NT8D14 Enhanced Universal Trunk card	8
– NT8D15 E&M Trunk card	4
Note: Terminal number (TN) density per segment is 16 to 128 TNs, with 64 to 512 TNs per IPE Module. The maximum TN density assumes all slots are equipped with NT8D02 Digital Line Cards with 16 voice and 16 data TNs provisioned. A typical mix of line and trunk cards yields a nominal density of 64 TNs per segment, 256 TNs per IPE Module.	

Succession Media Card

Succession Media Cards (32 port) should be distributed to a maximum of 3 per superloop $3 \times 32 = 96$ which leaves 24 timeslots for another card). ITG-P (24 port) cards should be distributed to a maximum of 5 per superloop $5 \times 24 = 120$ leaving no other circuits supported).

Peripheral equipment card distribution

Use Worksheet 2: Circuit card distribution on page 408 to determine the total number of each type of IPE card (line, trunk, DTR) for each IPE Module.

Use Worksheet 3: Multiple appearance group assignments on page 409 and Worksheet 4: Station load balancing on page 410 to determine the number of multiple appearance groups (MAGs) assigned to each loop (use Worksheet 5: Multiple appearance group record on page 411 as an MAG record sheet). Distribute MAGs evenly over all the loops.

Do not assign MAGs that call each other frequently to the same loop; assign them to the same network group to reduce intergroup calls in multiple network group systems. If possible, avoid MAGs of more than ten.

Within a multiple network group system, assign users that call each other frequently to the same network group. Similarly, assign trunk groups that are used primarily by certain groups of users within the same network group as those users.

Card slot priority

Input messages from card slots 0 and 1 in each IPE Module are directed to a high-priority input buffer. The input messages from the remaining slots are directed to a low-priority input buffer. To minimize input buffer delay on signals from devices in high-priority card slots, the system processes the low-priority input buffer only when the high-priority buffer and 500-type telephone output buffers are empty. This mechanism is important only for the types of trunks that require critical timing.

Class-Of-Service priority

Selected telephones and trunks can be assigned a high-priority class of service that allows their requests for dial tone to be processed first. The fewer the telephones and trunks assigned as high priority, the better the service will be during heavy load conditions.

Card slot assignment for trunks

The recommended card slot assignment for trunks is as follows:

- Always assign automatic inward and outward dial trunks to card slots 0 and 1.
- If possible, assign delay dial, wink start, and DTMF-type trunks to a high-priority card slot. Other types of trunks can be assigned to high-priority card slots to avoid glare, but can also be assigned to low-priority card slots (2 through 10).
- To minimize the number of high-priority input messages during pulsing, do not assign trunks using 10 or 20 pps (incoming) to a high-priority card slot unless necessary.

Card slot assignment for attendant consoles

Do not assign attendant consoles to a high priority card slot. Too many high priority messages from attendant consoles assigned to these card slots can result in delays in output messages to attendant consoles, telephones, and trunks. Always assign attendant consoles to card slots 2 through 10. Do not assign a large number of attendant consoles to the same network loop since buffer overflow may result.

Card slot assignment for analog (500/2500-type) telephones

The 500/2500-type telephones can be assigned to any card slot. However, assigning a 500/2500-type telephone to a high-priority card slot can cause input messages to delay output buffer processing during pulsing.

Card slot assignment for Voice Gateway Media Cards

Voice Gateway Media Cards can be assigned to any slot. The slot should be in a non-blocking segment.

Table 6
Voice Gateway Media Card capacity

Parameter	Capacity
Meridian 1 Option 61C CP PII or Meridian 1 Option 81C CP PII	— 10 cards in each IPE cabinet (Class B) — no more than 3 cards per superloop

Note: Within the limits above, the ITG-Pentium 24-port card has the following additional requirements:

Table 7
ITG-Pentium 24-port card additional requirements

Parameter	Capacity
Meridian 1 Option 61C CP PII and Meridian 1 Option 81C CP PII	— 4 cards in each IPE cabinet (Class B rating) — Class A no additional restrictions
Note: CallPilot MGate or 201i can be assigned to any slot. The slot should be in a blocking segment.	

Assigning card slots

Use Worksheet 6: Circuit card to module assignment on page 412 to assign cards to slots in all peripheral equipment modules. Calculate the average load after all cards of a particular type have been assigned. Total the load and keep a running total. This method prevents the need to interchange cards at the end of the process because of load imbalance.

Assign cards in the order listed below:

1. Assign cards requiring a high priority slot.

   Note: For IPE Modules, both card slots 0 and 1 are reserved for high-priority signaling.

2. Assign cards for high-usage trunks, such as central office (CO) trunks.
3. Assign cards for low-usage trunks, such as paging and dictation.
4. Assign cards for attendant consoles.
5. Assign DTR cards.
6. Assign cards for telephones associated with multiple appearance groups.
7. Assign remaining cards. On a system that has a high density of Digitone telephones, assign the least number of 500-telephone line cards to loops that have DTRs assigned.

   Note: Distribute loops and conference/TDS cards evenly across network modules and groups.

8. Calculate the total load per module.
9. Calculate the total load per loop.
10. If required, rearrange card assignments to balance the load.

Assigning terminal numbers

Once the cards are assigned, the individual units on each card can be assigned. Use Worksheet 7: Terminal number assignment on page 413 to record the terminal number (TN) assignments. TN 0000 cannot be used on superloop 0. Therefore, assign loop 0 to a QPC414 Network Card.

Terminal equipment

Succession 1000M and Meridian 1 Large Systems support a wide range of telephones, including multiple-line and single-line telephones, as well as digital telephones with key and display functions and data transmission capabilities. A range of options for attendant call processing and message center applications is also available. In addition, a number of add-on devices are available to extend and enhance the features of telephones and consoles. Add-on devices include key/lamp modules, lamp field arrays, handsets, and handsfree units.

Digital telephones

In digital telephones, analog-to-digital conversion takes place in the set itself, rather than in the associated peripheral line card. This eliminates attenuation, distortion, and noise generated over telephone lines. Signaling and control functions are also handled digitally. Time compression multiplexing (TCM) is used to integrate the voice, data, and signaling information over a single pair of telephone wires.

For applications where data communications are required, digital telephones offer an integrated data option that provides simultaneous voice and data communications over single pair wiring to a port on a digital line card.

The following digital telephones are supported:

- M2006 single-line telephone
- M2008/M2008HF standard business telephone
- M2216 Automatic Call Distribution (ACD) telephone
- M2317 intelligent telephone
- M2616 performance-plus telephone
- M3110 telephone
- M3310 telephone
- M3820 telephone
- M3900 telephone
- M3901 telephone
- M3902 telephone
- M3903 telephone
- M3904 telephone
- M8000 telephone

- M8009 telephone
- M8314 telephone
- M8417 telephone

Refer to *Telephones and Consoles: Description* (553-3001-367) for digital telephone details.

IP Telephones

i2002 Internet Telephone

The i2002 Internet Telephone brings voice and data to the desktop environment and connects directly to the LAN through the Ethernet connection. Similar in appearance and functionality to the i2004 Internet Telephone, the i2002 Internet Telephone has a smaller display and fewer feature keys.

i2004 Internet Telephone

The i2004 Internet Telephone connects directly to the LAN through an Ethernet connection bringing voice and data to the desktop environment. The i2004 Internet Telephone translates voice into data packets for transport using Internet Protocol. A Dynamic Host Configuration Protocol (DHCP) server can be used to provide information that enables the i2004 Internet Telephone network connection, and connection to the Succession Media Card. The i2004 Internet Telephone uses the customer's IP network to communicate with the Call Server.

i2050 Software Phone

The i2050 Software Phone is a Windows-based application that enables voice to make your computer a powerful tool. The i2050 Software Phone provides most of the attributes and features of the i2004 Internet Telephone. The i2050 Software Phone operates on PCs running Windows 98, Windows 98 SE, Windows 2000 Professional, Windows XP Pro, and Windows XP Home.

For more detailed information on IP Telephones, see *Internet Terminals: Description* (553-3001-368).

Attendant consoles

Attendant consoles (M2250) provide high volume call processing. Indicators and a 4 × 40 liquid crystal display provide information required for processing calls and personalizing call answering. Loop keys and Incoming Call Identification (ICI) keys allow the attendant to handle calls in sequence or to prioritize answering for specific trunk groups. An optional busy lamp field provides the attendant with user status.

Meridian attendant consoles support attendant message center options. The attendant console can be connected to an IBM® PC or IBM-compatible personal computers to provide electronic directory, dial-by-name, and text messaging functions. All call processing features can be accessed using the computer keyboard.

The Attendant PC software application software allows you to perform attendant console and call processing functions on a computer workstation using a mouse pointing device or keyboard within a Windows 95, Windows 98, Windows 2000 or Windows NT operating system environment.

Power equipment

The Succession 1000M and Meridian 1 provide a modular power distribution architecture.

Each column includes:

- A system monitor that provides:
  - power, cooling, and general system monitoring capabilities
  - error and status reporting down to the specific column and module
- Circuit breaker protection
- A cooling system with forced air impellers which automatically adjusts velocity to meet the cooling requirements of the Succession 1000M and Meridian 1 systems
- Backup capabilities

Each module includes:

- Individual power supply unit with shut-off (switch or breaker) protection
- Universal quick-connect power wiring harness which distributes input voltages and monitor signals to the power supply

All options are available in both ac-powered and dc-powered versions. The selection of an ac- or dc-powered system is determined primarily by reserve power requirements and existing power equipment at the installation site.

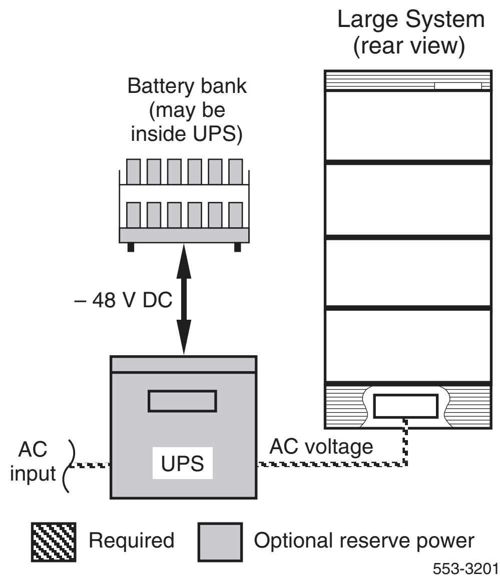
Although ac-powered and dc-powered systems have different internal power components, the internal architecture is virtually identical. Ac- and dc-powered systems differ primarily in the external power components.

Ac power

Ac-powered systems require no external power components and can plug directly into commercial ac (utility) power. Ac-powered systems are especially suitable for applications that do not require reserve power. They are also recommended for small to medium sized systems that require reserve power with backup times ranging from 15 minutes to 4 hours.

If reserve power is required with an ac-powered system, an uninterruptible power supply (UPS), along with its associated batteries (either internal or external to the unit), is installed in series with the ac power source (see Figure 19 on page 70). Ac-powered systems that do not require long-term backup can benefit from a UPS with short-term backup because the UPS typically provides power conditioning during normal operation, as well as reserve power during short outages or blowouts.

Figure 19
External ac-power architecture with reserve power

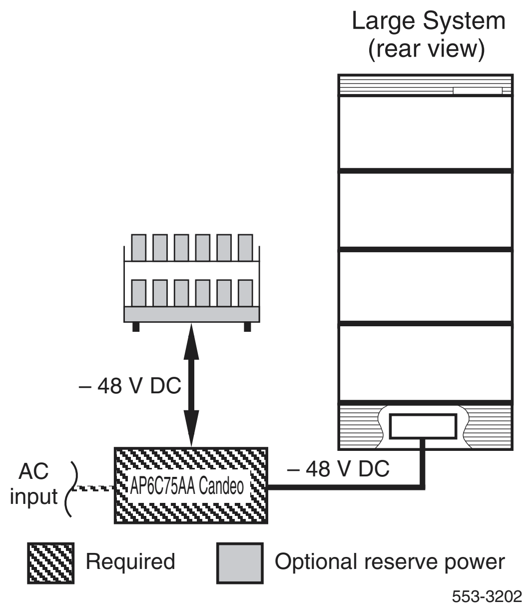


Dc power

Candeo dc-powered systems are available as complete systems, with external power equipment provided by Nortel Networks. These systems can also be equipped for customer-provided external power.

Dc-powered systems always require external rectifiers to convert commercial ac power into the standard –48V dc required within the system (see Figure 20 on page 71). Batteries are generally used with dc-powered systems, as the traditional telecommunications powering method is for the rectifiers to continuously charge a bank of batteries, while the system power “floats” in parallel on the battery voltage. However, batteries are required only if reserve power is needed.

Figure 20
External dc-power architecture with reserve power



Ongoing configuration

Ongoing assignment plan

Use the initial assignment records to complete an assignment plan for each equipped network loop in the system (see "System assignment plan" on page 414). Assignments for future trunks, Multiple Appearance Group (MAG) stations, consoles, and DTR requirements can be developed for each loop according to this profile.

Cutover study

Once the system is placed in service, a cutover study should be performed. The results of this study are used to update the loop profiles and create a new assignment plan. Ongoing assignments must follow the new assignment plan until the first customer busy-season trunking study. At that time, loop threshold measurements are set so that at least one of the predominant busy hours would produce a CCS load output.

Threshold study

From the threshold study printout, the loop profile must be updated and a new assignment plan developed. At this time, it is advisable to estimate the system capacity for growth. If the growth capacity is sufficient to last beyond the next annual threshold study, assignments can continue in accordance with the assignment plan. If the growth capacity is insufficient, plans must be made to establish a tentative date when new equipment (loops or modules) must be ordered and installed. This date is generally controlled by physical capacity and tracked by total working physical terminations.

Equipment relief

When additional equipment is installed, assignments should be concentrated on the new loop or modules until the first threshold study. At that time, the loop profile is updated and a new loading plan is developed. Any time a loop exceeds 560 CCS (based on an 85 percent traffic level), that loop must be suspended from future assignments. If a loop encounters service problems, it must be suspended and sufficient load removed to reduce service to an acceptable level.

Assignment records

The following printouts are available from the system. The printouts and the worksheets should be used to assist in maintaining assignment records:

- List of trunk route members
- List of TN blocks
- List of unused card positions
- List of unused units
- Directory number (DN) to TN matrix

Refer to *Features and Services* (553-3001-306) for information on obtaining and manipulating data in the system.

Module configuration

Contents

This section contains information on the following topics:

Introduction 73
CP PII NT4N41 Core/Network Module 74
NT5D21 Core/Network Module 76
NT8D35 Network Module 78
NT8D37 Intelligent Peripheral Equipment Module 82

Introduction

Each type of module is available in ac-powered and dc-powered versions.

Ac-powered modules generally require a module power distribution unit (MPDU) to provide circuit breakers for the power supplies. Dc-powered modules do not require an MPDU because a switch on each power supply performs the same function as the MPDU circuit breakers.

The figures in this section show a typical configuration for each module. (Dc power supplies are shown in these examples.)

CP PII NT4N41 Core/Network Module

This module provides common control and network interface functions in the Succession 1000M and Meridian 1 Large Systems. With Succession 1000M Multi Group and Meridian 1 Option 81C CP PII two Core/Net modules are installed side-by-side. With Succession 1000M Single Group and Meridian 1 Option 61C CP PII the modules are stacked or installed side by side.

The NT4N41 module contains the NT4N40 card cage which is divided into two distinct sides. The Core side and the Net side.

Core side

The Core side of the module houses the CPU, memory, up to four cCNI cards, and mass storage devices. These circuit cards process calls, manage network resources, store system memory, maintain the user database, and monitor the health of the system. These circuit cards also provide administration interfaces through a terminal, modem, or LAN.

Core cards and slot assignments are:

- Slots c9-c12: NT4N65 cCNI Core Network Interface card. Since each cCNI card can connect to two Network groups, each Core is connected to a minimum of two groups and a maximum of eight groups. The number of cCNI cards in a system depends on the number of Network groups in that system.

  Note: Succession 1000M Multi Group and Meridian 1 Option 81C with six or more network groups require the CNI 3-port card in the NT6D60 module.

- Slots c13-c14
- Slot c15: NT4N48 System Utility card
- Slot CP: NT4N64 CP PII Call Processor card (256 mb memory)
- MMDU: NT4N43 Multi-Media Disk Unit

Net side

The Net side of the module supports a Conference card, one Peripheral Signaling card, one 3-Port Extender card, and optional network cards. It can house up to four NT8D04 Superloop Network Cards, or eight QPC414 Network Cards, or a combination of the two, for a total of 16 network loops.

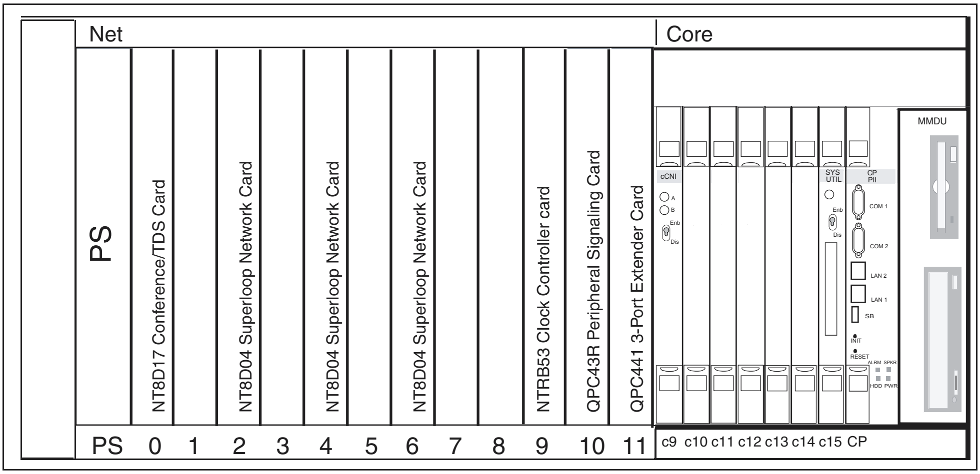
Net cards and slot assignments are:

- Slot 0: NT8D17 Conference/TDS card
- Slots 1-7: QPC414 Network card or NT8D04 Superloop Network card
- Slots 8-9: QPC412 IGS card, NT4D30 DIGS card or NTRB33 FIJI card

  Note: The Succession 1000M Multi Group and Meridian 1 Option 81C CP PII will support Fiber Network Fabric with FIJI cards in slots 8 and 9 on the Net side of the Core/Net Module.

- Slot 10: QPC43R Peripheral Signaling card
- Slot 11: QPC441 3-Port Extender card

Figure 21
CP PII NT4N41 Core/Net Module



NT5D21 Core/Network Module

This module is used for a dual CP, full group Meridian 1 Option 61C and for up to a five group Meridian 1 Option 81C. Both systems require two Core/ Network Modules.

The Core/Network Module supports up to 16 network loops. There are 12 card slots for the network interface cards and 7 slots for the CP, memory, and disk drive equipment listed below (see Figure 22 on page 78).

In the section labeled NET:

- Slots 0-7:
  - — NT1P61 Fiber Superloop Network Card
  - — NT8D04 Superloop Network Card
  - — NT8D17 Conference/Tone and Digit Switch (TDS) Card

- Primary Rate Interface/Digital Trunk Interface (PRI/DTI) card (slots 2-7 only)
- Serial Data Interface (SDI) card
- D-channel Handler Interface (DCHI) card (slots 0-7)
- Multi-purpose Serial Data Link (MSDL) card
- Multi-purpose ISDN Signaling Processor (MISP) card

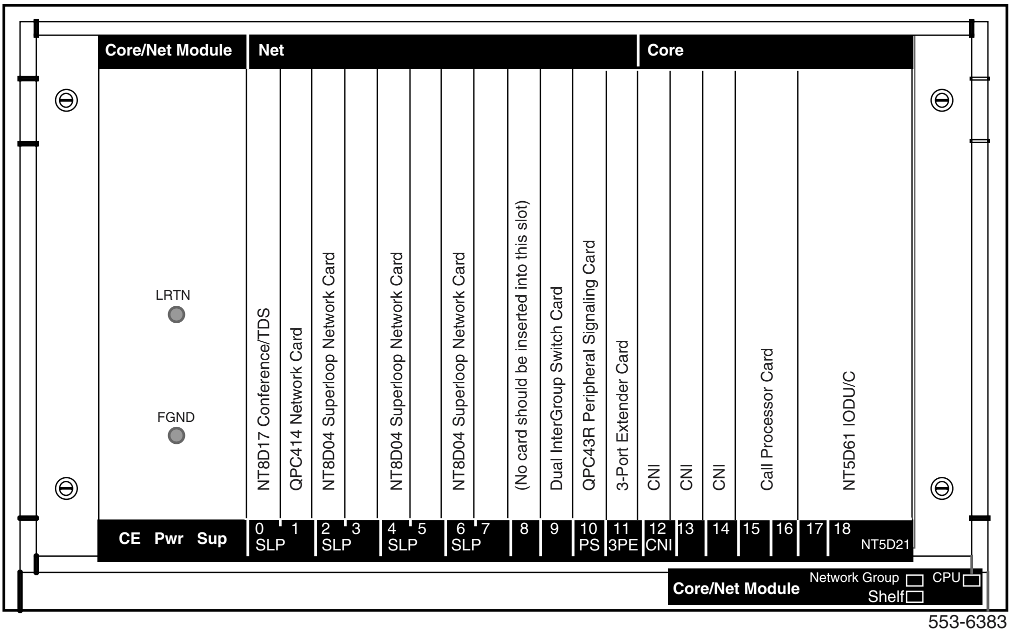
- Slots 8-9:
  - NTRB33 Fiber Junctor Interface (FIJI) Card and a spare slots for 61C
- Slot 10:
  - QPC43 Peripheral Signaling Card (minimum vintage R)
- Slot 11:
  - QPC441 3-Port Extender (3PE) Card (minimum vintage F)

In the section labeled Core:

- Slot 12:
  - NT6D65 Core to Network Interface (cCNI) Card
- Slot 13:
  - NT6D65 Core to Network Interface (cCNI) Card for 81C and a spare slot for Option 61C
- Slot 14:
  - NT6D65 Core to Network Interface (cCNI) Card for 81C and a spare slot for Option 61C
- Slots 15-16:
  - Call Processor Card
- Slot 17:
  - NT5D61 IODU/C

- In addition:
  - — NT8D41 SDI paddle boards can occupy slots 7 and 8 on the rear of the backplane
  - — QPC775 Clock Controller cards (all countries except USA) must be minimum vintage E

Figure 22
NT5D21 Core/Network Module configured as Meridian 1 Option 81C



NT8D35 Network Module

The Network Module houses up to four NT8D04 Superloop Network Cards, or eight QPC414 Network Cards, or a combination of the two, for a total of 16 network loops. The network cards are cabled to peripheral equipment controller cards in IPE Modules. In a typical configuration, one conference/ TDS card is configured in the module, leaving 14 voice/data loops available.

Two Network Modules are required to make a full network group of 32 loops. A maximum of ten Network Modules (five network groups) can be configured.

This module provides 15 card slots for the following network interface cards (see Figure 24 on page 81):

- Between PS and slot 1:
  - NTRE39 Optical Cable Management Card (OCMC)
- Slot 1:
  - QPC441 3PE Card
- Slots 2-3:
  - NTRB33 Fiber Junctor Interface (FIJI) Card
- Slots 2-3:
  - QPC412 InterGroup Switch (IGS) Card
- Slot 4:
  - QPC43 Peripheral Signaling Card
- Slots 5-12:
  - NT1P61 Fiber Superloop Network Card
  - NT8D04 Superloop Network Card
  - NT8D17 Conference/TDS Card
  - PRI/DTI card (slots 5-11 only)
  - SDI-type card
  - MSDL card
  - MISP card
- Slot 13:
  - Clock Controller for Meridian 1 Option 81C CP PII
- Slots 13-14:
  - PRI/DTI card

— SDI-type card (slot 13 only)

- Slot 15:

— not used

The Network Module can be used as a PRI/DTI expansion module. When it is used in this configuration, the Network Module can be used with any system Option. Figure 24 on page 81 shows the card slot configuration when the Network Module is used for PRI/DTI expansion.

Figure 23
NT8D35 Network Module

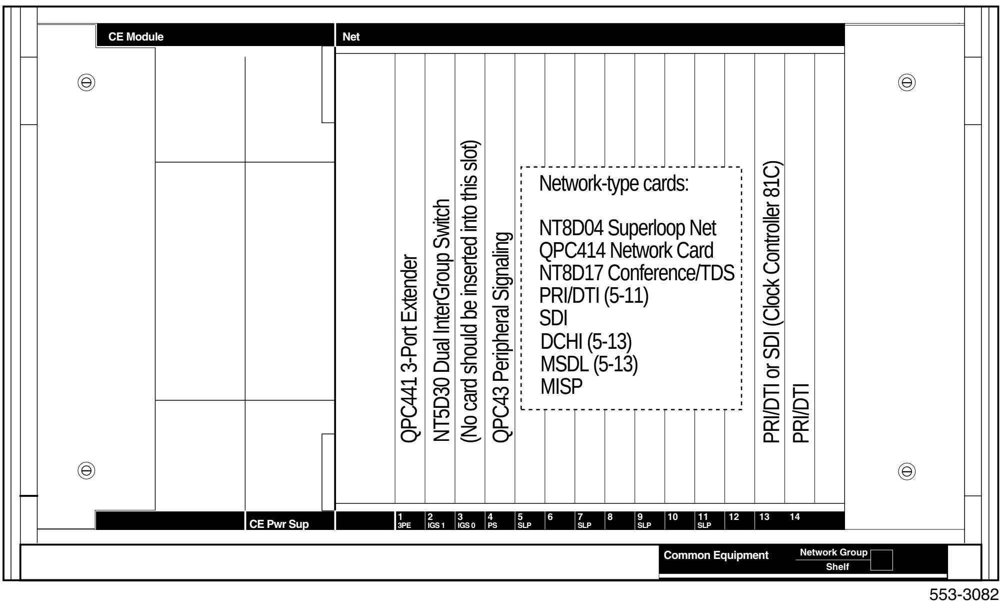
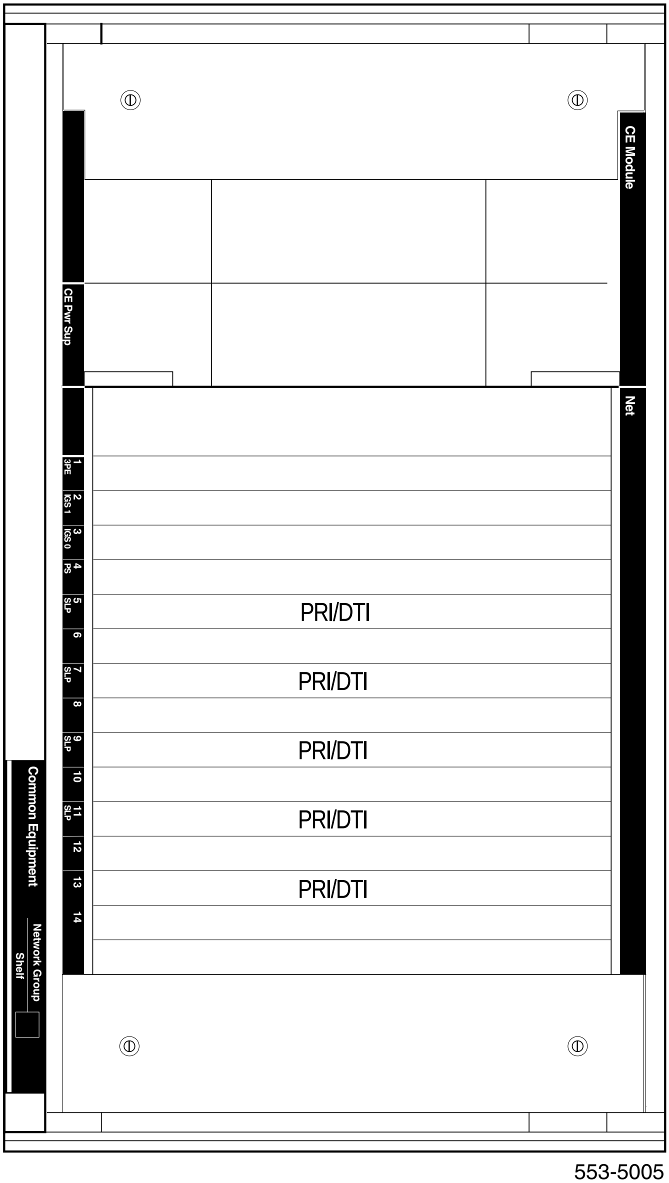


Figure 24
NT8D35 Network Module configured for PRI/DTI expansion



NT8D37 Intelligent Peripheral Equipment Module

This module can be used in all systems.

The IPE Module houses one NT8D01 Controller Card or one NT1P62 Fiber Peripheral Controller card and up to 16 IPE cards (such as line and trunk cards), supporting up to 512 terminal numbers (256 voice and 256 data). The controller card is cabled to the NT8D04 Superloop Network Card.

The controller card must be installed in the card slot labeled Cont (for controller). The other slots can house any IPE card (see Figure 25 on page 83).

> ***Note:*** When the backplane is configured for 16 cables (NT8D37 vintages BA and EC), the NT7D16 Data Access Card can be installed in any IPE slot. If the backplane is configured for 12 cables (NT8D37 vintages AA and DC), you must install the DAC in slots 0, 4, 8, or 12 because only those slots are fully cabled for 24 pairs.

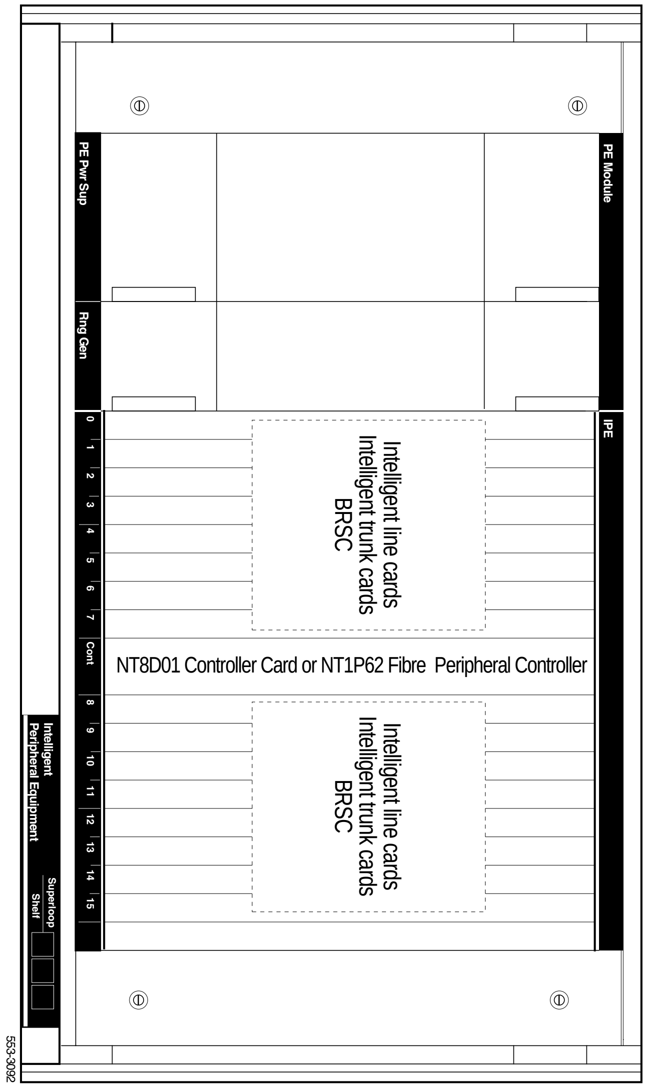
The IPE Module supports universal card slots for flexible configurations of Trunk/Line, Application cards, and Succession Media Cards.

Application cards

Application cards supported are:

- MIRAN
- MICB
- Voice Gateway Media Card
- Call Pilot VGate

Figure 25
NT8D37 IPE Module



Component power consumption

Contents

This section contains information on the following topics:

Introduction 85

Power consumption 88

Heat dissipation 90

Power calculation guidelines. 90

System upgrades 93

Powering upgraded systems from existing rectifiers 93

Introduction

Before you can calculate the total power consumption of your system configuration, you must have consumption figures for each component within the system.

The power consumption of intelligent peripheral equipment (IPE) and peripheral equipment (PE) circuit cards is given in Table 8 on page 86 and Table 9 on page 87.

Because electrical load varies depending on traffic load, some assumptions are made when presenting these figures:

- 25% of maximum capacity (9 CCS) for digital and analog lines
- 75% of maximum capacity (30 CCS) for trunks.

These figures also take into account the average efficiency of the module power supplies.

Table 8
Power consumption – IPE cards

Circuit card	Typical power (watts)
NT5K02 Flexible Analog Line card	20
NT5K17 Direct Dialing Inward Card	29
NT5K17 Direct Dialing Inward Card	29
NT5K19 DC5/AC15/RAN/Paging Trunk Card	29
NT1P62 Fiber Controller Card	26
NT7R52 Remote Carrier Interface	26
NT8D01AC Controller Card-4	26
NT8D01BC Controller Card-4 (SMT)	26
NT8D01AD Controller Card-2	26
NT8D02 Digital Line Card	20
NT8D03 Analog Line Card	16
NT8D09 Analog Message Waiting Line Card	16
NT8D14 Universal Trunk Card	28
NT8D15 E&M Trunk Card	34
NT8D16 Digitone Receiver Card	6

Table 9
Power consumption – PE cards

Circuit card	Typical power (watts)
NT1R20	YTD
NTND36	YTD
QPC578 Integrated Services Digital Line card	24.6
QPC789 16-Port 500/2500 (Message Waiting) Line card	26.4

Table 10 shows power consumption data for each fully configured module. Use this data for rectifier and reserve power (battery) calculation.

Table 10
Module power consumption (Part 1 of 2)

Module	Power consumption (watts)
NT4N40AA Core/Net Module	53.5
NT5D21 Core/Network Module	260
NT5K11 Enhanced Existing Peripheral Equipment (EEPE) Module	375
NT6D39 CPU/Network Module	360
NT6D44 Meridian Mail Module	240
NT6D60 Core Module	260
NT8D11 CE/PE Module	500
NT8D13 PE Module	240
NT8D34 CPU Module	260
NT8D35 Network Module	240
NT8D36 InterGroup Module	0

Table 10
Module power consumption (Part 2 of 2)

Module	Power consumption (watts)
NT8D37 IPE Module	460
NT8D47 RPE Module: — local site — remote site	 175 100
NT9D11 Core/Network Module	260
Application Equipment Module — single — dual	 210 420
Pedestal (with blower unit)	50

System power is calculated by adding the power consumption (in watts) of all equipped modules.

BTU (thermal load) = total power dissipation × 3.41

For air conditioning purposes, 1 ton = 1200 BTU.

Power consumption

The power consumption of intelligent peripheral equipment (IPE) circuit cards is given in Table 11 on page 89.

The traffic assumptions used are 25 percent active (9 CCS) for digital and analog lines, and 75 percent active (30 CCS) for trunks. These values take the average efficiency of the module power supplies into account.

The power consumption of digital line cards does not vary greatly with traffic, as it may with analog line cards.

Table 11
Power consumption – IPE cards

Circuit card	Power consumption (watts)
NT8D01AC Controller card-4	32
NT8D01AD Controller card-2	32
NT8D02 Digital Line card	24
NT8D09 Analog Message Waiting Line card	20
NT8D14 Universal Trunk card	36
NT8D15 E&M Trunk card	34
NT8D16 Digitone Receiver card	7
Succession Media Card	7.25

Table 12 shows power consumption data for fully configured modules. The data can be used for rectifier and reserve power (battery) provisioning.

Table 12
Power consumption – system module

Module	Power consumption (watts)
NT6D44 Meridian Mail Module	240
NT8D35 Network Module	240
NT8D37 IPE Module	460
NT4N41	53.5
NT4N46	53.5
Pedestal (with blower unit)	50

Power calculation algorithm

The method for calculating system power is based on the number of modules and columns in the system, regardless of how many cards are initially equipped. This method ensures that the external power supply provides adequate capacity, under all conditions and all possible growth scenarios, for the modules installed.

Heat dissipation

Large Systems are equipped with cooling systems and do not have heat dissipation problems under normal applications.

Power calculation guidelines

The method for calculating system power is based on the number of modules and columns in the system, regardless of how many cards are initially equipped. The method ensures that the external power supply provides adequate capacity, under all conditions and all possible growth scenarios, for the modules installed.

Using a system power consumption worksheet (Figure 26 on page 92), enter the quantity of each type of module, multiply by the power consumption per module, and then sum the individual module totals to obtain the total real power consumed by the system.

To calculate the current drain, divide the total real power consumption by the nominal input voltage. This gives the system current drain, or load in amperes. The worksheet shows nominal voltages of 208 (ac) input and 52 (dc) output. To calculate current drain for voltages other than those given in the worksheet, divide the total real power consumption by the desired voltage (such as 240 V AC or 54 V dc).

For calculations normally done for complex or apparent power (such as ac wire and panel size or the UPS rating for ac reserve power), divide the total real power in watts by the system power factor (typically 0.6) to obtain the complex power in volt-amperes (see Figure 26 on page 92).

If you are upgrading an installed system, you can determine the total power consumption of the installed system in several ways. Two methods are listed below (the first method is more accurate than the second):

- Measure current drain for the complete installation under actual operating conditions over at least a two-week period. Determine peak current drain from these measurements.
- Measure idle (or near idle) current drain for the complete installation. Estimate peak current drain by multiplying the number of idle amperes by 1.5.

When you add or upgrade equipment, use either of these methods to determine existing current drain/power consumption. Use the guidelines in this document to determine the added power consumption.

The existing power plant may have to be replaced or its capacity may have to be increased to accommodate added equipment. Be sure to provide sufficient capacity to accommodate future growth.

Figure 26
System power consumption worksheet

SYSTEM POWER CONSUMPTION WORKSHEET

Module	Quantity		Module power consumption		Total module power consumption
NT6D39	________	X	360	=	________
NT6D44	________	X	240	=	________
NT6D60	________	X	260	=	________
NT8D11	________	X	500	=	________
NT8D13	________	X	240	=	________
NT8D34	________	X	260	=	________
NT8D35	________	X	240	=	________
NT8D37	________	X	340	=	________
NT8D47	________	X	175	=	________
Pedestals	________	X	50	=	________
			Total real power (watts)	=	________

Current drain:

AC system:

$$\frac{\text{(total real power)}}{\text{(nominal AC voltage)} \quad 208} = \underline{\hspace{3cm}} \text{ amperes, AC}$$

DC system:

$$\frac{\text{(total real power)}}{\text{(nominal AC voltage)} \quad 52} = \underline{\hspace{3cm}} \text{ amperes, DC}$$

Comples (or apparent power) (AC only):

$$\frac{\text{(total real power)}}{\text{(power factor)} \quad 0.6} = \underline{\hspace{3cm}} \text{ volt-amperes (VA)}$$

553-5833

System upgrades

Both ac- and dc-powered system upgrade packages are available, although most of the module-level upgrades will be dc. However, the following suggestions are offered.

- Consider an ac upgrade if the existing system is not using reserve power. If reserve power is later desired, one or more UPS units can be added.
- If the existing system already has battery backup, or if there is an existing dc power plant or excess rectifier capacity, a dc upgrade package is usually chosen. For dc upgrades, there are several approaches to system powering:
  - Internal rectifiers that power the existing equipment may, in some cases, be connected in parallel to new external rectifiers in order to share a common battery string. The QBL15 Power Distribution Unit is typically used as an interface between the different power equipment.
  - An existing external dc power plant may be used as is, or expanded if necessary, to power both the existing equipment and the new equipment.
  - A new external dc power plant, such as the NT6D82 or Candeo may be purchased and installed to power both the existing and new equipment.

  Note: For all dc upgrades, carefully measure or calculate the system load of all equipment to make sure that the chosen power system will have enough capacity.

Consider each upgrade case individually, taking into account the existing equipment, space available at the site, and customer preferences.

Powering upgraded systems from existing rectifiers

Upgrades are available in shelf, cabinet, and module configurations. A shelf upgrade uses the power supplied by the cabinet into which it is installed. Cabinet and module upgrades where some or all of the existing cabinets are retained can be complex. The addition of one or more modules to the existing system requires careful planning.

In systems where rectifiers are mounted in the equipment cabinets, one or more rectifiers may be added to a rectifier rack to expand the existing power capacity of the system. In centralized power systems in a power cabinet or bay, rectifiers and additional power cabinets or bays may be added as required. If batteries are part of the upgraded system or a centralized power scheme is to be used, rectifier compatibility must be considered. This is due to the fact that rectifiers are connected in parallel through connections made at the QBL15 Battery Distribution Box and centralized power systems; the output voltages of the rectifiers must be balanced for proper load sharing across the entire system.

For detailed information on system upgrades, refer to the *Large System: Upgrade Procedures* (553-3021-258).

Power systems

Contents

This section contains information on the following topics:

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Ac power 96

Dc power 103

Grounding 116

Reserve power 125

Candeo dc power system 134

NT4N49AA Four Feed PDU 144

Introduction

Large Systems feature a modular power distribution architecture. As part of the modular design, the power system provides:

- A pedestal-mounted power distribution unit providing input voltage (ac or dc) to each module and protection from current overload
- Power supplies in each module
- A universal quick-connect power wiring harness carries the power and monitor signals to the power supplies in each module
- Modular backup capabilities on a per column basis

The terms “ac system” and “dc system” refer to the type of power brought into the pedestal and distributed within the system to the module power supplies. Figures 27, 28, and 30 starting on page 97 show the basic power distribution for ac and dc systems. All system options are available in both ac power and dc power versions.

To understand the system power architecture, consider the distinction between the “internal” and “external” power components. Internal power components are those contained within the system itself that form an integral part of the power subsystem. These include components such as the power distribution unit (PDU) in the pedestal, the power wiring harness, and the module power supplies.

Although the PDU and module power supplies differ in ac- and dc-powered systems, power distribution is similar: power is input to the pedestal and distributed to individual power supplies in each module. In ac-powered systems, the module power supplies convert the ac voltage to several usable dc voltages; in dc-powered systems, the module power supplies convert the dc voltage to several usable dc voltages. Except for the power components and the power wiring harness, all other functional elements within the system (such as card cages, backplanes, circuit cards, and system monitor) are identical in both ac and dc systems.

External power components are those outside the system columns. If reserve power is not required, ac-powered systems have no external components; ac systems plug directly into the commercial ac power source. If an uninterrupted power supply (UPS) is installed for reserve power, it is considered an external power component. All dc systems are powered by rectifiers that are external to the system.

Ac power

Ac-powered systems require no external power components and can plug directly into the commercial utility power source (see Figure 27 on page 97). Ac powering requires a single conversion from the ac input voltage to the dc voltages required by the system. This conversion is performed by power supplies in each module.

Ac-powered systems are well-suited for applications that do not require reserve power. They are also recommended for small-to-medium-sized (two columns or less) systems that require reserve power with backup times ranging from 15 minutes to 8 hours.

If reserve power is required with an ac-powered system, an uninterruptible power supply (UPS) is installed in series with the ac power source (see Figure 28 on page 98). Ac-powered systems that do not require long-term backup can benefit from a UPS with short-term backup. A UPS can provide power conditioning during normal operation, including protection against sags, brownouts, and other low-voltage transient conditions that cause most power disturbances.

Figure 27
Ac-powered system

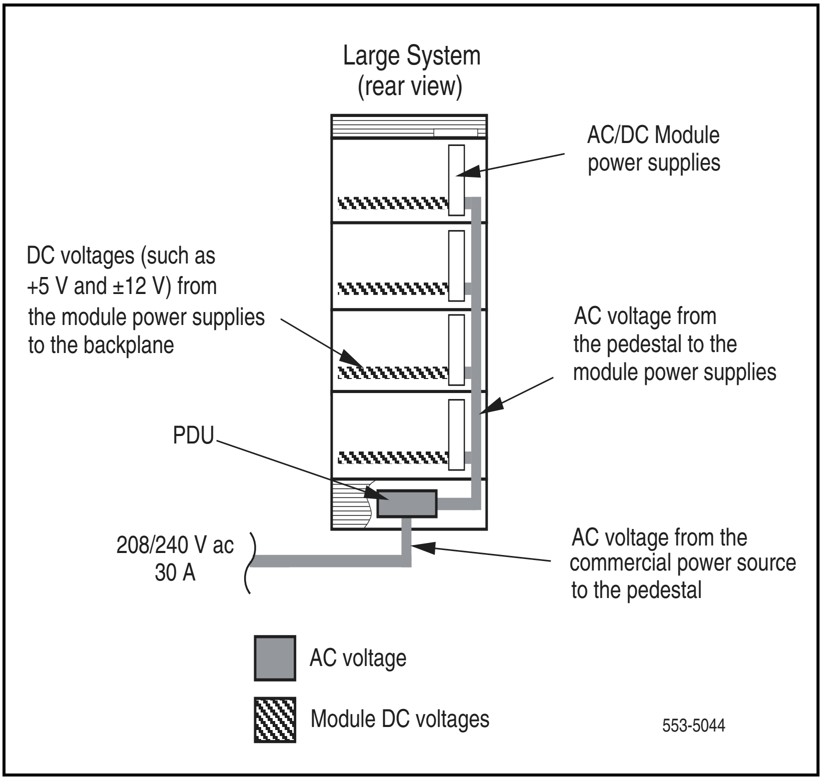
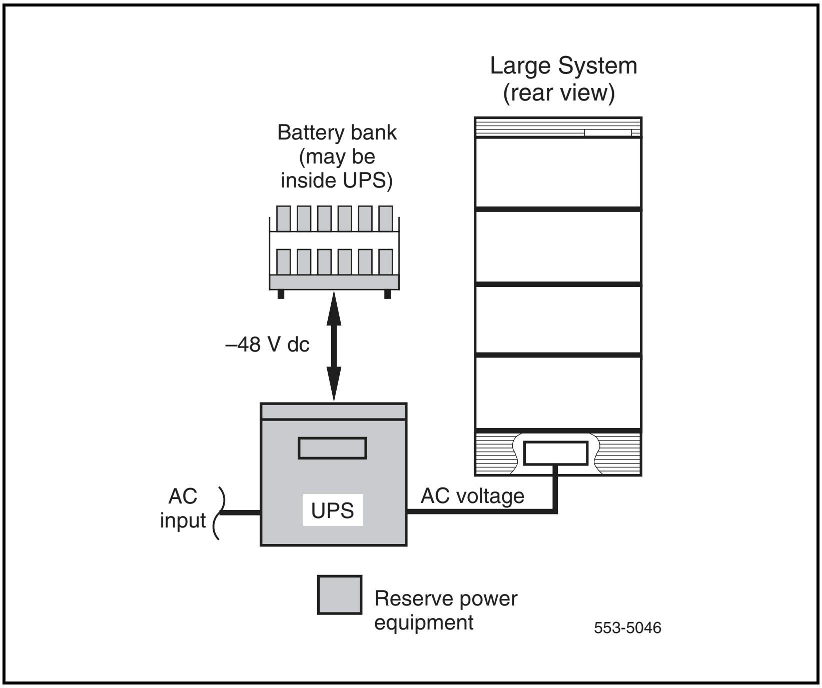


Figure 28
Ac-powered system with reserve power



Ac power input specifications

Ac power supplies operate from a nominal input of 208 to 240 volts ac, single-phase. While the actual input range of the ac power supplies is 180–280 V, no restrapping the power supplies is required if the input line voltage is within 208–240 V.

Ac-powered systems require one IG-L6-30 or L6-30 receptacle for each column within 2.4 m (8 ft) of the column's pedestal. Each column comes equipped with one 30 A cord and plug.

> ***Note:*** Do not use ground fault circuit interrupt (GFCI) devices on ac power circuits.

As an alternative to using the power cord and plug, ac input to the PDU may be wired directly. Use #10 AWG conductors routed through 1.9-cm (3/4-in.) conduit. Connect the conductors to the input terminals on the field wiring terminal block in the PDU for a 240 V ac input, as indicated in Table 13.

Table 13
Ac input connections

Ac input conductor	PDU terminal
Hot – Phase I	L1
Hot – Phase II	L2
Safety Ground	GND

All ac input power wiring must contain a separate safety ground conductor (green wire). Nortel Networks strongly recommends a dedicated ac supply that runs uninterrupted from the building primary source to a dedicated equipment room service panel.

> ***Note:*** Follow all applicable electrical codes if the ac input is wired directly to the PDU.

If reserve power is used, install the UPS, along with its associated batteries (which may be internal or external to the unit), in series with the commercial power source. The system then plugs into the UPS (see Figure 28 on page 98). Consult the UPS manufacturer for requirements of the UPS power input receptacle.

Ac internal power distribution

Figure 29 on page 101 shows the elements of the ac internal power system. Components of the distribution system include the power distribution unit (PDU), module-to-module power harness, module power distribution unit (MPDU), MPDU-to-backplane power harness, and module power supply.

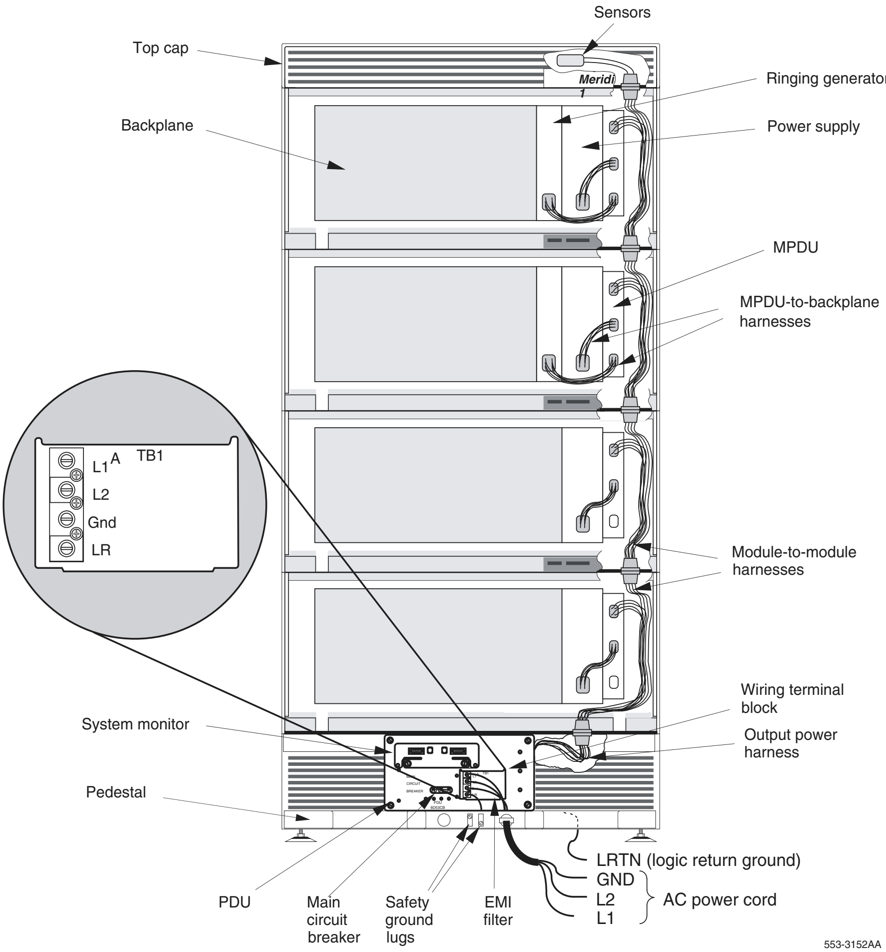
Input power wiring connects to the field wiring terminal block in the back of the PDU. The output power harness connects the field terminal block to the first module. The module-to-module harness distributes power to the MPDU in each successive module. The MPDU-to-backplane harness distributes power from the MPDU to the module power supply and ringing generator, if equipped. The module power supply converts the ac voltage to the dc voltages required by the circuit cards in the module.

Power distribution unit (PDU)

Located in the rear of the pedestal, the PDU serves several functions, but primarily it serves as a power distribution point for the entire column. The field wiring terminal block provides the connection point for the ac input wiring. The electromagnetic interference (EMI) filter (required for regulatory compliance) keeps EMI from radiating outside the confines of the column. The circuit breaker, which is the main circuit breaker for all modules in the column, protects the column if there is a current or thermal overload. The internal terminal block provides a distribution point for power output wiring to the modules. The power/signal harness (not shown in Figure 29 on page 101) provides power and signal interconnections for the blower unit and system monitor. The system monitor power supply provides +5 V power to the system monitor even when the main circuit breaker is off. The output power harness relays power from the pedestal to the module(s) above it.

> ***Note:*** The system monitor is housed in the PDU. The system monitor is powered by a small ac power supply, which is not connected to the circuit breaker for the column.

Figure 29
Ac internal power distribution (rear of column)



Intermodule harnesses

Several power harnesses conduct the input voltage throughout the column (see Figure 29 on page 101). The module-to-module harness connects to the MPDU in each module and to the module above. The MPDU-to-backplane harness distributes power from the MPDU to the module power supply and ringing generator, if equipped, through backplane power connectors.

Module power distribution unit (MPDU)

An MPDU provides the circuit breakers that provide current protection at the module level, so only a faulty module is shut down while others remain functional. Figure 14 on page 102 lists the MPDUs, power supplies, and compatible modules.

Table 14
MPDU, power supply, and module compatibility

MPDU	Power supply	Module
NT8D56AA	NT8D29BA	NT4N41Core/Net NT5D21 Core/Net NT8D35AA Network
NT8D57AA	NT8D06PE NT8D21 (ring generator)	NT8D37AA IPE NT8D13AA PE

Module power supplies

In each module, input voltage is carried through the backplane harness to the module power supply where it is converted to the voltages required by the circuit cards in the module. Table 14 lists the compatibility between module, MPDUs, and each power supply.

Table 15 lists the output voltages and currents for ac module power supplies.

Table 15
Output voltages and currents for ac power supplies

Module	Output volts (V ac)	Output amperes	Output volts/ volt-amperes (V ac / VA) (Note)	Output frequency (Hz)
NT8D06 PE Power Supply	+5.1 +8.5 +10.0 –10.0 +15.0 –15.0 –48.0	28.00 4.00 0.50 0.50 17.00 15.00 7.70	—	—
NT8D21 Ringing Generator	–150.0 +70.0 +80.0 +86.0	0.20 0.127 0.111 0.103	70/8 80/8 86/8	25/50 25/50 20/25
NT8D29BA Power Supply	+5.1 +3.3 +12.0 –12.0	60.00 5.00 2.50 1.00	—	—

Dc power

Dc power systems deliver dc to the pedestal of the system. Ac-powered systems accept ac at the pedestal and distribute ac to the power supplies located in each module.

Dc-powered systems require an external dc power plant consisting of rectifiers (also called *chargers* or ac/dc *converters*) and power distribution and control equipment. The external rectifiers connect directly to a commercial ac power source (see Figure 28 on page 98). Dc-powered systems require a double conversion: the rectifiers convert the ac voltage to –48 V DC which is distributed by the PDU in the pedestal to the power supplies in the modules. The power supplies convert –48 V DC to other dc voltages required in each module.

Dc-powered systems require two stages of power conversion. The rectifiers convert the input ac voltage into a nominal dc voltage that is adjustable to correspond to the normal float voltage of a battery bank. This dc voltage is distributed throughout the system to each of the modules, where the module power supplies convert this voltage to the voltages required by the circuit cards in the module.

Batteries are generally used with dc-powered systems because the traditional method for powering telecommunications uses rectifiers to continuously charge a bank of batteries, while the system power "floats" in parallel with the battery voltage. However, batteries are only used if reserve power is needed. Figure 31 on page 106 shows a Candeo system with reserve power equipment.

Complete systems—including dc power plants—can be provided by Nortel Networks. Systems can also be configured to connect to an existing power plant provided by the customer.

Dc systems should be considered for the following:

- Most Large Systems (any system larger than two columns)
- Most systems with long-term reserve power requirements (usually eight hours or more)
- When the customer site has an existing dc power plant or batteries available

Figure 30
Dc-powered system

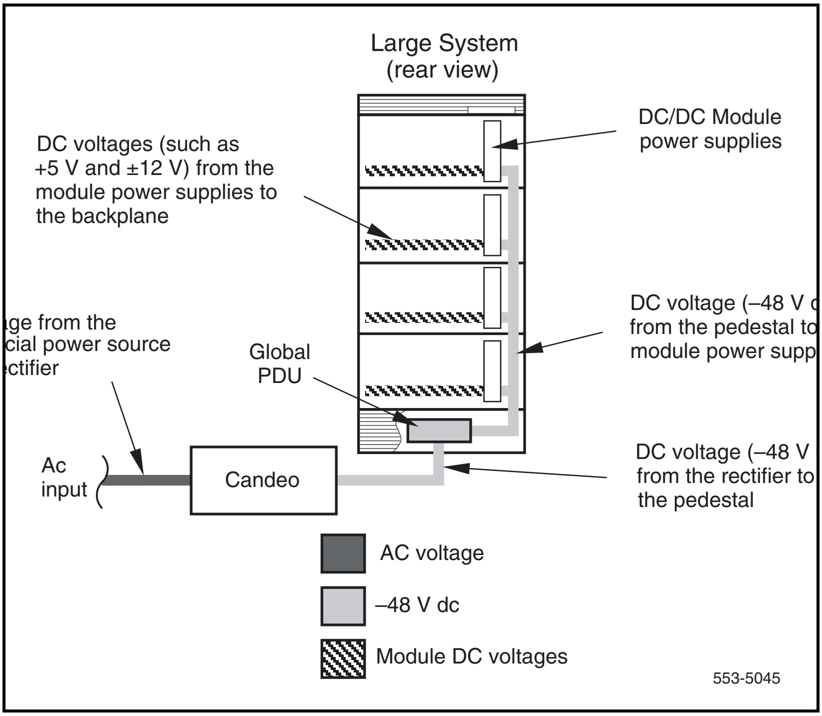
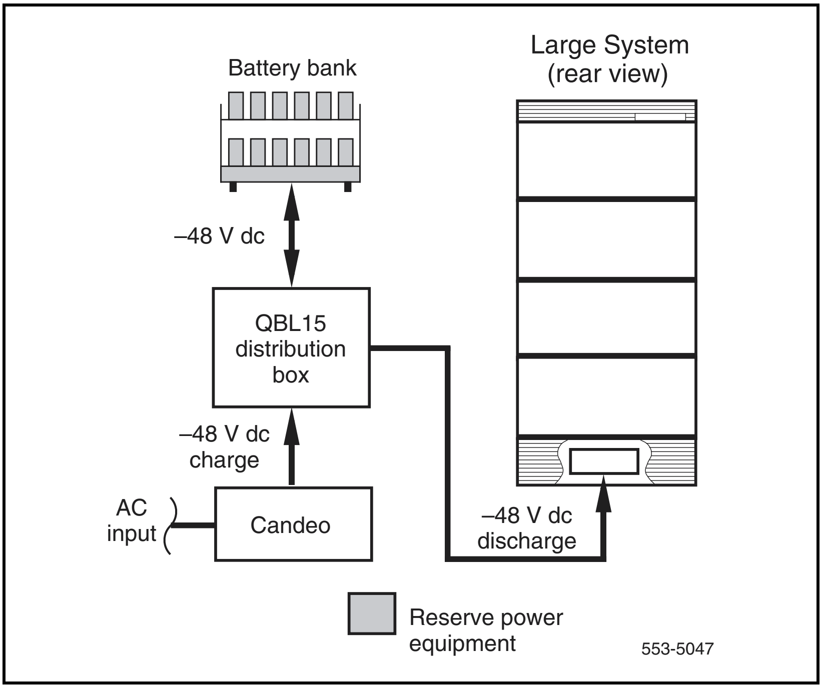


Figure 31
Dc-powered system with reserve power



The dc power system must be able to provide the required current and operate within the specifications listed in Table 16. For additional battery voltage requirements, see Table 20 on page 132.

Table 16
Input specifications – dc power system

Input	Pedestal	Battery
Maximum range	–42 to –56.5 V	–42 to –56.5 V
Expected nominal (24 stationary cells)	—	–52.08 V
Expected nominal (23 sealed cells)	—	–51.75 V
Expected nominal (24 sealed cells)	—	–54.00 V
Noise (max C msg)	—	22 dBrnC (See Note)
Note: Without battery, C msg (max) is 32 dBrnC.		

Input power specifications

Dc-power plants require one separate ac input per rectifier, within 1.8 m (6 ft) of the rectifier. The total requirements for commercial ac power input is determined by the number and type of rectifiers used.

> ***Note 1:*** Do not confuse the output rating of the rectifiers in dc amps with input requirements in ac amps.

> ***Note 2:*** NT4N49AA with the NT6D53 junction box can be used to distribute the power to the system when the power source is at a distance from the system. Refer to *Large System: Installation and Configuration* (553-3021-210) for junction box implementation and power and ground wire gauges determination for various distances of power source to the system. Also, refer to "Selecting proper wire size" on page 153 for determining the required wire size based on the current required and the distance between the power source and the system. A junction box may be used with the NT7D67CB PDU, but it is not required.

Internal power distribution

Power distribution in the dc-powered system (see Figure 32 on page 109) consists of the NT4N49AA PDU, the module-to-module power harness, the module-to-backplane power harness, and the module power supply.

Dc power cables connect to the field wiring terminal block where an output power harness carries the input voltage to the first module. Module-to-module harnesses distribute dc voltage to successive modules. Module-to-backplane harnesses distribute dc voltage to the module power supply and ringing generator, if equipped. In each module, the module power supply converts the dc input voltage to the several dc voltages required by the circuit cards in the module.

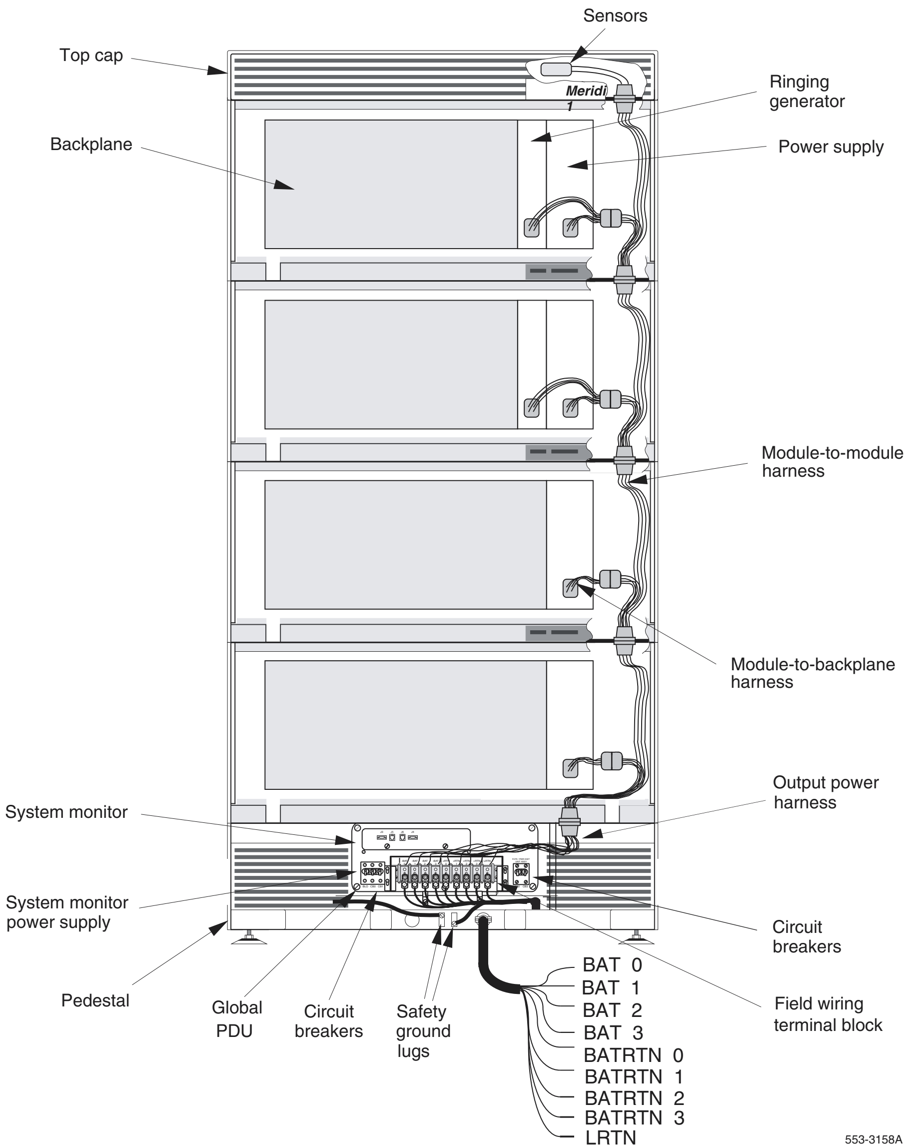
Power distribution unit

TheNT4N49AA PDU, located in the rear of each pedestal, distributes power to the entire column. The PDU provides a common distribution point for the input voltage. The output power harness connects the pedestal to the first module. Individual wiring harnesses carry the current to each successive module. The power/signal harness (not shown in Figure 32) provides power and signal connections between the blower unit and system monitor.

In the event of a current overload, one of four circuit breakers located in the PDU protects each module. A fifth circuit breaker provides protection for the whole column in the event of a thermal overload. The system monitor power supply provides +5 V power to the system monitor (even when the PDU circuit breakers are off).

Refer to “NT4N49AA Four Feed PDU” on page 144 for additional information.

Figure 32
Dc internal power distribution (rear of column)



Intermodule harnesses

Several power harnesses conduct the input voltage throughout the column. The module-to-module harness consists of the module connector, which distributes power to the module or modules above it, and the backplane connector, which distributes power through the module-to-backplane harness to each module power supply.

Module power supplies

In each module, –48 V is received through the module-to-backplane distribution harness and converted by the module power supply to the necessary voltages for the individual module. There is an on/off switch on each power supply for safe operation and easy maintenance.

There are five dc module power supplies:

1 The NT5K12AA Power Supply (EPEPS) (International) provides all power for the Enhanced Existing Peripheral Equipment (EEPE) module and includes the ringing generator.

Note: The NT5K12BA is not equipped with –120 or –150 V dc message waiting supply.

2 The NT6D40 PE Power Supply provides power to circuit cards and talk battery to lines and trunks.

3 The NT6D41 CE Power Supply provides power to circuit cards.

4 The NT6D42 Ringing Generator (replaces NT7D03) provides –150 or –100 V dc message waiting lamp voltages for 500/2500 telephones. It can provide ringing power to 48 ringers simultaneously.

5 The NT6D43 CE/PE Power Supply (replaces NT7D04) provides power to circuit cards, talk battery to lines and trunks, and ringing and message waiting lamp voltages for 500/2500 telephones.

Table 17 lists power supply compatibility. Table 18 on page 112 lists the output voltage and currents for dc power supplies.

Table 17
Power supply and module compatibility

Power supply	Module
NT6D40PE	NT8D13DC PE NT8D37DC IPE
NT6D41CE	NT5D21 Core/Network NT6D60BA Core NT8D35DC Network
NT6D42 ring generator (replaces NT7D03)	NT8D13DC PE NT8D37DC IPE
NT6D43 (replaces NT7D04)	NT8D11DC CE/PE

External power distribution

A variety of rectifiers and distribution equipment can be used to supply external dc power. Existing customer equipment can be used or a system that Nortel Networks either supplies or recommends. In any case, equipment for rectification and distribution is required, while reserve batteries are optional.

NT0R72 Switched Mode Rectifier

The NT0R72 Switched Mode Rectifier is used with half group and single group systems. This rectifier converts a range of input voltages (from 176 to 280V) to –48 V dc up to a maximum output of 25 A. NT0R72 rectifiers are used to replace defective NT6D52 rectifiers or to expend the power capacity of an existing NT7D12 Rectifier Rack Assembly.

The rectifier connects to the system through the QBL15 Power Distribution Box. Generally, one rectifier is needed for every two fully loaded modules. The exact quantity required depends on the system configuration and power requirements.

Table 18
Output voltages and currents for dc power supplies

Power supply	Output volts	Output amperes	Output volts/ volt-amperes (V ac / VA) (Note)	Output frequency (Hz)
NT6D41 CE Power Supply	+5.1 +12.0 –12.0	60.00 3.50 1.00	—	—
NT6D42 Ringing Generator	–100.0 –150.0 70.0 80.0 86.0	0.20 0.20 0.127 0.111 0.103	70/16 75/16 80/16 86/16	20/25/50 20/25/50 20/25/50
NT6D43 CE/PE Power Supply	+5.1 +8.5 +12.0 –12.0 +15.0 –15.0 –48.0 –120.0 –150.0	60.00 2.50 1.00 0.75 10.00 10.00 4.95 0.20 0.20	70/16 75/16 80/16 86/16	20/25/50 20/25/50 20/25/50

Up to three NT0R72 rectifiers can be installed in the NT7D12 Rectifier Rack Assembly. Up to two rectifier racks can be used for each system. This provides a total of six rectifiers (see Figure 33 on page 114). Each rectifier is mounted in the rack using a NT7D1201 Rectifier Support/Air Baffle, which consists of a set of rectifier support brackets and a heat baffle plate. One kit is required for each rectifier.

The NT7D1204 Mounting Hardware kit is used to mount an NT0R72 rectifier on to the NT7D12 Rack.

Each rectifier comes equipped with a QCAD274 Rectifier Cord and requires one L6-20 locking receptacle for each rectifier.

QBL15 Power Distribution Box

The QBL15 (see Figure 34 on page 115) is a common connection point for the rectifier output and battery backup power, and common distribution point for dc power and power monitor signals. Up to three NT0R72 rectifiers can be connected to a QBL15, as can backup battery output. Two QBL15s must be used to support two NT7D12 Rectifier Rack Assemblies.

The QBL15 can also be used to connect NT0RL72 or rectifiers with existing QRF12 or NT0R71 rectifiers in a load sharing arrangement (for more information on load sharing, see "Powering upgraded systems from existing rectifiers" on page 93).

Also built into the QBL15 are a QPC188 battery monitor card, test points, and fused sense leads for each rectifier. A maximum of two QBL15 distribution boxes can be used per system.

For installation procedures, see *Large System: Installation and Configuration* (553-3021-210).

Figure 33
NT7D12 Rectifier Rack Assembly with three NT0R72 rectifiers

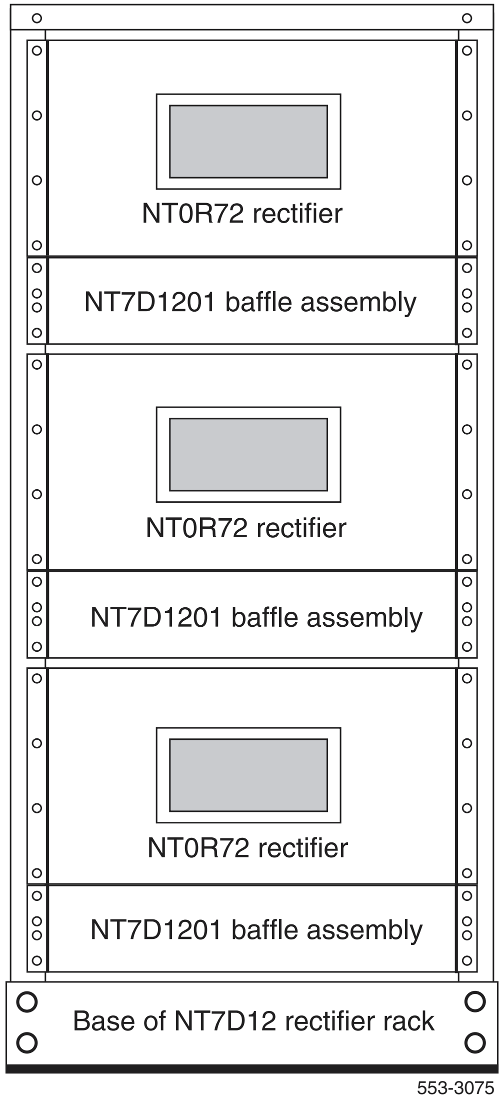
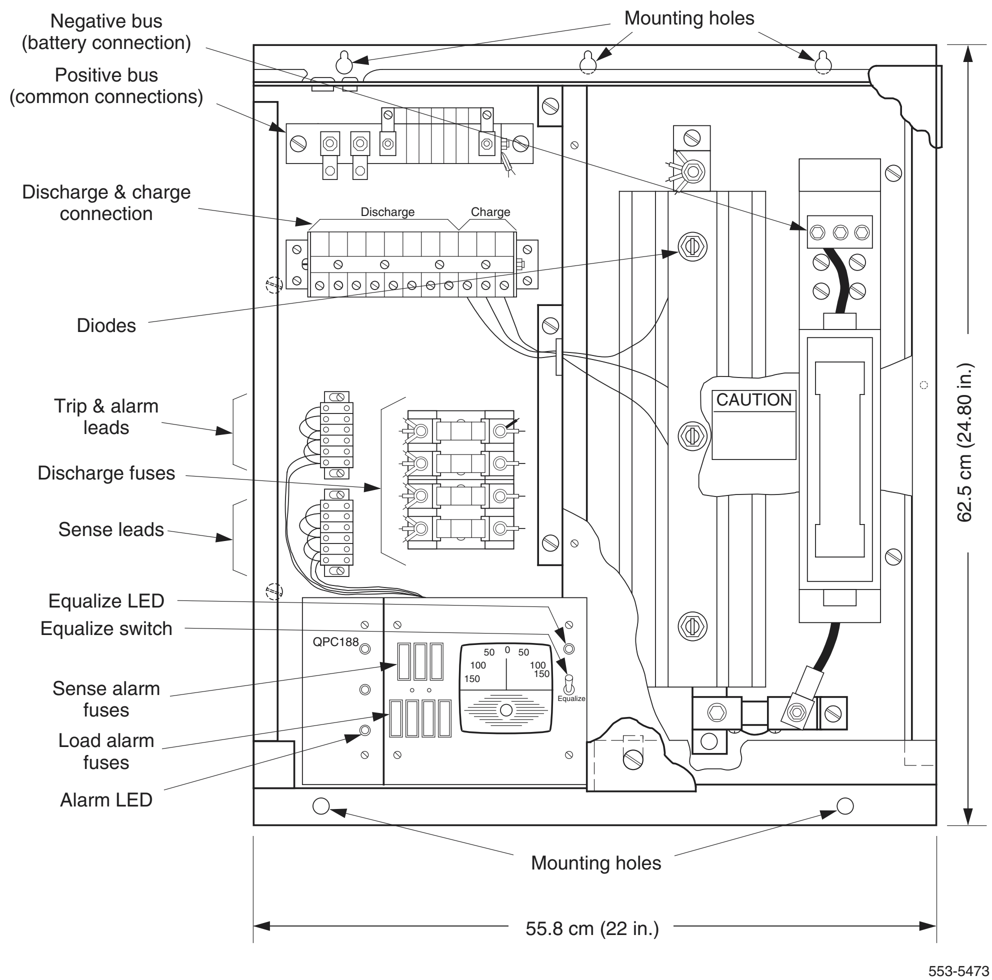


Figure 34
QBL15 Power Distribution Box



Grounding

Proper grounding is essential for trouble-free system operation and the safety of personnel.

Single Point Grounding

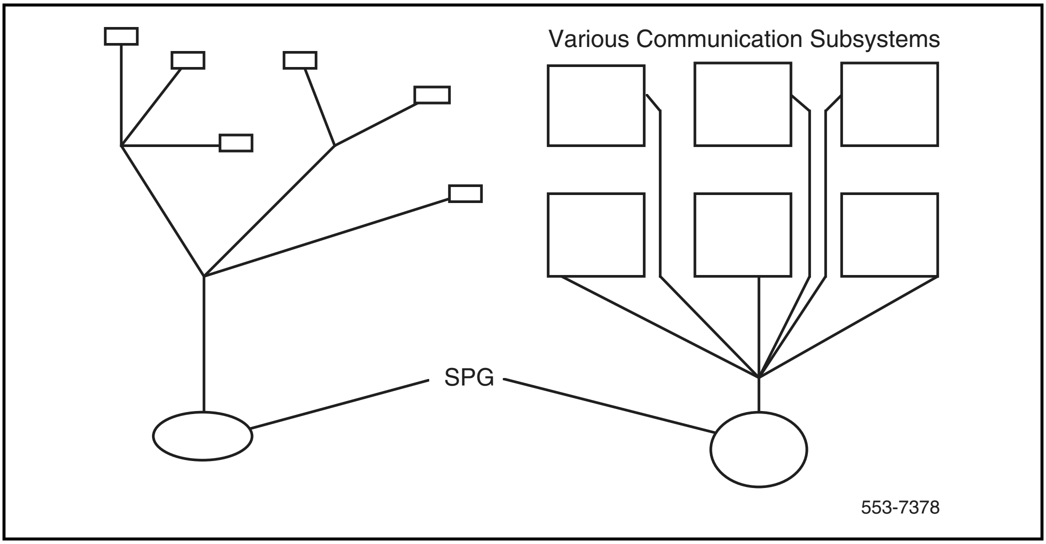
The single point grounding (SPG), otherwise known as the Star—IBN (Isolated Bonding Network), is the standard for the system. The SPG of a system is the point at which an IBN is bonded to ground. Physically, the system SPG is usually implemented as a copper busbar. See Figure 35 on page 117.

Any of the following busbars can be used as system SPG:

- Building principal ground (BPG), typically in single floor buildings
- Floor ground bar (FGB), typically in multi-floor buildings
- Dedicated SPG bar bonded to the building grounding system
- A section of the battery return (BR) bar of the power plant

The various subsystems (such as groups of frames or equipment) of an IBN system can be configured as individual SPG entities, connected in a star configuration to the system SPG (star IBN).

Figure 35
Single point grounding



SPG requirements

SPG requirements are divided into the following major categories:

- Safety
- Protection
- EMC
- Installation and Maintenance Concern
- Power

Safety

To ensure a safe working environment for trained company personnel, the customer premises grounding system must be able to dissipate surge energies (such as lighting strikes on the outside plant). In addition, the grounding system must be designed to ensure that fuses or breakers operate to disrupt any excessive current flow caused by a power fault.

Protection

A proper ground is essential to systems protecting equipment. This includes grounding for outside plant cable shields and protectors, as well as the grounds associated with framework, battery, and logic references.

EMC

Grounding must be considered at all times to ensure good Electromagnetic Compatibility (EMC), emission and susceptibility performance.

Installation and maintenance

If included as part of the initial electrical installation for the customer premises, a grounding system is cost effective to install and maintain. Adding a grounding system after the initial installation is complete can be difficult and costly.

Powering

Consider the powering options for the equipment, when planning the grounding system.Look at whether the equipment is backed up with batteries or an uninterruptible power supply (UPS). The grounding and powering of all equipment associated with the telecommunication system should be considered as one large system.

Types of grounding

The system has several different grounds and signal returns that are generally referred to as grounds. The types of grounds include:

- Safety (personal hazard) ground
- Logic return
- Battery return (for dc systems)
- Ac “green wire” ground

Safety ground

Figure 36 on page 120 through to Figure 38 on page 122 illustrate examples of power and ground connections in several ac system configurations.

If conduit is used to connect ac power from a service panel to the pedestal, it must contain an insulated ground wire (green) that is #6 AWG or larger size. If a cord-and-plug connection is used, a separate safety ground must be provided.

The safety ground is required to reduce the risk of electric shock to personnel and avoid system malfunctions under these conditions:

- A telephone wire contacts ac current elsewhere in the building while the ac input cord is unplugged.
- Lightning transients when the cord is unplugged.
- Stray grounds during normal operation.

This safety ground, also known as frame ground or chassis ground, must be an insulated wire #6 AWG or larger, and must connect to both the pedestal safety ground lugs and the service panel ground bus. In all systems, one 30 A circuit is required for each column. Isolation, as required by NEC 250-74 and 384-27 (exception 1), is preferred.

A single-point ground (SPG) is an isolated ground (IG) bus or ac equipment ground (ACEG) bus in the service panel or transformer. It may also be a separate external bus bar that connects at a single point to the service panel or transformer. Figures 36 through 38 starting on page 120 show an isolated ACEG as the single-point ground.

Depending on the distance between columns (and cabinets in upgraded systems) and the service panel, the safety ground wiring may be daisy-chained or run independently from each column (or each row) to the ACEG. Figure 36 on page 120 through to Figure 38 on page 122 show safety ground wiring in daisy-chain configurations.

To implement the single-point ground, follow these guidelines:

- All ground conductors must comply with local electrical codes and be terminated in a manner that is permanent, resulting in low impedance connections.
- All terminations should be readily accessible for inspection and maintenance.
- A grounding conductor must be continuous with no splices or junctions.

- The insulated grounding wire size must comply with the National Electric Code (NEC) Sections 250-94, 250-95, and 310-15.
- Conductors must be insulated against contact with foreign (non-ac) grounds.
- Grounding conductors must be no-load type and carry no current under normal operating conditions.
- The use of building steel as an integral part of the ground system is not recommended.

Figure 36
Ac power – multiple-column distribution ACEG

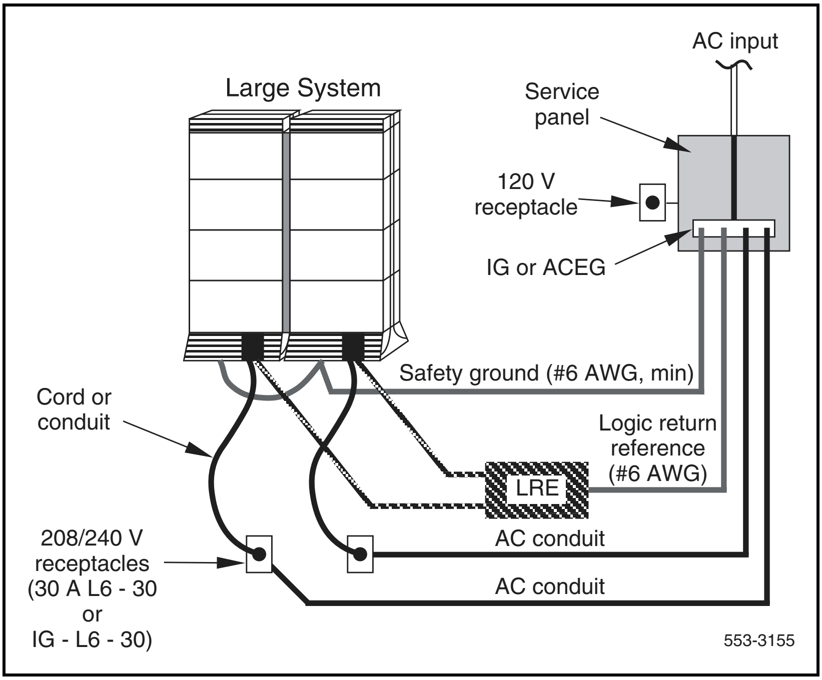


Figure 37
Ac power – multiple-row distribution ACEG

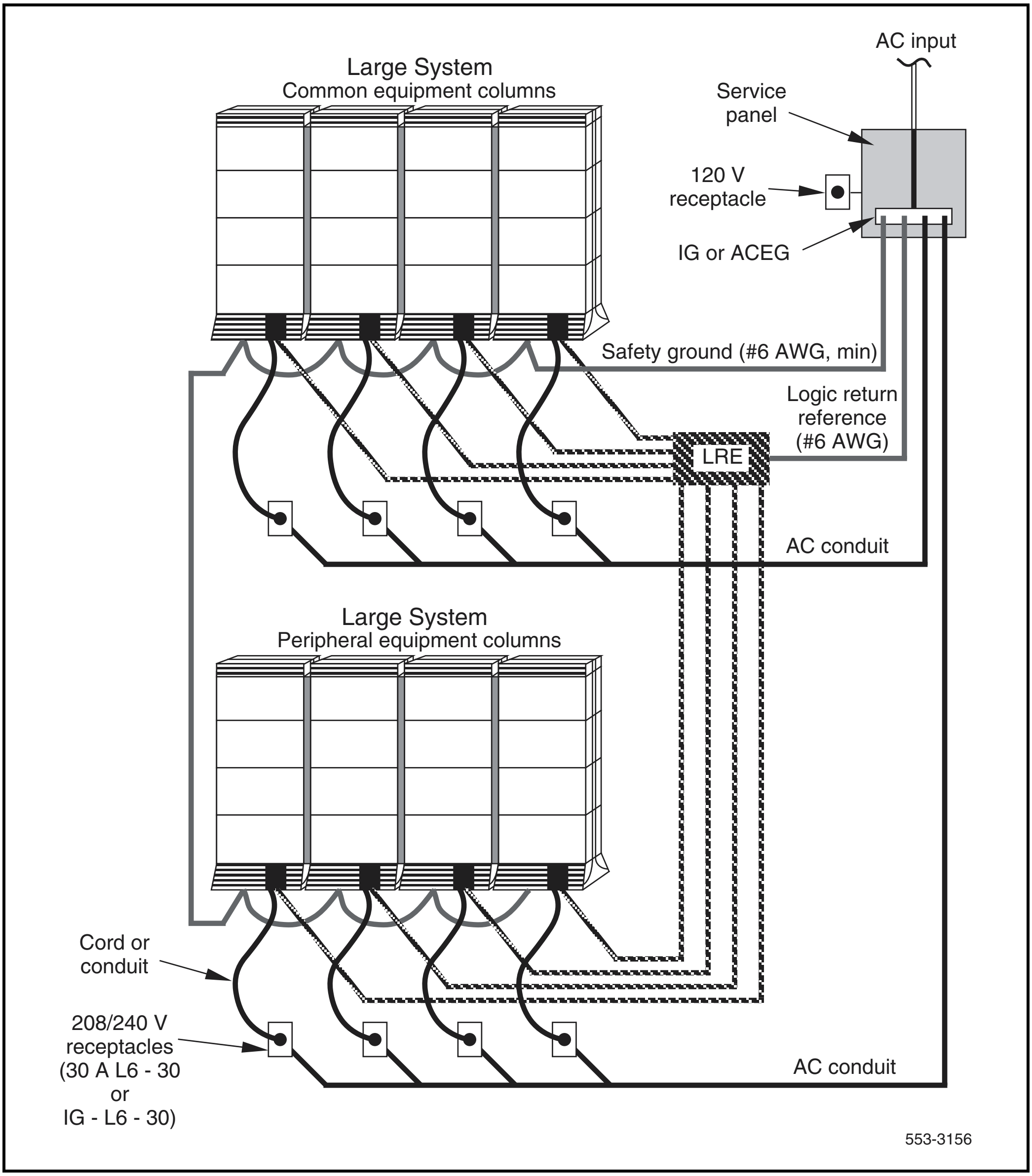
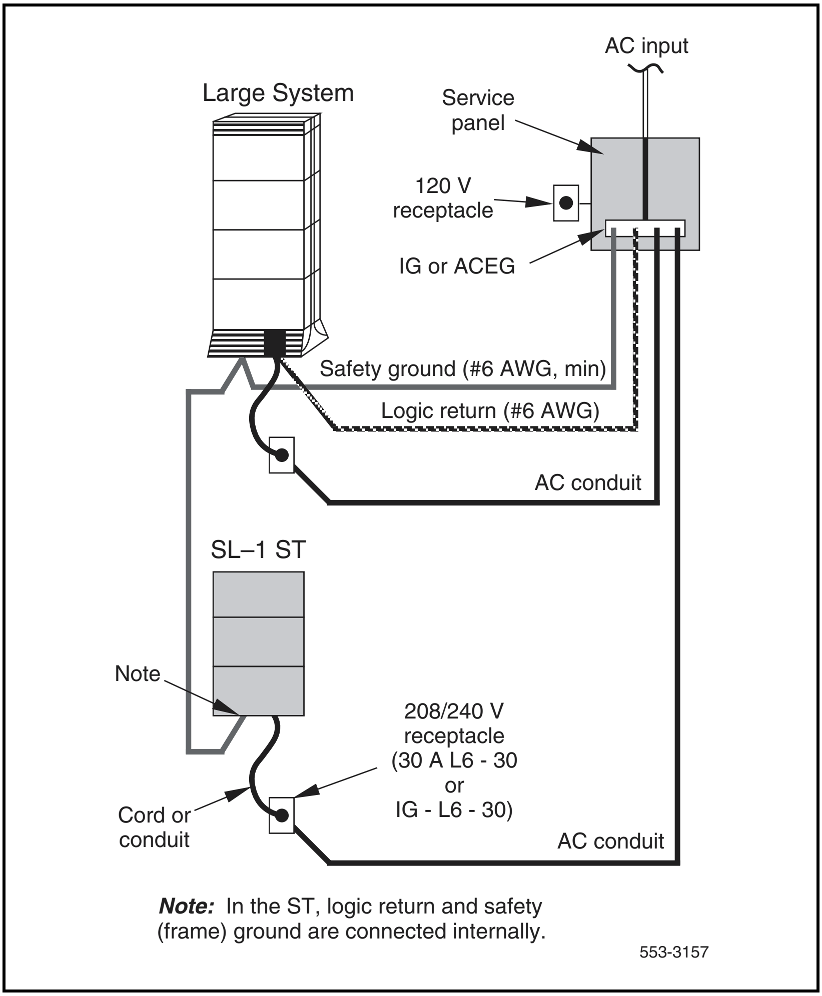


Figure 38
Ac power – upgraded system distribution ACEG



Logic return

A logic return equalizer (LRE) is a separate bus bar (such as an NT6D5303 or NT6D5304) used to join logic return wires at a common point. A #6 AWG conductor connects the LRE to the ACEG in the service panel. With multiple columns, the LRE is typically located in a nearby rack, in an overhead trough, or under a raised floor. The LRE must be insulated from the ac-grounded support structure. Figures 36 through 38 show the use of an LRE in multi-column configurations.

The logic return equalizer is a consolidation point for all the logic return grounds. It is connected to the AC Equipment Ground (ACEG) which is located within the systems dedicated ac panel. The isolated ground bus within the dedicated ac service panel serves as the “system” SPG. The dedicated ac service panel should be supplied from the buildings principle ground source, usually a transformer which is located within the building. It is at this point that the neutral to ground bound is performed and the live, neutral and grounding conductors are supplied, all together within a single conduit, to the dedicated ac panel for the communication equipment. The dedicated ac panel should service all the communication equipment and any logically interconnected devices (such as modems, TTYs, multiplexers, etc.). This ensures that all equipment has the same ground reference.

The LRE must be insulated from the ac-grounded support structure. Figure 36 on page 120 through to Figure 38 on page 122 show the use of an LRE in multi-column configurations.

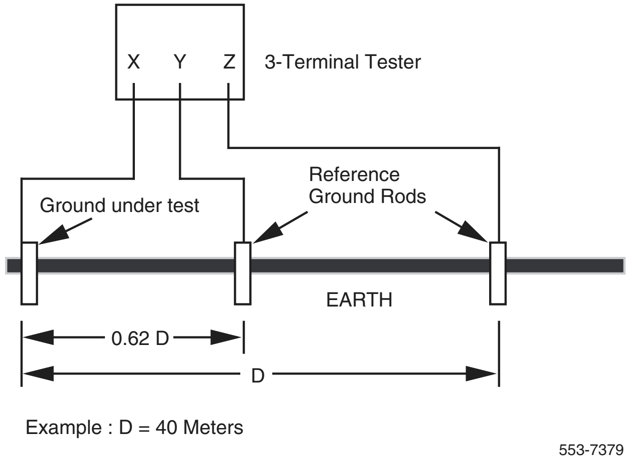
Identifying good grounds

The main ground consists of rods or plates and is considered a good ground when the resistance of the rods or plates to ground is as low as practical. A recognized industrial standard is 4 ohms.

Usually a visual inspection will suffice to ensure that the connection of the ground conductor to the main ground is soundly made. It is possible to verify the quality of the ground by using a three terminal tester. Figure 39 on page 124 outlines this procedure.

Refer to the three terminal tester manufacturers handbook for testing instructions.

Figure 39
Three terminal testing



Circuit protection

RS-232 port protection

RS-232 type interfaces are susceptible to induced lightening damage when hardwired lines are run building to building. As little as 25 volts can cause damage. Typically only pins 2 (send), 3 (receive) and 7 (signal ground) are connected end-to-end via twisted shielded pairs.

Although the RS-232 specification supports only 50 feet of operation, many applications successfully pass data at much longer distances. However, problems arise when different grounds are used at the two ends of the cable. Grounding at both ends will cause a ground loop current to flow in the shield due to the fact that each ground point will most likely be at a different potential. This current flow will induce a voltage onto the signal or data lines resulting in erroneous data or fault conditions.

To prevent the creation of a current loop, the shield must only be grounded at one end and in general this takes place at the system end. SDI ports must be connected to the I/O panel at the rear of the switch. RS-232 cables should then be connected to the I/O panel. RS-232 cables should never be connected directly to the connector on the SDI pack.

A modem or isolator must be installed for all RS-232 devices not connected to the ac equipment panel ground.

Off Premises Line Protection

All voice and data lines which run externally from the building that contains the system must have proper line protection. The cable sheath must be connected to the SPG.

Power service panel

Power service panels must meet the following requirements or be modified when used for the system:

- Panels should be located in the equipment room.
- No lights, air conditioners, heaters, generators, or motors may be connected to this service panel.

Reserve power

Reserve power is available for both ac and dc systems. When selecting reserve power equipment, consider:

- Future system growth
- Maximum time back-up power is required
- Existing power system capacity
- Space and thermal environment (air conditioning)
- Other equipment, such as lights and alarm systems

Reserve power for ac systems is provided by uninterruptible power supplies (UPS), installed in a series with the commercial power source. A UPS generally consists of a combination battery charger (ac/dc converter) and inverter (dc/ac converter), along with associated batteries. The batteries may be internal or external to the UPS. A UPS is not a standby power source, but an on-line unit with no output interruption when the ac power is interrupted.

Dc systems use the traditional telecommunications powering method: external rectifiers (ac/dc converters) continuously charge a bank of batteries while the system power "floats" in parallel on the battery voltage.

Ac reserve power

There are a number of UPS vendors and systems available. Factors to consider when choosing a UPS include:

- Input voltage and frequency range
- Output voltage and current capacity
- Number and type of output receptacles
- Regulatory and safety agency approvals
- Efficiency and performance considerations
- Alarm and status indications
- Battery recharge time
- Maximum time backup power is required
- Existing batteries or other power equipment available at the site
- Future system growth

UPS sizing

To determine UPS sizing, first calculate the total power requirements of the column (or columns) supported by the UPS, as described later in the chapter "Component power consumption" on page 85. Convert the real power in watts (W) to complex or "apparent" power in volt-amperes (VA) by dividing the real power by the typical system power factor of 0.6. Then size the UPS in terms of its rating in VA (or kVA). For ac-powered systems, Autoquote calculates the system power consumption in both watts and volt-amperes.

$$VA = \frac{W}{0.6}$$

To determine the sizing and provisioning of UPS batteries, follow the instructions provided by the UPS manufacturer. A general approach, however, is to take the total system power in watts, divide by the UPS inverter efficiency, and convert to battery current drain by dividing by the nominal discharge voltage of the battery string. Then multiply the battery current drain by the time needed for the reserve power to operate to determine the battery requirements in ampere-hours (A-hrs).

$$\mathrm{Ahr} = \left(\frac{W_{\mathrm{total}}}{V_{\mathrm{dischg}}}\right) T_{\mathrm{reserve}}$$

UPS interfacing

A UPS must meet the following requirements in order to be used with a system:

- The UPS specifications must meet the commercial power specifications of the system:
  - Nominal output voltage range of 208–240 V AC, with a total input range of 180–250 V AC
  - Nominal frequency of 50–60 Hz, with a total range of 47–63 Hz
  - Total harmonic distortion (THD) of 5%, with 3% on any single harmonic, of the ac sine wave
- The UPS must be able to handle a non-linear loads (the ac module power supplies are a switched-mode design) and have a current crest ratio of 3.0 or greater.
- The UPS must be UL listed and certified under FCC Part 15, Subpart J as a Class A device.
- The UPS must have a 30 A, 250 V locking power receptacle (L6-30) for each column to be powered.
- The UPS must meet ANSI standard C62.41 and IEEE standard 587-1980, class A and B, for transient surge suppression.

  Note: It is convenient for the UPS to have one or more 120 V power outlets (5-15R) for auxiliary devices that must have backup power, such as the power fail transfer unit power supply.

UPS installation

When installing a UPS, follow the vendor's instructions carefully.

> ***Note:*** UPS installation can be complex. Nortel Networks recommends taking advantage of vendor training programs.

It is recommended that a bypass switch be installed during the initial UPS wiring (if the switch function is not inherently a part of the UPS itself). The UPS bypass switch allows the system to run directly from the commercial power source while the UPS is taken off-line during installation, service, or battery maintenance.

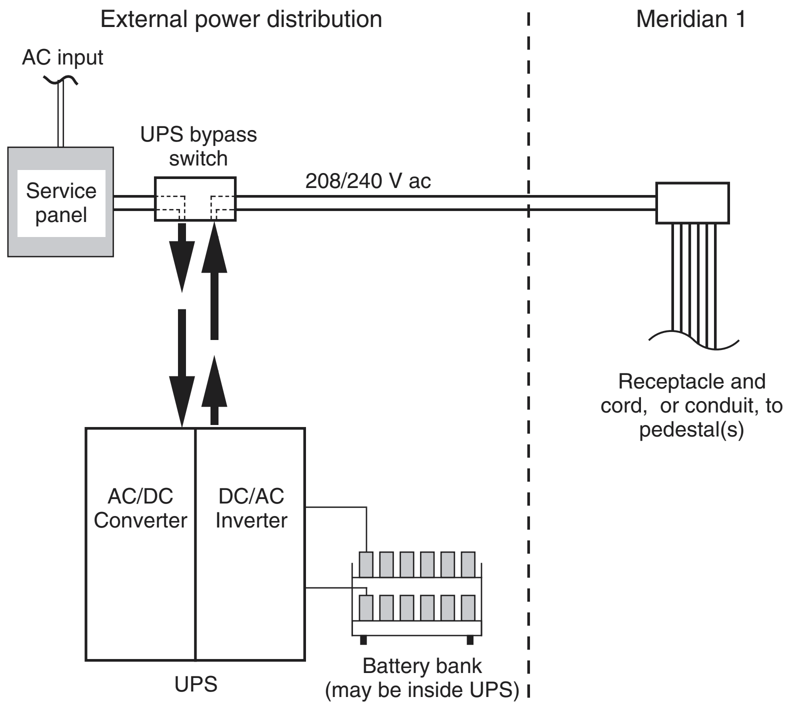
CAUTION

Damage to Equipment

Take care when connecting battery cables to the UPS. Connecting battery cables backward can result in severe damage to the UPS.

Figure 40 shows a general block diagram of a UPS installation and associated wiring.

Figure 40
Ac reserve power configuration



Note: The AC safety ground (green wire) must route from the service panel, through the UPS, to the Meridian 1 panel or receptacles.

Power conditioning

The term “power conditioner” refers to a wide variety of power protection or power quality improvement devices, such as low-pass filters, surge arrestors, line voltage regulators, and isolation transformers. Most of these devices can help prevent power line spikes and surges, and some isolation transformers can provide good noise rejection.

Although most power conditioning devices do not provide energy storage for undervoltage conditions, they can help prevent surges and other overvoltage conditions that can cause permanent damage to equipment.

When choosing UPS protection and power conditioning equipment, remember that over 90 percent of power disturbances in the U.S. are undervoltage conditions such as sags and outages. When there are U.S. power disturbances:

- 87% are power sags; 90% of these last 0.53 seconds or less
- 7.4% are impulses or spikes lasting less than 100 microseconds
- 4.7% are longer-term power failure; 90% of these last 4.2 hours or less, 75% last 40 minutes or less, and 50% last 38 seconds or less
- 0.7% are surges lasting more than 100 microseconds

Low voltage transients occur most frequently and may cause temporary loss of operation. High voltage transients occur much less often, but can cause damage to equipment as well as loss of operation.

Carefully consider the type of power line protection needed for the installation under consideration. A power conditioner can help provide overvoltage protection, but a UPS can (usually at a higher price) provide both overvoltage and undervoltage protection.

Alarm monitoring

Nortel Networks offers a system monitor to UPS interface cable for each of the product lines that have been tested for system compatibility. The system monitor interface is not supported for other vendors. Table 19 on page 131 lists the UPS-to-system monitor alarm cables that are available. UPS systems are not offered by, or available through Nortel Networks, but can be purchased directly from vendors or through authorized distributors.

The alarm interface consists of an “Inverter On” signal to indicate that the commercial power is interrupted and the UPS alone is supplying power to the system, and a “Summary Alarm” signal to indicate a fault or alarm condition at the UPS.

Table 19
UPS-to-system monitor alarm cables

UPS vendor	Cable part number	Quantity
Alpha Technologies	NT8D46AU	one per UPS
Best Power Technology	NT8D46AJ	one per UPS
Exide Electronics	NT8D46AQ	one per UPS

Dc reserve power

Reserve power for dc systems is provided by adding batteries to the external power distribution system. Calculate reserve battery capacity as shown in “UPS sizing” on page 126. This determines the total ampere-hour requirements of the batteries (see also “Component power consumption” on page 85).

To comply with safety requirements, read and fully understand the following documents before working with any battery systems:

- OSHA “Material Safety Data Sheet” that must be posted to meet OSHA requirements. This document outlines save reserve battery handling procedures.
- National Electric Code 645-10. This document outlines requirements that call for the installation of ac- and dc-power kill switches to battery systems in certain environments.

Current requirements

The dc current required for battery reserves is based on the total system power requirement. For new installations you can determine power and battery requirements from data provided by Nortel Networks. For existing installations, see “Component power consumption” on page 85 for information on calculating current required for battery reserves.

Batteries

The reserve battery capacity required depends on the system line size (load), the time the reserve supply must last in the event of a power failure, and the battery end voltage. Refer to Table 20 for reserve battery float voltage and equalization voltage guidelines. These voltages must never be more negative than – 56.5 V.

Table 20
Battery requirements

Battery configuration	Float voltage (V)		Equalize voltage (V)	
	Cell	Bank	Cell	Bank
24 stationary cells	–2.17	–52.08	–2.25	–54.00
23 sealed cells	–2.25	–51.75	–2.35	–54.05
24 sealed cells	–2.25	–54.00	–2.35	–56.40

Lead-calcium/absolyte batteries

Battery package provisioning is based on the number of Amp-hours required. Since battery package Amp-hour ratings are generally given at an 8-hour discharge rate, adjustment factors are required to determine the required battery package. Table 21 lists adjustment factors for lead-calcium and absolyte batteries. These factors are based on the discharge rates of the respective battery types from a specific supplier. Discharge characteristics may vary by manufacturer.

Table 21
Adjustment factors for lead-calcium and absolyte batteries (Part 1 of 2)

Reserve Hours	Lead Calcium Factor	(Sealed) Absolyte Factor
1	3.0	1.8
2	4.0	3.1
3	5.0	4.2
4	5.9	5.2
Note: If a system requires more than 10 hours of backup, the factor is linear. For example, if 15 hours are required, the factor is 15.		

Table 21
Adjustment factors for lead-calcium and absolyte batteries (Part 2 of 2)

Reserve Hours	Lead Calcium Factor	(Sealed) Absolyte Factor
5	6.9	6.2
6	7.7	7.1
7	8.5	7.8
8	9.3	8.5
9	10.1	9.4
10	10.9	10.2
Note: If a system requires more than 10 hours of backup, the factor is linear. For example, if 15 hours are required, the factor is 15.		

Calculate battery requirement using this formula:

$$AHR = I_L \times F_{adj}$$

where

A_{HR} = battery requirement in amp-hours
I_L = system load, in amps
F_{ADJ} = appropriate adjustment factor from Table 21

When using lead-calcium or sealed batteries, calculate battery recharge time using this formula:

$$T = \frac{Ahr \times 1.15}{I_{RO} - I_L}$$

where

T = battery recharge time
A_{HR} = battery capacity in amp-hours
I_L = total system load, in amps
I_{RO} = total rectifier output, in amps

Other battery considerations are:

- Not all sealed cells require equalization, but equalization voltage can be used for fast charging. Use a battery end voltage of 44 V when choosing battery banks.
- Use these electrical noise limitations for a battery bank:
  - 20 mV rms maximum ripple
  - 32 dBrnC maximum noise
- CEMF cells are not recommended because the noise they generate is unacceptable.

Candeo dc power system

The Candeo platform provides a simple, quick to deploy, and easy to operate power solution. Based upon modular building blocks (rectifiers, System Manager, dc distribution and battery connection modules), the system is designed to power -48 Vdc applications. The Candeo platform can be expanded by adding rectifiers, battery connection modules, frames, and distribution modules.

The Candeo provides “plug and walk-away” installation and set-up. The platform can be reconfigured or expanded while it remains online. Installation and maintenance benefits include:

- Shelfless 50 A rectifiers
- Fully front accessible
- Automatic alarms and rectifier configuration settings
- No inter-module wiring
- All modules are hot insertable
- All internal bussing
- Fully insulated environment
- High efficiency
- IP ready for simplified internet connectivity
- HTML-based graphical user interface

- Automated web-based maintenance and comprehensive on-screen troubleshooting
- Remote access via modem or Ethernet permits remote operation of the power system
- Intelligent backbone simultaneously carry dc power, alarm information and data signals
- Built-in temperature compensation
- Built-in charge current limiting
- EMI FCC class B or CISPR class B for systems up to 1000 A (50 kW)

Note 1: The Candeo dc Power Plant is considered “external” power equipment because it is not housed in Large System columns.

Note 2: Dc-powered systems generally require one input receptacle for each rectifier, within 1.8 m (6 ft) of each rectifier. The commercial power receptacles required are determined by the number and type of rectifiers used.

In a single frame configuration, a Candeo system can power a complete range of medium-sized applications. Built around the shelf less Candeo Rectifier 50/48, this system operates from any voltage between 80 vac to 300 vac (single phase). When configured with 50 A Candeo rectifiers, the system delivers up to 500 A from a single 42" (1050mm) frame and up to 1000 A from a single, 84" (2100 mm) frame.

More detailed information is supplied in the following Candeo Power System manuals that are included with the system: Candeo Power System User guide (P0914425) and Candeo Power System Installation Guide (P0914426).

Candeo modules

The Candeo platform uses a combination of modules or building blocks to deliver custom configurations. The modules include:

1 Rectifier 50/48 Module

2 System Manager Module

3 Distribution 500 Module

Rectifier 50/48 Module

The shelfless Rectifier 50/48 provides up to 50 Amps (2 750 W) of -48 Vdc power. Designed to operate at a nominal input voltage of 208/240 Vac, the rectifier will also operate over an input range of 80 Vac to 300 Vac (45 to 65 Hz) at reduced output power. The rectifier delivers full output power when operating in environments ranging between 0 and 50 degrees Celsius.

Rectifier features include:

- High power density - 4.3 W /in3
- High efficiency (>92%)
- Shelfless design
- Hot insertable
- Tool-less rectifier installation
- 100% tool-less maintenance strategy
- Ultra-low THD of less than 5 percent
- Temperature-controlled cooling fans
- MTBF > 250 000
- Zone 4 seismic
- Compliant with global standards (FCC part 15 class B, UL 1950, CSA 22.2#950, CE, VDE, IEC 950 and CISPR22 class B)

System Manager Module

The System Manager is the main control element of the Candeo system. The System Manager's local and remote system management capabilities provide total control over the power system.

System Manager Module features include:

- Automatic set-up
- Single point of adjustment
- User-friendly interface
- Rapid troubleshooting

- Real-time updates
- Extensive data reporting
- Inventory mapping
- Battery management functions: temperature compensation, discharge tests, charge control, equalize, load shedding and rectifier sequential start
- Alarm and statistical history
- Built in remote access using any web browser
- System cloning
- Integrated system management facilities through several interfaces, including RS-232 and RS-485 serial data ports and programmable dry –C contacts
- Optional MODEM

Distribution 500 Module

The Distribution 500 provides the dc distribution connectivity for a capacity of 500 A. The module plugs in the system anywhere when greater distribution capacity is required. The module can accommodate a wide variety of distribution elements, including single and double pole circuit breakers as well as GMTX type fuses.

Distribution Module features include:

- Wide selection of distribution elements:
  - — up to twenty, 1 to 100 A single pole circuit breakers
  - — or up to ten, 100 to 150 A double pole circuit breakers
  - — or up to six, 50 A capacity blocks, each providing 10 positions for (0-10 A) GMTX fuses
  - — up to 20 fuse holders
  - — or any mix of the above elements
- Completely modular
- No pre-set limits to the number of distribution modules
- Tool-less additions or upgrades

- Hot-insertable
- Front access
- Fully insulated environment
- No configuration required
- Troubleshooter alarm indicators
- System capacity monitoring

Additional information is available in the following Candeo Power System manuals:

- *Candeo Power System User Guide* (P0914425)
- *Candeo Power System Installation Guide* (P0914426)

Sample configurations

Example Configuration #1

- 42" Frame with battery kit, LVD and distribution 500 (with 20 breaker positions).
- 17 mid trip breakers (30 amp), one GMTX fuse block (takes up 3 breaker positions).
- System monitor.
- Up to 10 rectifiers (500 amp capacity).

Example Configuration #2

- 42" Frame with battery kit, LVD and distribution 500 (with 20 breaker positions). 17 mid trip breakers (30 amp), one GMTX fuse block (takes up 3 breaker positions).
- Additional distribution 500 (with 20 breaker positions). 11 mid trip breakers (30 amp), three GMTX fuse blocks (takes up 3 breaker positions per block).
- System monitor.
- Up to 6 rectifiers (300 amp capacity).

Example Configuration #3

- 84" Frame with battery kit, LVD and distribution 500 (with 20 breaker positions). 20 mid trip breakers (30 amp).
- A second 84" Frame with battery kit, LVD and distribution 500 (with 20 breaker positions). 11 mid trip breakers (30 amp), three GMTX fuse blocks (takes up 3 breaker positions per block).
- Additional distribution 500 (with 20 breaker positions), 10 mid trip breakers (30 amp).
- System monitor.
- Up to 10 rectifiers (500 amp capacity) in frame one, up to 10 rectifiers (500 amp capacity) in frame two.
- One interframe dc link bar kit.

Installation Reference Guide

The Candeo system can be easily installed using the *Candeo Power Systems Installation Guide* (P0914426). A basic synopsis of the installation manual is as follows:

- Site Preparation – Overview, tools and test equipment, precautions and receiving materials.
- Locating and Erecting Frames – Locating and installing the frame on various floor types and consideration for earthquake anchoring. Included also are procedures for isolating the frame for ISG (isolated system ground).
- Cabling and Connecting – Basic rules, connecting ac to rectifiers, connecting dc cables from batteries, connecting dc loads and miscellaneous cabling. This section details all grounding for frame as well as battery return connections. Under connecting the dc load cables details on wiring and installing the load clips, fuse blocks and breakers are detailed. Miscellaneous cables details remote sensing to batteries, input ports and alarm connections, communication port connections to connect to RS-232, Ethernet, or external modem.

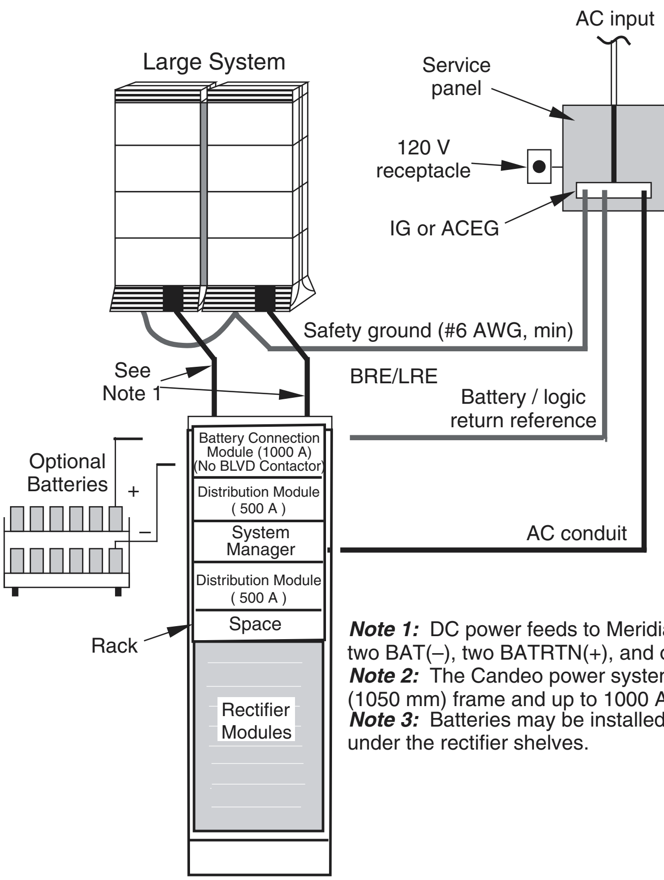
- Startup and Adjustment Procedures – The Candeo system comes pre-configured with the Distribution 500 and Battery Connection Kit installed. In this section the rectifiers are added and the system is powered up and will go through a self test. At this point the User manual (P0914425) needs to be consulted in chapter 5 "Configuring and Operating the Candeo Power System."
- End of Job Routines and Turnover – This section covers end of job routines such as designating circuits, numbering frames, installing the top cover, optional doors and turn over to the customer.

Configuration Reference Guide

The Candeo system can be easily configured using the *Candeo Power System User Guide* (P0914425). The manual content is as follows:

- Overview of the Candeo Power System
- System Description and Specifications
- System Engineering
- Configuring and Operating the Candeo Power System
- Maintenance
- Troubleshooting
- Replacement Parts
- Abbreviations and Acronyms
- Technical Service Assistance

Figure 41
Candeo ground and logic return distribution

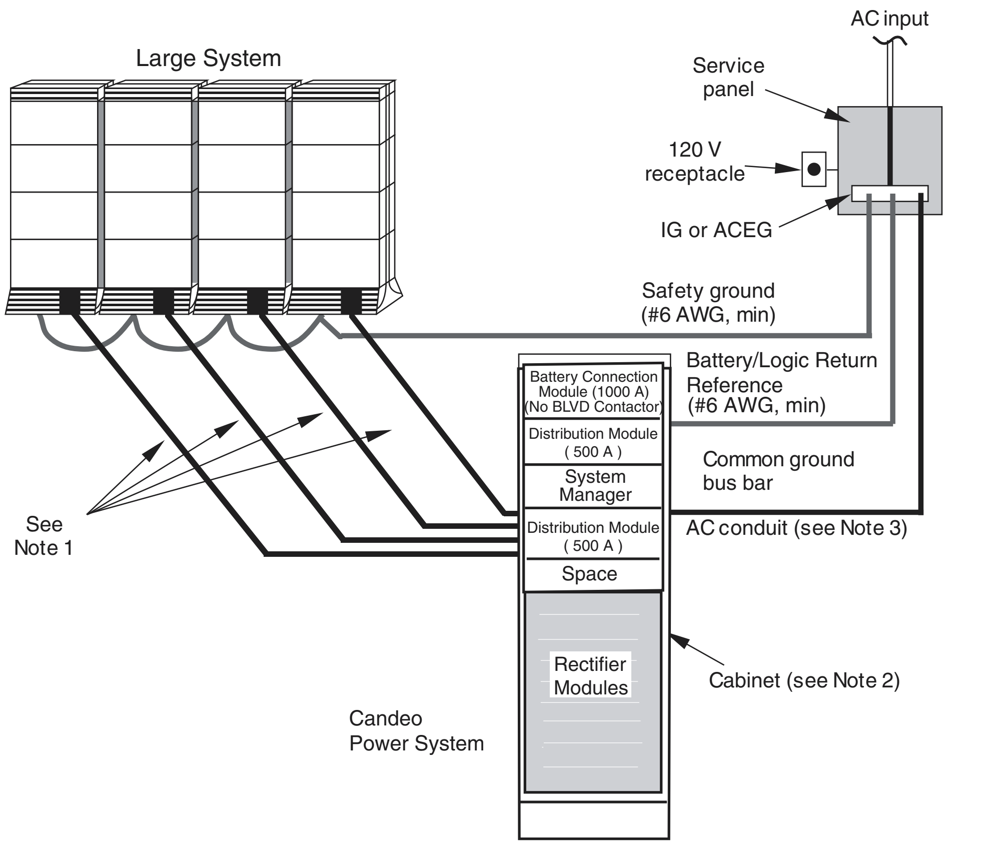


Note 1: DC power feeds to Meridian 1 pedestals. Each feed consists of two BAT(–), two BATRTN(+), and one LRTN(+) conductors.

Note 2: The Candeo power system delivers up to 500 A from a single 42" (1050 mm) frame and up to 1000 A from a single 84" (2100 mm) frame.

Note 3: Batteries may be installed in two optional battery trays located under the rectifier shelves.

Figure 42
Dc power – multiple-column distribution with Candeo



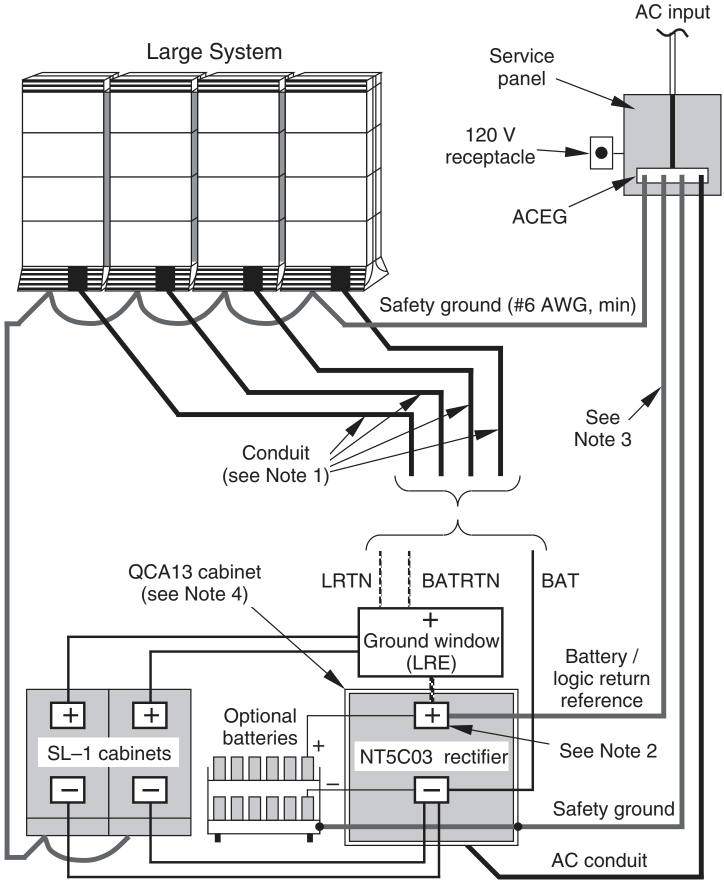
Note 1: DC power feeds to pedestals. Each feed consists of two BAT (–), two BATRTN (+), and one LRTN (+) conductors. All (5) conductors terminate **inside** the distribution panel.

Note 2: The system delivers up to 500 A from a single 42" frame and up to 1000 A from a single 84" frame.

Note 3: The cabinet safety ground is furnished through the green wire ground in the AC input wiring.

553-AAA0534

Figure 43
Dc power example of upgraded system distribution ACEG



Note 1: DC power feeds to system pedestals. Each feed consists of two BAT (–), two BATRTN (+), and one LRTN (+) conductors. If required, conductors can be run in conduit, as shown. BAT (–) connects to the appropriate fuse in the rectifier cabinet.

Note 2: The QCA13 cabinet does not contain a bus for terminating individual battery and logic returns. A ground window should be used to consolidate all battery and logic returns.

Note 3: This conductor and the safety ground must be #6 AWG, minimum.

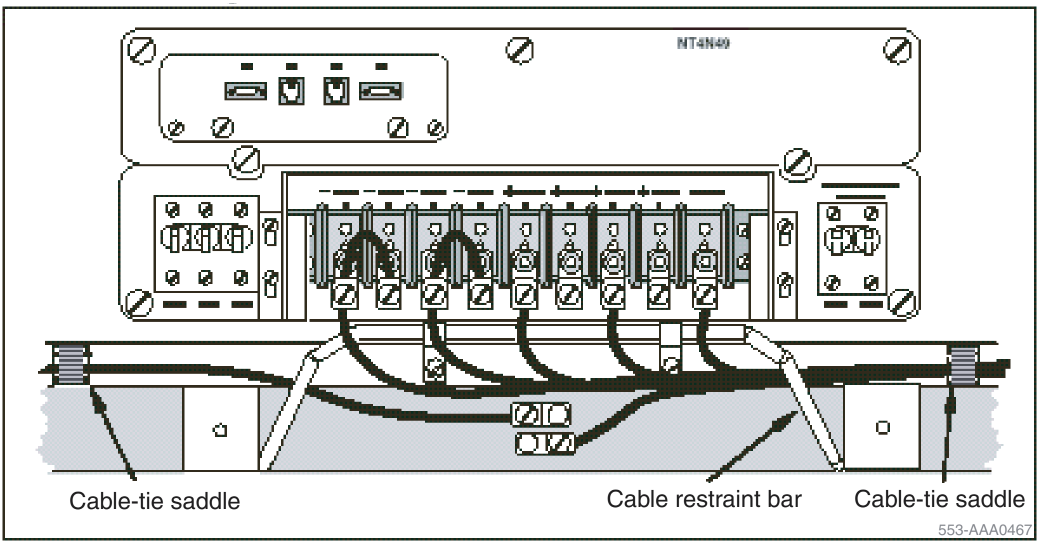
Note 4: Up to four NT5C03 rectifiers can be equipped in a QCA13 cabinet for a total of 200 amps.

553-3162

NT4N49AA Four Feed PDU

The NT4N49AA 4-wire PDU supports independent power feeds to each of 4 modules in a stack if required. However, in a typical installation where independent power feeds are not required, 2 jumper wires are provided to jumper adjacent battery leads. When the jumper wires are used, the 4-wire PDU effectively provides the same “shared” power configuration provided by the existing dc PDU. Therefore the new PDU is backward compatible and can replace an existing PDU unit in a stack if required.

Figure 44
Standard 2-feed wiring



The NT4N49AA dc PDU:

1 Supports 4 input circuits, implemented through the following terminal configuration: 4 (negative) battery leads, 4 return leads and logic return lead.

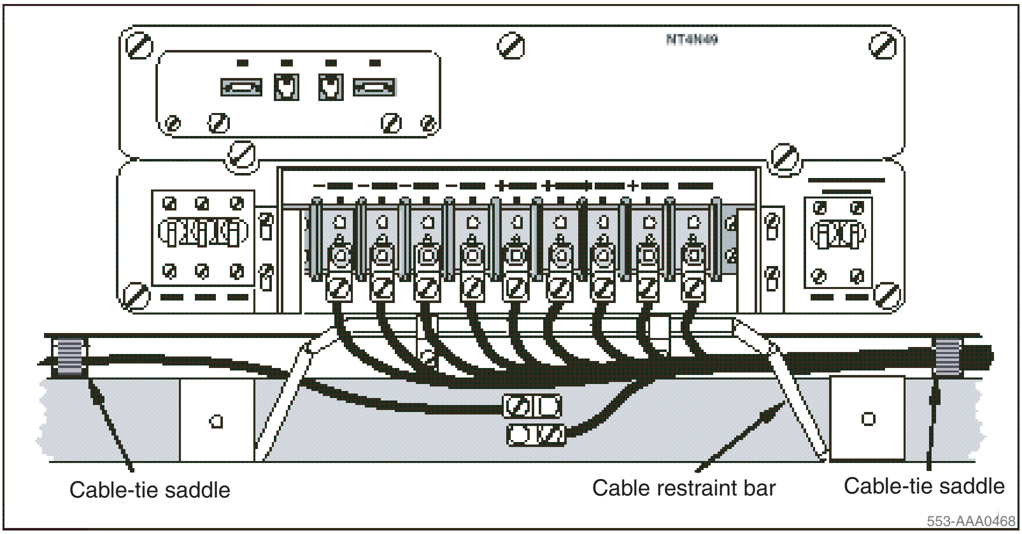
2 Is fully backward compatible with the existing PDU it is replacing.

3 Supports independent power feeds to each of 4 modules.

Where independent power feeds are not required, 2 jumper wires are provided to jumper adjacent battery leads. When the jumper wires are used, the 4-wire PDU effectively provides the same “shared” power configuration provided by the existing dc PDU.

The 4 breakers (one for each module) in the existing dc PDU (NT4N50AA) are rated at 18 amps each. The same breakers in the 4-feed PDU are rated at 28 amps.

Figure 45
Optional 4-feed wiring



PDU Connections

A readily accessible disconnect device for input power is required.

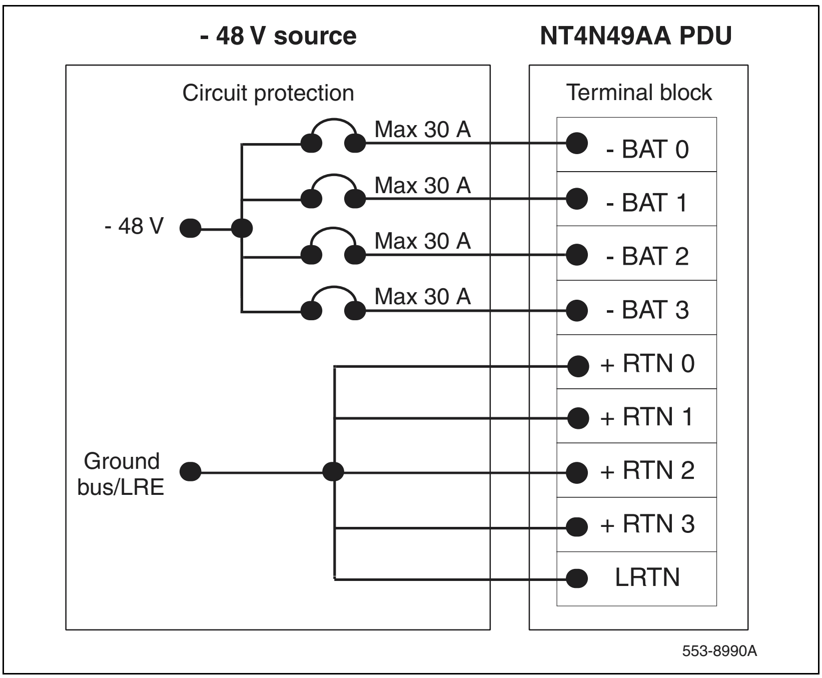
CAUTION

Damage to Equipment

Dc power for the NT7D09 pedestal must be provided with circuit protection of 30 amps for each feed (– BAT 0, – BAT 1, – BAT 2 and –BAT 3 (see Figure 46 on page 146).

Circuit breakers must be located next to each other and labeled to show that both must be shut off to remove all power to the system.

Figure 46
PDU circuit protection



A maximum loop drop of two volts is allowed between the pedestal, or junction box, and the external power equipment. See Table 22 for allowable wire sizes. See *Large System: Planning and Engineering* (553-3021-120) for detailed information on calculating wire size.

Table 22
Wire gauge requirements with two 30-amp feeds (five wires)

Length	#8 AWG	#6 AWG	Single #4 AWG	Double #4 AWG
0–3 m (10 ft)	Yes	Yes	Yes	Yes
3–6 m (20 ft)	Yes	Yes	Yes	Yes
6–9 m (30 ft)	Yes	Yes	Yes	Yes
9–12 m (40 ft)	Yes	Yes	Yes	Yes
12–15 m (50 ft)	Yes	Yes	Yes	Yes
15–18 m (60 ft)	No	Yes	Yes	Yes
18–21 m (70 ft)	No	Yes	Yes	Yes
21–24 m (80 ft)	No	Yes	Yes	Yes
24–27 m (90 ft)	No	No	Yes	Yes
27–30 m (100 ft)	No	No	Yes	Yes
30–60 m (200 ft)	No	No	No	Yes
over 60 m (200 ft)	No	No	No	No

Note 1: Two 30-amp feeds are typically adequate for a column with four modules (five wires total—two 30-amp feed pairs plus logic return).

Note 2: If dual conduit is used, the wires must be run in battery/battery return pairs, with one pair in one conduit and the other pair, plus logic return, in the other conduit.

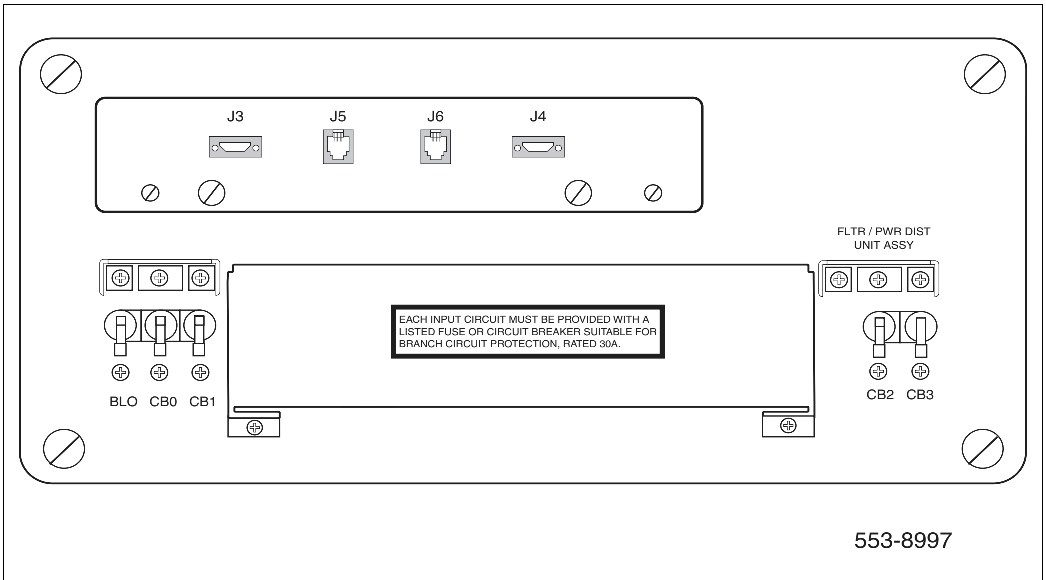
Legend:
Yes – Wire size is adequate for the distance.
No – Wire size has too high a voltage drop and is inadequate for the distance.

The following equipment is located in the rear of each pedestal (see Figure 47) in Large System columns:

1. The PDU distributes power to the entire column.
2. The field wiring terminal provides the connection point for wiring brought into the pedestal.
3. A circuit breaker is provided for each module in the column and for the blower unit.

All column circuit breakers will trip if a column thermal overload is detected or a dc-power low-voltage condition is sensed. The system monitor checks the column temperature, cooling system status, system voltage status, and controls alarms and line transfer states accordingly.

Figure 47
Dc-power equipment in the rear of the pedestal – NT4N49AA PDU



With the NT4N49AA PDU, the safety ground/protective earth wires and all wiring to the terminal block in the PDU must be neatly routed within the cable-tie saddles and under the cable restraint bar at the base of the pedestal (see Figure 48 on page 149). This ensures that there is room to install the PDU cover, safety cover, and rear grill.

Conduit is not required with the NT4N49AA PDU. However, 1-1/4 or 3/4 in. conduit can be used if local codes or individual installations require it. Conduit can be routed down through the column from overhead racks or up through the floor. Conduit clamps and the hardware to fasten the conduit are provided in the pedestal. If the NT7D0902 Rear Mount Conduit Kit is used, conduit can enter from the rear of the column (above the floor).

Figure 48
Cable routing in the rear of the pedestal – NT4N49AA PDU

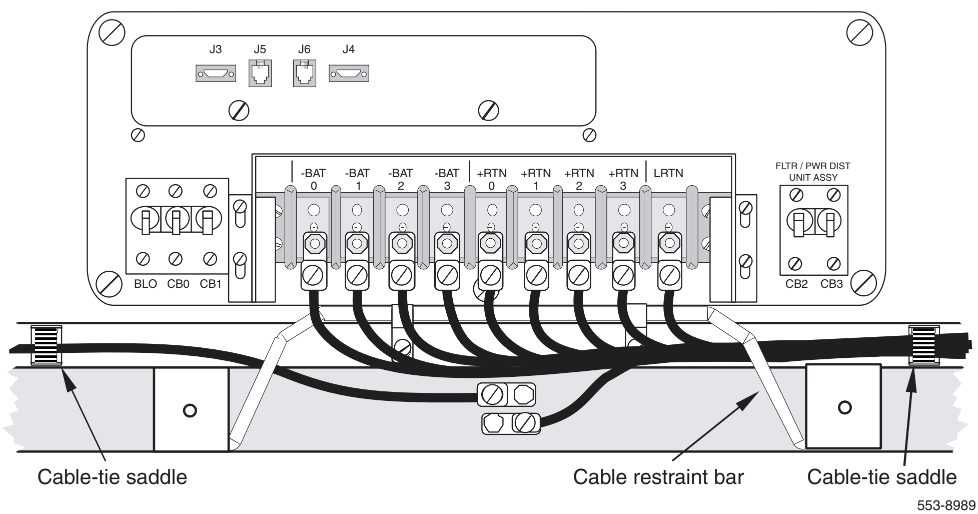


Figure 49
PDU to Candeo connections

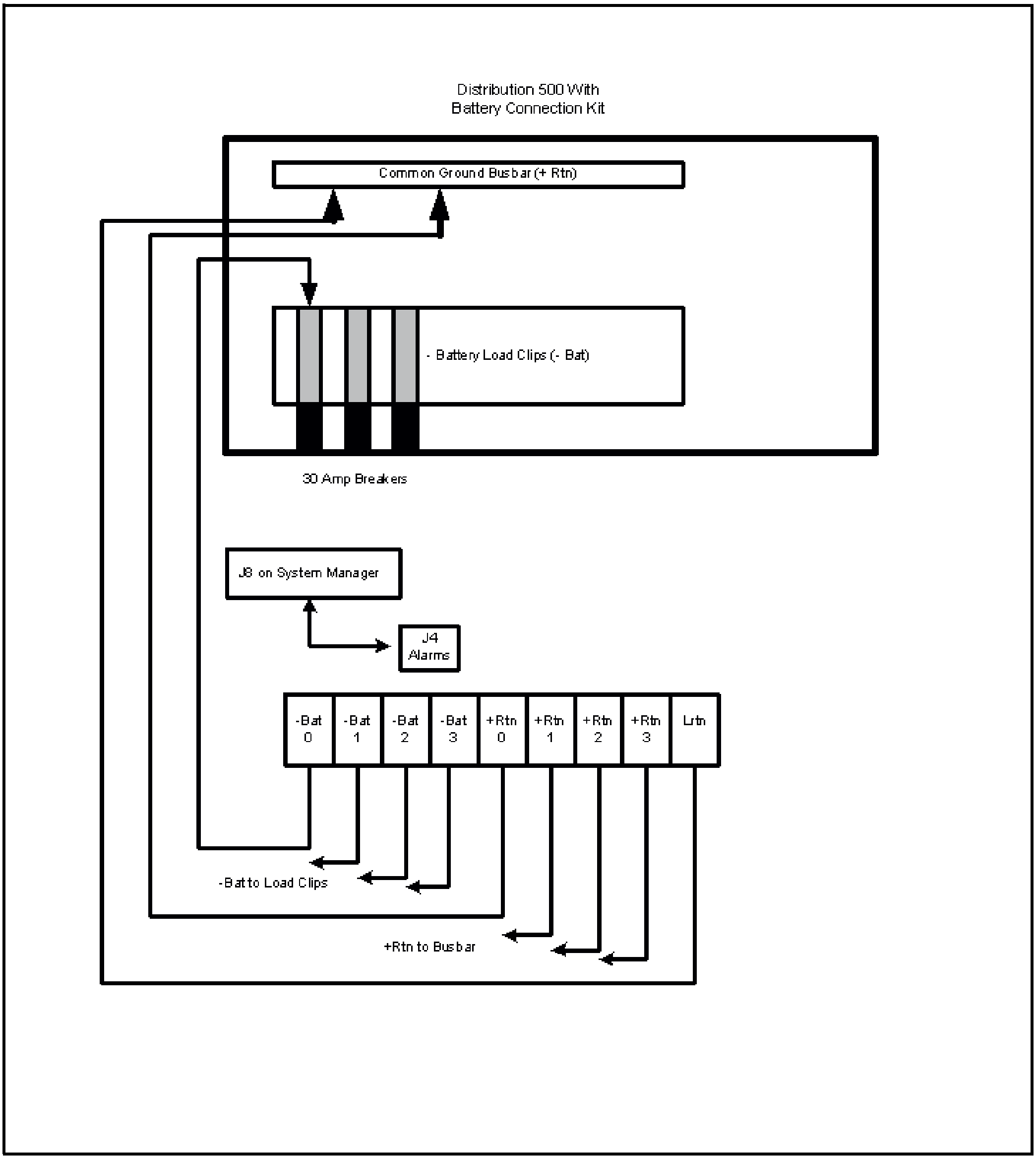
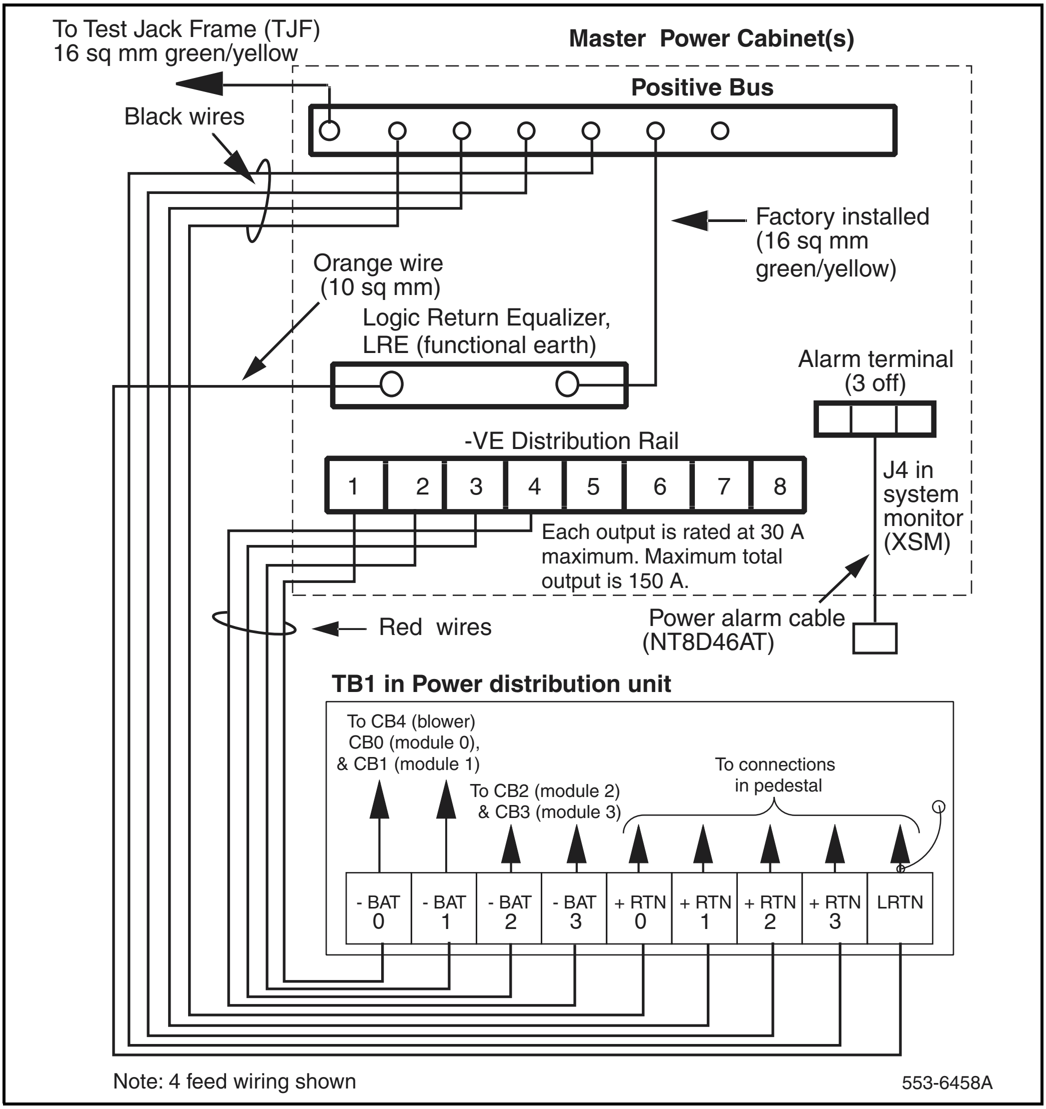


Figure 50
UEM to 8B/4R Master Power Cabinet 2R or 8B/4R Master Power cabinet connections



Selecting proper wire size

Contents

This section contains information on the following topics:

Introduction 153
Typical wire values 153
Metric conversion 155
Calculating wire size 155
Input wire size 157

Introduction

This section provides guidelines for determining wire gauges to connect a pedestal to a rectifier, dc distribution panel, or other external power equipment.

Typical wire values

Table 23 on page 154 lists typical wire sizes in AWG and circular mils for a given maximum current. Table 24 on page 154 lists maximum allowable voltage drops for dc power system conductors.

Table 23
Wire characteristics

Wire gauge (AWG)	Circular mils	Maximum amperes
4	41 750	90
6	26 250	65
8	16 510	50
10	10 380	35
12	6530	25

Note 1: Maximum amperage is affected by many factors, including temperature and insulation. Consult a wire handbook for precise tables.

Note 2: Although gauges smaller than 8 AWG are shown in this table for reference, it is not recommended that sizes smaller than 8 AWG be used for any of the conductors listed in Table 24.

Table 24
Maximum allowable voltage drops

Conductor	From	To	Allowable Voltage drop (max)
– Battery	Pedestal	– Distribution discharge	1.00
+ Battery return	Pedestal	+ Distribution ground	1.00
– Battery	Distribution	– Battery terminal	0.25
+ Battery return	Distribution	+ Battery terminal	0.25
– Battery	Rectifier	– Distribution charge	0.50
+ Battery return	Rectifier	+ Distribution ground	0.50

Note: "Distribution" means the dc power distribution panel (box).

Metric conversion

AWG measurements are not directly related to European Industry standard metric measurements. The following table provides guidance when converting from the AWG system to the Metric system for the most commonly used power and ground conductor cables.

Table 25
Metric wire conversion

AWG Number	Industry standard Nominal (sq mm)	Resistance at 20 deg.C. (Ohm/100m)
2	35	0.05
4	25	0.08
6	16	0.13
8	10	0.20
10	6	0.33
12	4	0.63
14	2.5	1.00
16	1.5	1.40
18	1	2.00
20	0.75	2.90
22	0.5	4.60

Calculating wire size

Using the maximum current in a conductor, determine the length that the conductor must be to meet the required maximum voltage drop. When you know the current, distance, and allowable voltage drop for a specific conductor, you can calculate the minimum wire size using the following formula:

$$CM = \frac{11.1 \times I \times D}{V}$$

where

CM = wire size required in circular mils
I = current in amperes (use the maximum expected)
D = distance in feet (to convert meters to feet, divide by 0.3048)
V = maximum allowable voltage drop

> **CAUTION**
>
> Although the voltage drops listed in Table 24 are the maximum drops allowed, the insulation and temperature rating versus current often dictates a wire size that creates smaller voltage drops on short lengths. After using the formula, check the wire tables to make sure the temperature rise is acceptable.

The following examples show wire size calculations using the formula given above:

- Example 1
  A battery or battery return conductor from a dc distribution panel to a pedestal is 11.0 m (36 ft.) long and must carry a maximum of 30 A with voltage drop of no more than 1V:

$$CM = \frac{11.1 \times 30 \times 36}{1} = 11,988$$

  — Choosing a standard gauge equal to or larger than this requires #8 AWG, which has a cross section of 16 510 circular mils.

- Example 2
  A battery or battery return conductor from a dc distribution panel to the battery is 7.6 m (25 ft.) long and must carry a maximum of 35 A:

$$\text{CM} = \frac{11.1 \times 35 \times 25}{0.25} = 38850$$

  — Choosing a standard gauge equal to or larger than this requires #4 AWG, which has a cross section of 41 740 circular mils.

Sense lead wire size

When sense leads are required, the loop resistance of the wire used to connect the ± sense terminals at the rectifiers or dc distribution panel to the ± terminals of the batteries must not exceed 2.5 ohms.

Input wire size

Table 26 provides a means for determining the size of wire used to connect the distribution box and the pedestal. A maximum total voltage drop of two volts is allowed between the pedestal and the external power equipment. Table 26 lists cable sizes that give acceptable voltage drops for a given cable length, and those that do not.

Note: Conduit is not necessary with the NT7D67CB PDU.

Table 26
Pedestal wire gauge requirements with two 30 A feeds (five wires)

Length	#8 AWG	#6 AWG	Single #4 AWG	Double #4 AWG
0–3 m (10 ft)	Yes	Yes	Yes	Yes
3–6 m (20 ft)	Yes	Yes	Yes	Yes
6–9 m (30 ft)	Yes	Yes	Yes	Yes
9–12 m (40 ft)	Yes	Yes	Yes	Yes
12–15 m (50 ft)	Yes	Yes	Yes	Yes
15–18 m (60 ft)	No	Yes	Yes	Yes
18–21 m (70 ft)	No	Yes	Yes	Yes
21–24 m (80 ft)	No	Yes	Yes	Yes
24–27 m (90 ft)	No	No	Yes	Yes
27–30 m (100 ft)	No	No	Yes	Yes
30–60 m (200 ft)	No	No	No	Yes
over 60 m (200 ft)	No	No	No	No

Note: Two 30 A feeds are typically adequate for a column with four modules (five wires total—two 30 A feed pairs, BAT(–) and BATRTN(+), plus logic return, LRTN(+).

Legend: Yes = Wire size is adequate for the distance.
No = Wire size has too high a voltage drop and is inadequate for the distance.

Preparing a system installation plan

Contents

This section contains information on the following topics:

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Cable requirements 197
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Introduction

Planning for system installation affects the installation cost, as well as operation and maintenance, and can have an overall effect on system performance. Consider the following requirements (in addition to local and national building and electrical codes) when you plan a system installation.

Select and evaluate sites according to the requirements in this document and the following criteria:

- Space:
  - The site must provide adequate space for unpacking, installation, operation, potential expansion, service, and storage. The site must provide space for sufficient cooling. You may need additional space for a maintenance and technician area.
- Location:
  - The location should be convenient for equipment delivery and close to related work areas. You must consider the location of related equipment (such as the distribution frame and batteries) and the cable limitations when selecting the site.
- Grounding and power:
  - Proper grounding and sufficient power facilities must be available.
- Structural integrity:
  - The floor must be strong enough to support anticipated loads and, if applicable, the ceiling must be able to support overhead cable racks.

Creating an installation plan

To assist with the development of the installation plan, create an Installation Outline and a Milestone Chart.

Installation outline

Use Table 27 on page 161 as a guide for preparing a detailed installation plan.

Table 27
Installation plan outline

Procedure	Requirements
Researching site requirements	— Determine fire, security, and safety requirements — Determine equipment room requirements — Determine grounding and power requirements — Determine cable requirements
Planning the site	— Prepare a floor plan — Estimate floor loading — Prepare the building cabling plan
Preparing for delivery and installation	— Prepare for delivery — Prepare for installation

Milestone chart

Planning and monitoring site preparation activities is easier when you use a milestone chart. A milestone chart is a general site planning schedule showing the sequence of activities necessary to complete a job.

Table 28 on page 162 lists typical activities included in a milestone chart. For a complex site, you must create a more detailed chart.

Table 28
Milestone chart

Task	Action
1	Select the site.
2	Plan fire prevention and safety features.
3	Plan the equipment room layout.
4	Plan grounding and power.
5	Plan cable routes and terminations.
6	Plan and start any renovations to the equipment room.
7	Continue site construction and renovation tasks.
8	Install grounding, power, air conditioning, and heating.
9	Install special rigging, such as overhead cable racks and distribution frame equipment, as required.
10	Test site wiring to ensure that minimum requirements are met.
11	Complete construction and ensure that grounding and power are in place.
12	Test air conditioning and heating systems.
13	Make equipment delivery arrangements.
14	Complete equipment room inspection, identifying and resolving any delivery constraints.

When you prepare a milestone chart, consider not only individual operations, but the overall installation schedule. The milestone chart should show the necessary operations in order and may assign a start and end date for each activity.

Fire, security, and safety requirements

Building, fire, and safety codes establish the degree of protection required for an installation. Additional information is available from the National Fire Protection Association (NFPA) in “Standard for the Protection of Electronic Computer/Data Processing Equipment” (NFPA 75) and “National Electrical Code (NEC)” (NFPA 70).

Fire protection and prevention

Expertise is required to properly locate and install:

1. Sprinkler heads
2. Fire and smoke sensing devices
3. Other fire extinguishing equipment

During the planning stage, consult local codes, experts, insurance underwriters, and local building authorities.

You can implement some fire precautions when an equipment area is constructed. For example, extend walls from floor to ceiling, and construct walls, floor, and dropped ceiling of noncombustible material.

If the structural floor is made from combustible materials, cover it with a noncombustible covering and remove all debris between the raised and permanent floors before the system is installed. If there are power connections beneath a raised floor, use waterproof electrical receptacles and connectors.

You can install shatterproof windows and sprinklers outside and above the windows to keep fire from spreading from an adjacent room or building. The roof or floor above the equipment area must be watertight. Design ducts and plumbing for air-conditioning systems to keep fire, heat, and smoke from spreading from one part of a building to another. Install smoke detectors in all appropriate places.

Regularly check services such as steam, water, and power, and inspect pipes for excess condensation, leaks, or corrosion.

Fire extinguishing systems

In most cases, carbon dioxide or water sprinkler systems are the recommended fire extinguishing systems.

Dry-pipe water sprinklers are strongly recommended. This type of system interrupts power to the room and opens a master valve that fills the overhead sprinklers.

Carbon dioxide systems are also effective in containing a fire, but they quickly exhaust the oxygen supply. If you use a carbon dioxide system, you must install an alarm to warn site personnel when carbon dioxide is released. For health and safety reasons, employees must be evacuated within 30 seconds of the release.

DANGER

Nortel Networks does not recommend using Halon or any other fire extinguishing system that is not described above. Nortel Networks is supported by the Environmental Protection Agency to enforce any restrictions on the use of other fire extinguishing systems.

Security precautions

You may need to extend and improve existing building security to provide adequate protection for the equipment. For example, you can install safeguards such as tamper proof keylock door controls and electrically taped glass doors and windows that can tie into an alarm system. You can also install a monitoring unit using closed-circuit television.

> ***Note:*** Electric locks, such as push button access code or card reader locks, are not recommended unless you provide a battery backup or a key override.

Protect critical data, such as business records, by storing backups well away from the equipment room. A regular updating program is highly recommended.

Safety procedures and training

Company personnel should be taught how to respond to emergencies; some companies designate trained individuals as security members. Training can include when and how to evacuate personnel and records, notify the fire department, shut off all electrical power, and handle fire extinguishers properly.

In addition, install temperature and humidity monitoring devices (both visual and audible alarm signals) in equipment and storage rooms so people can respond quickly to an emergency.

Occupational noise exposure

If employees are subjected to noise levels exceeding local standards, or the levels listed in 1910.5 of the Occupational Safety and Health Administration (OSHA) Standards, initiate administrative and engineering controls. If these controls do not reduce sound levels effectively, provide protective equipment.

> ***Note:*** The acoustic noise generated by a column ranges from 45 dBA to 60 dBA (decibels "A"-weighted).

Equipment room requirements

The environment for the system (and for storing spare parts) can influence system performance and reliability. Temperature, humidity, and other environmental factors, such as static electricity, must be controlled to meet system operating requirements.

Space requirements

Space and equipment layout requirements differ with each installation. When you plan the site, consider the following requirements:

- Primary storage
- Secondary storage
- Maintenance and technician space

Primary storage

The floor area required for a system depends on the number of columns, the length-to-width ratio of the area, and the location of walls, partitions, windows, and doors. To determine the exact layout required, prepare a detailed floor plan after regarding all of the requirements in this chapter.

Although operating needs determine the general location of terminal devices, these devices must not be located beyond the maximum distances defined for their interface cards. Wall jacks and outlets must be provided for all devices located in the equipment room.

Secondary storage

Provide space in the equipment area for storing disks, printer paper, printouts, and daily reports. A secure storage room for spare parts is recommended.

Whenever possible, maintain the same environmental conditions in the equipment room and storage areas. If it is not possible to maintain the environment of the storage area exactly the same as the environment of the operating equipment, give stored materials time to adjust to the equipment room environment before using them.

Maintenance and technician space

You can use the maintenance and technician area as an online work center and a place to store tools, test equipment, system documents, and spare parts. The area should have good lighting and convenient access to the system.

Typical items in a maintenance and technician area include:

- Shelves for instruction books
- Spare parts storage room
- Paper storage area
- Locking cabinet or storage area for backup disks
- Table or desk
- Terminal, printer, or equivalent device

During regular system operation, a terminal, or a modem, or both must be connected permanently to the system to provide a constant I/O interface. You can use more than one terminal or modem. Plan for surface apace, power outlets, and the availability of the terminals/modems before installation.

Temperature and humidity control

Frequent and extended system operation above recommended temperature limits can degrade system reliability. Low humidity can increase static electricity build-up, while high humidity can affect the performance of disks and printers.

Take temperature readings 76 cm (30 in.) from the front of the system. Table 29 shows system operating requirements.

DANGER

Damage to Equipment

Do not expose equipment to absolute temperature limits for more than 72 hours. Do not place heat sources (such as floor heaters) near the equipment.

Table 29
Operating environment

Equipment	Temperature and humidity considerations
Large System	Recommended: — 15° to 30°C (59° to 86°F) — RH 20% to 55%, non-condensing Absolute: — 10° to 45°C (50° to 113°F) — RH 20% to 80%, non-condensing — temperature change less than 10°C (18°F) per hour
Telephones	Absolute: — 0° to 50°C (32° to 122°F) — RH 20% to 80%, non-condensing
Other terminal devices (such as personal computers, data sets, and printers)	Refer to the specific documentation or manufacturer's guidelines

If you operate the system within recommended temperature limits, there are no thermal restrictions on any equipment. If you operate the system above recommended limits (it must remain within absolute limits), be sure to locate disk drive units in one of the lower two modules in a column.

Follow the specifications listed in Table 30 to store or transport equipment.

Table 30
Storage environment (Part 1 of 2)

Equipment	Temperature/humidity considerations
Large System (without disk drive units)	Long and short term: — –50° to 70°C (–58° to 158°F) — RH 0% to 95%, non-condensing
Telephones	Long and short term: — –50° to 70°C (–58° to 158°F) — RH 5% to 95%, non-condensing
Disk drives	Long term: — –20° to 60°C (–4° to 140°F) — RH 10% to 90%, non-condensing Short term: — –40° to 60°C (–40° to 140°F) — RH 5% to 95%, non-condensing
Disks	Long term: — 10° to 53°C (50° to 128°F) — RH 20% to 80%, non-condensing Short term: — –40° to 60°C (–40° to 140°F) — RH 10% to 90%, non-condensing

Table 30
Storage environment (Part 2 of 2)

Equipment	Temperature/humidity considerations
Other terminal devices	Refer to the specific Nortel Networks publication or the manufacturer's guidelines
Note: Temperature changes must be less than 30° C (54° F) per hour for long- and short-term storage and during transportation.	

Air conditioning guidelines

Use the following guidelines to estimate air conditioning requirements. Exact requirements must be determined by a qualified air conditioning engineer.

1 The air conditioning system in equipment areas must handle:

- **a** the heat produced by the equipment, room personnel, and lighting; and,
- **b** the heat that comes through walls, windows, floors, and ceilings.

2 A stable ambient operating temperature of approximately 22 degrees C (72 degrees F) is recommended. The temperature differential in the equipment room must not exceed ±3.0 degrees C (±5 degrees F).

Note: For systems with reserve power equipment, consult the manufacturer's specifications for recommended operating temperatures.

3 Heat dissipation from a system is estimated in BTUs per hour (BTU/hr). You can estimate the amount of air conditioning required at a rate of one ton of refrigeration for every 12 000 BTU/hr of heat generated in the equipment area plus one ton for each 500 sq ft of floor space.

Note: Each person in the equipment room generates 600 BTU/hr.

> **CAUTION**
>
> **Damage to Equipment**
>
> Because digital systems require constant power (even if the system is idle), they generate heat continuously. Air conditioning requirements must be met at all times.

4 Table 31 on page 171 shows the maximum power dissipation in the form of heat for each module. The measurements are the same for ac- and dc-powered modules.

Table 31
Heat dissipation – modules

Module	Heat dissipation	
	Watts	**BTU/hr**
NT4N41 Core/Network	360	1230
NT4N46 Core/Network	360	1230
NT5D21 Core/Network	360	1230
NT6D44 Meridian Mail	240	820
NT6D60 Core	260	890
NT8D11 Common/Peripheral Equipment	500	1700
NT8D13 Peripheral Equipment	240	820
NT8D34 CPU	260	890
NT8D35 Network	240	820
NT8D36 InterGroup	0	0
NT8D37 Intelligent Peripheral Equipment	340	1160
NT8D47 Remote Peripheral Equipment	240	820
NT9D11 Core/Network:	360	1230
— local site	175	600
— remote site	100	340
Application Equipment Module:		
— single	210	710
— dual	420	1420
Succession Signaling Server	125	430
Note: Thermal load (BTU/hr) = total power dissipation (watts) × 3.4		

5 Table 32 shows the maximum heat dissipation for dc-power rectifiers supplied by Nortel Networks.

Table 32
Heat dissipation – rectifiers

Rectifier	Heat dissipation	
	Watts	**BTU/hr**
NT5C06 25-A	130	444
NT6D52 30-A	175	600
NT5C03 50-A	290	990
NT5C07 50-A	380	1297
A0354954 100-A	580	1980

Note 1: Thermal load (BTU/hr) = total power dissipation (watts) × 3.4

Note 2: NT5C07 rectifier is a part of the MPP600 power plant. MPP600 may contain up to three such rectifiers in one power shelf. The maximum MPP600 plant capacity is 12 NT5C07 rectifiers or 600A at -48 Vdc or four power shelves when using the main and the supplemental cabinets. Total MPP600 heat dissipation is 12 × 1297 = 15 570 BTU/hr.

Other environmental factors

In addition to temperature and humidity, many environmental factors must be controlled in equipment areas. The environmental factors that must be controlled include:

- Static electricity
- Vibration
- Electromagnetic and radio frequency interference (EMI/RFI)
- Dust
- Lighting

- Earthquake bracing
- Structural features

Static electricity

Electronic circuits are extremely sensitive to static discharge. Static discharge can damage circuitry permanently, interrupt system operation, and cause lost data.

Static electricity can be caused by physical vibration, friction, and the separation of materials. Other common causes of static electricity build-up are low humidity, certain types of carpeting, the wax on equipment room floors, and plastic-soled shoes. The human body is the most common collector of static electricity. A combination of plastic-soled shoes, certain flooring materials, and low humidity can cause body charges in excess of 15 kV.

> ***Note:*** IEEE Standard 142-1982 recommends that flooring resistance be more than 25 000 ohms and less than 1 million megohms, measured by two electrodes 0.91 m (3 ft) apart on the floor. Each electrode must weigh 2.2 kg (5 lb) and have a dry flat contact area of 6.35 cm (2.5 in.) in diameter.

Antistatic wrist straps, sprays, and mats are available. Nortel Networks recommends at least using an antistatic wrist strap whenever you work on equipment.

Vibration

Vibration can cause the slow deterioration of mechanical parts and, if severe, can cause serious disk errors. Avoid structure-borne vibration and consequent noise transferred to the equipment room. Raised floors must have extra support jacks at strategic places to prevent the transmission of vibration.

Limit vibration in an office environment to a frequency range of 0.5–200 Hz and a G-force magnitude of 0.1 G (in accordance with the Bellcore “Network Equipment Building Systems Generic Equipment Requirements” specification TR-EOP-000063).

Electromagnetic and radio frequency interference

Sources of electromagnetic and EMI/RFI located close to equipment can cause problems with system operation. Common EMI/RFI sources known to disturb system operation include:

- Thunderstorms, static electricity, and high-voltage power lines
- Radar, broadcast stations, and mobile communications
- Power tools, appliances (such as vacuum cleaners), and office business machines (such as copiers)
- Industrial machines and ultrasonic cleaners
- Vehicle ignition, arc welders, and dielectric heaters
- Dimmer switches

Note: The equipment meets the United States FCC Rules, Part 15, and Canadian Standards Association (CSA) C108.8 for EMI/RFI radiation.

Dust

Accumulated dust and dirt can degrade system reliability and performance. Dust and dirt can:

- Scratch the contacts on circuit cards causing intermittent failures
- Have conductive contents that increase static electricity in the environment
- Cause components to operate at higher temperatures

Average dust density for an office environment must be 0.00014 g/m3 or better. False ceilings and tiled floors help maintain dust density requirements.

Lighting

Lighting illumination of 50 to 75 footcandles measured 76 cm (30 in.) above the equipment room floor is recommended. Avoid direct sunlight in the equipment room to prevent malfunctions by devices with light sensors (such as disk units).

Lighting must not be powered from the equipment room service panel. For large system installations, consider provisions for emergency lighting in the equipment room.

Earthquake bracing

Earthquake (seismic) bracing is required or should be considered in some locations. See *Large System: Installation and Configuration* (553-3021-210) for detailed instructions on installing earthquake bracing.

Structural features

Use sealed concrete, vinyl, or mastic tile for flooring and ensure that it meets the floor loading requirements described later in this document. Avoid using sprayed ceilings or walls.

Grounding and power requirements

This section describes isolated and non-isolated ground topologies, commercial power source, auxiliary power, and power failure transfer unit (PFTU) requirements. If there is a conflict between information in this chapter and a local or national code, follow the code.

Grounding

DANGER OF ELECTRIC SHOCK

If you fail to follow grounding procedures, the installation can be unsafe for personnel, unprotected from lightning or power transients, subject to service interruptions, and subject to degraded performance.

Power and ground must originate from the supply service (equipment room service panel or transformer), where the ground conductor and the neutral conductor connect and are referenced to the main building ground. All power feeds should contain a separate safety conductor (green wire).

IMPORTANT!

Do not use the main building ground directly as the ground reference for the system.

The equipment service panel must be located in the equipment room. This service panel must not service lighting, air conditioning, heating, generators, or motors. Nortel Networks strongly recommends that supply conductors be dedicated and uninterrupted from a building primary source to the dedicated equipment room service panel.

Power is supplied to the service panel by a power transformer. The transformer typically provides secondary voltages of 208/120 V three-phase four-wire “wye” service, 240/120 V single-phase four-wire “delta” service, or 240/120 V single-phase three-wire service. Collectively, these secondary voltages are referred to as “nominal 208/240 V ac” throughout system documentation.

A dedicated power transformer for the system and associated auxiliary and telephone operating company interface equipment is preferred; however, a shared transformer or distribution is acceptable. (Figures 51 through 54 starting on page 182 illustrate the differences between dedicated and shared distribution.)

WARNING

Do not use ground fault circuit interrupt (GFCI) devices on system ac power feeds

Single point ground (SPG)

The system requires a single point ground (SPG) topology for all equipment and all associated auxiliary equipment.

The system has several types of grounds and several types of signal returns that are generally referred to as “grounds.”

- In ac systems, there is a logic return (LR or LRTN) and a green wire frame ground, called the ac equipment ground (ACEG), that is typically part of the input power cord.
- In dc systems, there is a logic return (LR or LRTN) and a battery return (RTN), as well as an ac equipment ground (ACEG) green wire on the input to the rectifier(s).
- All systems must have an external hard-wired frame ground connection (also called the personal hazard safety ground). The frame ground is connected internally to the ACEG green wire, but because it is hard-wired it ensures that the equipment has a ground connection even if the system is “unplugged.”
- External Communications wiring that meet the requirements as stipulated in NEC Article 800-30 FPN 4 require the use of lightning protection. The cable sheaths, and protection grounds must be installed per NEC Article 800 - 33, and Article 800 - 40 (b).

For SPG topology, each of these grounds from each of the columns, must terminate at a single connection point before attaching to the actual ground reference at the service panel or transformer. Physically, the SPG is usually a copper bar or plate (referred to as a “bus”). In its simplest form, the SPG (the single connection point) can be an isolated ground bus or ACEG bus in the service panel or transformer.

In some conditions, a logic return equalizing (LRE) bus is needed. Multiple-column systems, for example, often require an LRE bus as a ground connection point. The LRE serves as the point where the logic return (LR or LRTN) wires from different columns are consolidated before connecting to the SPG.

Two LRE assemblies are available from Nortel Networks:

1 NT6D5304 Ground Bus/LRE – Small; typically used with ac-powered systems; and,

2 NT6D5303 Ground Bus/LRE – Large; typically used with dc-powered systems.

SPG requirements

Follow these requirements for the SPG:

- All ground conductors must be identified according to local codes and terminated permanently.
- Terminations must be accessible for inspection and maintenance during the life of the installation.
- All grounding conductors must be continuous, with no splices or junctions, tagged "Do not remove or disconnect," and insulated against contact with foreign grounds.
- Grounding conductors must be no load, non-current-carrying cables, under normal operating conditions.
- The ground interface, in a steel-framed building, must have a single connecting reference, located at the service panel, to the building steel on the same floor as the system (or within one floor).

  Note: Nortel Networks does not recommend the use of building steel as an integral part of the system ground system. The building steel is a reference point only.

The dc resistance of the system ground conductor, which runs from the system to the main building ground, must be as close to zero as possible. The maximum total resistance on all runs within the building must not exceed 0.5 ohms.

All voice and data lines that run outside to the building, leaving or entering the system, must have fault protectors that connect directly to an approved ground. Fault protectors provide protection from external faults and transients on data lines. Refer to the 800 section of the NEC Handbook, 1996 edition or later, for what constitutes an approved ground.

To meet system requirements for an SPG:

- Installation must adhere to the SPG requirements.
- The building ground must meet National Electrical Code (NEC) and Canadian Electrical Code (CEC) regulations.
- Use the proper wire size for the system ground reference conductor.

Isolated and non-isolated ground

You can install the system with an isolated or non-isolated ground topology. Nortel Networks strongly recommends using an isolated ground for grounding system integrity. Use non-isolated ground systems only where they are required by code.

In an isolated ground system, the dedicated isolated ground bus bar in the service panel serves as the ground window. It is used for all ac safety grounds and logic returns. It also accommodates a conductor that references the (+) battery bus in dc systems.

In addition, one or more isolated LREs can be located outside of the service panel, but they must connect to ground exclusively through the isolated ground bus.

Isolated IG-L6-20 or IG-L6-30 orange receptacles are used with an isolated ground system. All ground wiring for isolated ground receptacles must terminate on the dedicated isolated ground bus according to applicable codes.

In a non-isolated ground system, the ACEG connects to the metal panel, and any associated conduit can also contact various structural metal. Because this ground alone is not adequate for the system, a dedicated ground conductor connected to the main building ground is used for the main ground window to terminate logic returns and reference the (+) battery bus. Frame grounds connect to the ACEG.

Non-isolated L6-20 or L6-30 brown receptacles are used with a non-isolated ground system.

> ***Note:*** For more detailed information on receptacles, see "Commercial power source" on page 186.

All circuit breakers must be clearly labeled in both isolated and non-isolated ground ac panels.

Figures 51 through 54 starting on page 182 illustrate the differences between (a) dedicated and shared distribution, and (b) isolated and non-isolated ground systems.

The following notes apply to Figures 51 through 54.

> ***Note 3:*** Run the ground conductor in the same conduit with the phase and neutral conductors. Use the appropriate NEC table to determine the correct wire size.
>
> ***Note 4:*** Use of an isolation transformer is recommended. Locate it as close as possible to the ac panel.
>
> ***Note 5:*** You must bond the Ground electrode conductor to a recognized ground, such as a vertical ground riser or a building principal ground. Keep it at a low impedance and do not run it in a conduit. Ground in accordance with the NEC/CEC guidelines.
>
> ***Note 6:*** This conductor may not be smaller than number 6 AWG.
>
> ***Note 7:*** Locate the dedicated equipment service panel in the equipment room.
>
> ***Note 8:*** Amperage level depends on the equipment being fed; refer to the *Large System: Installation and Configuration* (553-3021-210).
>
> ***Note 9:*** For ac systems, this goes to the Logic Return Equalizer (may not be required where enough terminations exist on the IG bus). For dc systems, this goes to the dc ground reference.
>
> ***Note 10:*** Bond Telco/OSP shields, bonds, and protection at an approved reference per NEC Article 800 and CEC Article 10-1000, and Appendix B 36-310 (9). Do not bond them at the LRE or Service Panel.
>
> ***Note 11:*** It is required that all 120 VAC service drops in the equipment room have IG-type receptacles. Each receptacle must have an individual hot, neutral, and IG ground conductor run in the same conduit (NEC 250-74 Exception 4, CEC 10-906(8). Some local codes require an additional bonding lead to bond the outlet box back to the frame panel.

Note 12: Label circuits at both ends in accordance with NEC 110-2/CEC guidelines. Identify NEMA numbers for IG-type receptacles at the panel and outlet as follows:

- 120V @ 15A = IG.5.15
- 208V @ 20A = IG.L6.20
- 208V @ 30A = IG.L6.30

Note 13: In Canada, it may be required that the IG ground bus be bonded to the panel frame.

Note 14: Refer to "Auxiliary power" on page 190 for more information.

Note 15: An alternate earthing electrode, if required, must be installed at a minimum of 1.8 m (6 ft) from the building earth reference.

Note 16: If you use PVC conduit, a dirty grounding conductor may be required.

Note 17: Label circuits at both ends in accordance with NEC 110-2/CEC guidelines. Identify NEMA numbers for non IG-type receptacles at the panel and outlet as follows:

- 120V @ 15A = 5.15
- 208V @ 20A = L6.20
- 208V @ 30A = L6.30

Figure 51
Dedicated transformer in an isolated ground system

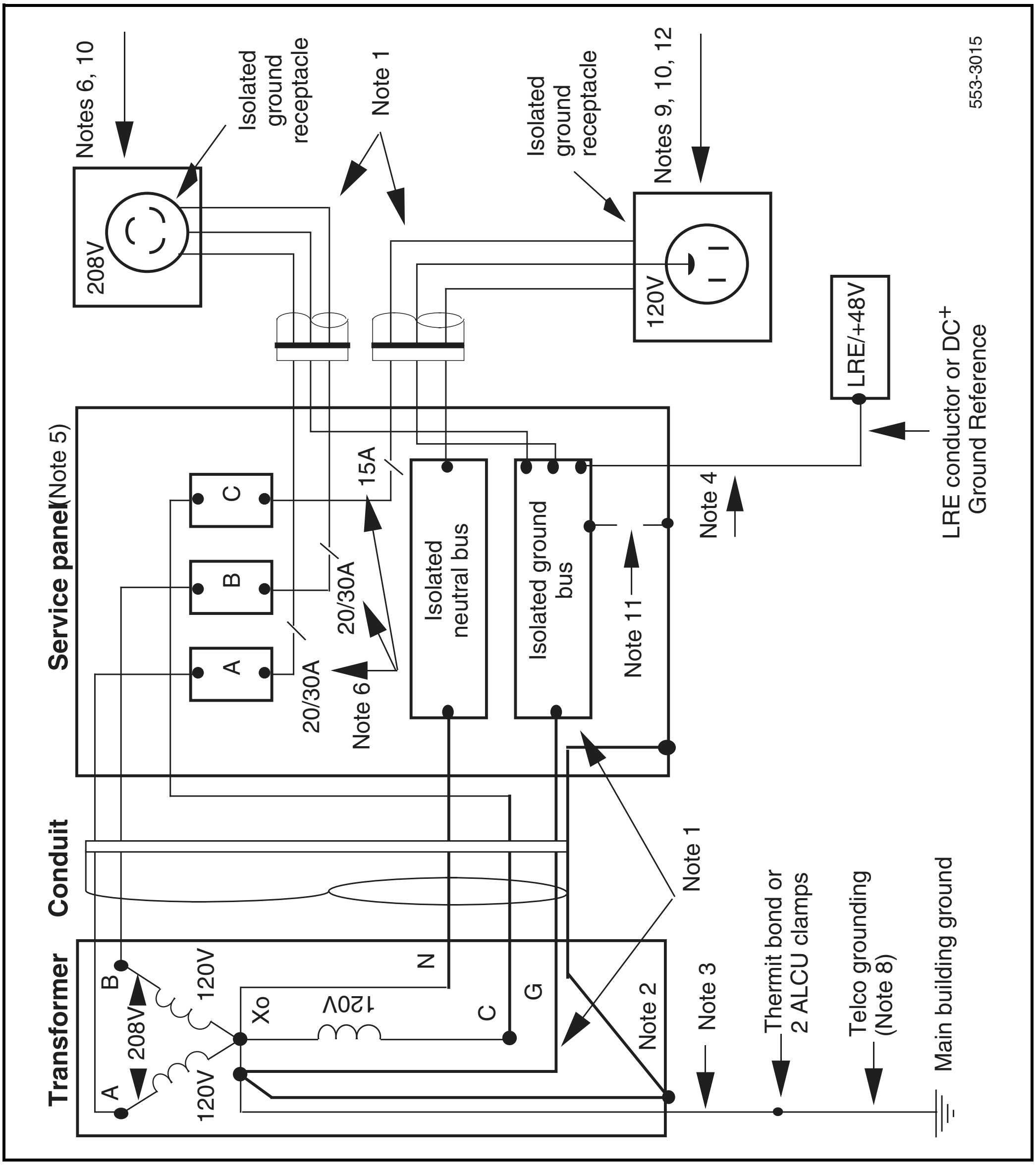


Figure 52
Dedicated transformer in a non-isolated ground system

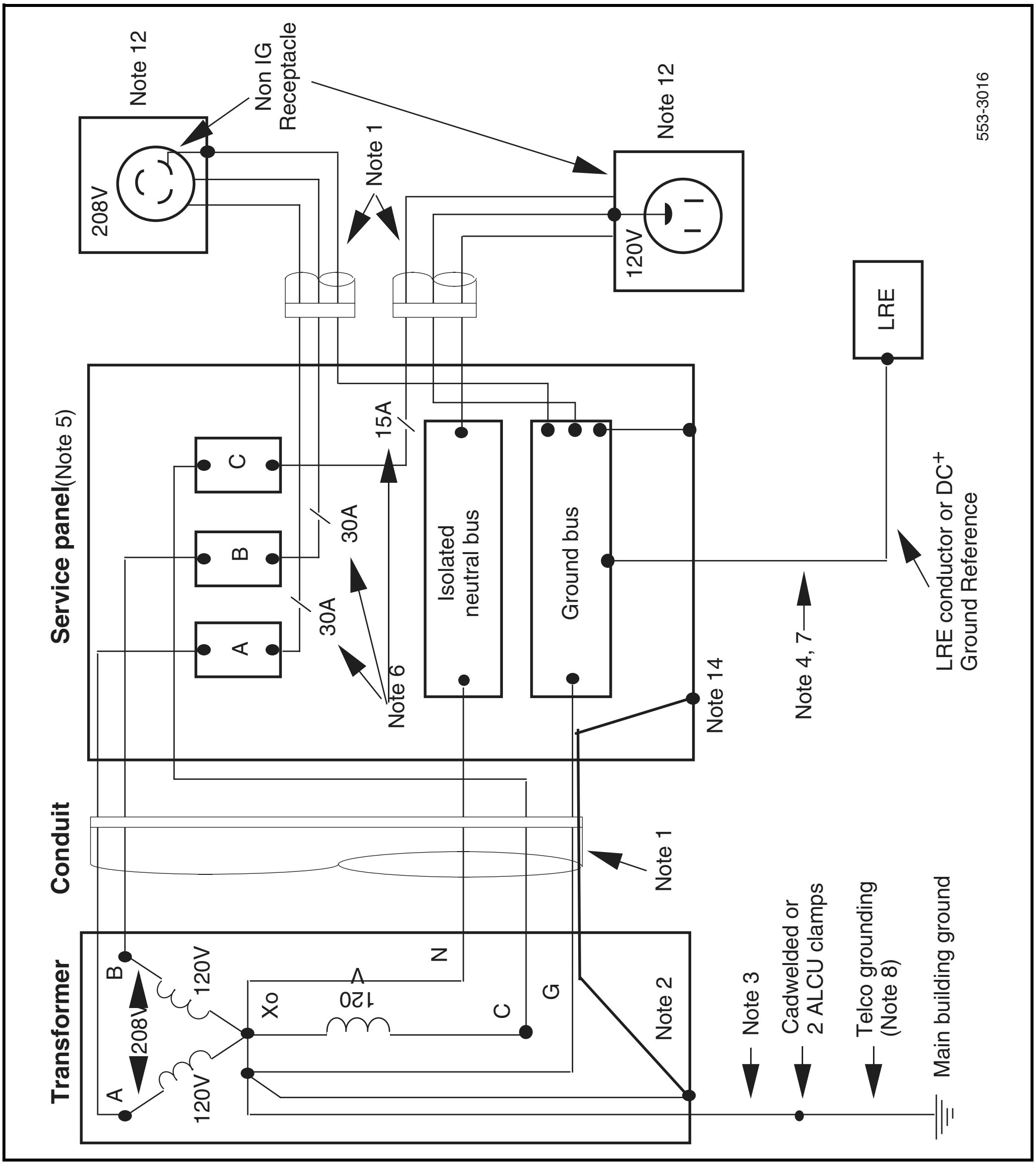


Figure 53
Shared distribution in an isolated ground system

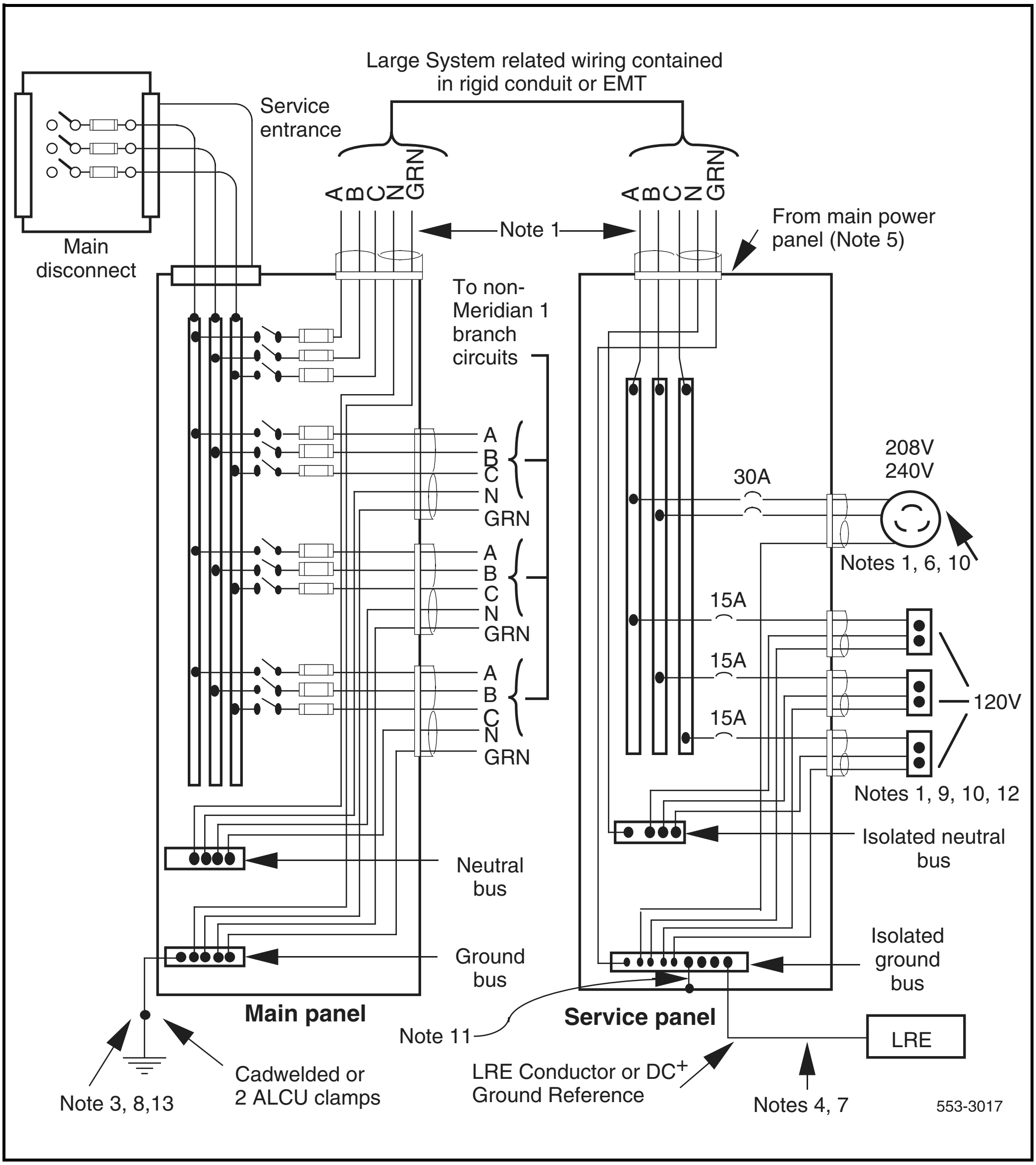
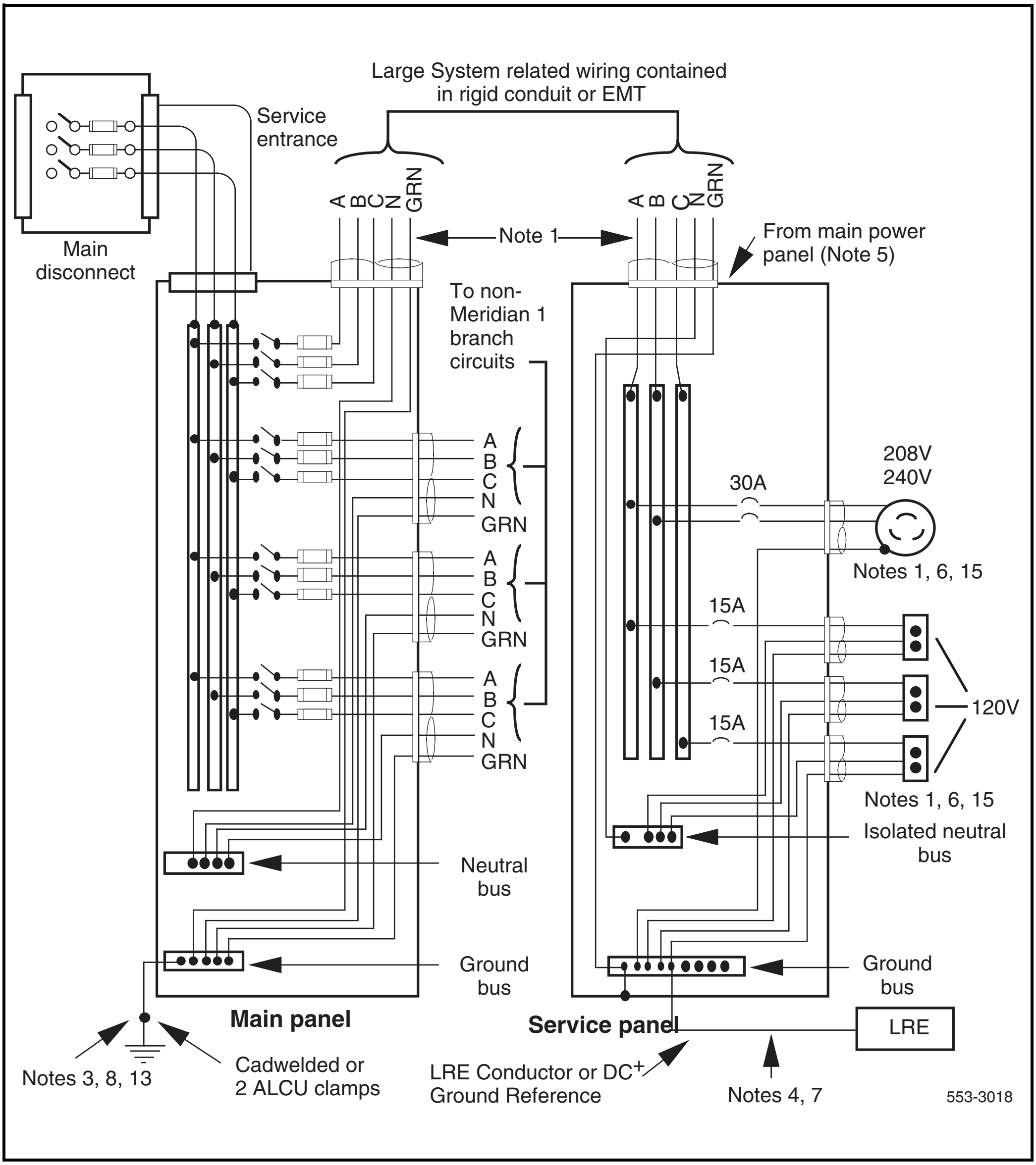


Figure 54
Shared distribution in a non-isolated ground system



Commercial power source

The commercial power source is the main ac utility power feed, which is required for both ac- or dc-powered systems. For ac systems, this power source connects directly to the system. For dc systems, this power source connects to the rectifiers, which convert the ac voltage to –48 V dc voltage for distribution to the system.

In North America, the power supplied can be either 208 V ac or 240 V ac nominal. Three-phase power is not required, but single power feeds from alternate phases (phase-to-phase wiring) are normal practice where three-phase power is available.

Table 33 lists the input power required from the commercial power source for ac-powered systems. As shown, any voltage in the range of 180 V to 250 V is acceptable.

Table 33
Ac input specifications for ac-powered systems

Input	Minimum	Nominal	Maximum
Voltage (V ac) at pedestal	180	208/240	250
Frequency (Hz)	47	50/60	63
Note: Distortion on voltage sine wave: 5% total harmonic distortion (THD), 3% any single harmonic.			

Table 34 on page 187 shows the transient tolerance for abnormally high- and low-line conditions for module power supplies in ac-powered systems. When subjected to these transients, the power supplies continue to maintain their outputs within their specified operating limits. Spikes and notches are defined in terms of 0.5 and 0.25 cycle power disturbances. Surges and sags tend to be temporary changes in the nominal ac voltage, sometimes over several 60 Hz cycles.

Table 34
Transient tolerance for ac-powered systems

Transient	Amplitude	Duration
High-voltage conditions:		
Spikes	815 V ac 408 to 815 V ac	up to 4.16 ms 4.17 to 8.33 ms
Surges	288 V ac 276 V ac	8.34 to 50 ms 51 to 500 ms
Low-voltage conditions:		
Notches	0 V 0 to 206 V	up to 4.16 ms 4.17 to 8.33 ms
Sags	146 V 166 V	8.34 to 50 ms 51 to 500 ms
Note: All transients are applied at the peak of the ac waveform.		

The specifications in Table 34 are derived from NEC and various telephone operating company specifications. These specifications are based on power disturbances that have been measured or observed, or that can be expected to commonly occur. Therefore, these specifications for transient tolerance are the minimum requirements that the equipment must meet.

The "hold-up" time specification for an ac module power supply is 20 ms at full load, when measured at the peak of the input voltage waveform and with nominal input of 208 V ac. Hold-up time is the time from the removal of the ac input voltage to the time when any one output voltage drops below its specified operating limit. At less than full load, the hold-up time is greater.

> ***Note:*** The hold-up specification exceeds the low-voltage transient specifications listed in Table 34 above.

Table 35 lists the input power required from the commercial power source for the rectifiers used with dc-powered systems. All ac input voltage is continuous over the range from minimum to maximum (no straps) except for the A0354954 100 A rectifier that has strap options for 208 and 240V ac.

Table 35
Ac input specifications for dc-power rectifiers

Rectifier	Minimum	Nominal	Maximum
NT5C06 25A:			
— Voltage at rectifier	176V ac	220V ac	264 V ac
— Frequency	47 Hz	50/60 Hz	63 Hz
NT6D52 30A:			
— Voltage at rectifier	110V ac	110V ac	129 V ac
— Voltage at rectifier	220V ac	220V ac	250V ac
— Frequency	47 Hz	50/60 Hz	63 Hz
NT5C03 50A:			
— Voltage at rectifier	183V ac	220V ac	264V ac
— Frequency	47 Hz	50/60 Hz	63 Hz
NT5C07 50A:			
— Voltage at rectifier	176V ac	220V ac	264V ac
— Frequency	47 Hz	50/60 Hz	63 Hz
A0354954 100A:			
— Voltage at rectifier/208 V strap	184 V ac	208 V ac	220 V ac
— Voltage at rectifier/240 V strap	212 V ac	240 V ac	264 V ac
— Frequency	57 Hz	60 Hz	63 Hz
Note: Distortion on voltage sine wave: 5% total harmonic distortion, 3% any single harmonic.			

Table 36 lists the National Electrical Manufacturer's Association (NEMA) numbers for acceptable commercial power service receptacles.

Table 36
Service receptacle requirements

<table>
<tr><th>Receptacles</th><th>Isolated</th><th>Non-isolated</th><th>Used with</th></tr>
<tr><td>208/240 V at 20 A</td><td>IG-L6-20</td><td>L6-20</td><td>NT6D52 rectifier</td></tr>
<tr><td>208/240 V at 30 A</td><td>IG-L6-30</td><td>L6-30</td><td>ac systems</td></tr>
<tr><td rowspan="4">208/240 V at 30 A</td><td rowspan="4" colspan="2">hard-wired</td><td>NT5C03 rectifier</td></tr>
<tr><td>A0354954 rectifier</td></tr>
<tr><td>NT5C07 rectifier</td></tr>
<tr><td>NT5C06 rectifier</td></tr>
</table>

Power conditioning

The term "power conditioner" refers to a variety of power protection or power quality improvement devices, such as low-pass filters, surge arrestors, line voltage regulators, and isolation transformers. Some of these devices reduce noise on the commercial power feed, and others help prevent power line spikes and surges. Many uninterruptible power supply (UPS) systems, in addition to providing reserve power for ac-powered systems, provide conditioning and protection during normal operation.

If the quality of the commercial power meets the specifications listed in this document, you do not need power conditioning equipment. If you want protection beyond the transient specifications listed, supplemental power devices can be helpful. However, carefully evaluate the specifications for the power protection equipment to be sure the equipment provides the type of protection that you want.

Power conditioning equipment of any sort is not a substitute for proper system grounding. As emphasized throughout this document, an SPG topology must be maintained for the system and all directly connected switchroom equipment. If you use supplemental protection equipment, you must install it in series with the commercial power feed to the system, without altering the overall grounding scheme.

Auxiliary power

Terminal devices located in the equipment room require local power. Power for these devices must be wired and fused independently from all other receptacles, labeled at the service panel (to prevent unauthorized power interruption), and referenced to the same interface point on the building system ground as the service panel ground.

Auxiliary power in the equipment room can be supplied by isolated or non-isolated service receptacles, but the receptacles must match the grounding for the system. In other words, if the system has an isolated ground topology, the receptacles must also be isolated. You can use the A0367916 Auxiliary –48 V Power Supply as a general purpose power supply for terminal devices (as well as supplying power to PFTUs). All 120 V circuits in the equipment room must have individual hot, neutral, and ground conductors.

If auxiliary equipment using an RS-232 interface is too remote to be powered from the service panel, a modem or fiber link is required for ground isolation. Failure to provide this isolation defeats the SPG required by the system.

Existing powering and grounding on some sites can make it difficult to ensure that the local power grounding is referenced to the same potential as the system ground. In addition, local power grounding can form part of a common grounding network that is subject to noise from external sources. Under these conditions, where locally powered terminals and equipment connect directly to the system through dc-coupled links sharing a common ground, incidental ground loops can form and inject noise into the system.

Where you suspect ground related problems, and you have eliminated other sources of the problem, isolate the auxiliary equipment from the system. The best way to do this depends on the individual installation and local practices, but a few possibilities are listed here:

- Connect the auxiliary equipment to the system through an opto coupler isolation device.
- Connect the auxiliary equipment to the system through fiber optic links.

- Use teletypewriters (TTYs) configured in the 20 mA loop current mode (such as current loop adapters).
- Use isolation modems configured back-to-back. (Do not reference modems on the system side to the ac ground.)

Isolated service receptacles

For auxiliary power receptacles in isolated ground systems, use 120 V, 60 Hz, 15 A, individually fused, isolated ground receptacles terminating on non-locking type IG-5-15 receptacles (such as Hubbell, Cat. No. IG-5262, 2-pole, 3-wire, orange duplex receptacles). Use a green conductor for extending the safety ground, and wire it according to the isolated ground specifications. (This requirement is based on safety concerns and exceeds NEC and CEC requirements.)

Outlets must comply with NEC 250-74 Exception 4. Route grounding conductors with the phase conductors (NEC 300-20). All ground wiring must terminate on the dedicated isolated ground bus according to applicable codes (NEC 384-27).

Non-isolated service receptacles

For auxiliary power receptacles in non-isolated ground systems, use 120 V, 60 Hz, 15 A, individually fused receptacles terminating on non-locking type 5-15 receptacles.

Power options

Two power options are available:

1. Ac-powered systems with or without reserve (backup) power
2. Dc-powered systems with or without reserve (backup) power

In any configuration, you can route power connections to the system through the floor or along overhead racks.

Ac-powered systems

In an ac-powered system, commercial power voltage is brought directly into the power distribution unit (PDU) in the pedestal. If reserve power is required, install an uninterruptible power source (UPS), along with its associated batteries (which may be internal or external to the unit), in series with the ac power source.

> *Note:* Refer to the manufacturer's specifications for details on the storage and operating environment, especially temperature and humidity ranges, required for proper UPS operation.

Ac module power supplies operate at a nominal 208/240 V. The actual input range of ac power supply is 180 to 250 V, so restrapping the power supplies is unnecessary for either 208 V or 240 V power feeds. The 208 V wiring can plug into a 240 V system and vice-versa.

Ac-powered systems without reserve power require one input receptacle per column, within 2.4 m (8 ft) of each column's pedestal.

As an alternative to using the power cord and plug, input to the PDU can be wired directly. In this case, #10 AWG conductors routed through 0.75 in. conduit is generally used. The leads connect to the L1, L2, and GND terminations on the field wiring terminal block on the PDU.

Systems that use reserve power plug into the UPS that in turn plugs into the commercial power source. Consult the UPS manufacturer for the receptacle requirements.

Dc-powered systems

The external dc power system, generally referred to as the power plant, consists mainly of rectifiers and distribution equipment, and can include batteries for reserve power. Dc-powered systems connect to the commercial power source through the rectifiers, which provide –48 V dc to the PDU in the pedestal.

A customer-provided power plant can be used with all dc-powered systems. Refer to the manufacturer's specifications for the power plant requirements.

Dc-powered systems – UK systems

The dc-powered system for UK systems operates at a nominal –48V dc. Modules in a column are fed dc power from the power distribution unit (PDU) in the Pedestal. The Pedestal is powered from an external dc power plant.

Each power system is comprised of a master cabinet 8B/2R and up to a maximum of three slave cabinets.

Reserve power equipment room

If the reserve power equipment is located in a separate room then that room must meet the following conditions.

1 Well-ventilated and operating at optimum temperature; specific gravity readings are based on 25 degrees C (77 degrees F)

2 Located within the recommended proximity to the system

3 Equipped with protective equipment (such as goggles, face shields, acid-resistant gloves, protective aprons, water for rinsing eyes/skin, and bicarbonate of soda)

4 Well-secured

5 Accessible (the doorway must not be blocked)

6 Meet all floor loading requirements and the noise levels required by OSHA standards 1910.5 (or local standards)

Note: For detailed instructions on battery usage, see ANSI/IEEE Standard 450-1987: “Maintenance, Testing and Replacement of Large Storage Batteries.”

Power Failure Transfer Unit

A0355200 Power Failure Transfer Units (PFTUs) provide emergency telephone service during commercial power outages or certain system malfunctions. Each PFTU supports up to eight designated telephones that bypass the system and connect the designated telephones directly to the central office (CO) during power failures when activated by the system monitor or when activated manually.

A PFTU always requires a –48 V dc input and a positive return (ground):

- For ac-powered systems:
  - — Without reserve power, a separate A0367916 Power Supply –48 V is required. (Up to six PFTUs can be supported by one power supply.) The auxiliary power supply is equipped with a 120 V ac input cord and plug that connects to a properly wired and grounded auxiliary receptacle.
  - — With an UPS for reserve power, the auxiliary power supply plugs into an auxiliary 120 V ac output on the UPS.
- For dc-powered systems:
  - — A PFTU can be powered from a separately fused auxiliary –48 V feed from the external power system. For this purpose, the MFA150 and MPP600 power systems are equipped with spare fuse positions, which can support 0.25 A to 5.0 A fuses. These power systems are factory equipped with 1.33 A fuses that can support up to six PFTUs.
  - — A separate A0367916 Auxiliary –48 V Power Supply can also be used to power PFTUs in a dc-powered system.

Input power requirements for the PFTU, and input and output specifications for the auxiliary power supply are given in Table 37.

Table 37
Equipment specifications

Equipment	Input power requirements	Output specifications
PFTU	–40 to –56 V dc 170 mA	—
Auxiliary power supply	90 to 130 V ac at 57 to 63 Hz	–48 V dc, ± 15% at 1.25 A

The PFTU is a wall-mount unit. The auxiliary power supply can be mounted on the floor or wall. PFTU and auxiliary power supply dimensions are given in Table 38.

Table 38
PFTU and auxiliary power supply dimensions

Equipment	Width		Length		Height		Weight	
	cm	in.	cm	in.	cm	in.	cm	in.
PFTU	12.1	4.75	34.3	13.5	4.1	1.6	1.5	3.3
Auxiliary power supply	12.7	5.00	16.7	6.6	6.4	2.5	1.0	2.2

QUA6 Power Fail Transfer Unit (United Kingdom)

The QUA6 Power Fail Transfer Unit provides emergency telephone service during commercial power outages or certain system malfunctions. Each QUA6 PFTU supports up to five designated telephones. The PFTU bypasses the system and connects the designated telephones directly to the central office during power failures, when activated by the system monitor, or when activated manually.

Input requirements

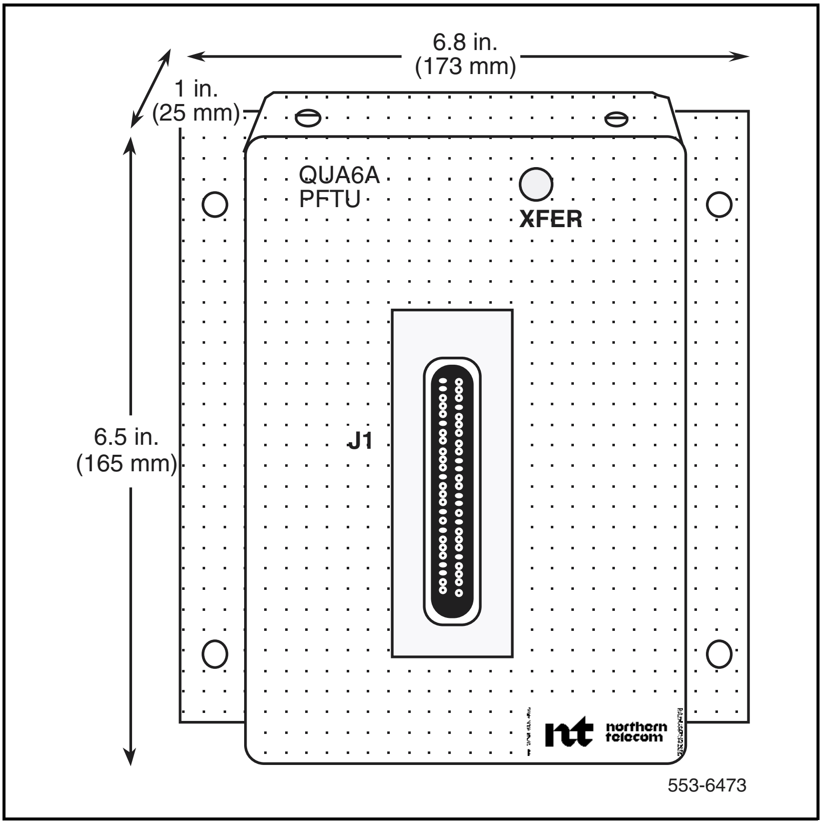
The PFTU requires a –48 V dc input and a positive return (ground). In the United Kingdom, the PFTU is powered from a separately fused auxiliary –48V feed from the external power system.

Input requirement: QUA6 PFTU:–42 to –56 V dc at 150 mA nominal

Dimensions and weight

The QUA6 PFTU is a wall-mounted unit and weighs 2 lbs (0.8 kg). The dimensions of the unit are shown in Figure 55 on page 196.

Figure 55
QUA6 PFTU dimensions



Cable requirements

This section describes the types of cable used in the system. It also provides some cabling guidelines.

Cable types

The system uses the following major types of wiring:

- 25-pair main distribution frame (MDF) cables:
  These cables carry voice and data information between modules and the distribution frame. One end of the cable must be equipped with a 25-pair female connector that terminates on the module input/output (I/O) panel. The other end of the cable terminates on the MDF block.
- Interface cables:
  Interface, or I/O, cables are typically 25-conductor interfaced through RS-232-C connectors. These cables are used to connect data units to printers, host computers, and modems.
- Twisted-pair shielded and non-shielded cables:
  These cables interconnect the trip power monitoring connections between power interface units and the MDF. Typically, a #22 AWG, stranded (Belden type 8408-2 conductor or equivalent) shielded cable is used for trip connections and to connect the system 1 to QCA13 Power Cabinets. All other connections are serviced by non-shielded, #22 AWG stranded cable.
- Twisted-pair telephone cables:
  These cables carry analog voice and digitized voice and data information between distribution frames and terminal devices throughout the building. They connect to 8-pin modular jacks located within 2.4 m (8 ft) of each device.

  Note: Consider cable length requirements and limitations for both initial installation and later growth when you plan a system.

System cabling

This section contains information on:

1 Power and ground cables

2 Module cable routing

3 Network to peripheral equipment cabling

Power and ground cables

For ac-powered systems, a 2.7 m (9 ft), 3-conductor line cord is supplied, except in areas where conduit is required.

For dc-powered systems equipped with an NT7D10 PDU, wiring is generally run through conduit. For systems equipped with an NT7D67CA PDU, conduit is not required. However, conduit may be used, if preferred or required by local code or practices, and attached to the pedestal at any of three locations. (Rear access is provided by the NT7D0902 Rear Mount Conduit Kit.)

Metallic conduit is used primarily to contain electromagnetic emissions. Where conduit is used, it must provide an end-to-end enclosure for the power wiring.

> ***Note:*** Metal ducts and raceways usually do not provide electromagnetic containment; they can be used with, but not in place of, conduit.

Module cable routing

Because the cable troughs and spaces on the sides of each module are within the EMI shielding of the system, unshielded cables can be routed in those areas. The corner vertical channels in the rear of the module are outside of the EMI shield. Cables routed in the vertical channels must be shielded, and must enter and exit the EMI-shielded area through I/O panels and adapters.

As space permits, you can route cables in the following ways:

- Horizontally in the cable troughs at the front, rear, and sides of the module

Note: In a dc-powered module, because there is no module power distribution unit (MPDU), there is room to route cables horizontally from front to rear on the left side (front view) of the module.

- Vertically on the sides of the module
- Vertically in the corner channels in the rear of the module (shielded cables only)

CAUTION

Loss of Data

You must route cables as perpendicular as possible to any nearby power cables. Avoid routing cables near power cables if alternate routing is available. (At the rear of the module, cables routed between the I/O panel and the rear cover can be parallel to the power cables because the panel provides EMI shielding.)

Network to peripheral equipment cabling

Cabling between the network and peripheral equipment runs:

1 from the faceplate of an NT8D04 Superloop Network Card to the backplane connectors for an NT8D01 Controller Card in an intelligent peripheral equipment (IPE) Module, or

2 from the faceplate of a QPC414 Network Card to the faceplate of a QPC659 Dual Loop Peripheral Buffer in a peripheral equipment (PE) Module.

Cable access

The customer is responsible for supplying all access for station, feeder, and riser cabling. This includes (where necessary):

- Conduit
- Floor boring
- Wall boring
- Access into hung ceilings

Preparing a floor plan

Prepare a detailed floor plan for each site. The floor plan must indicate the size and location of:

- The system columns and modules, including planned expansion areas
- The main distribution frame (MDF)
- The service panel
- System terminal, printer, or other terminal devices (such as modems)
- External power equipment (such as rectifiers)
- Any cable racks
- PTFUs and auxiliary power supplies (if either are equipped)
- Space for additional equipment, such as reserve power equipment or auxiliary processors

Follow these guidelines when you plan the equipment room layout:

- The minimum acceptable distance between equipment aisles is 76 cm (30 in.)
- The minimum acceptable distance between the end of the column and walls, and between rows, is 91.r cm (3 ft)
- The minimum acceptable ceiling height is 243.8 cm (8 ft) or greater

IMPORTANT!

According to the National Fire Code, equipment must be at least 30.5 cm (12 in.) from a sprinkler head. If a system is four modules high with a cable rack, do not place the equipment directly under any sprinkler heads.

When building or upgrading multiple-group systems, you must consider network expansion in the floor plan because network group modules must be co-located. There are several ways to expand the system. One way is to provide space for additional network groups to the left of the CPU modules, and additional peripheral equipment (IPE or PE) to the right. Another way is to add peripheral equipment modules in a separate row of columns.

Equipment dimensions appear in Table 39. Figures 56 and 57 starting on page 202 illustrate sample equipment room floor plans. These samples may vary from your floor plan, depending on your system needs and the size and arrangement of your equipment room.

Table 39
Equipment dimensions

Equipment	Width		Depth		Height	
	cm	in.	cm	in.	cm	in.
Pedestal	81.3	32.0	66.0	26.0	25.4	10.0
Top cap	81.3	32.0	55.9	22.0	10.2	4.0
Module	81.3	32.0	55.9	22.0	43.2	17.0
One-module column	81.3	32.0	66.0	26.0	78.7	31.0
Two-module column	81.3	32.0	66.0	26.0	121.9	48.0
Three-module column	81.3	32.0	66.0	26.0	165.1	65.0
Four-module column	81.3	32.0	66.0	26.0	208.3	82.0
Note: Note: Multiple-column systems require a 7.6 cm (3 in.) spacer between each column for cable routing and to provide EMI shielding.						

Figure 56
Succession 1000M Half Group or Succession 1000M Single Group equipment room floor plan

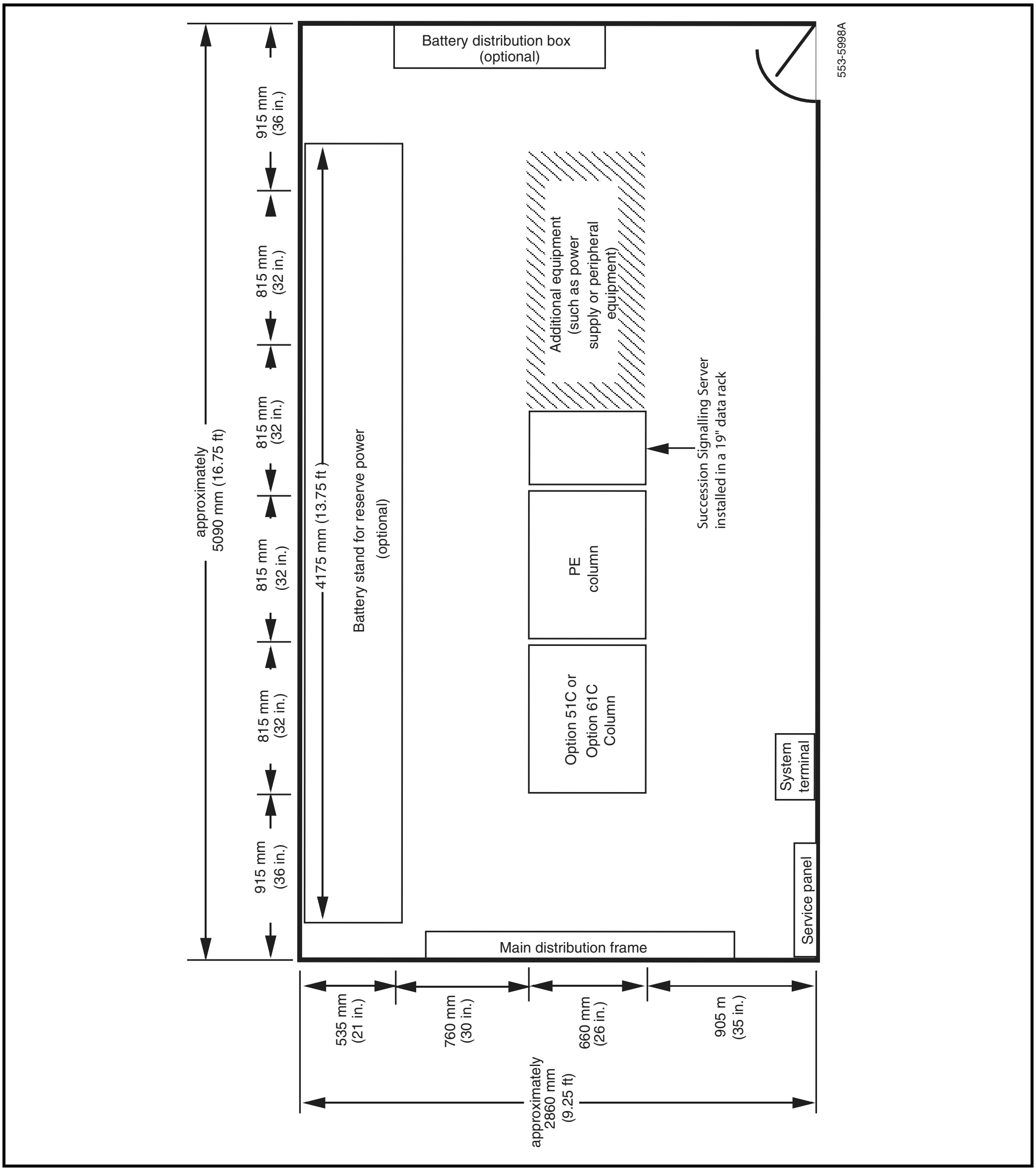
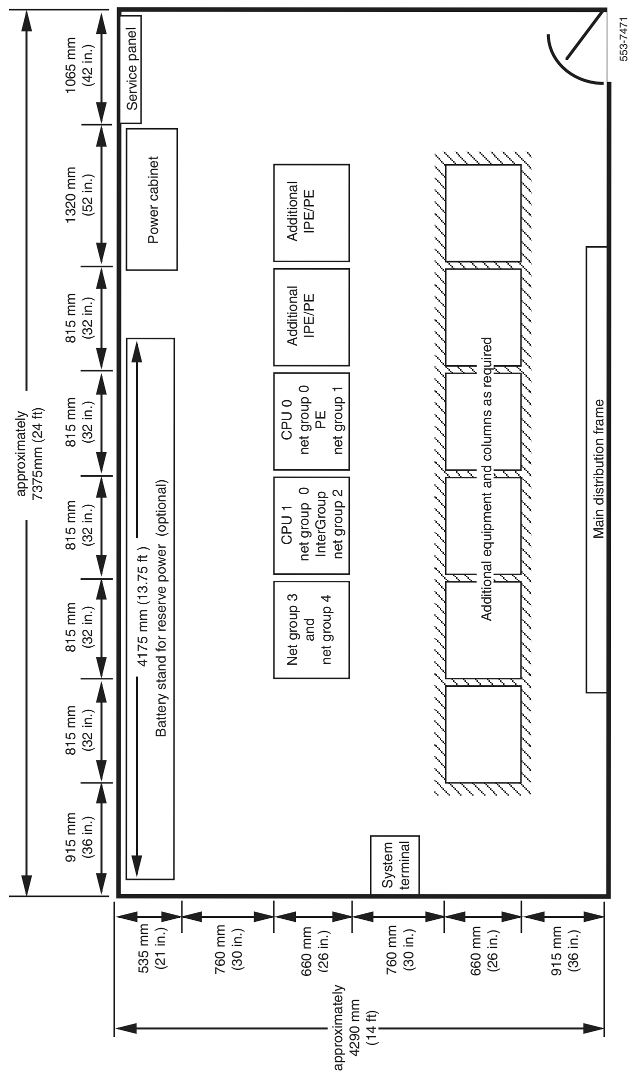


Figure 57
Meridian 1 Option 81C CP PII equipment room floor plan



Estimating floor loading

You must estimate floor loading to plan module distribution. “Floor loading” is the weight of the system divided by the occupied floor area. “Point loading” is the local pressure exerted by the feet of the system on the floor.

Table 40 gives system weights. Table 41 on page 205 lists floor load estimates, and assumes fully loaded columns complete with pedestal, maximum circuit card configurations, power supplies, and cables.

Table 40
Equipment weights

Equipment	Weight empty		Weight full	
	kg	lbs	kg	lbs
Pedestal	18.1	40	31.7	70
Top cap	6.8	15	6.8	15
Module	22.7	50	58.9	130
One-module column	N/A	N/A	97.5	215
Two-module column	N/A	N/A	156.5	345
Three-module column	N/A	N/A	215.4	475
Four-module column	N/A	N/A	274.4	605

Table 41
Floor loading estimates

	Floor load		Point load	
Number of modules	**lbs/ft2**	**kPa**	**lbs/ft2**	**kPa**
One	38.1	1.8	11.0	75.8
Two	60.3	2.8	17.3	119.0
Three	82.4	3.9	23.7	163.4
Four	104.6	5.0	30.0	206.8

Note: The numbers under “Floor load (lbs/ft2) and kPa” are based on a floor area of 0.52 sq m (5.64 sq t) for the system. These numbers do not include the weight of the optional overhead cable rack. The numbers under “Point Load (lbs/in2) and (kPa)” are based on distributing the system weight among four feet, each with an area of 317 sq mm (4.91 sq in.); these numbers do not reflect the use of optional casters.

Creating a building cable plan

To create a building cable plan, complete the following tasks.

1 Show the routing of all wiring, the location and wiring requirements of each terminal device connected to the system, and any other relevant information about the device.

2 Show the location of distribution frames, conduits and access points, and power outlets.

3 Identify the ownership of existing building wire if it is to be used.

4 Perform a random sampling of in-place wiring to ensure that it meets specifications for high-speed lines. All wiring carrying high-speed data must pass a verification test as part of the installation procedures.

5 Identify the location of conduits and floor ducts. If telephone cable is run in conduit then that conduit can not be used for any other wiring.

6 Identify the location of all main and intermediate distribution points.

7 Provide three pairs of telephone wire from a distribution frame to a nearby telephone jack for each terminal device. Modular jacks must be within 2.0 m (8 ft) of the device.

8 Provide a 16-pair (or 25-pair) cable equipped with an Amphenol-type connector for each attendant console.

9 Divide the building cable plan into zones. Zones are typically the termination point of conduits throughout the office. Identify each zone on the building cable plan with a letter or number, and assign a block of numbers to each zone. Figure 58 on page 208 illustrates zoning.

Note: Be sure to leave room for expansion.

Wire routing

To plan wire routing, establish the start and end point of each cable relative to the location of the terminal devices in the building, then examine the construction of the office to determine the best wiring routes. Consider the following guidelines when performing this task.

- Floors:
  - In the open, wires can run along baseboard, ceiling moldings, or door and window casings. For the safety of employees, never run wire across the top of the floor.
  - When concealed, wires can run inside floor conduits hat travel between distribution frames and jacks. (Under-carpet cable is not recommended.)
- Ceilings:

  National and local building codes specify the types of telephone wire that you can run in each type of ceiling. Local building codes take precedence.
- Walls:

  Cables that run vertically should, when possible, run inside a wall, pole, or similar facility for vertical wire drops. Cables that run horizontally cannot b e blind-fed through walls.

- Between floors:

  Locate distribution frames as closely to one another as possible. Local coding laws specify whether or not a licensed contractor if required if conduit is installed.

- EMI:

  Data degradation may occur if wires travel near strong EMI sources. See “Electromagnetic and radio frequency interference” on page 174 for a description of common interference sources.

Termination points

Once you have determined the wire routing, establish termination points. Cables can terminate at:

1 the MDF (typically in the equipment room)

2 intermediate distribution frames, typically on each floor in telephone utility closets

3 wall jacks to terminal boxes, typically located near the terminal device

At the distribution frame (also called the cross-connect terminal), house cables terminate on the vertical side of the two-sided frame and cross connect to equipment that is typically located on the horizontal. If you use a color field scheme, house cables typically terminate in the blue field and the equipment terminates on the purple (U.S.A.) or white (Canada) field.

In all cases, clearly designate the block where the cables terminate with the cable location information and the cable pair assignments. Keep a log book (cable record) of termination information. See Figure 59 on page 209 for an example.

Figure 58
Building cable zones

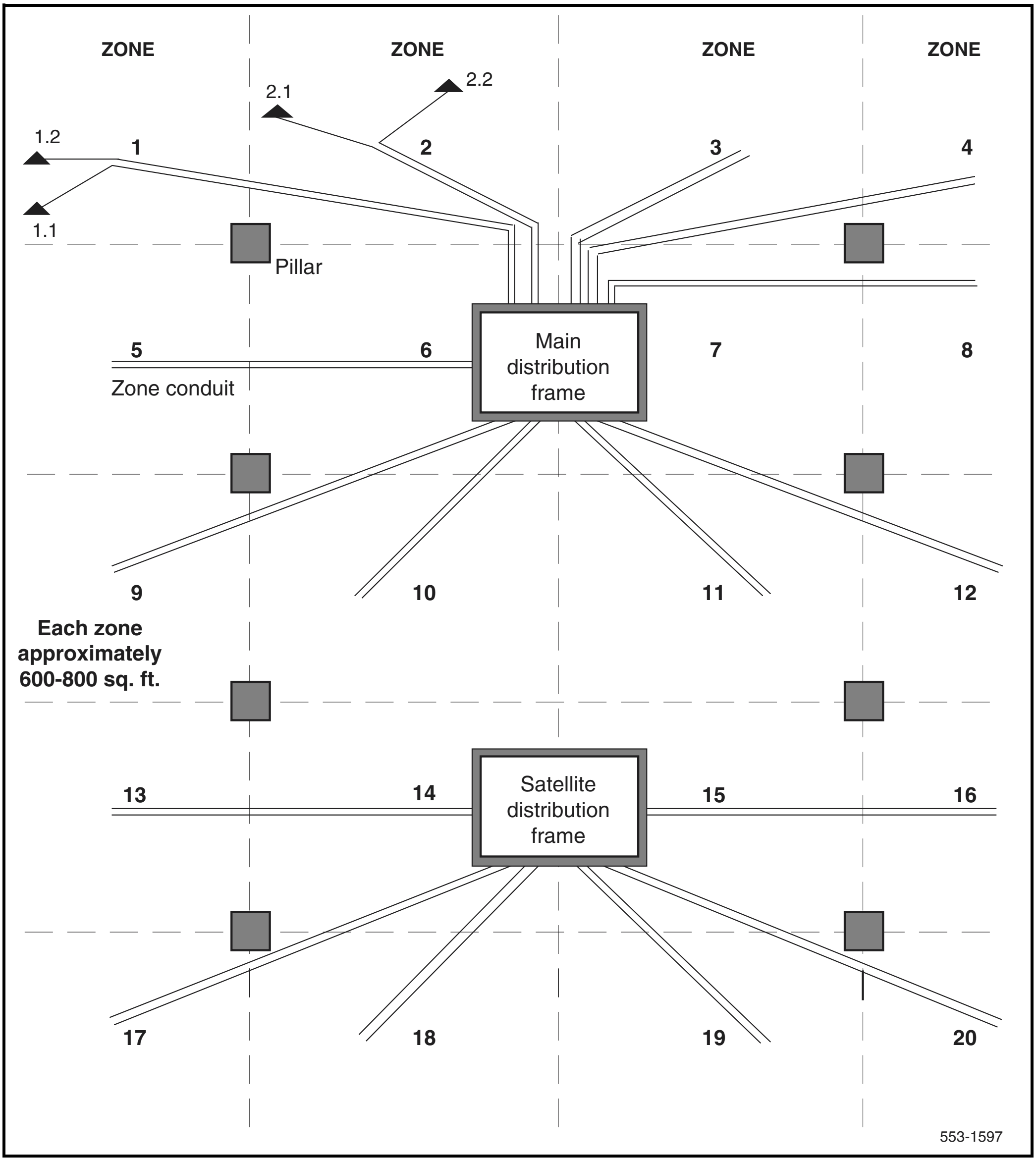


Figure 59
Sample cable record

CABLE RECORD

Customer ______________________________________

Location ____

Cable ______________________ Binder ____________ Page ____ of ____

DN	TN				NAME	FEATURES / REMARKS	TERMINAL DEVICE	BLOCKS DF / HOUSE	COLOR
	M	S	C	U					
									W BL
									W OR
									W GR
									W BR
									W SL
									R BL
									R OR
									R GR
									R BR
									R SL
									BK BL
									BK OR
									BK GR
									BK BR
									BK SL
									Y BL
									Y OR
									Y GR
									Y BR
									Y SL
									V BL
									V OR
									V GR
									V BR
									V SL

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Preparing for delivery

When preparing for equipment delivery, answer these questions.

1 Has a request been made for equipment delivery?

2 Are transportation arrangements to the premises completed?

3 Is a list of all ordered equipment available on site?

4 Is help needed and available for preparing the equipment room?

5 Are unloading and unpacking facilities and tools available?

6 Is help needed and available for delivery?

Note: Plan to unload equipment as close to the final installation area as possible for an easier, and perhaps safer, installation.

Conducting pre-installation inspections

Obtain any appropriate sign-offs before the site is ready for equipment delivery and installation. Sign-offs can include regulatory items such as electrical inspections, air conditioning inspections, and cable plan approval. In addition, an overall equipment room inspection and a building cable inspection should be performed before installation.

Inspect the equipment room to verify that all physical and environmental requirements are met, system grounding and power equipment is installed and tested, and the equipment layout is marked on the floor.

Inspect the building cable to verify that sufficient distribution frames are provided, conduits or floor ducts to terminal locations are installed, terminal jacks are installed, and sufficient wiring is on hand.

Assessing the delivery route

Before the system is delivered, examine and measure the route from the receiving area to the installation area. (See Table 39 on page 201 for dimensions.)

These factors must be considered:

1 Size and security of unloading and storage areas

2 Availability and capacity of elevators

3 Number and size of aisles and doors on the route

4 Restrictions, such as bends or obstructions, in halls or at doors

5 Floor loading capacity of unloading, storage, and equipment room areas

6 Number of steps and stairways

Note: A four-module column is shipped in two segments. One shipping pallet carries the pedestal and three modules. Another shipping pallet carries the fourth module and top cap.

Preparing for installation

The installation plan, work orders, and appropriate documentation should be on hand at the time of installation.

Reviewing the installation plan

The installation plan can consist of the equipment room floor plan, the building cable plan, and an installation and test sequence chart.

The equipment room floor plan should show:

- System columns and modules, including planned expansion areas
- Main distribution frame
- Service panel
- System terminal, printer, or other terminal devices
- External power equipment (such as rectifiers)
- Cable racks
- PFTUs and auxiliary power supplies (if either are equipped)
- Additional equipment such as reserve power equipment or auxiliary processors

The building cable plan should show:

- Cable routing and designation information
- Location of each terminal device
- Type of cable or wiring required for each terminal device
- Location of all distribution frames and system and terminal cross-connect assignments
- Location of conduits and floor ducts, including access points
- Location of power outlets for terminal devices

An installation and test sequence (ITS) chart shows typical installation tasks, the sequence of the tasks, and task start and duration information.

Reviewing the work orders

The work order can include:

- Detailed listing of the equipment ordered
- Terminal Number (TN) assignments
- Directory Number (DN) assignments for each terminal device
- Office Data Administration System (ODAS) designators for each terminal device (if the software package is equipped)
- Features available to each telephone and data set
- Administration database entries for telephone and data set features

Reviewing the documentation

Instructions for unloading and unpacking system equipment and a full set of standard Nortel Networks technical publications (NTPs), are delivered with each system.

Design parameters

Contents

This section contains information on the following topics:

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System parameters. 213
Customer parameters. 214
Console and telephone parameters 215
Trunk and route parameters. 216
ACD feature parameters 217
Special feature parameters 218
Hardware and capacity parameters 220
Memory related parameters. 222

Introduction

This section contains sets of design parameters which set an upper boundary on certain system capacities. Changes to these parameters generally require a revision to the software and are constrained by other basic capacities such as memory and traffic or system load. The design parameters are set to provide the best possible balance between the two limits.

System parameters

Table 42 on page 214 lists system parameters and provides the maximum value for each.

Table 42
System parameters

System parameters	Maximum value	Comments
Customers	100	
Display messages for background terminal	255	
Input/output ports (e.g., TTYs, printers)	16	Each MSDL counts as one device; a history file counts as one device
AML/CSL links	16	With MSDL
TNs	64kB	Software design limit, actual number of TNs will be constrained by physical capacity, real time, memory, and ISM limits

Customer parameters

Table 43 lists customer parameters and provides the maximum value for each.

Table 43
Customer parameters

Customer parameters	Maximum value	Comments
Tenants	512	
Dial Intercom Groups	2046	
Members per Dial Intercom Group	100	
Ringing Number Pickup groups	4095	Call Pickup Group 0 = no pickup group
Listed Directory Numbers (direct inward dialing only)	6	
DISA DNs	240	

Console and telephone parameters

Table 44 lists console and telephone-related parameters and provides the maximum value for each.

Table 44
Console and telephone related parameters

Console/telephone parameters	Maximum value	Comments
Consoles per customer	63	
Lamp field arrays per customer	1	May be repeated once on another console
Lamps per array (all numbers must be consecutive)	150	
Feature keys per attendant console: – M2250	 20	
Incoming call indicators per console	20	
Trunk group busy indicators per console: – M2250	 20	
Additional key/lamp strips: – console – telephones	 2 6	
Add on modules: – M2x16	 2	
Protect bcs block length	512	

Trunk and route parameters

Table 45 lists trunk and network-related parameters and provides the maximum value for each.

Table 45
Trunk and network related parameters (Part 1 of 2)

Trunk/network parameters	Maximum value	Comments
Trunk routes per customer	512	
Members per trunk route	510	
RAN trunks per RAN route	10	
Trunk access restriction groups	32	
Locations in an ESN network	256	
Basic authorization codes	4096	
Length of basic authcode	14 digits	
Network authorization codes	20 000	ESN networks
Length of network authcode	7 digits	Fixed length defined per customer
NCOS: – CDP – BARS/NFCR – NARS/NSIG/AUTOVON	 3 7 15	
Route lists: – CDP – BARS – NARS	 32 128 256	
Route list entries	64	
NFCR trees	255	New Flexible Code Restriction
IDC trees	255	Incoming DID Digit Conversion
ISDN D-channels	64	With MSDL

Table 45
Trunk and network related parameters (Part 2 of 2)

Trunk/network parameters	Maximum value	Comments
ISDN B-channels per D-channel	382	16 T1's with a D-channel and backup D-channel, subject to members per trunk route limitations and physical limitations
	359	15 T1's with a single D-channel, subject to members per trunk route limitations and physical limitations

ACD feature parameters

Table 46 lists ACD feature parameters and provides the maximum value for each.

Table 46
ACD feature parameters (Part 1 of 2)

ACD parameters	Maximum value	Comments
ACD DNs per customer	240	
Agent positions per DN	1200	Real-time and physical capacity constraints may limit this further
Agent priorities	48	
Agent IDs per customer	9999	
Agents logged in at one time per system	9999	Real-time constraints may limit this further
CDNs per customer	240	
AST DNs per telephone	2	
Number of ACD-ADS customers	5	

Table 46
ACD feature parameters (Part 2 of 2)

ACD parameters	Maximum value	Comments
Terminals and printers on CCR	8	
Links per VASID	1	

Special feature parameters

Table 47 lists non-ACD feature parameters and provides the maximum value for each.

Table 47
Non-ACD feature parameters (Part 1 of 2)

Feature parameters	Maximum value	Comments
Speed call lists per system	8191	The number of speed call lists and the number of DNs per speed call list can be limited by the amount of available memory on the system (protected and unprotected data store).
Number of DNs in speed call list	1000	
Multiple appearances of the same directory number	30*	Limited by watchdog timer * See steps in a hunting group
Steps in a hunting group	30*	Marketing objective, limited by watchdog timer * In combination with MADN, each hunt step with more than 16 appearances is counted as two, so the maximum combination of MADN and hunt steps is 30 MADN and 15 hunt steps

Table 47
Non-ACD feature parameters (Part 2 of 2)

Feature parameters	Maximum value	Comments
Number of Call Party Name Display names defined	Variable	Limited by the number of DNs defined and available space in the Protected Data Store
CPND length: – SL-1 protocol – ISDN protocol	 27 24	 – Software design limit – Display IE limitation (DMS switches have a display IE limit of 15)
AWU calls in 5 minutes	500	Marketing objective, constrained by ring generator
Group Call Feature: – Groups per customer – Stations per group	 64 10	
BRI application: – Protocol parameter set groups per system – Terminal service profiles (per DSL) DSLs – LTIDs	 16 32kB 640kB	 – Software design limit; actual number is constrained by the number of TNs in the system. – Each DSL occupies 2 TNs. Software design limit; each DSL can have a max of 20 LTIDs. The max number of LTIDs is limited by the number of DSLs, memory, and real time.

Hardware and capacity parameters

The software design limits are not typically the binding constraints. The number of items of a particular type is usually determined by a combination of loop and slot constraints, if the item requires loops, or slot constraints alone.

Table 48 lists hardware and capacity parameters and provides the maximum value for each.

Table 48
Physical capacity/hardware related parameters

Physical capacity/hardware parameters	Maximum value (loops)	Comments
Multifrequency sender cards	64	Software design limit, each MFS card requires 2 loops
XCT cards	64	Provides TDS, CONF, and MFS functionality, requires 2 loops (TDS and MFS share timeslots on one loop, CONF uses the other loop)
Total service and terminal loops: – Option 61C/51C – Opt 81C <= 5 groups – Opt 81C (FNF, 8 groups)	 32 160 256	 Each XNET card requires 4 loops Each MISP card requires 2 loops
Digitone receivers	255	Software design limit
Multifrequency receivers	255	Software design limit
Tone detectors	255	Software design limit

Voice Gateway Media Cards

Voice Gateway Media Cards can be assigned to any slot. The slot should be in a non-blocking segment.

Table 49
Voice Gateway Media Card capacity

Parameter	Capacity
Meridian 1 Option 61C CP PII or Meridian 1 Option 81C CP PII	— 10 cards in each IPE cabinet (Class B) — no more than 3 cards per superloop

Note: Within the limits above, the ITG-Pentium 24-port card has the following additional requirements:

Table 50
ITG-Pentium 24-port card additional requirements

Parameter	Capacity
Meridian 1 Option 61C CP PII and Meridian 1 Option 81C CP PII	— 4 cards in each IPE cabinet (Class B rating) — Class A no additional restrictions
Note: CallPilot MGate or 201i can be assigned to any slot. The slot should be in a blocking segment.	

Memory related parameters

Table 51 lists console and telephone-related parameters and provides the maximum value for each.

Table 51
Memory related parameters (Part 1 of 2)

Parameter	Values
Low priority input buffers — (recommended default) — (81C CP PII recommended default)	96 – 7500 (1850) (3500)
High priority input buffers — (recommended default) — (81C CP PII recommended default)	16 – 7500 (1850) (3500)
Input buffer size (words)	4
500-set, trunk and digital set output buffer size per PS card (messages) — (recommended default)	16 – 7500 (800)
SL-1 set output buffer size per PS card (messages): — (recommended default)	16 – 255 (255)
Message length (words)	4
D-channel input buffer size (bytes)	261
D-channel output buffer size (bytes)	266
TTY input buffer size (characters)	512
TTY output buffer size (characters)	2048

Table 51
Memory related parameters (Part 2 of 2)

Parameter	Values
Number of call registers	26 – 50 000
— expected maximum	2000/4000/10 000
— 81C CP PII with five or fewer groups expected maximum	20 000
— 81C CP PII with six to eight groups expected maximum	25 000
Call registers assigned to SL-1/AUX	26–255
Number of AML msg call registers	20 — the minimum of 25% of total call registers or 255, default 20
Call registers for CSL input queues	20 — the minimum of 25% of total call registers or 4095, default 20
Call registers for CSL/AML output queues	20 — the minimum of 25% of total call registers or 4095, default 20
Auxiliary input queue	20 — the minimum of 25% of total call registers or 255, default 20
Auxiliary output queue	20 — the minimum of 25% of total call registers of 255, default 20
History file buffer length (characters)	0 – 65 535

CLASS network engineering rules

Contents

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Feature operation 225

Fibre Network Fabric 226

Guidelines for non-Call Center applications 228

Guidelines for Call Center applications 229

Introduction

In a single group network system, the network internal blocking is determined by the concentration ratio of equipped ports on peripheral equipment and the number of interfaced loops or superloops. Depending on traffic engineering, a non-blocking network is achievable.

Feature operation

A call originated from Set A (or trunk A) seeks to terminate on a CLASS set B. When B starts to ring, A will hear ringback. A unit in CMOD (CLASS Modem) is assigned to collect originator's CND information and waits for the CND delivery interval. After the first ring at B, a silence period (deliver interval) ensues, the CMOD unit begins to deliver CND information to the CLASS set.

The CND information of a traffic source (A) is a system information, which is obtained by the system when a call is originated. During the 2-second ringing period of the CLASS set B, A's CND is delivered to CMOD via SSD messages (using signaling channel only). When the CND information is sent from CMOD to CLASS set B, it is delivered through a voice path during the 4-second silence cycle of set B. The CMOD unit is held for a duration of 6 seconds.

If the XCMC (Extended CLASS Modem Card) IPE card, which provides up to 32 CMOD units, is located in the IPE of Group 0, the CMOD unit in the card will receive CND data through the SSD messages and use one of the voice channels of the inter-group junctor to deliver it to CLASS set B in Group 1.

If the XCMC IPE card is located in Group 1, the system will deliver SSD messages containing CND information to CMOD and then send it to Set B during the delivery interval through a voice path, which is an intra-group channel not involving an inter-group junctor.

When CMOD units and CLASS sets are co-located in the same network group, there are no voice paths on the inter-group junctor required to deliver CND information; when they are equipped on different groups, inter-group junctors must carry CND traffic. The resource allocation algorithm will search for a CMOD unit located in the same group as the terminating CLASS set first before it attempts to use a CMOD unit from a different group.

> ***Note:*** The process continues to be valid. However, due to non-blocking on the fiber link, a multi-group system can be treated as a single group system, since inter-group blocking no long exists.

Fibre Network Fabric

Multi-group networks are inter-connected with fiber optic rings. The OC-12 fabric has such a large capacity that all channels from expanded eight network groups can be inter-connected without junctor blocking. Therefore, engineering of the CLASS feature is reduced to the equivalent of a single group case. The only engineering needed is to find the required number of CMOD units from Table 52 on page 227 to serve a given number of CLASS sets. Capacity limit due to network group size can be ignored.

Table 52 is the CMOD capacity table. It provides the number of CMOD units required to serve a given number of CLASS sets with the desired grade of service (P.001). The required number of CMOD units should have a capacity range whose upper limit is greater than the number of CLASS sets equipped in a given configuration.

Table 52
CMOD Unit Capacity (Part 1 of 2)

CMOD Unit	CLASS Set	CMOD Unit	CLASS Set
1	1-2	33	2339-2436
2	3-7	34	2437-2535
3	8-27	35	2536-2635
4	28-59	36	2637-2735
5	60-100	37	2736-2835
6	101-150	38	2836-2936
7	151-206	39	2937-3037
8	207-267	40	3038-3139
9	268-332	41	3140-3241
10	333-401	42	3242-3344
11	402-473	43	3345-3447
12	474-548	44	3448-3550
13	549-625	45	3551-3653
14	626-704	46	3654-3757
15	705-785	47	3768-3861
16	786-868	48	3862-3966
17	869-953	49	3967-4070
18	954-1039	50	4071-4175
19	1040-1126	51	4176-4281
20	1127-1214	52	4282-4386

Table 52
CMOD Unit Capacity (Part 2 of 2)

CMOD Unit	CLASS Set	CMOD Unit	CLASS Set
21	1215-1298	53	4387-4492
22	1299-1388	54	4493-4598
23	1389-1480	55	4599-4704
24	1481-1572	56	4705-4811
25	1573-1665	57	4812-4918
26	1666-1759	58	4919-5025
27	1760-1854	59	5026-5132
28	1855-1949	60	5133-5239
29	1950-2046	61	5240-5347
30	2047-2142	62	5348-5455
31	2143-2240	63	5456-5563
32	2241-2338	64	5564-5671

Guidelines for non-Call Center applications

In a non-call center application, there is no significant number of agent sets. Therefore, no agent set to regular set conversion is needed.

Configurations following engineering rule (no re-configuration required)

The following engineering rule should be followed to avoid the need to re-configure a switch to accommodate the CLASS feature: provide the number of CMOD units serving all CLASS sets in the system based on the capacity table (see Table 52 above).

Engineering Examples

One XCMC card serving a single group system

No special engineering rule is needed for a Meridian 1 Option 51C or a single group system.

Refer to Table 52 on page 227 above to find the required number of CMOD units to serve the given CLASS sets. For example, to serve a Meridian 1 Option 61C with 400 CLASS sets, use Table 52 on page 227 to find the number of CMOD units serving a range that includes 400 sets. The result is 10 units which can serve from 333 to 401 CLASS sets.

Guidelines for Call Center applications

Configurations following engineering rules (no re-configuration required)

The following engineering rules should be followed to avoid the need to re-configure a switch to accommodate the CLASS feature for call center environment.

1 Convert an agent set to regular set by using 1 agent CLASS set equals 4 sets (called equivalent sets).

2 Sum up the total number of regular CLASS sets and equivalent CLASS sets and find the number of CMOD units required based on the capacity table (see Table 52 on page 227).

In case of an existing multi-group site upgrading to provide CLASS feature, re-configuring the system may be necessary.

When above rules are not fully met, continue the system engineering by following the procedure in the next subsection.

Engineering Examples

One XCMC card serving a single group system

Look up Table 52 on page 227 to find the required number of CMOD units to serve the given CLASS sets. For example, to serve a Meridian 1 Option 61C with 300 agent CLASS sets, use Table 52 on page 227 to find the CMOD units that can serve 1200 equivalent sets (300 × 4). The result is 20 units.

Multi-purpose serial data link

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Application Module Link (AML) 246
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Meridian MAX 253
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Examples 261

Introduction

Prior to the introduction of the MSDL card, a system could support a total of 16 I/O ports. Now, a system can support up to 16 MSDL cards, each of which can be flexibly configured to support combinations of SDI, AML, CSL, and DCH on 4 ports, for a total of 64 I/O ports. This chapter provides guidelines to help the user engineer the MSDL.

Note that these engineering guidelines assume normal traffic consisting of valid call processing and administrative messages. For example, engineering rules cannot prevent a piece of equipment on the network from malfunctioning and generating spurious messages which overload the MSDL. At this point the recovery mechanism becomes essential. The mechanism should be graceful, not requiring manual intervention, and should provide as much diagnostic information as possible, to help isolate the root cause of the problem. Refinements and improvements to the recovery mechanisms have been introduced over various software releases.

The D-channel expansion feature increases the number of I/O addresses allowable for D-channel application to 16 per network group and 256 per system. The number of non-D-channel applications is still limited to 16 per system (or 64 if all MSDLs are used).

As a result of this expansion, a study was conducted which looked into capacity constraints of configurations utilizing a high number of D-channels. Even though the new limit is set at 256 D-channels, a more realistic upper limit was obtained for practical applications.

The main conclusions of the D-channel expansion impact study are:

- For office/commercial applications: In a fully equipped 8-group system, the optimal configuration in terms of port capacity and trunking percentage (15%) will require about 112 D-channels, assuming one D-channel per T1. The same optimal configuration can be reached with fewer D-channels in E1 applications.
- For Call Center applications: About 144 D-channels can be deployed to achieve a trunk to agent ratio of 1.5 and 2400 agents. The optimal configuration can be reached at 136 D-channels for E1 applications.
- The current MSDL card is used for D-channel expansion. When multiple D-channels are configured on a card, the MSDL engineering guidelines should be strictly followed. Otherwise, there is no direct capacity impact.

As long as feature penetration is accounted for in the system real time engineering model, D-channel expansion has no direct impact on CP capacity.

Engineering the MSDL requires an understanding of the end-to-end performance characteristics of the system, including the system, MSDL, link, and terminating or originating node. Outgoing messages originate from the system CP, are passed to the MSDL, and travel across the appropriate link to the destination. In equilibrium, or over a relatively long period of time, i.e. on the order of several minutes, the system cannot generate messages faster than the MSDL processor can process them, than the link can transmit them, or than the destination can process them. Otherwise, messages will build up at the bottleneck and will eventually be lost. The entity with the lowest capacity will be the system bottleneck. For very short periods of time, however, one or more entities is able to send messages at a higher rate than the system bottleneck, since buffers are available to queue the excess messages. These periods are referred to as bursts. The length of the burst and the size of the burst that can be supported depend on the sizes of the buffers.

Thus, to properly engineer a system, two areas are considered: equilibrium or steady-state performance which requires an analysis of the CP processing capacity of the various components of the system along with link bandwidth; and burst performance which requires an analysis of the buffer utilization of the system. The equilibrium analysis assumes 30% peakedness which is consistent with models for the system CP.

The applications which will be discussed here are: DCH, CSL/AML, and SDI. The system CPs considered include the 68060 processor.

The following section, MSDL architecture, provides a brief overview of the MSDL architecture. “D-channel” on page 234 through “Serial Data Interface (SDI)” on page 250 describe general conditions for equilibrium and peak engineering for key applications. A step-by-step procedure for engineering the MSDL is provided in “MSDL engineering procedure” on page 255. Several examples of the engineering procedure are given in “Examples” on page 261.

MSDL architecture

The MSDL processor is a 68020 processor. The MSDL and system exchange messages using an SRAM and interrupt scheme. To prevent any one application from tying up buffer resources, a flow control mechanism is defined at the system and MSDL/MISP interface level, where Meridian 1 denotes the call processing software running on the system core CP. The flow control mechanism is based on the common window mechanism in which the number of messages outstanding in the transmit or receive direction per socket, or port, cannot exceed T(K) or R(K), respectively. In the transmit direction, for example, a message is considered outstanding from the time the SL-1 software writes it into the transmit ring until all processing of the message by the MSDL is completed. Currently T(K) and R(K) are both set at 30. Each application must queue messages if the flow control threshold is exceeded. Typically, the system task also has a buffer for messages.

An overload control threshold is also implemented in the incoming direction to protect the system CP from excess messages. To account for the new, faster processors, the thresholds have been changed so that MSDL304 is printed if 100 messages in 2 seconds is exceeded, MSDL305 is printed if 200 messages in 2 seconds is exceeded, and MSDL306 is printed and the card is disabled if 300 messages in 2 seconds is exceeded. In both cases Background Audit will bring the MSDL back up if no problems are found. The Port Overload Counter is introduced. If the incoming messages on a single port exceed 200 messages in 2 seconds, the port will be locked out, and an MSDL_port_overload message will be printed. Manual intervention is required to clear the overloaded port. This feature prevents a single port from locking up the whole MSDL card.

Several software tasks exist on the MSDL. Layer 1 message processing operates at the highest priority. If the link is noisy, Layer 1 processing may starve the Layer 2 and Layer 3 processing tasks, resulting in buffer overflows. If such a problem is suspected, the Protocol Log (PLOG) should be examined. PLOG reporting is requested in LD 96, as described in the *Software Input/ Output: Administration* (553-3001-311).

D-channel

For interfaces including NI-2, Q-SIG, and Euro-ISDN, Layer 3 processing is also performed on the MSDL, so the MSDL performs some functions previously performed by the system core processor, thus reducing the capacity on the MSDL. These interfaces will be referred to as R20+ interfaces. The steady state message rate allowable for D-channel messages is 29 msg/sec for R20+ interfaces.

The SL-1 software output queue for DCH messages is the Output Buffer (OTBF) which is user configurable for between 1 and 127 buffers in LD 17. This is a single system resource which is shared by all D-channels.

It is possible to define overload thresholds for R20+ interfaces on a per-D-channel basis. The ISDN_MCNT (ISDN message count), defined in LD 17, specifies the number of ISDN Layer 3 call control messages allowed per 5-second interval. Overload control thresholds can be set on a per D-channel basis, ranging from 60 to 350 messages in a 5 second window, with a default of 300 messages. If the overload control threshold is exceeded, DCH421 is output. When the message rate exceeds the threshold for two consecutive 5 second periods, overload control is invoked and new incoming call requests are rejected by the Layer 3 protocol control in the third 5 second time interval. Layer 3 will resume accepting new calls at the end of the third time interval. This flexibility allows the user to regulate the MSDL processing required by a specific R20+ DCH port. Note that the default value implies no overload control since 300 messages/5 seconds exceeds the rated capacity of 29 messages/second.

PRI network

Equilibrium analysis

A D-channel can be configured to support up to 383 B-channels (or 382 with a back-up D channel) on a T1 or 480 B-channels on an E1. The bandwidth available for messages is 64 kbps. Assumptions for a typical application are: 8 messages/call, 29 bytes/message, including 18 bytes of Layer 3 data and 11 bytes of Layer 2 overhead, 28 centi-call seconds (CCS)/trunk, and 180 second Average Hold Time (AHT)/call. The system capacity is derived from its call carrying capacity for 100% incoming PRI calls.

Under the traffic assumptions described above, the MSDL is able to support basic call processing messages for 4 D-channels under normal operation (see Table 53 on page 236).

Table 53
Steady-state requirements and capacities per D-channel (outgoing and incoming)

System	Requirement msg/sec	System CP capacity msg/sec	MSDL capacity msg/sec	Link capacity msg/sec	Comment
68060 CP	13(T1)/16(E1)	161	87	212 input 212 output	Limited by traffic require-ments
68060E CP	13(T1)/16(E1)	242	87	212 input 212 output	Limited by traffic require-ments

Peak analysis

When there is a link re-start, STATUS messages are sent to all trunks with established calls. Since the SL-1 software task does not implement flow control on this mechanism, a burst of up to several hundred messages can be sent to the MSDL, exceeding MSDL flow control thresholds. When this happens, messages back up on the OTBF buffer, possibly resulting in buffer overflow, as indicated by DCH1030 messages. OTBF overflow is also possible after an initialization since a burst of messages is sent to each D-channel in the system, and the OTBF is a shared system resource.

The system capacity is significantly higher in this scenario than in the previous one because it is sending out D-channel messages which do not involve call processing. MSDL and Link capacities are also higher because, for equilibrium analysis, some capacity is reserved for peaking.

Table 54 on page 237 illustrates the worst case scenario for a single D-channel. If the system sends messages at its peak rate, OTBF buffer overflow is possible. Also, once the messages are sent, a burst of responses can be expected in the incoming direction, resulting in additional congestion at the MSDL.

Table 54
Peak requirements per D-channel (outgoing)

System	Burst Size	System capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	Comment
68060 CP	382(T1)/480(E1)	410	113	276 output	MSDL is bottleneck
68060E CP	382(T1)/480(E1)	615	113	276 output	MSDL is bottleneck

This situation also occurs when a back-up D-channel becomes active, since STATUS messages are exchanged to resynchronize the link.

To reduce the possibility of this problem occurring, limit the number of B-channels supported by a D-channel, separate D-channels onto several MSDL cards so that message bursts are not being sent to four ports on the same MSDL after initialization, and increase the size of OTBF to the maximum value of 127.

The Status Enquiry Message Throttle is implemented. This feature applies only to system to system interface networks and allows the user the configure the number of Status Enquiry messages sent within 128 msec on a per D-channel basis. The parameter, SEMT, is set in LD 17, and can range between 1 and 5. The default value is 1. Since this feature provides a flow control mechanism for Status Enquiry messages, the likelihood of buffer overload is reduced.

B-channel overload

In an ACD environment in which the number of ACD agents plus the maximum ACD queue length is considerably less than the number of B-channels available for incoming calls, a burst of incoming messages may impact the performance of the MSDL as well as the system via the following mechanism: Calls from the CO terminate on a specified ACD queue. When the destination is busy, (the destination set is busy or the ACD queue has reached its maximum limit of calls) the system immediately releases the call. The CO will immediately present another call to the same destination, which is released immediately by the PBX, etc.

The B-channel Overload Control feature is introduced to address this problem by delaying the release of an ISDN PRI call by a user-configurable time when the call encounters a busy condition. The delay in releasing the seized B-channel prevents a new call from being presented on the same B-channel, decreasing the incoming call rate. The timer BCOT is set in LD 16, and falls in the range 0 to 4000 msec.

ISL network

In an ISL application, a modem is used to transmit ISDN signaling messages. Baud rates are user configurable at the standard RS232/RS422 rates: 300, 1200, 2400, 4800, 9600, and 19 200 bps (see Table 55). In this case, the modem baud rate constraint can be the limiting constraint. The messages/second that can be supported by the baud rates are given below, where the values allow for 30% peakedness.

The B-channels that can be supported assume the messaging required for a typical application as described in “Equilibrium analysis” on page 235.

Table 55
ISL link capacities

Modem baud rate	Link capacity (msgs/sec)	B-channels that can be supported
300	1 input 1 output	46
1200	4 input 4 output	180
2400	7 input 7 output	316
4800	15 input 15 output	382(T1)/480(E1)
9600	29 input 29 output	382(T1)/480(E1)
19 200	58 input 58 output	382(T1)/480(E1)

For the baud rates listed in Table 55, the link will be the limiting constraint. The potential peak traffic problems described in “Peak analysis” on page 236 apply here as well, to an even greater extent since the rate mismatch between the system and the system bottleneck, now the link instead of the MSDL, is greater. To minimize the risk, set the baud rate as high as possible.

VNS network

The concepts mentioned in ISL networks also applies to VNS networks. Up to 4000 VDNs are supported.

D-channel bit rate

These guidelines provide the basis for engineering the NACD/VNS D-channel speed.

The bit rate load on the D-channel equals:

the amount of messages × the octets per message
× the number of messages per second

For example, if Facility Message burst is opened with 25 calls in the queue then the Call Request queue size is greater than or equal to 25. The outgoing facility call request is 25 messages in one second. The incoming facility call request acknowledges 25 messages in the same second. The outgoing and incoming call requests total 50 messages.

In this example, the bit rate load on the D-channel equals:

50 messages × 70 octets × 8 bits/octet
= 28 800 bits/second

Total bandwidth of a 9600 baud modem is approximately:

9600 baud × 2
= 19 200 bits/second

With a total bandwidth of 19 200 bits/second and a bit rate load of 28 800 bits/second, the D-channel cannot handle the messaging. D-channel messaging will backlog.

If the customer is having problems networking calls during high traffic then the D-channel may be the cause (especially if the bandwidth is less than 2800 baud). If the D-channel messaging is delayed to the point where VNS call processing gets delayed, the calls will fail to network and many PRI/VNS/DCH messages will be output at both the source and target nodes.

NACD network

A Network ACD (NACD) network is difficult to engineer since performance depends on specific network configuration details including connectivity, routing tables, the number of nodes, the number of queues at each node, and calling patterns.

Diverting calls in NACD is controlled by Routing Tables with timers. Calls diverted by NACD can be answered by the Source ACD DN or any one of up to 20 Target ACD DNs. Each Target can have an individual timer defined, from 0 to 1800 seconds. By using ISDN D-channel messaging to queue Call Requests at remote Target ACD DNs, voice calls are not physically diverted until an idle agent is reserved for that call at the remote Target node.

It is recommended that the Routing Table be designed so that Call Requests cascade to the network with the timers staggered. The node that is most likely to have available agents should have the smallest timer value. Otherwise Call Requests will flood the network, resulting in inefficient use of network and real time resources.

An Active Target is available to accept NACD calls, while a Closed Target is closed to incoming calls. When calls in the Call Request queue exceed the Call Request Queue Size (CRQS) threshold, the status changes to Closed. A Status Exchange message is sent from the Target node to the Source ACD DNs indicating the new status. The Target ACD DN remains Closed to further network call requests until the number of calls in the queue is reduced by the Flow Control Threshold (FCTH).

Equilibrium analysis

At the source node, for each call queued to the network but not answered, 4 messages are exchanged. For each call queued to the network and answered, 11 messages are exchanged. Likewise, at the target node, a network call that is queued but not answered requires 4 messages while a call that is queued and answered requires 11 messages. Messages average 31 bytes.

From a single D-channel perspective, the most difficult network topology is a star network in which each agent node is connected to a tandem node (see Table 56). All messages to the other nodes are sent across the D-channel connected to the tandem node. As an example, consider a site with 2000 calls arriving locally during the busy hour. The timers in the Routing Table are staggered so that 1000 are answered locally without being queued to the network, 500 are answered locally after being queued to an average of two network target queues, and 500 are answered in the network after being queued to an average of four network target queues. Meanwhile, 200 Logical Call Requests arrive from the network, of which 100 calls are answered.

Table 56
Steady-state requirements and capacities per D-channel with staggered timers (outgoing and incoming)

System	Requirement (msg/sec)	Meridian 1 CP capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	Comment
68060 CP	5	161	87	212 input 212 output	Limited by traffic requirements
68060E CP	5	242	87	212 input 212 output	Limited by traffic requirements

For this same network, assume now that the timers in the Routing Table are not staggered; instead, Logical Call Requests are broadcast to the four target nodes in the network as soon as calls arrive at the local node. Also assume that a total of 4000 calls arrive elsewhere in the network, and are queued at local ACD DNs. Even if the calls are answered exactly where they were before, the number of messages exchanged will increase significantly, to the values provided in Table 57, using the following calculations:

- 1500 calls queued on 4 ACD DNs and not answered × 4 msgs/call/DN = 24 000 msgs
- 500 calls answered × 11 msgs/call = 5500 msgs
- 500 calls queued on 3 ACD DNs and not answered × 4 msgs/call/DN = 6000 msgs

- 3900 network calls queued on local DN and not answered × 4 msgs/call = 15 600 msgs
- 100 network calls answered × 11 msgs/call = 1100 msgs
- Total 52 200 msgs/hr
- (52 200 msgs/hr) ÷ (3600 secs/hr) = 14.5 msgs/sec

Table 57
Steady-state requirements and capacities per D-channel with immediate broadcast of Logical Call Requests (outgoing and incoming)

System	Requirement (msg/sec)	Meridian 1 CP capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	Comment
68060 CP	14.5	161	87	212 input 212 output	Limited by traffic requirements
68060E CP	14.5	242	87	212 input 212 output	Limited by traffic requirements

Peak analysis

When the CRQS threshold is reached, the target queue will broadcast messages to the source ACD DNs informing them that it will no longer accept calls. The size of this outgoing burst of messages depends on the number of source ACD DNs in the network.

Once the FCTH threshold is reached, another Status Exchange message is sent. At that point, Logical Call Request messages are sent by the Source ACD DNs. While the target queue has been closed, many calls may have queued at source ACD DNs, resulting in a burst of Logical Call Request messages once the DN becomes available.

Unlike the PRI network case, there is no specific worst case scenario for peakedness. The examples in Table 58 and Table 59 are based on a 5 node network, where each node has three source ACD DNs.

Table 58
Peak requirements for NACD messages (outgoing)

System	Burst size	Meridian 1 capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	Comment
68060 CP	12	410	113	258 output	MSDL is bottleneck
68060E CP	12	615	113	258 output	MSDL is bottleneck

Table 59
Peak requirements for NACD messages (incoming)

System	Burst size	Meridian 1 capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	Comment
68060 CP	40	410	113	258 input	MSDL is bottleneck
68060E CP	40	615	113	258 input	MSDL is bottleneck

If CRQS values are set high, many messages will be exchanged, with the network emulating a single virtual queue. If the CRQS values are lowered, fewer Call Requests will be sent across the network, however, average source delays may be increased. If FCTH levels are set too low, target nodes can ping pong between Active and Closed states, resulting in network congestion and excessive real time utilization. However, if FCTH levels are set too high, a target node may be inundated with Logical Call Request messages once it becomes available. CRQS is configurable for the range [0, 255] while FCTH is configurable for the range [10, 100]. Since the impact of these parameters is so configuration dependent, it is beyond the scope of this document to make recommendations on how to configure them. They should be determined as part of the custom network design process. Contact your local Nortel Networks representative for network engineering services.

Impact of proper engineering of B-channels

In the NACD environment another problem arises when insufficient B-channels are configured across the network. When an agent becomes available, an Agent Free Notification message is sent to the source node. An ISDN Call Setup message is sent from the source node to the target node. Since no B-channel is available, the agent reservation timer expires, and an ISDN Cancellation Message is sent from the target node to the source node and an ISDN Cancellation Acknowledge message is sent from the source node to the target node. At this point, the agent is still free, so the process repeats until a trunk becomes available or the target closes. This scenario results in a significant amount of message passing.

Parameter settings

The following are parameters that can be configured in LD 17 for Meridian 1 D-channels. They are listed with their input range and default value in brackets.

1 OTBF 1 - (32) - 127: Size of output buffer for DCH

This parameter configures how many output buffers are allocated for DCH messages outgoing from the Meridian 1 CP to the MSDL card. The more that are created, the deeper the buffering. Normally a message created in a buffer is sent to the MMIH (Meridian MSDL Interface Handler) and copied into the ring. If the ring is flow controlled, the message occupies a buffer until it can be sent. For systems with extensive D-channel messaging, such as call centers using NACD, the parameter should be set at 127. For other systems with moderate levels of D-channel messaging, OTBF should be set at the smaller of the following two quantities: Total B-channels - (30 × MSDL cards with D-channels) or 127.

For example, if a system in a standard office environment is configured with 7 T1 spans, 2 D-channels which are located on two different MSDLs, and 2 back-up D-channels, the total number of B-channels is (7 × 24) - 4 = 164. OTBF should be configured to be the smaller of 164 - (30 × 2) = 104 and 127 which is 104.

2 T200 2 - (3) - 40: Maximum time for acknowledgment of frame (units of 0.5 secs)

This timer defines how long the MSDL's Layer 2 LAPD will wait before it retransmits a frame. It if doesn't receive an acknowledgment from the far end for a given frame before this timer expires, it will retransmit a frame. Setting this value too low can cause unnecessary retransmissions. The default of 1.5 seconds is long enough for most land connections. Special connections, over radio, for instance, may require higher values.

3 T203 2 - (10) - 40: Link Idle Timer (units of seconds)

This timer defines how long the Layer 2 LAPD will wait without receiving any frames from the far end. If no frames are received for a period of T203 seconds, the Layer 2 will send a frame to the other side to check that the far end is still alive. The expiration of this timer causes the periodic "RR" or Receiver Ready to be sent across an idle link. Setting this value too low causes unnecessary traffic on an idle link. However, setting the value too high will delay the system from detecting that the far end has dropped the link and initiating the recovery process. The value should be higher than T200. It should also be coordinated with the far end so that one end does not use a small value while the other end uses a large value.

4 N200 1 - (3) - 8: Maximum Number of Retransmissions

This value defines how many times the Layer 2 will resend a frame if it doesn't receive an acknowledgment from the far end. Every time a frame is sent by Layer 2, it expects to receive an acknowledgment. If it does not receive the acknowledgment, it will retransmit the frame N200 times before attempting link recovery action. The default (3) is a standard number of retransmissions and is enough for a good link to accommodate occasional noise on the link. If the link is bad, increasing N200 may keep the D-channel up longer, but in general this is not recommended.

5 N201 4 - (260): Maximum Number of Octets (bytes) in the Information Field

This value defines the maximum I-frame (Info frame) size. There is no reason to reduce the number from the default value unless the Meridian 1 is connected to a system that does not support the 260-byte I-frame.

6 K 1 - (7): Maximum number of outstanding frames

This value defines the window size used by the Layer 2 state machine. The default value of 7 means that the Layer 2 state machine will send up to 7 frames out to the link before it stops and requires an acknowledgment for at least one of the frames. A larger window allows for more efficient transmission. Ideally, the Layer 2 will receive an acknowledgment for a message before reaching the K value so that it can send a constant stream of messages. The disadvantage of a large K value is that more frames must be retransmitted if an acknowledgment is not received. The default value of 7 should be sufficient for all applications. The K value must be the same for both sides of the link.

7 ISDN_MCNT (ISDN Message Count) 60 - (300) - 350: Layer 3 call control messages per 5 second interval

It is possible to define overload thresholds for interfaces on a per-D-channel basis. This flexibility allows the user to regulate the MSDL processing required by a specific R20+ DCH port. The default value of 300 messages/5 seconds is equivalent to allowing a single port to utilize the full real time capacity of an MSDL. To limit the real time utilization of a single R20+ DCH port to $(1 \div n)$ of the real time capacity of the MSDL, for $n > 1$, set ISDN_MCNT to $(300 \div n) \times 1.2$ where the 1.2 factor accounts for the fact that peak periods on different ports are unlikely to occur simultaneously. For example, to limit a single port to 1/3 of the processing capacity of the MSDL, ISDN_MCNT is set to $(300 \div 3) \times 1.2 = 120$.

If the ISDN_MCNT threshold is exceeded for one 5 second period, error message DCH421 is printed. If the threshold is exceeded for two consecutive periods, incoming call requests arriving in the third 5 second interval are rejected by the MSDL Layer 3 software. At the end of the third 5 second interval, Layer 3 will resume accepting incoming call requests.

Application Module Link (AML)

The Application Module Link (AML) provides the connection between the system and the CCR, Meridian Link, or Meridian 911 module. The current maximum speed for the link is 19200 baud. CCR is the application addressed here because it is the one that results in the highest level of messaging. The amount of messaging involved depends on the complexity of call handling.

Simple call handling results in approximately 10 messages per call, with an average of 45 bytes/message. Statistics messages are sent from the system to the CCR module every 4 seconds for ACD DNs referenced in the CCR variable table or scripts. Thus messaging levels depend not only on the number of calls handled but on the number of ACD DNs with statistics configured. *Current recommendations are that a system be limited to 80 ACD DNs with statistics*.

On the system, messages queue in the CSQI and CSQO buffers, command status queue input and output buffers, which are configurable in LD 17.

Equilibrium analysis

For equilibrium analysis, we focus on calls, and assume ten ACD DNs sending statistics messages. The system capacity assumes an inbound call center with simple CCR treatment on 100% of the calls, and Meridian MAX.

For Large Systems, the CCR module capacity is the system bottleneck (see Table 60 on page 248). Since there is no flow control or overload control available to protect the CCR module, it is essential that the system be engineered to ensure that the CCR module is not overloaded. Otherwise, link failures or other CCR performance problems may result. To engineer the CCR module, refer to the *Meridian Link/Customer Controlled Routing Engineering Guide* (553-3211-520).

Table 60
Steady-state requirements and capacities per AML (outgoing and incoming)

System	System CP capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	CCR capacity msg/sec (167 module)	Comment
68060 CP	74	107	41 input 41 output	46	CCR bottleneck
68060E CP	111	107	41 input 41 output	46	CCR bottleneck

Peak analysis

Since message bursts are most likely to cause buffer overflow, we consider the system with 80 ACD DNs sending statistics messages every 4 seconds. Recall that this is the maximum recommended number for ACD DNs sending statistics. The system capacity is based on the real time required to process CCR statistics messages (see Table 61).

Table 61
Peak capacities for CCR statistics messages per AML (outgoing)

System	Burst size	System capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	CCR capacity msg/sec (167 module)	Comment
68060 CP	80	920	139	53	60	AML bottleneck
68060E CP	80	1380	139	53	60	AML bottleneck

In this scenario, the AML link is the bottleneck. Messages will begin to queue in the MSDL output buffers and possibly the CSQO buffers, if there are many ACD DNs sending statistics messages.

The AML link will disable if 10 consecutive messages do not receive a response within a 4-second window. The CSA105 message is normally output when this occurs. If a message arrives immediately after the statistics messages for the 80 ACD DNs are generated, it may be queued behind these 80 statistics messages. For 80 messages, processing time at the MSDL, queueing time for the AML, and processing time at the CCR module add up to approximately 3 seconds, so it is easy to understand how the 4 second threshold might be exceeded if the MSDL is also processing messages from other applications.

AML can be configured on the system embedded LAN (ELAN). In this configuration, the AML is no longer the bottleneck.

In Meridian Link applications, similar types of problems may occur when the host is too slow and becomes the system bottleneck.

Parameters

On the system side, AML messages are queued in the CSQI/CSQO buffers, which are shared with the CSL. The maximum configurable size of each is 25% of the number of call registers in the system or 255. It is recommended that 68060 CP systems configure the CSQI and CSQO buffers to be 255. CSQO and CSQI sizes are configured in LD 17.

The flow control parameters MCNT and INTL for each AML are also set in LD 17. This flow control mechanism limits the number of messages sent from the CCR to the system to MCNT [5.9999] in the time interval INTL [1.12] where INTL is measured in units of 5 seconds. When this threshold is violated for one interval, a warning message is sent to CCR requesting that it slow down. If the threshold is violated for two consecutive periods, CCR rejects all new calls back to the system where they will receive default treatment. No new calls will be accepted until the level of traffic is reduced to an acceptable level. If the threshold is exceeded for three consecutive periods, all inbound traffic will be lost. If inbound traffic continues, the link will fail.

Recommended settings for MCNT and INTL are listed in Table 62.

Table 62
Recommended AML flow control values

MCNT	INTL
230	1

This mechanism was originally designed to protect the system from overload. With the faster processors, this flow control threshold is now being used to control traffic levels at the CCR module.

Serial Data Interface (SDI)

An asynchronous serial data interface was provided on the MSDL card. Capabilities include interface to TTYs, printers, modems, and CRTs, High Speed Link (HSL) for ACD, Auxiliary Processor Link (APL) for ACD, ACD-C package displays and reports, and CDR TTYs. An SDI port is only configurable on Port 0 of an MSDL. Therefore, only one SDI port can be configured on an MSDL.

Normally, in the output direction, the SDI Application will pass any character received from the system to the Layer 1 Driver to be sent out over the interface. If XON/XOFF Handling is enabled for printing, the SDI Application will buffer up to 500 characters once an XOFF is received. The system is not aware that an XOFF has been received. After the buffer is full, if further output is received, the oldest data will be discarded. Output resumes when an XON is received or 1 minute has passed since the output was halted by an XOFF. At this point, the contents in the buffer will be emptied first, followed by output from the system. If any data has been discarded, an error message will be sent.

In the input direction, every character received by the Layer 1 Driver will be passed to the SDI Application. The SDI Application will echo any input character unless it is told not to by the system. In Line Editing Mode, the SDI Application will buffer a line of up to 80 characters which can be edited before being sent to the system.

Under certain conditions, control characters can cause messages to ping pong between a modem or printer and the system, resulting in MSDL305 or MSDL306 conditions. To avoid these situations, configure modems in dumb mode and disable printer flow control.

The system input buffer is the TTY input buffer which can store 512 characters. The system output buffer is the TTY output buffer which can store 2048 characters.

Call Detail Records (CDR)

CDR records are available in two formats: *FCDR=old* and *FCDR=new*. A typical record for the old format is 100 bytes long while a typical record for the new format is 213 bytes long (see Table 63). Due to the nature of the SDI interface, characters are output one at a time, resulting in 100 messages and 213 messages generated for *FCDR=old* and *FCDR=new*, respectively. Each message requires 10 bits. Based on real time measurements, the MSDL rated capacity for processing CDR messages is 16 631 messages/second.

Table 63
Link capacities for CDR application (outgoing)

Modem baud rate	Link capacity (msg/sec) (peak)	Calls/Hour for *FCDR=old*	Call/Hour for *FCDR=new*
300	30	831	390
1200	120	3323	1560
2400	240	6646	3120
4800	480	13 292	6241
9600	960	26 585	12 481
19 200	1920	53 169	24 962
38 400	3840	106 338	49 924

Equilibrium analysis

The system capacity for messages per second is conservatively based on the assumption of 100% outgoing calls with *FCDR=new*. Typically, CDR records are not generated for 100% of the calls (see Table 64).

Table 64
Steady state requirements for CDR application (outgoing)

System	System CP capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	Comment
68060 CP	2044	16 631	See Table 63 on page 251	19 200 baud recommended
68060E CP	3066	16 631	See Table 63 on page 251	38 400 baud recommended

Peak analysis

Since each character is sent as a separate message, every time a CDR record is sent, a traffic peak is generated. In Table 65, consider *FCDR=new*.

Table 65
Peak requirements for *FCDR=new* (outgoing)

System	Burst size	System capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec)	Comment
68060 CP	213	3090	21 620	See Table 63 on page 251	38 400 baud recommended
68060E CP	213	4635	21 620	See Table 63 on page 251	38 400 baud recommended

MSDL real time capacity is not the bottleneck in this case. However, to prevent system buffers from building up, the recommended baud rate should be set. If a lower baud rate is chosen, assume that the CDR application will frequently be in a state of flow control. Note that this is true even if the steady state message rate is low, due to the nature of the SDI interface.

The burst sizes will be even greater if CDR is configured with queue records for incoming ACD calls.

MAT customers must upgrade to OTM to configure Succession Release 3.0.

Meridian MAX

The system communicates with Meridian MAX via the HSL (High Speed Link) using 8 bits plus one stop bit. Prior to MAX 8, the HSL bandwidth was 9600 baud. With MAX 8, 19 200 baud is available. Unlike the CDR application, MAX reports are not sent out character by character. The MAX report for a simple call is 5 messages of 20 bytes. The Meridian MAX module capacities are given in Table 66.

Table 66
Capacity of MAX Module in simple calls

	MAX Capacity (simple calls/hour)	MAX Capacity (msg/sec)
Meridian MAX Rls 4	10 000	14
Meridian MAX Rls 5	15 000	21
Meridian MAX Rls 6	15 000	21
Meridian MAX Rls 7	15 000	21
Meridian MAX Rls 8	30 000	42
Meridian MAX Rls 9	30 000	42

Equilibrium Analysis

The system capacity requirements are derived assuming a simple inbound call center with all calls answered by ACD agents and MAX reporting on all calls (see Table 67). Incoming CDR is not turned on.

Table 67
Steady-state requirements for Meridian MAX (outgoing)

System	System CP capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity (msg/sec) (9600/19200)	MAX module capacity
68060 CP	48	87	41/82	See Table 66 on page 253
68060E CP	72	87	41/82	See Table 66 on page 253

The 19 200 baud option for HSL is recommended for 68060 and 68060E CP systems.

Note that Meridian MAX messages queue on call registers. There is no software limit to the number of call registers that can be used to store MAX reports. If the PBX becomes overloaded, MAX messages may build up in the call registers, potentially impacting call processing since call registers may not be available for call setup.

Peak analysis

Complex calls may require 15 or more messages per call. Depending on the configuration, the MSDL or the link could be the bottleneck. In either of these cases, messages queue in the system buffers (see Table 68).

Table 68
Peak requirements for MAX (outgoing)

System	Burst size	System capacity (msg/sec)	MSDL capacity (msg/sec)	Link capacity msg/sec (9600/19 200)	MAX capacity
68060 CP	15	189	87	53/106	See Table 66 on page 253
68060E CP	15	284	87	53/106	See Table 66 on page 253

MSDL engineering procedure

It is important to engineer MSDLs in the context of engineering the entire system, as discussed in previous sections. Refer to *Traffic Measurement: Formats and Output* (553-3001-450) for additional information on real time engineering of the system. In all cases with a user configurable link rate, it is essential that the link be configured so that the rate is high enough to support steady state requirements and some peakedness. Otherwise these applications messages will occupy system buffers, increasing the chance of buffer overflow.

Table 69 on page 256 is the high-level worksheet for analysis of MSDL capacity. The appropriate values can be derived from Table 70 on page 257 through Table 75 on page 261.

Table 69
MSDL engineering worksheet

Port	Application	Real Time required	Peak Buffer usage outgoing	Peak Buffer usage incoming
0	____________	________	________	________
1	____________	________	________	________
2	____________	________	________	________
3	____________	________	________	________
Total		________	________	________

Assuming 30% peakedness for the applications, the total real time required should be less than 2 770 000 msec. The projected real time utilization of the MSDL is given by:

MSDL_RTU = Total Real Time Required ÷ 2 770 000

It is recommended that peak buffer usage be less than 60 in each direction. As the peak buffer usage increases over 60, the likelihood of an intermittent buffer full problem increases.

Application engineering

The following sections provide procedures for calculating the real time required on the MSDL for various applications. In any of these cases, if the calls/hour value is known, insert that value into Column A. Otherwise, follow the guidelines provided. Values in parentheses ( ) are default values. For example, the default number of calls/hr/trunk is 15.6. The value in Column E should be inserted in the Real Time Required column of Table 69 on page 256 and the appropriate Peak Buffer Usage values should be inserted in the corresponding Peak Buffer Usage columns of Table 69.

DCH applications

If several applications share a D-channel, the final real time requirements for the applications should be added and then entered in the appropriate entry in Table 70.

Table 70
MSDL real time requirements for D-channel applications

DCH	Calls/hr A	Msgs/call B	Msgs/hr C = A × B	Msec/msg** D	Msec E = C × D
ISDN Network	trunks/DCH (see note) ×* calls/hr/trunk (15.6) = ______	8	______	pre-R20: 8.8 R20+: 26.5	______
NACD	NACD agents (see note) × calls/hr/agent (18.3) = ______	30	______	pre-R20: 8.8	______
NMS	NMS ports (see note) × calls/hr/port (65) = ______	10	______	pre_R20: 8.8	______

Note: For clarification of the terms "pre-R20" and "R20+," refer to "D-channel" on page 234

The calculations described for NACD provide a simplified approximation of a "typical" NACD network. If call flows can be predicted or estimated, they can be used to develop a more accurate model using the number of messages described in. When this is done, the msgs/hr is computed directly, so columns A and B are not used. See "Examples" on page 261 for a detailed example of how this can be done.

If a live system is being modeled, add the "number of all incoming messages received on the D-channel" and the "number of all outgoing messages sent on the D-channel" field from a busy hour TFS009 report to derive the entry for

Column C. See *Traffic Measurement: Formats and Output* (553-3001-450) for details.

Table 71
MSDL peak buffer requirements for D-channel applications

DCH	Outgoing	Incoming
ISDN Network	Prior to R24: • B-channels ÷ DCH = _____ • R24+: SEMT (1) × 8	Prior to R24: • B-channels ÷ DCH = _____ • R24+: SEMT (1) × 8
NACD	Source ACD DNs + 5 = ____	Network congestion level: • Low: 10 • Medium: 20 • High: 30
NMS	10	10

In the case of an ISL D-channel, ensure that the baud rate of the connection is greater than

$$(\text{C msgs/hr} \times 29 \text{ bytes/msg} \times 8 \text{ bits/byte}) \div 3600 \text{ sec/hr}$$

where C comes from column C in Table 70 on page 257.

If the baud rate is too low to meet requirements, performance of the entire MSDL card may be jeopardized since 30 of the MSDL output buffers will be occupied with ISL D-channel messages and the real time spent processing these messages will increase due to additional flow control and queueing logic.

Depending on the application, it may be too conservative to engineer an MSDL for link restarts. In that case, the ISDN Network peak outgoing and incoming buffer requirements can be set at 15 for 68060 CP systems.

AML applications

If an existing system is being modeled, add the number of incoming messages, messages in the IMSG category, and outgoing messages, messages in the OMSG category, from a busy hour TFS008 report and enter the value in Column C. For a quick approximation of the number of incoming messages, add the number of messages of priority 1 to 4, as provided in TFS008. For more details, refer to *Traffic Measurement: Formats and Output* (553-3001-450).

Table 72
MSDL real time requirements for AML applications

AML	calls/hr A	msgs/call B	msgs/hr C = A × B	msec/msg D	msec E = C × D
CCR	agents × calls ÷ agent/hr (18.3) × % calls with CCR=_____	simple: 10 medium: 20 complex: 30	A × B + 900 ACD DNs w/ statistics = _____	7.2	____
HER/AST	agents × calls ÷ agent/hr (18.3) × % calls with HER/AST =____	10	_____	7.2	_____
M911	M911 agents × calls ÷ agent/hr (18.3) = ____	6	_____	7.2	_____
Meridian Mail voice mail	MM ports × calls/hr/port (65) = _____	10	_____	7.2	_____
Meridian Mail voice menu	agents × calls/agent/hr (120) = _____	10	_____	7.2	_____
Meridian Mail announcements	agents × calls/agent/hr (150) = _____	5	_____	7.2	_____

Table 73
MSDL peak buffer requirements for AML applications (Part 1 of 2)

AML	Outgoing	Incoming	Minimum Baud Rate
CCR	CDNs with statistics= _____	68060 CP: 20 68060E CP:30	(msgs/hr × 45 bytes/msg × 8 bits/byte) ÷ (3600 sec/hr) = _____
HER/AST	68060 CP: 12 68060E CP: 18	68060 CP: 12 68060E CP: 18	(msgs/hr × 45 bytes/msg × 8 bits/byte) ÷ (3600 sec/hr) = _____

Table 73
MSDL peak buffer requirements for AML applications (Part 2 of 2)

AML	Outgoing	Incoming	Minimum Baud Rate
M911	68060 CP: 5 68060E CP: 8	68060 CP: 5 68060E CP:8	(msgs/hr × 45 bytes/msg × 8 bits/byte) ÷ (3600 sec/hr) = ____
Meridian Mail voice mail	68060 CP: 8 68060E CP: 12	68060 CP: 8 68060E CP: 12	(msgs/hr × 38.5 bytes/msg × 8 bits/byte) ÷ (3600 sec/hr) = ____
Meridian Mail voice menu	68060 CP: 12 68060E CP: 18	68060 CP: 12 68060E CP: 18	(msgs/hr × 38.5 bytes/msg × 8 bits/byte) ÷ (3600 sec/hr) = ____
Meridian Mail announcements	68060 CP: 15 68060E CP: 22	68060 CP: 15 68060E CP: 22	(msgs/hr × 38.5 bytes/msg × 8 bits/byte) ÷ (3600 sec/hr) = ____

For Meridian Mail 1 through Meridian Mail 9, the CSL link was 4800 baud. Beginning with Meridian Mail 10, the link is 9600 baud. Meridian Mail 11 supports a maximum of 96 ports. Previous releases supported 48 ports.

SDI applications

In the HSL analysis, include live agents, automated agents, and Meridian Mail agents in the agent total. This will compensate for the assumption of simple calls, since transferred calls will generate additional MAX messages.

Table 74
MSDL real time requirements for SDI applications

SDI	calls/hr A	msgs/call B	msgs/hr C=A×B	msec/msg D	msec E=C×D
CDR	calls/hr with reports = _____	FCDR = old:100 CDR = new: 213	_____	0.05	_____
HSL-Meridian MAX	agents × calls/agent/hr (18.3) = _____	5	_____	8.8	_____
TTY	NA	NA	15 000	0.05	_____

There are no traffic reports that provide information on the number of SDI messages directly. For CDR records, determine whether CDR is enabled for incoming, outgoing, and/or internal calls. The number of incoming, outgoing, internal, and tandem calls is available from TFC001. Tandem calls are considered both incoming and outgoing. Alternatively, the number of CDR records can be counted directly. MAX reports can also be counted directly.

Table 75
MSDL peak buffer requirements for SDI applications

SDI	Outgoing	Incoming	Minimum baud rate
CDR	• 30 if baud rate is less than recommended in Table 63 on page 251 • otherwise: — 68060 CP: 20 — 68060E CP:	1	(msgs/hr × 10 bits/msg) ÷ (3600 sec/hr) = _____
HSL – Meridian MAX	• Messages per call — simple: 5 — medium: 10 — complex: 15	1	(msgs/hr × 20 bytes/msg × 9 bits/byte) ÷ (3600 sec/hr) = _____
TTY	10	10	

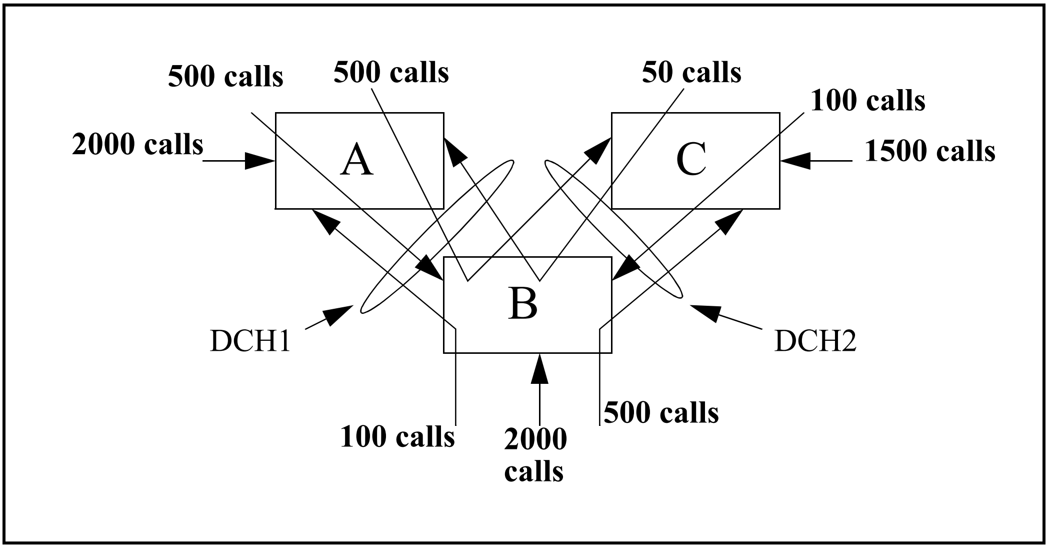
Examples

NACD network with CDR reports

Consider an NACD network with the topology given in Figure 60 on page 262. The call flow is provided, where arrows indicate where calls enter the network and where they are answered.

Each node has a single ACD DN and calls are queued to the network target DNs as soon as they arrive.

Figure 60
NACD network



For this network, we wish to determine whether a single MSDL on Node B can support DCH1, DCH2, and an SDI port for CDR records on Port 0.

Since we have detailed call flow information, we can develop a messaging model for DCH1 and DCH2 (see Table 76).

Table 76
NACD Message Model

Originating Node	Total Queued	Queued and answered	Queued but not answered	Total messages	DCH1	DCH2
Node A to Node B	3000	500	2500	15 500	x	x
Node A to Node C	3000	500	2500	15 500	x	x
Node B to Node A	2600	100	2500	11 100	x	
Node B to Node C	2600	500	2100	13 900		x
Node C to Node A	1650	50	1600	6950	x	x
Node C to Node B	1650	100	1550	7300	x	x

The DCH1 and DCH2 columns indicate whether the messages should be included in the DCH1 and DCH2 message count, respectively. For each row, multiply the entry in the “Queued and answered” column by 11 messages and multiply the entry in the “Queued but not answered” column by 4 messages. The sum of these two values is provided in the “Total messages” column. By summing the rows which should be included for DCH1 and DCH2, we derive the total messages for DCH1: 56 350 msg/hr and DCH2: 59 150 msg/hr. Note that these messages do not include the impact of CRQS and FCTH which are beyond the scope of this analysis (see Table 70 on page 257).

Table 77
MSDL real time requirements for D-channel applications

DCH	calls/hr A	msgs/call B	msgs/hr C=A×B	msec/msg D	msec E=C×D
NACD DCH1	NA	NA	56 350	pre-R20: 8.8	495 880
NACD DCH2	NA	NA	59 150	pre-R20: 8.8	520 520

Assuming that no non-NACD calls are carried, Node B carries 3750 calls/hour.

Table 78
MSDL real time requirements for SDI applications

SDI	calls/hr A	msgs/call B	msgs/hr C=A×B	msec/ msg D	msec E=C×D
CDR	calls/hr with reports=3750	FCDR=old: 100 FCDR=new: 213	798 750 (FCDR=new)	0.05	39 938

The total MSDL requirements can then be computed:

Table 79
MSDL engineering worksheet

Port	Application	Real Time required	Peak Buffer usage outgoing	Peak Buffer usage incoming
0	CDR	39 938	10	1
1	DCH-NACD	495 880	7	10
2	DCH-NACD	520 520	7	10
3				
Total		1 056 338	24	21

The projected MSDL utilization is 1 056 338 ÷ 2 770 000 = 38%. Assuming low network congestion, incoming and outgoing peak buffer usage are below 60, so a single MSDL is able to support this configuration. However, due to the potentially high messaging impact of NACD, this MSDL should be re-engineered periodically to determine whether the call volumes or call flow patterns have changed.

Application engineering

Contents

This section contains information on the following topics:

Introduction 265
Meridian Mail 265
CallPilot engineering. 268
Meridian Link 269
ELAN engineering 292
Configuration parameters 293

Introduction

In this section, applications that have significant capacity impact and require engineering are addressed. Suggestions are given for engineering the application for proper operation from a capacity perspective.

Descriptions of features and their functionality are not given here. Please refer to feature documentation in the Nortel Networks Technical Publications.

Meridian Mail

Traffic calculations and capacity table

Refer to *Site and Installation Planning* (553-7011-200) for a detailed engineering of Meridian Mail (MM), including menu utilization, call duration, storage size, disk size, up requirements, and so on. However, for easy reference, a simplified table is extracted and included here (see Table 80).

Each Meridian Mail Module consists of 16 ports that interface with a DTI type of loop with 24 ports to provide voice channels. In other words, every 16 Meridian Mail ports interface with one loop of 30 timeslots.

As with other traffic calculations, the first step is to determine the average holding time of an MM call. This includes both the time the user is logged on to MM and the time callers are leaving messages for that user. A typical range is 30 to 60 seconds per user depending on the type of application.

The calling rate per MM registered user is about 10 percent of busy hour calls. For example, if a set generates or receives five calls per hour, the MM calls would be 0.5 per hour. If there are 2000 MM users in a switch with average holding time (AHT) of 60 seconds, its MM traffic would be:

$$\text{MM traffic in CCS} = 2000 \times 0.5 \times 60 \div 100 = 600 \text{ CCS}$$

From Table 80, approximately 23 MM ports are needed for this application.

Note that if complicated voice menus are involved for an application, the AHT needs to reflect that fact.

Table 80
Meridian Mail channel capacity (Part 1 of 2)

Number of channels	Capacity in CCS
4	54
8	157
12	273
20	522
24	651
28	782
32	915

Table 80
Meridian Mail channel capacity (Part 2 of 2)

Number of channels	Capacity in CCS
36	1049
40	1183
44	1318
48	1455
52	1592
56	1729
60	1867
64	2005
68	2143
72	2282
76	2421
80	2561
84	2700
88	2840
92	2980
96	3120

The main objective to present Meridian Mail engineering procedure here is to show how it fits into the overall Call Center engineering in the later section. For a high level MM port requirements estimate, interpolation or extrapolation between entries is permitted.

The major MM parameter that impacts the real-time capacity of a co-located system is the type of signaling between the MM processor and the system CP. For locally generated MM calls, CSL and End to End signaling have significant capacity effects and have different real-time factors as shown in the real-time calculation worksheet.

There are many voice processing features offered with the Meridian Mail application, all of which present unique characteristics in MM usage. Each specific feature, with varying AHT, will impact the MM port requirement differently. This needs to be considered when engineering a specific MM application. The following are known applications of the MM feature: Voice Mail, Voice Menu, Voice Forms, Auto Attendant, Meridian Interactive Voice Response (MIVR), Host Enhanced Voice Processing (HEVP), Network Message Service, and Third Party Voice Messaging Systems.

CallPilot engineering

Refer to *CallPilot Planning and Engineering (*553-7101-101) for engineering details. The abbreviated procedure in this chapter is for system engineering where a rough estimate of CallPilot ports (or channels) is required.

The difference in Meridian Mail and CallPilot engineering is that in addition to voice channels, a CallPilot allows fax and speech-recognition media. As a measure of Digital Signal Processing (DSP) power, different media types require different Multimedia Processing Unit (MPU) quantities:

- One voice channel requires one MPU
- One fax channel requires two MPUs
- One speech-recognition channel requires four MPUs

A Multimedia Processing Card (MPC-8) is a credit-card sized PC card that resides in the CallPilot Server. Each MPC-8 has eight MPUs. The maximum number of MPUs in a CallPilot is 96. Any use of non-voice application will reduce the number of channels available for voice traffic.

For an IP source to access CallPilot, the codec must be set for G.711, since a non-standard proprietary codec is used in CallPilot, a multi-rate transcoding will render the resulting voice samples with very poor quality.

The default holding time for a voice channel user is 40 seconds in the CallPilot port engineering. Another resource to be estimated in CallPilot is storage size. This requires a complicated calculation and will not be covered here. Please refer to the *CallPilot Planning and Engineering* (553-7101-101) for details.

Once the CCS for each type of media is calculated, sum up the total and refer to capacity tables in the NTP MPU requirement based on the offered CCS traffic. If a precise calculation is not required, refer to Table 80 on page 266 for capacity estimation. This table was calculated with Erlang C P.05 GOS. An alternative cited in *CallPilot Planning and Engineering* (553-7101-101) is Erlang B with P.02 GOS, which is slightly on the conservative side compared with the Erlang C model.

Meridian Link

Major Meridian Link applications and their real-time impacts are addressed in this section.

Data rate determination

Although the subject of signaling link engineering is a part of the *Meridian Link Engineering Guide* (553-3203-151), it will be useful to extract some data from that document to make this engineering guide more complete, since most Call Center applications involve Meridian Link in the configuration.

The data rate chosen for a link, if it is within the limit of the system CP capacity, should correspond to an Application Module Link (AML) call capacity value greater than a system is expected to handle.

As long as there are physical I/O ports in the system to interface the AML, there is no practical limit to the number of AML/MLs a system can serve. However, the number of calls corresponding to each application must be added together to determine whether the total is within the CP capacity of that system.

The data link requirement for the CCR application is only 3.2 percent higher than for the ML. In other words, the entry in Table 81 on page 270 should be divided by 1.032 for the CCR application. For example, at 1200 bps rate, the link can handle 1480 CCR calls (1528 ÷ 1.032).

Table 81
Data Link capacity for typical ACD/AML applications

Link data rate (D) in kbps	64.0	19.2	9.6	4.8	2.4	1.2
Avg. AML calls/hr	82 202	24 660	12 330	6115	3057	1528

When application modules begin using a common base, all applications sharing the same AML can add up message link call requirements by using the following formula:

AML calls/hour
= (Type 1 calls × 1.0 + Type 2 calls × 1.0 + …+ CCR calls × 1.032)

Then, check the AML calls/hour against the data rate requirement in the above table. At this time the only application with factor other than one is CCR. This may change when message usages of more applications are studied.

Incoming AST calls

In an Associated Telephone (AST), the DN of the set is assigned to be controlled by a host. The AST is a set associated with a computer terminal through a database stored in the host. A host, alerted by messages of an incoming call from the system, can bring up customer or sales information on the terminal screen while a connection is made to the AST, which is frequently an ACD agent.

Autodialer calls with transfers (Predictive Dialing)

An Autodialer, controlled by a host, directs the system to make a central office (CO) trunk call. When a potential customer answers, the Autodialer detects the connection and transfers the call to an agent to answer. The average holding time of this type of call is relatively short for the Autodialer compare with a conventional call, thus the frequency of calls can be very high. The number of calls successfully transferred is normally a small percentage (5-20 percent) of total Autodialer calls.

Customer Controlled Routing

Customer Controlled Routing (CCR) is an auxiliary product connected to the system via the AML. Depending on the Controlled Direct Number (CDN) of the incoming call, CCR can route calls based on a variety of attributes, such as Calling Line ID (CLID), Dialed Number Identification Service (DNIS), time of call arrival, and the call processing states of the ACD-DN (queue size, agent number, and so on). The CCR can put a waiting call on a maximum of four queues simultaneously. It also provides the flexibility of routing a call to RAN and Music treatments with conditions.

Host Enhanced Routing

The Host Enhanced Routing (HER) feature intercepts an incoming ACD call based on the CDN dialed, and gives the call special treatment according to the script programmed, such as routing to a specific DN queue, connecting to a RAN or Music. It can also make routing decisions based on the conditions of agent load and the service criterion. The real-time impacts of basic CCR and HER features are similar. Depending on the complexity of scripts, either feature can become very sophisticated and real-time extensive.

Direct Autodialer calls (Preview dialing)

An Autodialer connected to a 2500 type line card is controlled by a host through AML to make calls according to a database in the host. This type of call does not involve an ACD agent. The Autodialer either monitors control points by dialing these numbers periodically, as used in factory automation and sales updates, or is connected to a recording machine to perform customer surveys or market research.

Call Center

The Call Center is an ACD switch, whose calls are mostly incoming or outgoing, with extensive applications features, such as CCR, HER, MIVR, HEVP. A port in the Call Center environment, either as an agent set or trunk, tends to be more heavily loaded than other types of applications.

Based on customer application requirements, such as calls processed in a busy hour, and feature suite such as RAN, Music, and IVR, the system capacity requirements can be calculated.

ACD

Automatic Call Distribution (ACD) is an optional feature available with the system. It is used by organizations where the calls received are for a service rather than a specific person.

For basic ACD, incoming calls are handled on a first-come, first-served basis and are distributed among the available agents. The agent that has been idle the longest is presented with the first call. This ensures an equitable distribution of incoming calls among agents.

The system is managed or supervised by supervisors who have access to the ACD information through a video display terminal. These supervisors deal with agent-customer transactions and the distribution of incoming calls among agents.

Many sophisticated control mechanisms have been built on the basic ACD features. Various packages of ACD features discussed in this NTP will have real-time impact on the system CP capacity.

ACD-C1 and C2 packages

ACD Management Reporting provides the ACD customer with timely and accurate statistics relevant to the ACD operation. These statistics form periodic printed reports and ongoing status displays so the customer can monitor changing ACD traffic loads and levels of service and implement corrective action where required.

The ACD-C1 package primarily provides status reporting of the system through a TTY terminal. To control and alter the configuration of the system, the ACD-C2 package is required; it provides the load management commands. The following is a partial list of functions of a supervisor position in the C2 package:

- Assign auto-terminating ACD trunk routes
- Assign priority status to ACD trunks
- Reassign ACD agent positions to other ACD DNs
- Set the timers and routes for first and second RAN

- Define the overflow thresholds
- Specify a night RAN route

ACD-D package

The ACD-D system is designed to serve customers whose ACD operation requires sophisticated management reporting and load management capabilities. It has an enhanced management display as the system is supplemented by an auxiliary data system. The system and the auxiliary processor are connected by data links through SDI ports for communications. Call processing and service management functions are split between the system and the auxiliary processor.

ACD-MAX

ACD-MAX offers a customer managerial control over the ACD operation by providing past performance reporting and current performance displays. It is connected through an SDI port to communicate with the system CP. The ACD-MAX feature makes the necessary calculations of data received from the system to produce ACD report data for current and past performance reports. Every 30 seconds, ACD-MAX takes the last 10 minutes of performance data and uses it to generate statistics for the current performance displays. The accumulated past performance report data is stored on disk every 30 minutes.

The impact of ACD-MAX calls in the capacity engineering will be in the real-time area only. The Meridian MAX is an AP version of the ACD-MAX which uses an AP module instead of an HP computer as an auxiliary processor. To estimate the impact of MAX on the system CP, both versions can be treated the same.

NACD

The majority of tasks in the engineering of Network ACD (NACD) involve the design of an NACD routing table and the engineering of overflow traffic. The process is too complex to be included here. The engineering procedure in this NTP is for single node capacity engineering, which accounts for the real-time impact of NACD calls on a switch either as a source node or remote target node. Therefore, the overall design of a network is not in the scope of this document.

MIVR

The Meridian Interactive Voice Response (MIVR) is a Meridian Mail application in which a third-party module (Voicetek™ machine) controls the operation of an MM through the 9600 baud ACCESS link. The communication between the system and MM continues to use the CSL. Voice ports required for the MIVR feature are MM ports.

Provisioning requirements ensure a balanced configuration among trunks, MIVR ports (or MM ports), and agents in the system's overall configuration. The provisioning requirements include the following recommendations.

1 Physically, the MIVR port is the same as the MM port, except that it is controlled by the MIVR application module through the 9600 baud ACCESS link (an asynchronous link). The provisioning of MIVR ports is a multiple of 24, just like MM ports. In MIVR release 1, with one ACCESS link, 48 MIVR ports are the maximum. In release 2, a second ACCESS link will be permitted, which can support another 16 MIVR ports.

2 The data link, CSL, which provides signaling between the system and Meridian Mail, is always a 4800 baud synchronous link.

3 The distribution of Holding Times (HTs) for MIVR ports are bimodal: one short HT for calls that are transferred to live agents; and, one long HT for calls that are served by the MIVR menu.

4 The long HT call occupies a trunk circuit just like any other ACD call. The short HT call has an incremental impact on trunk occupancy. The average HT of a trunk is equal to the sum of the MIVR HT and the agent HT. In other words, all transferred MIVR calls have an incremental impact on trunking requirements.

5 If the default short HT on the MIVR port is 15 seconds, the additional CCS to trunk can be estimated as follows:
Incremental MIVR CCS to trunks = Transferred MIVR calls × 15 ÷ 100.

Host Enhanced Voice Processing

The Host Enhanced Voice Processing (HEVP) feature is similar to the MIVR except that the ACCESS link is replaced by a Meridian Mail link, and the voice processing is controlled by the Meridian Application Module instead of a Voicetek machine.

An HEVP call involves the AML to control a voice mail treatment; its real-time impact on the Meridian 1 is like a combined MM and AML call. HEVP real-time impact can be treated like the MIVR.

Meridian 911

The primary difference between the M911 application and other Application Module link related incoming ACD calls is the requirement of MF Receivers (MFR), which interpret digits received from CO through MF trunks for M911 calls.

Procedure 1
Estimating MFR requirements

1 Calculate the number of calls from MF trunks:

M911 calls = No. of MF trunks $\times$ 28 $\times$ 100 $\div$ 180
= 15.56 $\times$ No. of MF trunks.

where the default value of CCS for the trunk is 28 and the average holding time is 180 seconds. These numbers should be replaced by specific values at your site if they are available.

2 Calculate MFR traffic:

MFR traffic in CCS = M911 calls $\times$ 6 $\div$ 100

where the ANI digits of 8 were estimated conservatively to hold up a receiver for 6 seconds.

3 Refer to *Dialing Plans: Description* (553-3001-183) to find the requirements of MFRs. For the purpose of estimating MFR requirements, the DTR table can be applied. Read the number of DTRs (MFRs) corresponding to a CCS entry greater than the above calculated CCS value under the column of 6-second holding time. An abbreviated table is shown here for simple reference.

Table 82
MFR table with 6-second holding time

No. of MF receivers	2	4	6	8	10	15	20	25	30	35	40
Capacity in CCS	3	24	61	106	157	300	454	615	779	947	1117

End of Procedure

RAN and Music

The RAN trunk can be treated just like a normal trunk. The only potential capacity impact is for Large Systems that include RAN trunks in blocking or non-blocking calculations. The calculations determine the total number of loops or card slots required. Refer to “Service loops and circuits” on page 316 to calculate RAN requirements.

Music in the system is provided by broadcasting a music source from a RAN trunk to a conference loop. Therefore, a maximum of 30 users can listen to music at one time. If this is not sufficient, an additional conference loop needs to be provided for each additional 30 simultaneous music users.

The conference loop connects to one half of the TDS/CON card. The second conference loop, if needed, will take another card and card slot, because it cannot be separated from the TDS loop.

Music Broadcast requires any Music trunk and an external music source or a Meridian Integrated RAN (MIRAN) card (NTAG36). MIRAN has the capability to provide audio input for external music. A Conference loop is not required for Music Broadcast.

Other features

Features such as CCR, HER, and Predictive Dialing are as much a Call Center feature as an AML one. However, since they were already discussed under the Meridian Link umbrella, they will not be repeated here.

Symposium Call Center

Symposium is a Host Server that interfaces through an Ethernet to reach Meridian’s Network Interface Card to enable the system to provide advanced Call Center features to users. The NIC port can be set for many options, such as 10T (10 Mbps), or 100T (100 Mbps) data rate, half duplex or full duplex depending on processor capacity of the system. For CP3 and CP4 processor, only 10T with half duplex is allowed. For CP PII, all options are available, including full duplex and 100T data rate. Although Internet Protocol is used for communications, the underlining message to Meridian input queue is still AML messages.

The customer can create simple to write script in Symposium to control processing of an arriving call which is eventually delivered to an agent queue after following various call processing rules, such as skill set of agent, call priority, length of waiting time, etc.

The impact of Symposium call center on the system is the complexity of call handling on the system call processor. Depending on the script used, the call processing can include giving RAN, Music and IVR which requires a voice processing system such as Meridian Mail or CallPilot be also provided.

From the system CPU's point of view, service functions provided by Symposium are similar to that available for CCR, or HEVP, the only difference is reflected by real time factor corresponding to each application type.

Symposium Call Center with IP phones and Virtual Trunks

When IP phones are used as ACD agent sets, some special engineering rules are to be followed to engineer the system properly. Two new resources need to be engineered:

- Digital Signaling Processing (DSP) channels (therefore, Media Cards)
- Virtual Trunks

The following four configurations demonstrate the application of different rules to accommodate different configurations.

1 New Pure IP System with IP sets and VTs

In a pure IP system, if Signaling Processing and Gateway functions are provided, no DSP channels are needed for pure IP connections. The number of VTs provided should be equal to or more than the number of IP agent sets depending on the queuing provisioning. Typically, trunks should be 15-20% more than the agents.

2 PRI trunks and IP agent sets

One DSP channel per IP agent set. How many more PRI trunks than IP agent sets depends on the queueing consideration.

3 Mixed PRI trunks and Virtual Trunks to IP agent sets

For DSP channel calculation, consider only the number of PRI trunks and required IP agent sets. The subset of VTs vs. IP agents can be excluded. However, for bandwidth calculation, all traffic should be accounted for.

4 Mixed TDM and IP Call Center

When both PRI trunks and VTs carry traffic to agents with digital sets and IP sets, the first step is to determine whether there is a community of interests among PRI trunks and digital agent sets. If so, their connections should be preferred through the control of CDN, making codecs unnecessary in the call set up which reduces usage of DSP resources and maintains high QoS.

Call Center examples

Real time factors are used in the following examples. The same method and procedures can be applied to later releases and faster CPs by substituting the real time factors and EBC capacities used in the examples with their updated counterparts.

A basic Call Center with MIVR

In this example, assume:

- 12 000 calls per hour incoming to MIVR
- Calls receive on average one 30 second cycle of MIRAN RAN and MUSIC before being connected to a live agent
- Average hold time (AHT) with the live agent is 150 seconds
- CCS per live agent is 30
- Assume a PRI trunk/agent ratio of 1.5
- AHT per trunk equals AHT per agent + the 30 second MIRAN cycle, and CCS per trunk is balanced (that is, trunk CCS = set CCS)

We will need to determine how many MIVR ports and how many live agents, assuming 5% blocking. We will also need to determine the number of PRI loops, given the trunking specs above.

Solution

MIVR ports: The number of Meridian Mail ports required to handle a given CCS at 5% blocking can be found in Table 80 on page 266. This same table can be applied to MIVR ports. The formula for calculating the MIVR CCS:

$$12\,000 \text{ calls} \times (30 \text{ secs/call}) \div 100 = 3600$$

The table only shows ports for up to 3120 CCS, but extrapolation is permissible. A linear fit on the last 6 entries in the table yields an R^2 of 1 and a port requirement of 112 ports to support a CCS of 3600.

Live agents: The agent count must be sufficient to support the call rate from the MIVR ports with no blocking. The call rate from the MIVR ports is 12 000 calls per hour. The formula for calculating live agents is:

$$12\,000 \text{ calls} \times 150 \text{ secs/call} \div (30 \times 100 \text{ secs/agent}) = 600$$

Trunks: We need 1.5 × 600 trunks = 900 trunks. Let this be a European site with 30 PRI channels per loop. Then we need 30 loops. Let's make sure that this is adequate trunking by determining now what CCS per trunk would be required to balance the model, and verifying that this is less than the 36 CCS that we have available in one hour. We have 12 000 calls per hour, (150 sec agent AHT + 30 sec MIVR treatment) per call, and 900 trunks.

The formula to calculate per trunk CCS is:

$$(12\,000 \text{ calls} \times 180 \text{ secs/call}) \div (900 \text{ trunks} \times 100 \text{ sec/CCS})$$
$$= 24$$

Therefore 900 trunks is adequate.

Now that you know all the terminal counts, you can go on to see what physical capacities we need (loop, line card). The live ACD agents will be assumed to be on IPE Aries sets.

The following reviews the three steps used to solve the model. The steps include calculating the loop requirement and calculating the real time requirement.

1 Loop requirement

Table 83
Worksheet for network loop calculation (example) (Part 1 of 2)

Column A					Column B (Loops)
TDS/CON loops	One card (2 loops) per Network Module*				_____6____
BLOCKING:	Admin. sets		______ × 6 =	______CCS	
XNET loop					
	Non-ACD trunks	+	______× 26 =	______CCS	
	Subtotal	=		______ ÷ 875	=_______(N_{0x})
NON_BLOCKING:					
XNET	Agent sets		___600___		
	Supervisor sets	+	_________		
	ACD analog and RAN trunks	+	________		
	Subtotal	=	___600_÷ 30		=___20___(N_1)
DTI Trunks		=	_______ ÷ 24		=_______(N_{2d})
PRI Trunks			___900_____		
		+			
		=	___900__ ÷ 30		=___30___(N_{2p})
MIRAN ports		=	___112__ ÷ 30		=____4__(N_{31})
MM/MIVR/HEVP ports			___112__ ÷ 16		=____7__(N_{32})

Table 83
Worksheet for network loop calculation (example) (Part 2 of 2)

Column A	Column B (Loops)
Total loops (Sum of entries under column B)	=___67___(N_L)

Note: All calculations should be rounded up to the next integer.

*Iterative procedure may be needed, if the number of network modules required was not correctly estimated at the outset.

Conclusion:

N_L <= 16, Meridian 1 Option 51C, Succession 1000M Half Group

16 < N_L <= 32 Meridian 1 Option 61C CP PII, Succession 1000M Single Group

32 < N_L <= 256 Meridian 1 Option 81C CP PII (8 group), Succession 1000M Multi Group

TDS/CON loops = 6	three Network Modules is initially estimated
$N_1 = [(600) \div 30] = 20$	loops for agent, supervisor sets and trunks
$N_{2p} = [(900) \div 30] = 30$	loops for PRI trunks
$N_{31} = [112 \div 30] = 4$	loops for MIRAN ports
$N_{32} = [112 \div 16] = 7$	loops for MM (MIVR) ports

Total required loops = 6 + 20 + 30 + 4 + 7 = 67

A Meridian 1 Option 81C can have up to 256 loops. With 32 loops per module, our initial estimate of 3 network modules was correct.

Because the configuration requires a Meridian 1 Option 81C, it is not necessary to check the card slot limitation.

2 Real-time requirement

The worksheet has been shortened to include only that features that are being used in this configuration. The charges for Symposium assume the “simple script”, which is defined as “calls routed directly to an agent after receiving one cycle of MIRAN plus MUSIC but no voice processing”. This is exactly the scenario we are modeling.

Feature	Usage	×	Real Time Factor	=	EBC
Busy hour basic calls	12 000	×	1.00	=	12 000
Digital set calls	12 000	×	0.03	=	360
ACD (Inbound) calls	12 000	×	0.13	=	1560
Symposium – overhead	12 000	×	1.33	=	15 960
Symposium – simple treatment with MIRAN	12 000	×	2.06	=	24 720
MIVR with transfer	12 000	×	1.41	=	16 920
PRA calls, incoming	12 000	×	0.16	=	1920

Total real-time impact of features in EBC = 61 440
(add up the EBC column)

Total system EBC
= 12 000 basic EBC + 61 440 feature EBC
= 73 440 EBC

Processor rated capacity in EBC (absolute loading of 70%, fully usable):

— if CP3 processor: 72 000

— if CP4 processor: 100 800

— if CPP processor: 315 000

Percent CP usage:

— if CP3 processor = 73 440 ÷ 72 000 = 102%

— if CP4 processor = 73 440 ÷ 100 800 = 73%

— if CPP processor = 73 440 ÷ 315 000 = 24%

3 Result

This Call Center can be served by a CP4 with some spare capacity (27%) or with a CPP with 76% spare capacity. The CP3 does not have enough processing power to handle this configuration (over 100% loaded).

A Networked Inbound Call Center

In this example, assume:

- Meridian 1 real-time factors are used and this is a typical configuration of that vintage. The same principals can be applied to later releases by updating the real time factors and the selection of machine types we have available. Unlike the previous examples, this illustrates checking the card slot limitation.
- 73 agents and 5 supervisors
- 64 PRI trunks and 22 analog trunks
- 21 TIE trunks to two other centers through NACD interflowed
- Center must support 2000 inbound calls per hour
- 25 percent of calls are interflowed to the two other centers
- 48 administrative sets with 6 CCS per set
- Meridian Mail (8 ports) used for non-ACD application
- A MAX is included in the Center
- Every call has a CDR record and 35 percent of calls served have to go through RAN (8 trunks) and Music (30 ports) while queuing
- Average holding time per call is 120 seconds

Solution

1 Loop requirement

TDS/CON loops = 2	assumed one module
$N_0 = [(48 \times 6 + 21 \times 26) \div 660]$ $= 2$	admin. sets and tie trunks are lumped together
$N_1 = [(73 + 5 + 22 + 8) \div 30]$ $= 4$	loops for agents, analog and RAN trunks
$N_{2p} = [(64 + 2) \div 24]$ $= 3$	loops for PRI trunks
$N_{31} = [30 \div 30]$ $= 1$	loops for Music
$N_{32} = [8 \div 24]$ $= 1$	loops for Meridian Mail ports

Total loops required = 2 + 2 + 4 + 3 + 1 + 1 = 13

The loop requirement can be met by a Meridian 1 Option 11 Cabinet.

2 Card slot requirement

With PRI trunks, we will consider only the case with the NT8D35 Network Module included.

TDS/CON = 1

$[N_1 \div 4]$ $= 4 \div 4$ $= 1$	a full superloop for high traffic ports
$[(N_{2P} + N32) \div 2]$ $= [(3 + 1) \div 2]$ $=2$	slots for PRI and Meridian Mail
Clock controller = 2	tentatively assumed using Meridian 1 Option 61C CP PII
Card for Music = 1	the CON of the second TDS/CON for Music
I/O ports slots = 2	2 MSDL for 2 DCHIs, Meridian Mail, Meridian MAX, and CDR

$S_c = 1 + 1 + 1 + 2 + 1 + 1 + 2 = 9$

This card slot requirement demands a Meridian 1 Option 61C CP PII or Succession 1000M Single Group system.

3 Real-time requirement

Supervisor telephone calls = $5 \times 9.2 = 46$

Administrative telephone calls = $(48 \times 6) \div (1.2 \times 0.5) = 120$

Basic Calls EBC = $(2000 + 46 + 120) \times 1 = 2166$

Digital set EBC = $(2000 + 46 + 120) \times 0.12 = 260$

Incoming ACD EBC = $(2000 + 46) \times 0.13 = 266$

NACD Overflowed Call EBC = $2000 \times 0.25 \times 2.89 = 1445$

RAN/MUS traffic in EBC = $2000 \times (1 - 0.25) \times 0.35 \times (0.63 + 0.25)$
$= 462$

MAX EBC = $2000 \times 0.81 = 1620$

CDR Record (inc.) EBC = $2000 \times 0.32 = 640$

Meridian Mail Call EBC = $120 \times 1.10 \times 0.1 = 14$
(assumed 10 percent of non-ACD calls being diverted to MM)

Incoming DTN trunk EBC = $2000 \times (22 \div (64 + 22)) \times 0.18 = 92$

Outgoing tie trunk EBC = $2000 \times 0.25 \times 0.16 = 80$

Incoming PRA calls EBC = $2000 \times (64 \div (64 + 22)) \times 0.16 = 238$

Total EBC used
$= 2166 + 260 + 266 + 1445 + 462 + 1620 + 640 + 14 + 92 + 80 + 238$
$= 7283$

Since the EBC is relatively small, the CP3 capacity of 72 000 per hour should be able to handle this configuration.

Percent CP usage = $7283 \div 72\,000 = 10\%$

4 Result

A Succession 1000M with single group and CP3 is sufficient to handle this application.

A Call Center with HEVP

This is an example using real time factors, and a typical configuration of that vintage. The same principals can be applied to later releases by updating the real time factors and the selection of machine types we have available.

In this example, assume:

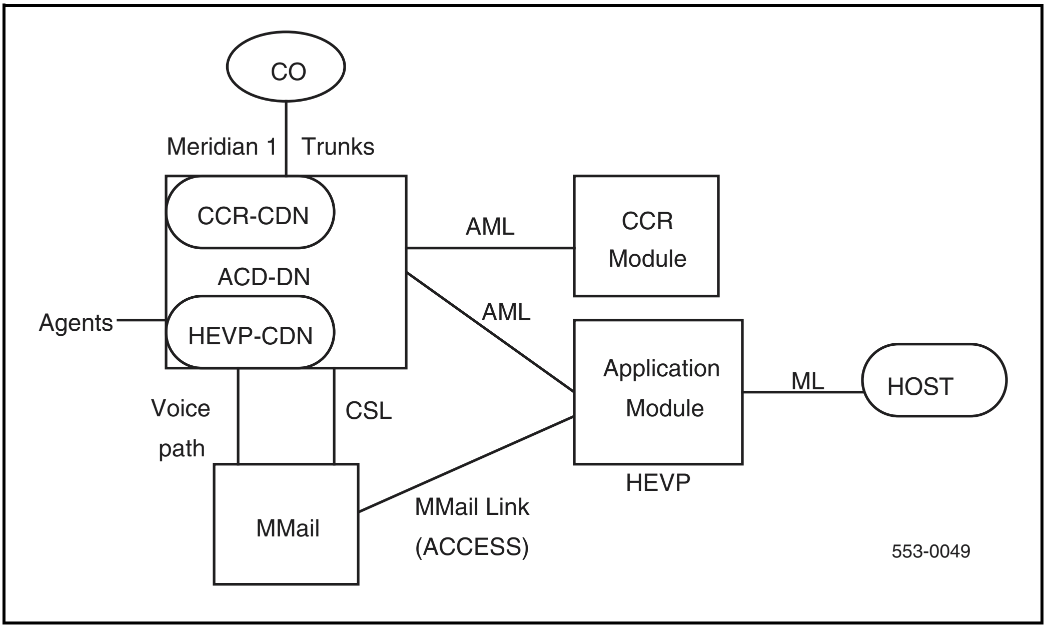
- Staff includes 480 agents and 50 supervisors
- 760 trunks available of which 510 are PRI
- 20% of all calls go to HEVP CDN first:
  - — 50% use voice menu for 90 seconds and disconnect
  - — 50% transfer to live agents after using voice ports for 20 seconds and be served
- 80% of all calls:
  - — 60% terminate on ACD TNs
  - — 40% terminate on CCR Cottons
- Average service time of a call by live agent is 180 seconds regardless of its source
- Average holding time per trunk is 180 seconds (because of queuing)

Questions to be answered:

- Is this configuration within the loop capacity of a Meridian 1?
- How many incoming calls are to be processed in this scenario?
- How many MM ports are needed to serve this HEVP?
- Which option of Meridian 1 is needed to handle this configuration and at what level of CP load?
- What data rates are required at various signaling links?

The block diagram of a typical HEVP application is given in Figure 61. Note that a common platform for CCR and HEVP applications is not available before software.

Figure 61
A simplified HEVP configuration



Solution

This scenario is simplified to concentrate on HEVP related issues only. Other applications demonstrated earlier can be superimposed on the HEVP feature to give a complete picture of a Call Center application.

1 Loop capacity

The information to determine loop requirement is not complete until we know how many voice ports on the MM are needed. Item 3 in this solution text indicates 44 ports are needed.

The required number of loops are:

TDS/CON loops = 8	re-calculated after initial estimate
$N_1 = [\{480 + 50 + (760 - 510)\} \div 30]$ $= 26$	either IPE or EPE will do
$N_{2p} = [(510 + 2) \div 24]$ $= 22$	card slots for PRI loops
$N_32 = [44 \div 16]$ $= 3$	Meridian Mail ports based on HEVP port calculation (item 3 below)
$N_L = 8 + 26 + 22 + 3$ $= 59$	

Physically, the system has to be a 2-group (4 Network Modules) Succession 1000M Multi Group or Meridian 1 Option 81C CP PII. There is no need to check card slot limitations for a large system.

2 Total system calls

The default CCS per trunk is 28, therefore, calls per trunk is 15.56 ($28 \div 1.8$)

Total incoming ACD calls/hour = $760 \times 15.56 = 11\ 826$

HEVP CDN calls = $11\ 826 \times 0.2 = 2365$

HEVP calls with transfer = $2365 \times 0.5 = 1183$

CCR CDN calls = $11\ 826 \times (1 - 0.2) \times (1 - 0.6) = 3784$

3 HEVP ports

Traffic calculation:

$$CCS = (2369 \times 0.5 \times 90 + 2369 \times 0.5 \times 20) \times 100$$
$$= 1066 + 237$$
$$= 1303$$

From Table 80 on page 266, forty-four voice ports are needed to handle 1303 CCS.

4 CP loading

Basic Call EBC = 11 826 × 1= 11 826

Digital set calls EBC = 11 826 × 0.03 = 355

ACD EBC = 11 826 × 0.13 = 1538

HEVP EBC = 2365 × 0.57 = 1348
(used MIVR factors for HEVP)

HEVP with transfer EBC = 1183 × 1.41 = 1668

CCR EBC = 3784 × 4.12 = 15 590
(used medium complex script)

Incoming trunk calls EBC = 11 826 × ((760 – 510) ÷ 760) × 0.18 = 700

PRA calls EBC = 11 826 × (510 ÷ 760) × (0.16) = 1270

Total system EBC
= 11 826 + 355 + 1538 + 1348 + 1668 + 15 590 + 700 + 1270
= 34 295

Percent CP usage with CP3 = 34 295 ÷ 72 000 = 48%

A Succession 1000M 81C CP3 has a rated capacity of 72 000 EBC. It has enough capacity to handle the given configuration with 52% spare capacity.

5 Signaling link requirements

According to Table 81 on page 270, 3784 CCR calls require a data link of 4800 baud. 2365 HEVP calls need a data link of 2400 baud. The

ACCESS link (Meridian Mail Link) is a fixed 9600 baud link. The CSL link is also a fixed 4800 baud link.

An IP Call Center with Symposium Application

Engineering a Call Center with IP ACD agent sets is illustrated in the following example. The example shows how to calculate DSP channel and Media Card requirements in a transitional environment; for example, PRI trunks carry traffic to a Call Center with IP ACD agent sets. For a mixed application involving analog sets and Virtual Trunks, refer to the section on general IP and VT engineering algorithm in "System capacities" on page 295.

In this example, assume:

- Symposium application comprised of 15 PRIs and 240 ACD agents using digital sets
- Expansion proposed to 20 PRIs and 384 ACD agents
- The additional 144 agents are equipped with i2004 IP phones
- Typical traffic load assumptions of 26 CCS per trunk and 33 CCS per agent, and non-blocking agent access

The calculations in the solution below determines the Succession 1000M capacity and configuration (network group, CPU type and number of DSPs (MCs)) to serve this requirement.

Solution

Digital trunks = 20 × 24 – 2 = 478
(assuming 2 D-channels for the trunk route)

Total trunk CCS = 478 × 26 = 12 428

IP fraction = (384 – 240) ÷ 384 = 0.375

1 CPU Real Time

Total incoming/outgoing calls = 12 428 × 100 ÷ 180 = 6905 calls/hour

System EBC
= 6905 × (0.375 × (1 + 5.74 + 1.60) + 0.625 × (1 + 5.74 + 1.40))
= 56 759

Factors:

— Symposium factor with complex script is 5.74

— PRI-IP factor 1.60

— PRI-Digital set factor 1.40

The System EBC of 56 759 is less than the CP3's rated capacity of 72 000 EBC. If using CP3, the real time usage is about 79%.

2 System Network Size

CCS/agent = 12 428 ÷ 384 = 32.4

This value, 32.4 CCS, can be rounded up to 33 CCS per agent. The trunk and agent traffic are very balanced.

Only agents with IP set will require DSP channel (1 DSP for each agent is required by non-blocking access).

Initial Media Cards required = 144 ÷ 32 = 4.5 or 5
(32-port Media Card is assumed)

Network loops required for 20 PRI = 20

Network loops required for 240 non-IP agents = 240 ÷ 30 = 8
(30 channels per loop)

Traffic loops required = 5 + 20 + 8 = 33

A network group has 28 traffic loops. This system requires 2 network groups (for example, a Succession 1000M Multi Group).

3 DSP and Media Cards requirements

There are 2 TDS/CON cards on each of network group. Each group has 60 conference channels. Since tones are provided by IP sets, TDS does not generate traffic to Media Cards.

DSP for TDS/CON = 60 × 0.375 = 23

Total DSP = 144 + 23 = 167

Final number of MCs required = 167 ÷ 32 = 6

For a mixed Call Center and office application, refer to IP-VT real time engineering section in “System capacities” on page 295 for the complete resource engineering procedure. The procedure will break up traffic into many different call types and from there to estimate DSP, MC and VT requirements.

ELAN engineering

The Embedded Local Area Network (ELAN) is designed to handle messaging traffic between the system and its applications, such as Symposium and CallPilot. It is not meant to handle the function of Customer LAN (CLAN) which carries customer application traffic.

From the previous section on Meridian Link, a 64 kbps link can handle messaging traffic of over 80 000 calls. The ELAN, being an Ethernet with data rate of 10 Mbps or 100 Mbps, will not be a bottleneck in a Symposium/ CallPilot configuration. However, certain engineering guidelines need to be followed to avoid any performance problems:

- Settings on the Network Interface Card (NIC), the physical interface of the system to Ethernet, have to be properly set in order to guarantee smooth operation. Certain CPUs in the system will function correctly only with proper settings on the interface. CP3, and CP4 will work with half-duplex and 10 Mbps setting. On the other hand, CP PII can handle half duplex or full duplex and 10 Mbps or 100 Mbps data rate.
- Although no traffic engineering is required on the ELAN, if the loading on link is extremely high (e.g., above 10% on the 10T-10 Mbps), collision on the Ethernet could happen. Use a sniffer to detect any performance problems. Decrease the loading on the link if it is overloaded.
- It is important to set a consistent data rate at NIC and application.
- Extreme fluctuation of traffic to the NIC may trigger the flow control mechanism, currently allowing 300 messages per second. Repeated violation of this threshold could cause the interface to turn traffic on and off every few seconds.

Certain remote maintenance applications may utilize the ELAN to access the system from a remote location. Care should be taken to ensure no other customer LAN traffic is introduced.

Configuration parameters

Design parameters are constraints on the system established by design decisions and enforced by software checks. A complete list is given in the Appendix, with default values, maximums and minimums, where applicable. Although defaults are provided in the factory installed database, the value of some of these parameters are to be set manually, through the OA&M interface, to reflect the actual needs of the customer’s application.

For guidelines on how to determine appropriate parameter values for call registers, I/O buffers, and so on, see “Mass storage size” on page 377.

System capacities

Contents

This section contains information on the following topics:

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Introduction

This section describes the system's primary capacity categories. For each category, the units in which the capacity is measured are identified. Primary physical and functional elements affecting the capacity are detailed, and actions which can be used to engineer the capacity are described. An algorithm is given by which capacity impacts can be computed.

The worksheets in "Worksheets" on page 405 implement the algorithms. In some cases applications such as call center require detailed engineering. These applications are discussed in "Application engineering" on page 265.

Physical configuration

With Fiber Network Fabric (FNF), a multi group system is expanded to eight groups inter-connected by fiber optic rings. IGS cards are replaced by FIJI cards for SONET interface. Due to the high capacity of OC-12 fiber fabric, non-blocking inter-group connection is achieved. Since network within a group can be engineered to non-blocking, with inter-group blocking removed, a truly non-blocking network can be engineered with the FNF network. For a more detailed description of system types and modules, see *Large System: Overview* (553-3021-010).

Physical capacity

Resource constraints consist primarily of loop and card slot limitations at the network shelf. From practical experience, running out of PE shelves is rare, particularly for Call Center applications.

Loop constraints

The maximum number of loops in a network group is 32, including service loops. For practical applications, the number of traffic loops is usually limited to 28, reserving two loops each for TDS and Conference.

1 Non-ACD (non-Automatic Call Distribution) sets and analog trunks

Non-ACD sets and trunks will be treated differently from ACD applications for estimating loop requirements. These circuits are equipped in the PE shelf, and do not use slots in the Network shelf, and, therefore, will not be included in the Network Module Card Slots Calculation.

If there is any doubt about potentially running out of PE slots for a given application (for example, Hotel/Motel environment), going over PE slots to check possible card slot limitations may be desired. Since this is a rare occurrence, a calculation procedure will not be developed for it.

For Call Center applications, due to high Centi Call Seconds (CCS) on circuits (agents or trunks), there is no need to be concerned about physical slot constraints on the PE shelf since real time will be the limiting resource.

The following procedure applies for general and Call Center applications. For IPE XNET loops:

Number of loops for non-ACD set and trunk traffic = N_{0x}=

$[(\text{No. of sets} \times 6 + \text{No. of non-ACD trunks} \times 26) \div 875]^{+}$
and $N_0 = N_{0e} + N_{0x}$

The above calculations account for blocking XNET loops.

$[\ ]^{+}$ means use the next higher integer, or "round up." For example, $[4]^{+} = 4$ and $[3.1]^{+} = 4$.

To simplify the notation in this document, the "+" at the upper right corner of the bracket will be omitted. Therefore, [x] will mean to round up x to the next higher integer.

The default value of 6 CCS per set and 26 CCS per trunk can be replaced by actual numbers for a particular site if they are given. Note that the default trunk traffic assumed for non-ACD application is lower than that of an ACD trunk (28 CCS). The 875 CCS per loop in IPE is derived from superloop capacity of 3500 CCS divided by 4 to obtain the average CCS per loop.

When Primary Rate Interface (PRI) trunks are involved in non-ACD applications, they should be treated just like ACD PRI trunks and included in the calculations for both loop and card slot requirements.

2 Agent sets and ACD analog trunks

When the system serves as a Call Center, it will most likely be equipped with more trunks than agent sets (lines). The reason for having a higher number of trunks is that there are calls in the queue which engage trunk circuits but not ACD agents until being served. In addition, in an NACD application, the overflowed calls continue to occupy trunks without the service of agents at the source node. However, this trunk-to-agent ratio may change if a service requires a long post-call processing time from an agent. In that case, CCS per agent should be reduced reflecting the actual agent service time which are associated with actual calls to the call processor (CP).

Traffic at agent sets is conservatively assumed to be 33 CCS and 18.3 (= 33 × 100 ÷ 180) calls per agent in the busy hour as a default in examples. For applications with long post-call processing time, the numbers 18 CCS and 10 calls per agent perhaps are appropriate default values.

Based on the standard system engineering rules, a loop can handle 660 CCS and a superloop can handle 3500 CCS. When an agent is loaded to 33 CCS, a loop can equip 20 agents (= 660 ÷ 33) and a superloop 106 (= 3500 ÷ 33); both numbers are less than their respective number of time slots (30 for loop, 120 for superloop). Thus, normal network engineering rules do not apply in a Call Center environment, because the "infinite traffic source" assumption in the Erlang model is violated.

The traffic model will be ignored here. Instead the rule of equipping 30 agents per loop and 120 agents per superloop for a non-blocking connection will be used. A superloop was created to take advantage of the traffic theory that a bigger server group is more efficient than a smaller one. This is no longer true in a non-blocking application, so any superloop can be replaced by four loops without capacity impact. To get the equivalent number of superloops divide the required number of loops by four.

For loop requirement calculations, an agent supervisor set is treated like an agent set. However, its call intensity is reduced for real time calculations.

The following is the calculation procedure for loop requirements. Let the number of agent sets be L_1, the number of supervisor sets be L_2, the number of ACD analog trunks be T_A, and the number of Recorded Announcement (RAN) trunks be T_R:

Number of non-blocking loops for agent sets, supervisor sets and ACD analog trunks = $N_1 = [(L_1 + L_2 + T_A + T_R) \div 30]$

3 DTI/PRI trunks

At an average of 28 CCS per trunk, a loop of 660 CCS can equip 23 (= 660 ÷ 28) trunks. It is more practical to equip 24 trunks per PRI/DTI loop as a rule rather than doing traffic calculations. Let T_D be the number of DTI trunks and T_P be the number of PRI trunks.

The equations for trunk loop calculation are as follows:

Number of loops for DTI trunks, $N_{2D} = [T_D \div 24]$

Number of loops for PRI trunks, $N_{2P} = [(T_P + 2) \div 24]$

Number of loops for digital trunks, $N_2 = N_{2D} + N_{2P}$

When a back-up D-channel is not needed, the term $(T_P + 2)$ in the equation for PRI trunks can be replaced by $(T_P + 1)$.

When the number of analog trunks is small (say, 15 or less), it may be included in the N_0 calculation to save loop and slot requirements.

Techniques for reducing the number of card slots required will be illustrated in engineering examples with Small Systems where physical slots are scarce.

For the international version of PRI, 24 ports should be replaced by 30 in the above calculations. The rest of the engineering procedure is the same.

4 Loops for CallPilot, Music (MUS), Music Broadcast, and Meridian Mail (MM) applications

Music is provided by broadcasting a music source to a conference loop. Therefore, a maximum of 30 users can listen to music at one time, which is sufficient for most applications. If not, an additional conference loop must be provided for each additional set of 30 simultaneous music users.

Music Broadcast requires any Music trunk and an external music source or a Meridian Integrated RAN (MIRAN) card (NTAG36). MIRAN has the capability to provide audio input for external music. A Conference loop is not required for Music Broadcast.

Meridian Mail ports are interfaced with a loop to provide voice channels for messaging. Each set of 24 ports in the Meridian Mail interfaced with one loop. The conference loop connects to one half of the TDS/CON card. The second conference loop, if needed, will take another card and card slot, because it cannot be separated from the TDS loop.

The network to interface Meridian Mail must be an ENET. The Meridian Mail Module takes up a whole shelf, normally underneath the CE/PE or CP module. Therefore, it does not impact the available card slots in the Network Module.

Calculation procedure:

N_{31} = [Music ports ÷ 30]

N_{32} = [MM ports for MM or MIVR or HEVP ÷ 24]

Number of loops for applications, $N_3 = N_{31} + N_{32}$

5 Succession Media Card (N4)

The 32-port Succession Media Card is a function of IP phones and gateway traffic from TDM to LAN/WAN. Refer to engineering procedure for calculation details.

6 Physical limits in loops

The following procedure can be used to calculate N_L, the total number of network loops required in the system:

$N_L = N_1 + N_2 + N_3 + N_4$

Music Broadcast requires any Music trunk and an external music source or a Meridian Integrated RAN (MIRAN) card (NTAG36). MIRAN has the capability to provide audio input for external music. A Conference loop is not required for Music Broadcast.

Card slot usage

The physical relations of cards discussed above are summarized in Table 84.

Table 84
Physical characteristics of Network cards and modules

Name of card/ module	No. of loops	Card slots	No. of ports/ cards	Comments
QPC414	2	1		Required for MM ports, QPC720 DTI/PRI loops
NTND46	16	8		
NT8D04 XNET	4	1		Take all 4 loops in two adjacent slots
NT8D17 TDS/CON	2	1		One (1) card per network module, not separable
SDI (QPC841)		1	4	For MMax (HSL), CDR
MSDL/MISP		1	4	Provides SDI, ESDI and DCHI functions
NT5D21 Core/ Network module	8	9		Single group system; CC & extra SDI slot in CE
NT8D35 Network module		8		Multi group system; extra space for single group system
NT4N40AA	16	9		CPCI Core/Network Card Cage ac/dc for single group and multi group systems
NT5D12	2	1	2	Needed for PRI/DTI T1s
NT5D97	2	1	2	Needed for PRI/DTI E1s

MSDL supports ESDI and DCHI. SDI functionality is added to the card's function.

Card slot requirements

Table 85
System modules

System	Modules
Meridian 1 Option 51C	1 – NT5D21 Core/Network module
Meridian 1 Option 61C	2 – NT5D21 Core/Network modules
Succession 1000M Single Group	2 – NT4N40/41 Core/Network modules
Meridian 1 Option 61C CP PII	2 – NT4N40/41 Core/Network modules
Meridian 1 Option 81	2 – NT6D60 Core modules
Meridian 1 Option 81C	2 – NT5D21 Core/Network modules
Meridian 1 Option 81C CP PII	2 – NT4N46 Core/Network modules OR 2 –NT4N41 Core/Network modules
Succession 1000M Multi Group	2 – NT4N46 Core/Network modules OR 2 –NT4N41 Core/Network modules
Note: The NT6D60 Core module does not contain network slots.	

- Meridian 1 Option 51C – the NT5D21 single Core/Network module contains eight card slots for Network and I/O cards. In addition to these card slots, there is a fixed card slot for a Clock Controller card and an SDI card. One NT8D17 Conference/TDS card is required. Without considering applications, the seven remaining card slots can support 14 traffic loops.

- Succession 1000M Single Group, Meridian 1 Option 61C – the two NT5D21 Core/Network modules each have eight card slots for Network and I/O cards. In addition to these card slots, there is a fixed card slot for a Clock Controller card and an SDI card. It is assumed that one NT8D17 Conference/TDS card is equipped for each Core/Network module. Without considering applications, the fourteen card slots can support 28 traffic loops.

  The Succession 1000M Single Group or Meridian 1 Option 61C has a maximum of 32 loops, if TDS/CON loops are also counted. Note that when a system requires between 16 and 26 loops, this is the preferred configuration. The decision can be made by card slot and real time requirements of the configuration.

- Succession 1000M Single Group or Meridian 1 Option 61C CP PII – the two NT4N41 Core/Network modules each have eight card slots for Network and I/O cards. In addition to these slots, there is a fixed slot for a Clock Controller card and an SDI card. It is assumed that one NT8D17 Conference/TDS card is equipped for each Core/Network module. Without considering applications, the 14 card slots can support 28 traffic loops.

- Succession 1000M Multi Group or Meridian 1 Option 81C – comprises a maximum of 16 NT8D35 Network Modules when the system is fully equipped with 8 groups and FNF. Each network module has 8 slots for network cards. Therefore, a maximum of 128 slots or 256 loops is allowed in the system. As a general practice, we assign 2 TDS/CON cards to each group, so the number of loops usable for general traffic becomes 28. The system capacity becomes 112 slots or 224 loops. This should be the upper limit for general applications.

  Other than potential space limitations in the switch room, the number of NT8D35 modules used for providing power and space is unlimited. Therefore, the capacity constraint is the number of loops, not card slots.

- Succession 1000M Multi Group or Meridian 1 Option 81C CP PII – the NT4N41 Core/Network modules and the NT4D46 Core/Network modules each have eight card slots for Network and I/O cards. It is assumed that one NT8D17 Conference/TDS card is equipped for each Core/Network module. Without considering applications, the 14 card slots can support 28 traffic loops. Additional groups are added for expansion. This configuration consists of a minimum of two groups that contains 28 card slots and can support 56 traffic loops.

The NT8D04 Superloop Network Card or NT1P61 Fiber Superloop Network Card provides four network loops grouped as one superloop. One superloop can serve up to two NT8D37 IPE Modules.

Note that since there are 8 card slots in an NT8D35 module, a maximum of 4 NT8D04 Superloop Network cards, or 16 loops, can be equipped per module without being adjacent to each other; the other 4 slots can be used for I/O cards.

With Fiber Optic Fabric, a system is expanded to eight groups. All engineering rules for 5-group system are applicable to 8-group system with the upper limit of loop number increased to 256 instead of 160.

Card slot calculation rules

From the above considerations, the following general rules are used to develop the card slot calculation worksheet:

- The NT5D12 occupies a single Network shelf slot. The DDP card supports all features (except the echo canceller and protocol conversion) of the QPC720. It provides an interface to the 1.5 Mbps external digital line, either directly or through an office repeater, Line Terminating Unit (LTU), or Channel Service Unit (CSU). The NT5D12 integrates the functionality of two QPC472 DTI/QPC720 PRI cards and one QPC414 Network card into a single card.
- A DCHI port is required for PRI. This port can be provided by a DCHI card (with one other port for SDI) or MSDL card (with three additional ports for other functions).
- A Clock Controller (CC) card is required for PRI or DTI. It has its own dedicated slot on either Core/Net module of Meridian 1 Option 61C, or CE module of Meridian 1 Option 81C.
- An XNET card takes one card slot, but its adjacent slot cannot be used by TDS/CON cards, due to address limitations. The slot next to an XNET card can equip only non-network cards (such as ESDI, MSDL).
- For the Meridian 1 Option 61C CP PII, a Clock Controller is required in slot 9.

Physical slots available to Succession 1000M platforms

A Large System based network group which has 32 loops:

1 each loop has 30 channels, and

2 four loops constitute a superloop of 120 channels.

Succession 1000M Half Group

This configuration uses the Large System platform. The half group has 16 loops (card slots). The Large System based cabinet must have the TDS/CON card to provide tones and conference capability. Each dual function card interfaces with 2 loops which must be equipped in pair. Excluding duplicated TDS/CON cards, the system has a maximum of 14 loops each with 30-channels for traffic.

Succession 1000M Single Group

The single group system has 32 loops. Typically, duplicated TDS/CON cards are recommended. That gives the system a maximum of 28 loops or 7 superloops. When H.323 Trunks (Peer H.323 Gateway Trunk) are configured on a logic superloop, no hardware is required. A superloop of 128 channels can be configured for up to 2048 Virtual Trunks.

Succession 1000M Multi Group

When a FNF is used to interconnect networks, the maximum size of the system is 8 groups with no intergroup junctor blocking. Some older systems with interconnections through Inter-Group Junctors causes some inter-group blocking.

The maximum size of a system using junctors is 5 groups. The maximum size of an 8-group network system is 256 loops. A 5-group network system is 160 loops.

The same recommendation of 2 TDS/CON cards per group in the single group system is also applicable to the multi-group system.

> ***Note:*** CP3 and CP4 are available for these platforms. However, a more powerful CP PII is recommended for Succession 1000M Single Group and Succession 1000M Multi Group.

I/O device requirements

Most advanced features on the system are controlled by auxiliary processors which communicate with the system CP on routing and other instructions. Since I/O cards compete with network cards for slot space in a network shelf, they are crucial in deciding whether a given small system is able to provide all necessary ports and features. Table 92 on page 332 summarizes information required to calculate the number of I/O cards needed as an input to the card slot calculation worksheet described in the following section.

Certain other applications such as data may require interface to I/O ports. Since they are not addressed in the context of a Call Center, they will not be covered here.

By knowing the applications for a given site, the required number of I/O ports can be calculated. Depending on the type of I/O cards provided, the number of card slots, which will be used as an input to the following worksheet, can be determined.

The system has a maximum of 64 I/O practising MSDL. This constraint may need to be considered for large systems with many application features. For smaller systems, the card slot constraint is a concern, but not the maximum number of I/O addresses.

For Succession 1000M Single Group and Meridian 1 Option 61C CP PII, ELAN (Embedded LAN) is a replacement for AML/ML interface with a data rate at 10/100 Mbps. Its interface to the system is through an Ethernet connection and the communication message is an emulation of AML message. The messages from ELAN continue to interface through CSQI and CSQO, the input/output buffer for AML.

Algorithm

The rules described in this section, which are summaries of earlier sections, will be implemented in the card slot worksheet for direct application by the user.

1 Determine TDS/CON card requirements: one card per Network Module or 14 loops (including virtual loops).

2 Determine MUSic loop card: one TDS/CON card per music loop.

3 Broadcast RAN does not require CON/Music loop. It broadcasts announcement to waiting calls directly.

4 Each Succession Media Card (SMC) interfaces with one loop. Each card provides transcoding between 32 TDM channels and 32 DSP channels.

5 Clock Controller slot: put in a zero in this space.

6 Calculate XNET card slots: sum up all XNET loops and divide by 4 to get the card slots required.

7 I/O card slot: the number of slots next to XNET cards that are usable only for I/O cards, regardless of whether needed or not.

8 The NT5D12 integrates the functionality of two QPC472 DTI/QPC720 PRI cards and one QPC414 Network card into a single card.

9 The sum of the total card slots above should not exceed 16 for Succession 1000M Single Group and Meridian 1 Option 61C CP PII. Under normal applications with expansion network modules, the Succession 1000M Multi Group and Meridian 1 Option 81C CP PII should have no physical constraints.

The algorithm described in this section will be implemented in the card slot calculation worksheet.

Network traffic

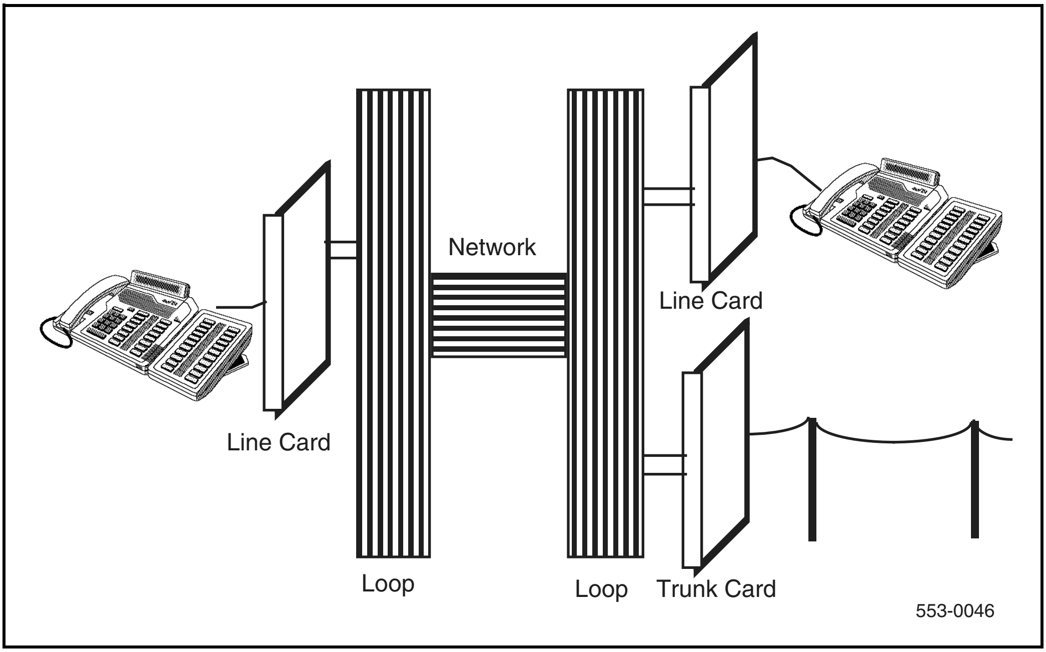
Traffic is a measure of the time a circuit is occupied. On the system, the circuit normally consists of a path from the set to its line card to a loop through the network to another loop, and on to another line or trunk card attached to the terminating set or trunk as illustrated in Figure 62.

Basic traffic terms used in this chapter are:

- ATTEMPT – any effort on the part of a traffic source to seize a circuit/channel/time-slot
- CALL – any actual engagement or seizure of a circuit or channel by two parties
- CALLING RATE – the number of calls per line per busy hour: Calls/Line
- BUSY HOUR – the continuous 60-minute period of day having the highest traffic usage; it usually begins on the hour or half-hour
- HOLDING TIME – the length of time during which a call engages a traffic path or channel
- TRAFFIC – the total occupied time of circuits or channels, generally expressed in CCS or Erlangs: CCS – a circuit occupied 100 seconds; Erlang – a circuit occupied one hour
- BLOCKING – attempts not accepted by the system due to unavailability of the resource
- OFFERED traffic = CARRIED traffic + BLOCKED traffic

- Traffic load in CCS = Number of calls × AHT ÷ 100
- Network CCS = Total CCS handled by the switching network
  OR
  CCS offered to the network by stations, trunks, attendants, Digitone receivers, conference circuits, and special features

Figure 62
Network traffic



In the context of Voice over IP (VoIP) application, the lines include IP phones, and the trunks include IP Peer H.323 Trunks (H.323 trunks). The ratio of IP calls to the total line calls, and the ratio of H.323 trunks calls to the total trunk calls are two new parameters required. The split of TDM traffic to IP/VT becomes important since resources such as DSP (Digital Signaling Processor) in Media Cards and H.323 trunks are affected by traffic distribution. The resources required for each type of connection are listed in Table 86.

Table 86
Connection type resources required

Connection Type	Resources
TDM to IP, IP to TDM	DSP
TDM to VT, VT to TDM	DSP and VT
IP to IP	no DSP
IP to VT or VT to IP	VT
TDM to TDM set or trunk calls	no DSP nor VT

Loops

The number of loops needed in the system can be calculated from lines, trunks and traffic requirements such as average holding time (AHT) and CCS. The algorithms for these computations are described in this section, and incorporated into the traffic worksheet in "Network loop traffic capacity" on page 422.

Superloop capacity

Each superloop can carry 3500 hundred call seconds (CCS), or 875 CCS per loop, of combined station, trunk, attendant console, and Digitone traffic during an average busy season busy hour (ABSBH). This capacity is subject to the following grades of service:

- The loss of no more than 1% of the incoming terminating calls, provided the called line is free
- The loss of no more than 1% of the originating outgoing calls in the system, provided an idle trunk is available
- The loss of no more than 1% of the intraoffice calls, provided the called line is free

- No more than 1.5% of originating calls with more than a 3-second wait for dial tone
- The loss of no more than 1% of tandem calls, provided an idle outgoing trunk is available

Intelligent peripheral equipment (IPE)

By combining four network loops, the superloop network card (NT8D04) makes 120 timeslots available to IPE peripheral cards. Compared to regular network loops, the increased bandwidth and larger pool of timeslots increase network traffic capacity for each 120-timeslot bundle by 25% (at a P.01 grade of service). The recommended traffic capacity for an IPE superloop is 3500 CCS, which meets all GOS requirements for network blocking. For non-blocking applications, a superloop can be equipped up to 120 lines or trunks, and each circuit can carry up to 36 CCS.

Lines and trunks

This chapter discusses the relationship between lines and trunks for the purpose of calculating loop requirements. The traffic parcels on a loop can be broken up as shown in Figure 63 on page 312. For additional information, refer to “Peripheral equipment” on page 59.

Line traffic includes traffic from IP phones and trunk traffic includes traffic from Virtual Trunks. Based on IP ratio and VT ratio, traffic source destination pairs requiring DSP and VT resources will be calculated.

- P – the ratio of IP Line calls to the total line calls
- V – the ratio of H.323 Trunk calls to the total trunk calls
- 794 CCS – the capacity of a 32-port Media Card at P.01 GOS

Figure 63
Traffic calls

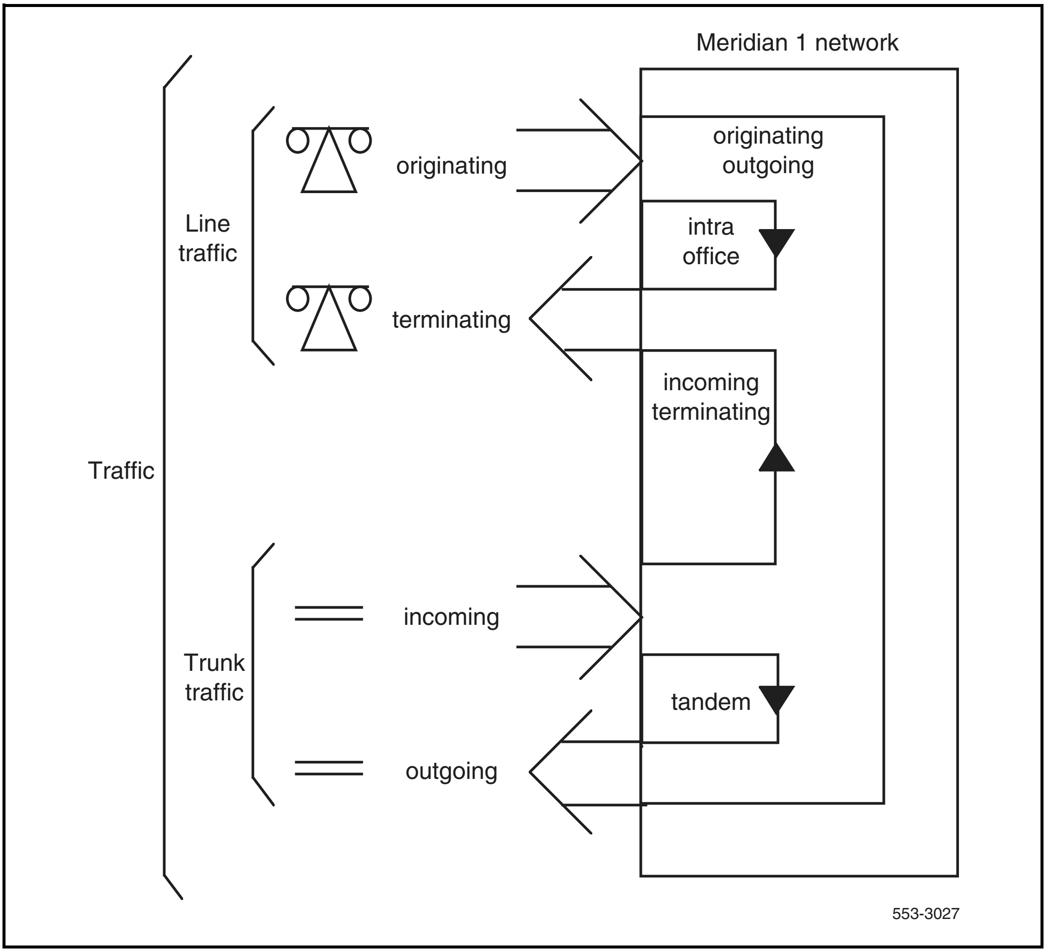


Table 87
Provisioning variables, equations and notations (Part 1 of 2)

Variables	Equations
Non-IP set CCS	Number of digital sets + Number of analog sets = CCS per set
IP set CCS	Number of IP set CCS per IP set
Total line CCS (Lccs)	Non-IP set CCS + IP set CCS
Non-IP trunk CCS	Number of analog trunks + Number of digital trunks = CCS per trunk
H.323 Trunk CCS	Number of Virtual Trunks or CCS per VT
Total system CCS (TCCS)	Total line CCS (Lccs) + Total trunk CCS (Ttccs)
Intraoffice ratio (R_1)	The portion of the total number of calls which are station to station calls
Tandem ratio (R_T)	The portion of the total number of calls which are trunk to trunk calls
Incoming ratio (I)	The portion of the total number of calls which are trunk to station calls
Outgoing ratio (O)	The portion of the total number of calls which are station to trunk calls
Average holding time (AHT **)	Average holding time for different call types (AHT_{SS}, AHT_{TT}, AHT_{ST}, AHT_{TS})
Weighted average holding time (WAHT)	$(R_1 \times AHT_{SS}) + (R_T \times AHT_{TT}) + (I \times AHT_{TS}) + (O \times AHT_{ST})$
Total calls (Calls)	$TCCS \times 100 \div (2 \times WAHT)$
Intraoffice calls (C_{SS})	$R_1 \times$ Calls

Table 87
Provisioning variables, equations and notations (Part 2 of 2)

Tandem calls (C_{TT})	$R_T \times$ Calls
Originating-outgoing calls (C_{ST})	O × Calls
Terminating-incoming calls (C_{TS})	I × Calls

Poisson P.01 table

To use the loop requirement calculation worksheet, the number of lines and trunks are given as inputs. In order to arrive at the number of trunks needed to meet the necessary GOS, the Poisson P.01 table is typically used. This table can also be used for other circuits requiring P.01 GOS, for example, RAN trunks. The Poisson P.01 table is included here for easy reference.

Table 88
Trunk traffic – Poisson 1 percent blocking (Part 1 of 2)

Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS
1	0.4	31	703	61	1595	91	2530	121	3488
2	5.4	32	732	62	1626	92	2563	122	3520
3	15.7	33	760	63	1657	93	2594	123	3552
4	29.6	34	789	64	1687	94	2625	124	3594
5	46.1	35	818	65	1718	95	2657	125	3616
6	64	36	847	66	1749	96	2689	126	3648
7	84	37	876	67	1780	97	2721	127	3681
8	105	38	905	68	1811	98	2752	128	3713
9	126	39	935	69	1842	99	2784	129	3746
10	149	40	964	70	1873	100	2816	130	3778
Note: For trunk traffic greater than 4427 CCS, allow 29.5 CCS per trunk.									

Table 88
Trunk traffic – Poisson 1 percent blocking (Part 2 of 2)

Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS
11	172	41	993	71	1904	101	2847	131	3810
12	195	42	1023	72	1935	102	2879	132	3843
13	220	43	1052	73	1966	103	2910	133	3875
14	244	44	1082	74	1997	104	2942	134	3907
15	269	45	1112	75	2028	105	2974	135	3939
16	294	46	1142	76	2059	106	3006	136	3972
17	320	47	1171	77	2091	107	3038	137	4004
18	346	48	1201	78	2122	108	3070	138	4037
19	373	49	1231	79	2153	109	3102	139	4070
20	399	50	1261	80	2184	110	3135	140	4102
21	426	51	1291	81	2215	111	3166	141	4134
22	453	52	1322	82	2247	112	3198	142	4167
23	480	53	1352	83	2278	113	3230	143	4199
24	507	54	1382	84	2310	114	3262	144	4231
25	535	55	1412	85	2341	115	3294	145	4264
26	562	56	1443	86	2373	116	3326	146	4297
27	590	57	1473	87	2404	117	3359	147	4329
28	618	58	1504	88	2436	118	3391	148	4362
29	647	59	1534	89	2467	119	3424	149	4395
30	675	60	1565	90	2499	120	3456	150	4427

Note: For trunk traffic greater than 4427 CCS, allow 29.5 CCS per trunk.

Groups

A network group is comprised of two network modules of 16 loops each for a total of 32. The maximum size of a system with (FNF), the network is expanded to allow 8 groups or 256 loops.

There are two types of loops: terminal loops to provide channels for general traffic, and service loops to provide tones and service functions. The number of groups in a system is determined by the number of terminal loops and service loops required, which was discussed under loop and card slot calculations.

To summarize the general rules, a group normally consists of 28 traffic loops and 2 TDS/CON dual loops for a total of 32. A multi-group system comprises multiple groups up to a maximum of eight groups.

Once a system is larger than 32 total loops, a second group is required. To communicate between the two network groups, intergroup junctors are used.

Fibre Network Fabric

With Fibre Network Fabric, the number of groups supported in a system is expanded to eight, and the intergroup junctor is replaced by two counter-rotate OC-12 Fiber Optical rings. The capacity of each Fiber Optic ring is large enough to carry all traffic from eight groups without blocking between groups.

The only remaining blocking in the network (loop blocking) can be eliminated if a shelf is equipped with no more than 120 ports in a single superloop configuration. So a truly non-blocking network can be achieved with a FNF configuration.

Service loops and circuits

Service circuits are required in call processing to provide specific functions to satisfy the requirements of a given application. They are system resources. Service circuits also consume system resources, such as physical space, real time, memory and so on. This section will describe the traffic characteristics of service circuits, their calculation algorithms and their impact on other system resources.

TDS

The Tone and Digit Switch (TDS) loop provides dial tone, busy tone, overflow tone, ringing tone, audible ringback tone, DP or dual tone multifrequency (DTMF) outpulsing and miscellaneous tones. All these tones are provided through the maximum 30 time slots in the TDS loop.

In other words, the maximum number of simultaneous users of tone circuits is 30, whether it be 30 of one tone or a combination of many different types of tones. One TDS loop is normally recommended for each Network Module or half network group of 14 traffic loops. Additional TDS loops may be added if needed, but this is rare.

Conference

The CONference loop is a part of the dual loop NT8D17 TDS/CON card. It provides circuits for 3-way or 6-way conferences. It can also broadcast music from a source to a maximum of 30 users simultaneously. In addition, a CON loop also provides temporary hold for a variety of features, chief among them, the End to End Signaling. One CON loop is normally recommended for each half network group or 14 traffic loops.

Music

Music is provided through conferencing a caller to a MUS source. Therefore, a CON loop is required for the Music on Hold feature. Each set of 30 simultaneous music users will require a CON loop, thus a TDS/CON card, since these two service loops are not separable. For a Small System, music users can share a conference loop with other applications. However, this is not a common practice in Call Center applications.

The MUS traffic can be calculated by the following formula:

$$\text{MUS CCS} = \text{Number of ACD calls using MUS} \times \text{MUS HT} \div 100$$

A segment of music typically runs from 40 seconds to 60 seconds. If the average for a specific application is not known, a default of 60 seconds can be used. After CCS is obtained, the MUS port requirement can be estimated from a Poisson P.01 table or a delay table (such as DTR table) matching the holding time of a MUS segment.

Music Broadcast requires any Music trunk and an external music source or a Meridian Integrated RAN (MIRAN) card (NTAG36). MIRAN has the capability to provide audio input for external music. A Conference loop is not required for Music Broadcast.

RAN

Recorded Announcement (RAN) trunks are located on 8-port trunk cards on PE shelves just like regular trunk circuits. They provide voice messages to waiting calls. RAN trunks are also needed to provide music to conference loops for music on hold.

Each RAN trunk is connected to one ACD call at a time, for the duration of the RAN message. Different RAN sources require different RAN trunk routes. If the first RAN is different from the second RAN, they need different RAN trunk routes. However, if the same message is to be used, the first RAN and second RAN can use the same route.

RAN traffic can be calculated by the following formula:

$$\text{RAN CCS} = \text{Number of ACD calls using RAN} \times \text{RAN HT} \div 100$$

A RAN message typically runs from 20 seconds to 40 seconds. If the average for a specific application is not known, a default of 30 seconds can be used. After RAN CCS is obtained, RAN trunk requirements can be estimated from a Poisson P.01 table or a delay table (such as DTR table) matching the holding time of a RAN message.

DTR

A Digitone receiver (DTR) serves features involving 2500 sets or Digitone trunks. DTRs are system wide resources, and should be distributed evenly over all network loops.

There are a number of features that require DTRs. General assumptions for DTR traffic calculations are:

- Digitone receiver traffic is inflated by 30% to cover unsuccessful dialing attempts.
- Call holding times used in intraoffice and outgoing call calculations is 135 seconds if actual values are unknown.

- Digitone receiver holding times are 6.2 and 14.1 seconds for intra and outgoing calls respectively.
- The number of incoming calls and outgoing calls are assumed to be equal if actual values are not specified.

The major DTR traffic sources and their calculation procedures are as follows:

1 Calculate intraoffice Digitone traffic
Intraoffice = 100 × Digitone station traffic (CCS) ÷ AHT × (R ÷ 2)
Recall that R is the intraoffice ratio.

2 Calculate outgoing DTR traffic
Outgoing = 100 × Digitone station traffic (CCS) ÷ AHT × (1 - R ÷ 2)

3 Calculate direct inward dial (DID) DTR traffic
DID calls = DID Digitone trunk traffic (CCS) × 100 ÷ AHT

4 Calculate total DTR traffic
Total = [(1.3 × 6.2 × intra) + (1.3 × 14.1 × outgoing calls) + (2.5 × DID calls)] ÷ 100

5 See Table 89 on page 320 to determine the number of DTRs required. Note that a weighted average for holding times should be used.

Table 89
Digitone receiver load capacity – 6 to 15 second holding time (Part 1 of 2)

Number of DTRs	Average holding time in seconds									
	6	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	0	0	0	0	0	0	0	0	0	0
2	3	2	2	2	2	2	2	2	2	2
3	11	10	10	9	9	9	9	8	8	8
4	24	23	22	21	20	19	19	19	18	18
5	41	39	37	36	35	34	33	33	32	32
6	61	57	55	53	52	50	49	49	48	47
7	83	78	75	73	71	69	68	67	66	65
8	106	101	97	94	91	89	88	86	85	84
9	131	125	120	116	113	111	109	107	106	104
10	157	150	144	140	136	133	131	129	127	126
11	185	176	170	165	161	157	154	152	150	148
12	212	203	196	190	185	182	178	176	173	171
13	241	231	223	216	211	207	203	200	198	196
14	270	259	250	243	237	233	229	225	223	220
15	300	288	278	271	264	259	255	251	248	245
16	339	317	307	298	292	286	282	278	274	271
17	361	346	335	327	320	313	310	306	302	298
18	391	377	365	356	348	342	336	331	327	324
19	422	409	396	386	378	371	364	359	355	351
20	454	438	425	414	405	398	393	388	383	379
21	487	469	455	444	435	427	420	415	410	406

Table 89
Digitone receiver load capacity – 6 to 15 second holding time (Part 2 of 2)

Number of DTRs	Average holding time in seconds									
	6	7	8	9	10	11	12	13	14	15
22	517	501	487	475	466	456	449	443	438	434
23	550	531	516	504	494	487	479	472	467	462
24	583	563	547	535	524	515	509	502	497	491
25	615	595	579	566	555	545	537	532	526	521
26	647	628	612	598	586	576	567	560	554	548
27	680	659	642	628	618	607	597	589	583	577
28	714	691	674	659	647	638	628	620	613	607
29	746	724	706	690	678	667	659	651	644	637
30	779	758	738	723	709	698	690	682	674	668
31	813	792	771	755	742	729	719	710	703	696
32	847	822	805	788	774	761	750	741	733	726
33	882	855	835	818	804	793	781	772	763	756
34	913	889	868	850	836	825	812	803	795	787
35	947	923	900	883	867	855	844	835	826	818
36	981	957	934	916	900	886	876	866	857	850
37	1016	989	967	949	933	919	909	898	889	881
38	1051	1022	1001	982	966	951	938	928	918	912
39	1083	1055	1035	1015	999	984	970	959	949	941
40	1117	1089	1066	1046	1029	1017	1002	990	981	972

Note: Load capacity is measured in CCS.

Table 90
IPL capacity when the TPS runs on a Succession Media Card

Parameter	Capacity
Internet Telephone on each Voice Gateway Media Card:	
— ITG-Pentium 24-Port Line Card	Maximum of 96 telephones supported on each ITG-Pentium 24-Port Line Card.
— Succession Media Card 32-Port and 8-port line card	Maximum of 128 telephones supported on each Succession Media Card 32-port line card and maximum of 32 Internet Telephones on each Succession Media Card8-port line card.
Gateway ports on each Voice Gateway Media Card:	
— ITG-Pentium 24-port line card	Maximum of 24 IP-to-circuit-switched gateway ports on each card.
— Succession Media Card 32-port and 8-port line card	Maximum of 32 IP-to-circuit-switched gateway ports on each Succession Media Card 32-port line card. Maximum of 8 IP-to-circuit-switched gateway ports on each Succession Media Card 8-port line card.

Capacity engineering considerations when the TPS runs on a Succession Media Card

The number of Internet Telephones is determined by the engineering of real time usage, traffic capacity, network loop usage, and IPE slot usage.

Traffic capacity of Succession Media Cards when the TPS runs on a Succession Media Card

Each ITG-P card has 24 ports that are used for establishing a voice connection between Internet Telephones and non-Internet Telephones (such as digital telephones or public network). To configure a system as non-blocking (as is typically the case for ACD configurations), ensure only 24 Internet Telephones are registered on each card.

Each Succession Media card has 32 ports that are used for establishing a voice connection between Internet Telephones and non-Internet Telephones. To configure a system as non-blocking (typically the case for ACD configurations), ensure that only 32 Internet Telephones are registered on each card.

Each Succession Media 8-port line card has 8 ports that are used for establishing a voice connection between Internet Telephones and non-Internet Telephones. To configure a system as non-blocking (typically the case for ACD configurations), ensure that only 8 Internet Telephones are registered on each card.

A registered telephone is not synonymous with a configured telephone. When a telephone is registered, it is as if the telephone is plugged in. When the telephone de-registers, it is as though the telephone is unplugged. Registration consists of two steps:

1 Verifying the user's TN is valid and has not yet been registered.

2 Associating the TN on the system.

If an Internet Telephone is unplugged, it is automatically un-registered after a pre-determined time-out. This limitation on simultaneous calls depends on the number and type of calls (not on the number of ports).

Succession Media Cards in a system are pooled by customer number, are assigned dynamically, and are allocated preferentially by matching bandwidth management zones.

> ***Note:*** The average number of Busy Hour Call Attempts must not exceed an average of 1200 BHCA each hour.

Refer to the following three examples for further clarification.

Example 1

One hundred fifty (150) Internet Telephones with “typical” business usage of 600 call seconds per hour (CCS) for each telephone on average (for example, 5 calls of 120 seconds duration per hour):

- 150 × 6 CCS = 900 CCS
- 2 ITG-Pentium Line Cards or 2 Succession Media Cards are required
  - 2 ITG-P Line Cards support up to 1232 CCS
  - 2 Succession Media Card support up to 1738 CCS

Example 2

Five hundred (500) telephones with “heavy” business usage of 12 CCS for each telephone on average (for example, 6-7 calls of 180 seconds duration every hour):

- 500 × 12 CCS = 6000 CCS
- 8 ITG-Pentium 24-Port Line Cards or 6 Succession Media Cards are required
  - 8 ITG-Pentium 24-Port Line Cards support up to 6013 CCS
  - 6 Succession Media Card 32-Port line cards support up to 6013 CCS

Example 3

Forty-eight (48) Call Center Agents with an allocation of 36 CCS for each telephone:

- 2 ITG-P Line Cards or 2 Succession Media Cards are required
  - 48 ports required ÷ 24 ports for each ITG-P Line Card = 2 ITG-P Line Cards
  - 48 ports required ÷ 32 ports for each Succession Media Card = 2 Succession Media Cards (1.5 must be rounded up to 2)

Note: For Call Center Agents, it is recommended that one port be provisioned for each agent.

Gateway channels traffic engineering

Configure no more than five Succession Media Cards on each superloop to eliminate the possibility of blocking because of insufficient talkslots (for example, 5 Voice Gateway Media Cards × 24 ports = 120 talkslots). Use Table 91 below to determine the number of Succession Media Cards required to maintain the recommended capacity.

Table 91
Voice Gateway Media Card recommendations based on CCS capacity (Part 1 of 2)

The Internet Telephone blocking probability is 0.005.		
Number of cards	**ITG-P Line Card CCS capacity**	**Succession Media Card CCS capacity**
1	511	744
2	1232	1738
3	1996	2780
4	2780	3845
5	3577	4924
6	4383	6013
7	5196	7110
8	6013	8212
9	6835	9318
10	7660	10 429
11	8488	11 542
12	9318	12 658
13	10 144	13 777
14	10 983	14 897
15	11 818	16 020

Table 91
Voice Gateway Media Card recommendations based on CCS capacity (Part 2 of 2)

The Internet Telephone blocking probability is 0.005.		
Number of cards	**ITG-P Line Card CCS capacity**	**Succession Media Card CCS capacity**
16	12 657	17 144
17	13 496	18 269
18	14 335	19 396
19	15 177	20 524
20	16 020	21 653

Note 1: CCS is the number of hundred call seconds per hour.

Note 2: If the number of ITG-P Line Cards exceeds 20, add 801 CCS to the total capacity for each additional card.

Note 3: If the number of Succession Media Cards exceeds 20, add 1082 CCS to the total capacity for each additional card.

Traffic capacity engineering algorithms

Traffic capacities of subsystems in the system are estimated based on statistical models which approximate the way a call is handled in that subsystem. The traffic models used in various subsystem engineering procedures are described in the following sections.

When inputs to the algorithm are lines, trunks, average holding time (AHT), and traffic load (CCS), these algorithms can be used to determine the number of loops and system size.

Alternatively, when the loop traffic capacity is known for a given configuration, the algorithms can be used to determine the traffic level allowed at the line and trunk level while meeting GOS requirements.

Traffic models

The basic assumptions, service criteria, and applicability of the following common models will be presented. The underlying assumptions of each model are listed.

1 Erlang B Model

— Infinite sources (traffic sources to circuits ratio > 5:1)

— Blocked calls cleared (no queueing)

— Applicability: loop, ringing circuit blocking

2 Erlang C Model

— Infinite sources

— Blocked calls delayed

— Infinite queue

— Applicability: Dial tone delay, I/O buffers, DIGITONE, RAN trunks

3 Engset Model

— Finite sources (traffic sources to circuits ratio < 5:1)

— Blocked calls cleared

— Applicability: loops with high traffic and low number of sources, blocking loops for ACD and data applications.

4 Poisson Model

— Infinite sources

— Blocked calls held for a fixed length

— Applicability: incoming/outgoing trunks, DIGITONE, Call Registers, RAN trunks

5 Binomial Model

— Finite sources

— Blocked calls held

— Applicability: small circuit groups, intergroup junctor blocking

Grade of service

In a broad sense, the grade of service (GOS) encompasses everything a telephone user perceives as the quality of services rendered. This includes:

1. Frequency of connection on first attempt
2. Speed of connection
3. Accuracy of connection
4. Average speed of answer by an operator
5. Quality of transmission

In the context of the system capacity engineering, the primary GOS measures are blocking probability and average delay.

Based on the EIA Subcommittee TR-41.1 Traffic Considerations for PBX Systems, the following GOS requirements must be met.

1. Dial tone delay is not greater than 3 seconds for more than 1.5 percent of call originations.
2. The probability of network blocking is 0.02 or less on line-to-line connections, 0.01 or less on line-to-trunk or trunk-to-line connections.
3. Blocking for ringing circuits is 0.001 or less.
4. Post dialing delay is less than 1.5 seconds on all calls.

Any connection in the system involves two loops, one originating and one terminating. In an intergroup connection of a multi-group system, it also involves an intergroup junctor which can also incur blocking. Each stage of connection is engineered to meet 0.0033 GOS. Therefore, overall network blocking in the system is less than 0.01, regardless of whether the call is a line or trunk call, or an intra- or intergroup call.

> ***Note:*** There is no inter-group blocking for the 8-group network with fiber junctors.

Signaling and data links

Two categories of signaling and data links discussed in this section:

1 "Physical links" on page 329

2 "Functional links" on page 330

Physical links

A brief description is given for each of the following physical links.

Serial Data Interface (SDI)

The SDI is an asynchronous port, providing input access to the system from an OA&M terminal, and printing out maintenance messages, traffic reports, and Call Detail Recording (CDR) records to a TTY or tape module. An SDI card has four ports. An MSDL card has four ports for a combination of interfaces.

Multi-purpose Serial Data Link and Multi-purpose ISDN Signaling Processor (MSDL/MISP)

An MSDL card has four ports providing a combination of SDI, ESDI, and DCHI functions. Using MSDL cards, the number of I/O ports in the system can reach 64. If older I/O cards are used, the maximum number per system is 16. The data rate of each port of an MSDL card is dependent on the function it provides. The maximum rate is 64 000 bps for D-channel applications, but lower for other applications.

Embedded Local Area Network (ELAN)

The system can communicate with a Host by Ethernet connection through a Network Interface Card (NIC). AML messages are embedded in the communication protocols, they continue to interface with the system through CSQI and CSQO queues.

The data rate at NIC port can be set at various rate, however, it is a function of CPU type in the system. For CP3 and CP4, only 10T (10 Mbps) half duplex are allowed. For CP PII, the rate can be 10T/100T (100 Mbps), half duplex or full duplex.

Functional links

For each of the following functions, the type of link and resulting capacity are given.

High Speed Link (HSL)

The HSL is a an asynchronous link, used for the system CP to communicate with the MAX module via an SDI port. Prior to MAX 8, the HSL bandwidth was 9600. With MAX 8 and later, 19 200 baud is available.

Application Module Link (AML)

AML is a synchronous link between the system and an Application Module (AM) through the ESDI port. The data rate of the link can be one of the following rates: 300, 1.2kB, 2.4kB, 4.8kB, 9.6kB, or 19.2 kbps. The standard setup between the system and an AM is the 19.2 kbps link.

Meridian Link (ML)

The Meridian Link is the signaling link between the AM and a host where the database for an application resides. The AM serves as an intermediary between the system and the host which instructs the system to take actions for a specific application.

Other than maintenance messages for the AM itself, there is a one-to-one correspondence between the message a host sends to the AM and the message the AM interprets and sends to the system, and vice versa. Communications between the AM and a host is conducted via standard X.25 protocols. Therefore, the ML interface is not limited to any particular computer vendor's products.

For practical applications, the same data rate at the AML and ML is recommended.

Command Status Link (CSL)

The CSL is the version of AML specifically used for the communications between the system and the Meridian Mail system (MM). It has some MM specific messages. The interface is through an ESDI port. For Meridian Mail 1 through Meridian Mail 9, the CSL link rate was 4800 baud. Beginning with Meridian Mail 10, the link rate is 9600 baud.

OA&M

The system uses an SDI port to connect to a teletype (TTY) to receive maintenance commands or to print traffic reports, maintenance messages or CDR records. CDR records can also be output directly to a magnetic tape system.

ISDN Signaling Link (ISL)

An ISL provides common channel signaling for an ISDN application without PRI trunks. An analog trunk with modems at the originating switch and the terminating switch can be used as an ISL to transmit ISDN messages between these two remote systems. The interface for an ISL is an ESDI port. The maximum data rate for the link is 19.2 kbps.

D-channel

A PRI interface consists of 23 B-channels and one D-channel. The D-channel at 64 kbps rate is used for signaling. A D-channel interfaces with the system through a DCHI card or a DCHI port on an MSDL. A D-channel on a BRI set is a 16 kbps link which is multiplexed to make a 64 kbps channel.

Property Management System Interface (PMSI)

The PMSI allows the system to interface directly to a customer-provided PMS through an SDI port. It is primarily used in Hotel/Motel environments to allow updates of the room status database either from the check-in counter or a guest room. The enhanced PMSI allows re-transmission of output messages from the system to a PMS. The maximum baud rate for this asynchronous port is 9600.

Table 92 summarizes the above functional links and interfaces and provides information required to calculate the number of I/O cards needed as an input to the card slot calculation worksheet described later.

Table 92
I/O interface for applications

Application	Type of link/ interface	Type of port	Sync or async
AML (associated set)	AML	ESDI	Sync
CCR	AML	ESDI	Sync
Symposium	ELAN	Ethernet	Sync
Call Pilot	ELAN	Ethernet	Sync
CDR	RS232 C	SDI	Async
Host Enhanced Routing	AML	ESDI	Sync
Host Enhanced Voice Processing	CSL & AML	ESDI	Sync
ISL	Modem	ESDI	Sync
Interactive Voice Response	CSL	ESDI	Sync
Meridian Mail	CSL	ESDI	Sync
Meridian MAX	HSL	SDI	Async
Meridian 911	AML	ESDI	sync
Property Management System Interface (PMSI)	PMSI Link	SDI	Async
NACD (PRI)	64 kB D-channel	DCHI	Sync
TTY (OA&M)	RS232 C	SDI	Async
Note: An ESDI card has two ports; an SDI card has two ports; a DCHI card has one DCHI port and one SDI port; an MSDL card has four combination ports			

Determining the load on the System CP

The call capacity report in TFS004 can be used to determine Rated Call Capacity and current utilization levels. Otherwise, the idle cycle count method can be used to calculate processor load. If a new switch is being configured, equivalent basic calls must be calculated, to estimate the processor loading of a proposed configuration.

Idle cycle count method

A procedure called the “idle cycle count method” is used to determine the call capacity and average load on an existing system CP. Two parameters are used in this procedure: idle cycle count, and CP attempts (also called “call attempts”). These are the first and second fields, respectively, of the TFS004 traffic report (after the header). Refer to *Traffic Measurement: Formats and Output* (553-3001-450) for a description of this report.

Pairs of these fields, taken over a 24-hour period or longer, are plotted on a graph with idle cycle counts on the y-axis, and CP attempts on the x-axis. The locus of points should be a well-defined straight line. If a few of the points fall below the line, they probably represent hours in which background activities, such as midnight routines, or maintenance were being done. These points should be ignored. If the remaining points do not define a clear straight line, error conditions and extraneous activities on the switch should be cleaned up, and a new set of measurements taken before proceeding. For more detail on interpreting TFS004 output, refer to *Traffic Measurement: Formats and Output* (553-3001-450).

Rated Call Capacity determination

Rated Call Capacity is the number of featured calls which a switch can handle without exceeding its advertised grade of service. The Rated Call Capacity of each installation is different, depending on software release, configuration, feature mix, and usage patterns. Rated Call Capacity can be determined from the graph constructed using the idle cycle count method.

For simplicity, the following description assumes that the graph was constructed from data taken from hourly traffic reports. If half-hourly reports were used, the procedure is still valid, but “hour” should be replaced by “half-hour” wherever it appears. Note that this means the rated capacity will be in terms of calls per half-hour. It should then be doubled, to make it comparable. Also, the number of milliseconds in a half-hour is 1 800 000 rather than 3 600 000.

The x-intercept is the point on the x-axis where it intersects the plotted line. The Rated Capacity of the switch is equal to 70 percent of this value. For example, if the line crosses the x-axis at 20 000 CP attempts, then the rated capacity of the switch is:

$0.7 \times 20\,000 = 14\,000$ calls-per-hour

Average load determination

The average load on the processor during a given hour is determined by dividing CP attempts (from the TFS004 report) by the Rated Call Capacity, and multiplying by 100 to produce a percentage. If the load during a certain hour on the switch in the above example was 10 500 CP attempts, then the switch was 10 500 ÷ 14 000 = 75% loaded during that hour.

Equivalent basic calls

Real time capacity of a switch can also be specified in terms of Equivalent Basic Calls (EBC). An EBC is a measure of the real time required to process a Basic Call. A basic call is defined as a simple, unfeatured call between two 2500 sets on the same switch using a 4-digit dialing plan. Both sets are on IPE loops. The terminating set is allowed to ring three times, then is answered, waits approximately 2 seconds, and hangs up. The originating set then hangs up as well.

When the capacity of a switch is stated in EBC, it is independent of such variables as configuration, feature mix, and usage patterns. It still varies from release to release, and between processors. However, since it is independent of other factors, it is a good way to compare the relative call processing capability of different machines running the same software release. Table 93 gives the real time capacity of the various system options.

Table 93
Real-time capacity (EBC) by system (with Succession 3.0 Software)

System	Capacity
Meridian 1 Options 51C/61C/81C w/NT5D10 CP card “CP3”	72 000
Meridian 1 Options 51C/61C/81C w/NT5D03 CP card “CP4”	100 800
Meridian 1 Option 61C CP PII, Succession 1000M Single Group	315 000
Meridian 1 Option 81C CP PII, Succession 1000M Multi Group	315 000

Feature impact

Every feature which is applied to a call increases the CP real time consumed by that call. These impacts can be measured and added incrementally to the cost of a basic call to determine the cost of a featured call. This is the basis of the algorithm used by Meridian Configurator to determine the Rated Capacity of a proposed switch configuration. Meridian Configurator is supported in US, UK, Canada and CALA only.

The incremental impact of a feature, expressed in EBC, is called the real time factor for that feature. Real time factors are computed by measuring the incremental real time for the feature in milliseconds, and dividing by the call service time of a basic call.

Each call is modeled as a basic call plus feature increments. For example, an incoming call from a DID trunk terminating on a digital set with incoming CDR is modeled as a basic call plus a real time increment for incoming DID plus an increment for digital sets plus an increment for incoming CDR.

A second factor is required to determine the overall impact of a feature on a switch. This is the “penetration factor.” The penetration factor is simply the proportion of calls in the system which invoke the feature.

The real time impact, in EBC, of a feature on the system can now be computed as follows:

(call attempts) × (penetration factor) × (real time factor)

The sum of the impacts of all features, plus the number of Call Attempts is the Real Time Load on the system, in EBC. This number can be compared with the real time capacity in Table 93 on page 335 to determine whether the proposed system will handle the load. If the projected real time load is larger than the system capacity, a processor upgrade is needed.

I/O impact

There are two types of I/O interface allowed at the system: the synchronous data link and asynchronous data link. ESDI and DCHI cards provide interface to synchronous links, and an SDI card provides interface to asynchronous links. The MISP/MSDL card can provide both.

At the I/O interface, the system CP processes an interrupt from SDI port on a per character basis while processing an ESDI/DCHI interrupt on a per message (multiple characters) basis. As a result, the average real time overhead is significantly higher in processing messages from a SDI port than from an ESDI port. MSDL, however, provides a ring buffer.

Auxiliary processors

Interactions with auxiliary processors also have real time impacts on the system CP depending on the number and length of messages exchanged. Several applications are described in "Application engineering" on page 265.

Real time algorithm

As described above, calculating the real time usage of a configuration requires information on the number of busy hour call attempts and the penetration factors of each feature.

Busy hour calls

If the switch is already running, the number of busy hour calls or call load can be determined from the traffic printout TFS004. The second field of this report (except for the header) contains a peg count of CP Attempts. A period of several days (a full week, if possible) should be examined to determine the maximum number of CP attempts experienced. This number varies with season, as well. The relevant number is the average of the highest 10 values from the busiest 4-week period of the year. An estimate will do, based on current observations, if this data is not available.

If the switch is not accessible, and call load is not known or estimated from external knowledge, it may be computed. For this purpose, assumptions about the usage characteristics of sets and trunks must be made. In particular, the average holding time and CCS per hour of each type of line and trunk must be estimated. In addition, estimates for the fraction of total calls that are intraoffice (R_I), that are tandem (R_T), that are incoming (I), and that are not successfully terminated (Ineff) ("ineffective") are required. It is also useful to have average holding time statistics for intraoffice, outgoing/originating, incoming/terminating, tandem trunk, and data calls, denoted AHT_{SS}, AHT_{SST}, AHT_{TS}, AHT_{TT}, and AHT_{DATA}, respectively. Default values are given in Table 94.

Table 94
Default traffic parameter values

Parameter	Default value
R_I	0.25
R_T	0.05
I	0.40
O	0.30
AHT_{SS}	60 sec
AHT_{ST}	150 sec
AHT_{TS}	150 sec
ATH_{TT}	180 sec
AHT_{DATA}	360 sec

Telephones

As the primary traffic source to the system, telephones have a unique real time impact on the system. For the major types listed below, the number of telephones of each type must be given, and the CCS and AHT must be estimated. In some cases it may be necessary to separate a single type into low usage and high usage categories. For example, a typical office environment with analog telephones may have a small call center with agents on analog telephones. A typical low usage default value is 6 CCS. A typical high usage default value is 28 CCS.

The principal types of telephones include:

- Analog: 500, 2500, message waiting 500, message waiting 2500 telephones, and CLASS sets
- Digital: M2000 series Meridian Modular Telephones, voice and/or data ports
- ISDN BRI: voice and data ports
- Mobility sets
- Consoles
- i2002-i2004 Internet Telephones
- i2050 Software Phones

Trunks

Trunks can be either traffic sources which generate calls to the system or a resource which satisfies traffic demands depending on the type of trunk and application involved. Default trunk CCS in an office environment is 18 CCS. Call center applications may require the default to be as high as 28 to 33 CCS.

Voice

Analog:

- CO
- DID
- WATS

- FX
- CCSA
- TIE E&M
- TIE Loop Start

Digital:

- DTI: number given in terms of links, each of which provides 24 trunks under the North American standard
- PRI: number given in terms of links, each of which provides 23B+D under the North American standard
- European varieties of PRI: VNS, DASS, DPNSS, QSIG, ETSI PRI DID

H.323 Trunk

An IP Peer H.323 trunk identified with a trunk route which is not associated with a physical hardware card.

Succession Signaling Server

The Succession Signaling Server is comprised of four basic elements:

1. Terminal Proxy Server (TPS)
2. GateKeeper
3. Gateway
4. Element Manager

The TPS, GateKeeper, and Gateway can co-exist on one Succession Signaling Server or reside individually on separate Succession Signaling

Servers, depending on traffic and redundancy requirement. Table 95 describes the function and engineering requirements of each element.

Table 95
Elements in Succession Signaling Server (Part 1 of 2)

Element	Function and engineering requirements
Terminal Proxy Server (TPS)	— Handles initial signaling exchanges between an Internet Telephone and the Succession Signaling Server. — Capacity is limited by a software parameter limit of 5000 Internet Telephones. — Hardware processor capacity limit is unknown, but expected to be higher than the software limit. — The redundancy of TPS is under the mode of N+1. Therefore one extra Succession Signaling Server can be provided to cover TPS functions from N other servers.
GateKeeper	— Capacity is limited by the endpoints it serves and the number of entries at each endpoint. — Potential hardware limits are the Succession Signaling Server processing power and memory limits. — Since the Gatekeeper is a network resource, its capacity is a function of the network configuration and network traffic (IP calls). Some basic network information is required to engineer a Gatekeeper. — The redundancy of the Gatekeeper is in a mode of 2 × N. Therefore an alternate Gatekeeper can only serve the Gatekeeper it is duplicating.

Table 95
Elements in Succession Signaling Server (Part 2 of 2)

Element	Function and engineering requirements
Gateway	— The IP Peer H.323 Gateway trunk, or H.323 Trunk, provides the function of a trunk route without a physical presence in the hardware. The H.323 Trunk is limited by a software limitation of 382 virtual trunks per route. Beyond that, a second Succession Signaling Server is required. — Deciding to combine the Terminal Proxy Server, Gatekeeper, and H.323 Trunk is determined by traffic associated with each element, and the required redundancy of each function. The redundancy mode of the Gateway is 2 × N. Two Gateways handling the same route can provide redundancy for each other, but not other routes. — For detailed Succession Signaling Server engineering rules and guidelines see "Succession Signaling Server Algorithm" on page 357.
Element Manager	— Has a negligible impact on capacity and can reside with any other element. This section therefore concentrates on the first three software elements of the Succession Signaling Server.

Data

- Sync/Async CP
- Async Modem Pool
- Sync/Async Modem Pool
- Sync/Async Data
- Async Data Lines

RAN

The default value for AHT_{RAN} is 30 seconds.

Music

The default value for AHT_{MUSIC} is 60 seconds.

Resource calculations

Table 96 lists the resource calculations.

Table 96
Resource calculations

Name	Calculation
Non-IP set CCS	Number of digital sets + Number of analog sets = CCS per set
IP set CCS	Number IP sets CCS per IP set
Total line CCS (L_{CCS})	Non-IP set CCS + IP set CCS
Non-IP trunk CCS	Number of analog trunks + Number of digital trunks = CCS per trunk
H.323 Trunk CCS	(Number of Virtual Trunks) CCS per VT
Total system CCS (TCCS)	Total line CCS (L_{CCS}) + Total trunk CCS (T_{TCCS})

Converting CCS to calls:

$$WAHT = R_I \times AHT_{SS} + R_T \times AHT_{TT} + ([I \times AHT_{TS}]+[O \times AHT_{ST}])$$

AHT_{SS} is the Average Holding Time of set to set call in seconds. The subscript “ST” on AHT denotes the call initiated from a set and terminates on a trunk, similarly for other combination of calls.

Total Calls (TCALL) = TCCS × 100 ÷ (2 × WAHT)

The system calls are comprised of four different types of traffic: Intraoffice Calls (set-to-set) (C_{SS}), Tandem Calls (trunk-to-trunk) (C_{TT}), Orig/outg (set-to-trunk) Calls (C_{ST}) and Term/incg (trunk-to-set) Calls (C_{TS}). All equations are existing equations, except the ones involving Virtual Trunks which are new.

1 Intraoffice Calls (C_{SS})

$= \text{Total Calls (CALLS)} \times \text{Intraoffice Ratio } (R_I)$

This parcel can be further broken down to three types:

— Intraoffice IP-IP Calls
$= C_{SS} \times P^2$ (require no DSP, no VT)
pf1 $= C_{SS} \times P^2 \div \text{TCALL}$, pf1 is the penetration factor for the intraoffice IP-IP calls.

— Intraoffice IP-NonIP Calls
$= C_{SS} \times 2 \times P \times (1 - P)$ (require DSP)
pf2 $= C_{SS} \times 2 \times P \times (1 - P) \div \text{CALLS}$, pf2 is the penetration factor for the intraoffice IP to non-IP calls.

— Intraoffice non-IP to non-IP
$= C_{SS} \times (1 - P)^2$ (require no DSP, no VT)
pf3 $= C_{SS} \times (1 - P)^2 \div \text{CALLS}$

2 Tandem Calls (C_{TT})

$= \text{Total Calls} \times \text{Tandem Ratio} = \text{CALLS} \times R_T$

The tandem calls can be further broken down into:

— Tandem VT-NonVT Calls
$= 2 \times \text{Tandem VT Calls} \times (1 - V)$
$= 2 \times C_{TT} \times V \times (1 - V)$ (require DSP and VT)
pf4 $= 2 \times C_{TT} \times V \times (1 - V) \div \text{CALLS}$

— Tandem non-VT – non-VT Calls
$= C_{TT} \times (1 - V)^2$ (require no DSP, no VT)
pf5 $= C_{TT} \times (1 - V)^2 \div \text{CALLS}$

3 Orig/outg Calls (C_{ST})

= Total Calls × Outgoing ratio = TCALL × O

— IP to VT calls
= C_{ST} × (fraction of IP calls) × (V)
= C_{ST} × P × V (require VT)
pf6 = C_{ST} × P × V ÷ CALLS

— IP to non-VT calls
= C_{ST} × (IP calls) × (1 – V)
= C_{ST} × P × (1 –V) (require DSP)
pf7 = C_{ST} × P × (1 – V) ÷ CALLS

— Non-IP set to VT
= C_{ST} × (1 – fraction of IP calls) × (V)
= C_{ST} × (1 – P) × V (require DSP, VT)
pf8 = Cst × (1 – P) × V ÷ CALLS

— Non-IP set to non-VT (Cstdd)
= C_{ST} × (1 – fraction of IP calls) × (1 – V)
= C_{ST} × (1 – P) × (1 – V) (require no DSP, no VT)
pf9 = C_{ST} × (1 – P) × (1 – V) ÷ CALLS

4 Term/incg (C_{TS})

= Total Calls × Incoming ratio = CALLS × I

— VT to non-IP set
= C_{TS} × (V) × (1 – fraction of IP calls)
= C_{TS} × V × (1 – P) (require DSP, VT)
pf10 = C_{TS} × V × (1 – P) ÷ CALLS

— VT to IP set
= C_{TS} × (V) × (fraction of IP calls)
= C_{TS} × V × P (require VT)
pf11 = C_{TS} × V × P ÷ CALLS

— Non-VT to IP set
$= C_{TS} \times (1 - V) \times$ (fraction of IP calls)
$= C_{TS} \times (1 - V) \times P$ (require DSP)
$pf12 = C_{TS} \times (1 - V) \times P \div CALLS$

— Non-VT to non-IP set
$= C_{TS} \times (1 - V) \times (1 -$ fraction of IP calls)
$= C_{TS} \times (1 - V) \times (1 - P)$ (require no DSP, no VT)
$pf13 = C_{TS} \times (1 - V) \times (1 - P) \div CALLS$

System Real Time EBC

System Real Time EBC = Total System calls × real time multiplier

= TCALL × (1+...+f3 × pf3+...)

This system EBC should be compared with M1/CSE CPU rated capacity to determine the processor utilization.

Real time usage

For each feature, Real Time Term = Penetration Factor × Real Time Factor

The Real Time Multiplier (RTM) is calculated by:

$$\mathrm{RTM} = 1 + \mathrm{Error\_term} + \sum_{\mathrm{features}} \mathrm{Real\_time\_term}_f$$

The Error_term accounts for features such as call forward or transfer, conference, multiple appearance, and so on, which are not included in the list above, and is assigned the value 0.2. In some environments such as Call Center, such features are not used, so the Error_term should be given a value of 0.

For each system and software release, there is a measured Basic Call Service Time which is the real time required to process a Basic Call. The Rated Call Capacity in Featured Calls or Rated Call Capacity (FC) is given by:

2 520 000 ÷ (RTM × Basic Call Service Time)

Table 97
Real time factors in EBC (Part 1 of 2)

Feature	CPP	CP3 / CP4
Digital set	0.03	0.03
TDM trunk	0.18	0.18
Inbound ACD	0.13	0.13
CallPilot transfer/play-prompt	3.32	3.32
SCCS – basic overhead	1.33	1.33
SCCS – simple ran/music	2.06	2.06
SCCS – typical (+IVR+MIRAN)	5.74	5.74
SCCS – complex	6.96	6.96
IP set – IP set (f1)	0.8	0.84
IP set – TDM set (f2)	1.7	1.7
TDM set – TDM set (f3)	0	0
VT – TDM trunk (f4)	1.5	1.5
TDM trunk – TDM trunk (f5)	1.8	1.8
IP set – VT (f6)	2.0	2.1
IP set – TDM trunk (f7)	2.2	2.2
TDM set – VT (f8)	1.6	1.6
TDM set – TDM trunk (f9)	1.4	1.4
VT – TDM set (f10)	1.0	1.0
VT – IP set (f11)	1.2	1.3
TDM trunk – IP set (f12)	1.6	1.6
TDM trunk – TDM set (f13)	1.4	1.4
CDR – internal	0.44	0.44

Table 97
Real time factors in EBC (Part 2 of 2)

Feature	CPP	CP3 / CP4
CDR – outgoing	0.32	0.32
CDR – incoming	0.32	0.32
Autodialer	1.17	1.17
Predictive Dialer	1.72	1.72
IVR w/o transfer	0.57	0.57
IVR with transfer	1.41	1.41
Auth code call	1.15	1.15
RAN	0.63	0.63
Music	0.25	0.25
Note: Real time factors (fi, i=1,...13) are used in IP/VT/DSP engineering algorithms.		

Illustrative engineering example

Numerical illustration

Assumptions used in the illustrated example:

- Intraoffice ratio (R_I): 0.33
- Tandem ratio (R_T): 0.03
- Incoming ratio (I): 0.33
- Outgoing ratio (O): 0.31

  The above, in fraction of calls, are added up to 1.

- AHT_{SS} = 60 (average hold time [AHT] for set to set [$_{SS}$])
- AHT_{TS} = 150 (AHT for trunk to set [$_{TS}$])
- AHT_{ST} = 150 (AHT for set to trunk [$_{ST}$])
- AHT_{TT} = 180 (AHT for trunk to trunk [$_{TT}$])

Given configuration:

- 6270 Digital and analogue sets at 5 CCS/set
- 2360 IP (#IP) sets including 400 IP ACD agent sets
  CCS/IP = 5
  CCS/IP agent set = 33
- 1700 Trunks including 260 Virtual Trunks
  C_{SS}/Trunk = 27
- 72 CallPilot ports at 26 CCS/Port

Other non-traffic sensitive, pre-selected application ports that require DSP channels when accessed by IP phones (proportional to the% IP calls in the system):

- 16 BRI SILC ports
- 24 MIRAN ports
- 16 MICB ports

The following real time factor values (f*i*) will be used for CPU utilization calculation:

f1 = 0.8, f2 = 1.7, f3 = 0.0, f4 = 1.5, f5 = 1.8, f6 = 2.0, f7 = 2.2, f8 = 1.6, f9 = 1.4, f10 = 1.0, f11 = 1.2, f12 = 1.6, f13 = 1.4, fsym = 5.7, fcp = 1.7.

The last two numbers are Symposium real time factor and Callpilot real time factor, respectively.

Calculations

- TDM sets CCS = 6270 × 5 = 31 350 CCS
- IP Sets CCS = 2360 × 5 = 11 800 CCS
- IP Agent Sets = 400 × 33 = 13 200 CCS
- CallPilot Ports = 72 × 26 = 1872 CCS
- Fraction of IP Call
  = ((2360 - 400) × 5 + 400 × 33) ÷ (6270 + 2360 - 400) × 5 + 400 × 33)
  = 0.42

- Weighted AHT (WAHT)
  $= 60 \times 0.33 + 150 \times 0.33 + 150 \times 0.31 + 180 \times 0.03$
  = 121 seconds
- Total line CCS (Lccs)
  = 31 350 + 11 800 + 13 200 + 1872
  = 58 222
- 1700 Trunks at 27 CCS per trunk = 1700×27 = 45 900
  Fraction of VT = $260 \div 1700 = 0.15$
  VT Traffic = 45 900 $\times$ 0.15 = 7020
  Total Trunk CCS (Ttccs) = 45 900
  Total CCS (TCCS)
  = 58 222 + 45 900
  = 104 122
- Total Calls (TCALL)
  $= 0.5 \times TCCS \times 100/WAHT$
  = 42 955

The system calls are comprised of four different types of traffic:

1 Intraoffice Calls (set-to-set) (C_{SS})

2 Tandem Calls (trunk-to-trunk) (C_{TT})

3 Orig/Outg Calls (set-to-trunk) (C_{ST})

4 Term/Incg Calls (trunk to set) (C_{TS})

Intraoffice calls

Intraoffice Calls (C_{SS})
$= TCALL \times R_I$
= 42 955 $\times$ 0.33
= 14 175

- Intraoffice IP-IP Calls (C_{2IP})
  $= C_{SS} \times P^2$
  = 14 175 $\times$ 0.42 $\times$ 0.42
  = 2539
  (require no DSP, no VT)
  pf1 = 2539 $\div$ 42 955 = 0.06

- Intraoffice IP-TDM Calls (C_{1IP})
  $= C_{SS} \times 2 \times P \times (1 - P)$
  $= 14\ 175 \times 2 \times 0.42 \times (1 - 0.42)$
  $= 6920$
  (require DSP)
  pf2 = 6920 ÷ 42 955 = 0.16

- Intraoffice TDM to TDM (C_{NOIP})
  $= C_{SS} \times (1 - P)^2$
  $= 14\ 175 \times (1 - 0.42) \times (1 - 0.42)$
  $= 4716$
  (require no DSP, no VT)
  pf3 = 4716 ÷ 42 955 = 0.11

Tandem Calls

Tandem Calls (C_{TT})
= Total Calls × Tandem Ratio
$= TCALL \times R_T$
$= 42\ 955 \times 0.03$
= 1289 calls

- Tandem VT – TDM Calls (C_{T1VT})
  $= 2 \times C_{TT} \times V \times (1 - V)$
  $= 2 \times 1289 \times 0.15 \times (1 - 0.15)$
  $= 334$
  (require DSP and VT)
  Pf4 = 334 ÷ 42 955 = 0.01

- Tandem TDM – TDM Calls (C_{T2NOVT})
  $= C_{TT} \times (1 - V) \times (1 - V)$
  $= 1289 \times (1 - 0.15) \times (1 - 0.15)$
  $= 925$
  (require no DSP, no VT)
  Pf5 = 925 ÷ 42 955 = 0.02

Orig/outg Calls

Orig/outg Calls (C_{ST})
$= TCALL \times O$
$= 42\ 955 \times 0.31$
= 13 316 calls

- IP to VT Calls (C_{STDI})
  $= C_{ST} \times P \times V$
  $= 13\,316 \times 0.42 \times 0.153$
  $= 862$
  (require VT)
  $Pf6 = 862 \div 42\,955 = 0.02$

- IP to TDM Calls (C_{STID})
  $= C_{ST} \times P \times (1 - V)$
  $= 13\,316 \times 0.42 \times (1 - 0.15)$
  $= 4773$
  (require DSP)
  $Pf7 = 4773 \div 42\,955 = 0.11$

- TDM to VT Calls (C_{STDV})
  $= C_{ST} \times (1 - P) \times (V)$
  $= 13\,316 \times (1 - 0.42) \times 0.15$
  $= 1175$
  (require DSP, VT)
  $Pf8 = 1175 \div 42\,955 = 0.03$

- TDM to TDM Calls (C_{STDD})
  $= C_{ST} \times (1 - P) \times (1 - V)$
  $= 13\,316 \times (1 - 0.42) \times (1 - 0.15)$
  $= 6506$
  (require no DSP, no VT)
  $Pf9 = 6506 \div 42\,955 = 0.15$

Term/incg

Term/incg (C_{TS})
$= TCALL \times I$
$= 42\,955 \times 0.33$
$= 14\,175$ calls

- VT to TDM Calls (C_{TSVD})
  $= C_{TS} \times V \times (1 - P)$
  $= 14\,175 \times 0.15 \times (1 - 0.42)$
  $= 1251$
  (require DSP, VT)
  $pf10 = 1251 \div 42\,955 = 0.03$

- VT to IP Calls (C_{TSVI})
  $= C_{TS} \times V \times P$
  $= 14\ 175 \times 0.15 \times 0.42$
  $= 917$
  (require VT)
  pf11 = 917 ÷ 42 955 = 0.02

- TDM to IP Calls (C_{TSDI})
  $= C_{TS} \times (1 - V) \times P$
  $= 14\ 175 \times (1 - 0.15) \times 0.42$
  $= 5081$
  (require DSP)
  Pf12 = 5081 ÷ 42 955 = 0.12

- TDM to TDM Calls (C_{TSDD})
  $= C_{TS} \times (1 - V) \times (1 - P)$
  $= 14\ 175 \times (1 - 0.15) \times (1 - 0.42)$
  $= 6926$
  (require no DSP, no VT)
  pf13 = 6926 ÷ 42 955 = 0.16

Calls involve at least one IP phone that will be needed for Gateway calculation:

- C_{IP}
  $= C_{2IP} + C_{1IP} + C_{STIV} + C_{STID} + C_{TSVI} + C_{TSDI}$
  $= 2539 + 6920 + 862 + 4773 + 917 + 5081$
  $= 21\ 092$

- System Real Time EBC = Total system calls × real time multiplier
  = TCALL × (1 + f1 × pf1 + f2 × pf2 + f3 × pf3 +…+ f12 × pf12 + f13 × pf13 + error_term]
  $= 42\ 955 \times (1 + 1.38 + 0.2)$
  $= 110\ 896$
  The error_term = 0.2 factor for basic feature

Real Time Calculation without other applications

- CPU utilization = 110 896 ÷ 315 000 = 35%

The system EBC is compared with M1 CPU rated capacity to determine the processor utilization. The result of 35% loading indicates that the CPU can handle this configuration with ease, and has plenty of spare capacity.

Real Time calculation with major applications (Symposium and CallPilot)

- Symposium calls EBC
  = (Number of agents × CCS × 100 ÷ AHT_{TS}) × fsym
  = (400 × 33 × 100 ÷ 150] × 5.7
  = 50 512
- CallPilot calls EBC
  = (Number of CallPilot ports × CCS × 100 ÷ 40) × fcp
  = (72 × 26 ÷ 100 ÷ 40 × 1.7
  = 7769
- CPU utilization with Symposium and CallPilot impact included
  = (110 896 + 50 512 + 7769) ÷ 315 000
  = 54% (for the CPP)

The system EBC is compared with M1 CPU rated capacity to determine the processor utilization. If other major features are involved and their impact can be calculated, the feature EBC should be added to the system EBC to obtain an accurate estimation of the total CPU load.

DSP calculation for TDS/CON cards

If the number of Network groups is known, use it in the following calculation. If it is unknown, use the approximation formula to estimate.

- Number of Network groups in the system
  = (6270 + 2360) ÷ 100 ÷ 28
  = 3.1
  = 4 (rounded up)
- Number of DSP channels for conference
  = 4 × 60 × 0.42
  = 104

This number should be included in calculating the total DSP and MC requirements.

Media Card Calculation without applications

- DSP Calls (C_{DSP})
  $= C_{1IP} + C_{T1VT} + C_{STID} + C_{STDV} + C_{TSVD} + C_{TSDI}$
  = 6920 + 334 + 4773 + 1175 + 1251 + 5081
  = 19 534 calls
- DSP CCS
  $= C_{DSP} \times$ WAHT ÷ 100
  = 19 534 × 121 ÷ 100
  = 23 675 CCS

Refer to Media Card Capacity Table (Erlang B P.005) if available. If not, use the following formula:

- MC = DSP CCS ÷ 795 + TDS/CON DSP ÷ 32
  = 23 675 ÷ 795 + 104 ÷ 32
  = 33.1

  If using an 8-port card, the result would be 33.1 × 4 = 132.4 MCs

DSP calculations before special application

- Basic DSP channels
  = Number of MCs × 32
  = 33.1 × 32
  = 1059

Nonblocking adjustment for ACD agents and CallPilot ports

The CCS difference between nonblocking (36 CCS) and default value (33 CCS) should be added back to traffic total to provide nonblocking ACD agents.

- DSP adjustment for ACD agents
  = Number of ACD agents × (36 – 33) ÷ 36
  = 400 × 3 ÷ 36
  = 34 when the default agent load is 33 CCS
- Total DSP channels before applications
  = 1059 + 34
  = 1093

When a special application is required to be nonblocking, an adjustment on the DSP channel needs to be done. Only CallPilot is qualified since all other applications (MIRAN, MICB, etc.) are provisioned by a fixed rule and not by traffic calculation.

The 72 CallPilot ports at 26 CCS/port would require additional DSP channels to become nonblocking:

- DSP channel adjustment
  $= 72 \times (36 - 26) \div 36$
  $= 20$

  An additional 20 DSP channels are needed to provide nonblocking (one DSP per port) CallPilot ports.

Media Card Calculation with major applications

Take traffic dependent ports (analog/digital sets, analog/digital trunks, IP sets, Virtual Trunks) out of the fixed rule provisioning. Make the fixed rule as a supplement to Meridian Configurator, and use these rules to add DSP channels after normal traffic calculation results are obtained. The number of DSP channels for special application is assumed to be in the same P ratio (IP calls to total line calls).

Use fraction of IP calls (0.42) to calculate DSP for applications:

- DSP for 16 BRI SILC ports
  $= 16 \times 0.42$
  $= 7$
- DSP for 24 MIRAN ports
  $= 24 \times 0.42$
  $= 10$
- DSP for 16 MICB ports
  $= 16 \times 0.42$
  $= 7$
- DSP for adjusted nonblocking CallPilot ports
  $= 20$

- Total DSP
  = 1093 + 7 + 10 + 7 + 20
  = 1137
- Number of 32-port Media Cards required
  = 1137 ÷ 32
  = 36 (rounding up the integer is recommended)

  If 8-port card:
  = 1137 ÷ 8
  = 143

H.323 Trunk Calculation Algorithm

- VT Calls (C_{VT})
  = $C_{TLVT} + C_{STIV} + C_{STDV} + C_{TSVD} + C_{TSVI}$
  = 334 + 766 + 1175 + 1346 + 917
  = 4538 calls
- VT CCS
  = $C_{VT} \times$ WAHT ÷ 100
  = 4538 × 121 ÷ 100
  = 5501 CCS

If available, use a typical Poisson Table with P.01 GOS to find the VT number. If the procedure is implemented in a spreadsheet, and it does not have a Poisson subroutine to calculate trunking requirement, the following approximation method can be used:

Number of VTs = 5501 ÷ 794 × 32 = 222

This method treats the VT group as a multiple of a 32-port group. It is a conservative approach. As long as it is less than input VT size (260), some variation in VT estimation is acceptable. The VT estimate will not impact the bandwidth requirement estimate that is directly based on traffic (erlangs).

LAN/WAN bandwidth Calculation Algorithm

The LAN/WAN bandwidth requirement calculation will be based on traffic directly. It does not depend on the traffic model used.

VT traffic in erlangs = 5501 ÷ 36 = 153

Succession Signaling Server Algorithm

This Meridian Configurator tool algorithm determines the number of Signaling Servers required for a given configuration. The algorithm will allow a change in constants for SS platform or SS application Software releases.

For the applications, there are performance factors and a software limit factors. The performance factors are determined through capacity analysis. The software limit factors are defined by the application. Element Manager can collocate with any of the other applications with negligible impact.

Most divisions are a type of parameter (endpoint, call, set, trunk) required in the configuration divides into system limit of itself. The largest number is chosen to denote the need of Signal Server for that type of application (GK, Gateway, TPS). Input on redundancy is used to calculate total SS required with designated alternate.

The algorithm calculates requirements individually for GateKeeper, TPS, and Gateway including any redundancy requirement. The total is then calculated by combining the individual results. See Table 98 on page 361 for definitions.

Succession Signaling Server Calculation

1 Gatekeeper Calculation

SSGR = larger of:
{

a $GKE \div GKE_l$ = endpoints limit

b $GKD \div GKD_l$ = dial plan entries limit

c $GKC \div GKC_{HL}$ = call per hour

}

SSGW = ROUNDUP(SSGR) × (2 if GKA true; else 1)
– Alternate Gatekeeper if needed

2 Terminal Proxy Server Calculation

SSTR = larger of:

{

a $IPL \div IPL_{SL}$ set limit

b $C_{IP} \div IPC_{HL}$ = calls per hour limit

}

SSTW = ROUNDUP(SSTR) + (1 if TPSA true; else 0)
N+1 redundant TPS if needed

3 H.323 Gateway Calculation

SSHR = larger of:

{

a $VT \div VT_{SL}$ number of trunks

b $C_{VT} \div VTC_{HL}$ call per hour

}

SSHW = ROUNDUP(SSHR) × (2 if GWA true; else 1)
Alternate Gateway if needed

The final calculation of SST will require picking the formula that suits the configuration and input by the user:

SST = evaluate in order,

a If (SSGR + SSTR + SSHR) < 1 and (GKC ÷ 100 000 + VTC ÷ 15 000 + C_{IP} ÷ 15 000) < SS_{CC}

SST = SSGR + SSTR + SSHR + (1 if GKA, GWA or TPSA true; else 0)

OR

b If $(SSTR + SSHR) < 1$ and $(SSGR + SSTR + SSHR) > 1$ and $(VTC \div 15\,000 + C_{IP} \div 15\,000) < SS_{CC}$

SST = SSGW + ROUNDUP(SSTR + SSHR) × (2 if GWA or TPSA true; else 1)

OR

c If $(SSGR + SSHR) < 1$ and $(SSGR + SSTR + SSHR) > 1$ and $(GKC \div 100\,000 + VTC \div 15\,000) < SS_{CC}$

SST = SSTW + ROUNDUP(SSGR + SSHR) × (2 if GKA or TPSA true; else 1)

d If $(SSTR + SSGR) < 1$ and $(SSGR + SSTR + SSHR) > 1$ and $(GKC \div 100\,000 + VTC \div 15\,000 + C_{IP} \div 15\,000) < SS_{CC}$

SST = SSHW + ROUNDUP(SSTR + SSGR) × (2 if GKA or TPSA true; else 1)

e Other combinations:
SSGW + SSTW+ SSHW
Each application is in standalone SS

Example

Input:

From the "Illustrative engineering example" on page 347, the following information was obtained:

- Number of IP phones in system: #IP = 2360
- Number of Virtual Trunks: #VT = 222
- Calls involving at least one IP set: C_{IP} = 21 092
- Calls involving virtual trunks: C_{VT} = 4538

Additional signaling server data is required. The additional data and values needed for this example include:

- Endpoints served by this GateKeeper = 100
- Gatekeeper entries (CDP + UDP + …) = 1000
- Virtual Trunks from other endpoints served by this GK = 800

- GateKeeper alternate (GKA) = yes
- H.323 Gateway alternate (GWA) = yes
- TPSA (TPS N+1 redundancy req.) = yes

Calculation:

1 SSGR (SS handling GateKeeper function)

a $GKE \div GKE_l$ endpoints
$= 100 \div 2000$
$= 0.05$

b $GKD \div GKD_l$ dialplan entries
$= 1000 \div 10\,000$
$= 0.1$

c $GKC \div GKC_{HL}$ = call per hour limit
calls from other nodes
$= 800 \times 28 \times 100 \div 180 \div 2$
$= 6222$

total busy hour calls per hour served by this GK
$= 4538 + 6222 = 10\,760$

$GKC \div GKC_{HL}$
$= 10\,760 \div 100\,000 = 0.11$

SSGR = 0.11 (the largest of (0.05, 0.1, 0.11))

2 SSTR (SS handling TPS function)

a $IPL \div IPL_{SL} = 2360 \div 5000 = 0.47$

b $C_{IP} \div IPC_{HL}$ (call rate limit)
$21\,092 \div 15\,000 = 1.41$
SSTR = 1.41

c SSTW = ROUNDUP(SSTR) + 1 = 3

3 SSHR (SS handling Gateway [VT] function)

a $VT \div VT_{SL}$
$= 222 \div 382 = 0.58$

b $C_{VT} \div VT_{CHL}$
$= 4538 \div 8000$
$= 0.57$

The largest of the numbers is 0.58
SSHR = 0.58
SSHW = ROUNDUP(SSHR) × 2 = 2

From “H.323 Gateway Calculation” on page 358, the following applies:

$(SSGR + SSHR) < 1$ and $(SSGR + SSTR + SSHR) > 1$ and
$(GKC \div 100\,000 + C_{IP} \div 15\,000) < SS_{CC}$
$(0.11 + 0.58) = 0.69 < 1$
$(0.11 + 1.05 + 0.58) = 1.74 > 1$
$(10\,760 \div 100\,000 + 4538 \div 15\,000) = 0.4 < 1$

SSTW + ROUNDUP(SSGR + SSHR) × (2 if GKA or TPSA true; else 1)
$3 + 1 \times 2 = 5$

Total number of Succession Signaling Servers required is 5.

Table 98
Succession Signaling Server algorithm constant and variable definitions (Part 1 of 3)

Algorithm Constant	Description	Value	Notes
GKA	Gate Keeper Alternate required	Enter	Yes or No
GKC	Gate Keeper Calls per Hour	Enter	Busy hour Gatekeeper routed call attempts
GKC_{HL}	Gate Keeper Calls per Hour	100 000	Call rate limit for SS

Table 98
Succession Signaling Server algorithm constant and variable definitions (Part 2 of 3)

Algorithm Constant	Description	Value	Notes
GKD	Gate Keeper dial plan entries	Enter	CDP, UDP, National, International, Special entries
GKD_l	Gate Keeper dial plan limit	10 000	Dial plan limit
GKE	Gate Keeper endpoints	Enter	
GKE_l	Gate Keeper endpoints limit	2000	Endpoint limit
GWA	H.323 Gateway Alternate required	Enter	Yes or No
C_{IP}	Internet phones calls per hour	Enter/ derived	Busy Hour call attempts per hour Busy hour IP phone calls. $C_{IP} = C_{2IP} + C_{1IP} + C_{STIV} + C_{STID} + C_{TSVI} + C_{TSDI}$ + (IP ACD set Calls, if separate)
IPC_{HL}	Internet phone call per hour limit	15 000	
IPL	Internet phones	Enter	
IPL_{SL}	Internet phone limit	5000	
SSGR	Gatekeeper SS calculation	Calculated	Real number requirement (i.e.,1.5) (= 0 if GK, which is a network wide resource, is not provisioned in this node)
SSGW	Gatekeeper SS requirements	Calculated	Whole number requirement including Alternate
SSHR	H.323 Gateway SS calculation	Calculated	Real number requirement (i.e.,1.5)

Table 98
Succession Signaling Server algorithm constant and variable definitions (Part 3 of 3)

Algorithm Constant	Description	Value	Notes
SSHW	H.323 Gateway SS requirements	Calculated	Whole number required including Alternate
SST	Total count of SS required	Calculated	
SSTR	TPS SS calculation	Calculated	Real number requirement (i.e.,1.5)
SSTW	TPS SS requirements	Calculated	Whole number required including Alternate
TPSA	TPS N+1 redundancy required	Enter	Yes or No
VTC	H.323 Gateway call per hour	Enter/ derive	
VTC_{HL}	H.323 Gateway call per hour limit	15 000	Limit
SS_{CC}	Signaling server combined call capacity	1	This is the weighted impact of call originations and call terminations for all applications on a single instance of a signaling server
VT_{SL}	H.323 Gateway virtual trunks per SS	382	Software limit

Maximum number of Failsafe Gatekeepers (GKF)

This algorithm defines the maximum number of GKFs that can be configured.

GKF is less than or equal to *GKPE*

$GKF = (\mathrm{GKE_L} \div GKPE)\ (\mathrm{FR} - [\mathrm{RFR_S} \text{ or } \mathrm{RFR_C}])\ (\mathrm{DDR} \div 24)$

Simplified Formulas:

$$GKF = (16\,000 \div GKPE) \text{ for standalone gatekeeper}$$
$$GKF = (10\,000 \div GKPE) \text{ for collocated gatekeeper}$$

Table 99
GKF algorithm constant and variable definitions

Algorithm Constant	Description	Value	Notes
DDR	Dynamic Data Resynch	24	In one day, the minimum number of synchronizations of dynamic data from Active GK to a GKF.
FR	FTP Resource	10	Software limit.
GKE_l	Gate Keeper endpoints limit	2000	Software limit
GKF	Maximum Failsafe Gatekeepers allowed	Calculated	
GKPE	GKP endpoints	Enter	
RFR_C	Reserved FTP Resource Collocated	5	Software limit. GKP shares SS with other applications such as TPS. Reserve 3 for other apps.
RFR_S	Reserved FTP Resource Standalone	2	Software limit. GKP is only application on SS. Reserve 1 for Static updates and 1 spare.

Example:

Using data from the previous example: co-location, 100 endpoints

$$GKF = (GKE_L \div GKPE)\ (FR - [RFR_S \text{ or } RFR_C])\ (DDR \div 24)$$
$$= (2000 \div 100) \times (10\text{-}5)\ (24 \div 24)$$
$$= 100$$

OR

$$GKF = (10\,000 \div GKPE) \text{ for collocated gatekeeper}$$
$$= 10\,000 \div 100 = 100$$

Memory size

In the following discussion, Large Systems with NT5D10 or NT5D03 CP (“CP3” or “CP4”) cards employ a Motorola 68060 CP. This CP uses a separate Flash EPROM memory for program store and a DRAM for Data store. CP PII employs a Pentium II CPU, which has code and data all stored in DRAM.

Memory options

The following memory cards are available:

1 NT5D10 or NT5D03 CP card:

- **a** Four SIMMs of EPROM for storing code; these SIMMs must all be the same size – either 8 MB or 16 MB.
- **b** There are four SIMMs of DRAM for storing data. Each of these SIMMs can be in any of the following sizes: 2 MB, 4 MB, 8 MB, 16 MB, or 32 MB.

2 NT4N64 – CPP PII has a single memory slot that can use either a 128 MB or a 256 MB DIMM.

Note: Succession 1000M requires 256 MB.

Table 100
Maximum memory sizes (MB)

Machine	EPROM	DRAM
Meridian 1 Options 51C/61C/81C, NT5D10 or NT5D03 CP card ***Note:*** Succession 1000M requires 128 MB minimum when using CP3 or CP4	64 MB	128 MB
Succession 1000M when running on a CPP PII	N/A	256 MB

Memory implications

In Table 101, “CP3” means “with NT5D10” and “CP4” means “with NT5D03”.

Call registers are 225 SL-1 words long. One SL-1 word is 4 bytes.

> ***Note:*** Sites experiencing memory shortages during an upgrade should check that the call register counts are within the bounds set by this table. Also check that the machine meets the minimum memory requirements listed in Table 102 and Table 103 on page 368.

Table 101
Recommended maximum Call Register counts and Succession 3.0

System type	Recommended Call Register Count	Memory Required (SL-1 words)	Memory Required (MB)
Succession 1000M Half Group / Meridian 1 Option 51C CP3/4	2000	450 000	1.717

Table 101
Recommended maximum Call Register counts and Succession 3.0

System type	Recommended Call Register Count	Memory Required (SL-1 words)	Memory Required (MB)
Succession 1000M Single Group / Meridian 1 61C CP3/4	4000	900 000	3.433
Succession 1000M Multi Group / Meridian 1 81C CP3/4	10 000	2 250 000	8.583
Succession 1000M Single Group / Meridian 1 Option 61C CP PII	20 000	4 500 000	17.166
Succession 1000M Multi Group / Meridian 1 Option 81C CP PII <= 5 groups	20 000	4 500 000	17.166
Succession 1000M Multi Group Meridian 1 Option 81C CP PII > 5 groups	25 000	5 625 000	21.458

Memory requirements

The following tables provide the memory requirements for Succession 3.0.

Table 102
Succession 3.0 memory requirements for 68060/68060E (CP3/4) processors

System	Flash memory required	DRAM memory required	Total memory
Succession 1000M Single Group / Option 51C/61C with CP3 (68060) or CP4 (68060E)	64 MB	64 MB	128 MB
Succession 1000M Multi Group / Option 81/81C (with or without Fiber Network Fabric)	64 MB	96 MB	160 MB

Table 103
Succession 3.0 memory requirements for Pentium CP PII processors

System	Flash memory required	DRAM memory required	Total memory
Succession 1000M Single Group / Option 51C/61C with CP3 (68060) or CP4 (68060E)	N/A	256 MB	256 MB
Succession 1000M Multi Group / Option 81/81C (with or without Fiber Network Fabric)	N/A	256 MB	256 MB

Memory engineering

The data store consists of both protected (page 369) and unprotected database information (page 373). This section describes the information stored in each area and how to determine the values for input to the memory size worksheet.

Protected data store

- Telephones

  Assumptions:

  — average number of features defined per 500/2500 telephone is 8

  — average number of 500/2500 telephones sharing the same template is 10

  — average number of key lamp strips per SL-1 telephone is 1

  — average number of SL-1/Digital telephones sharing the same template is 2

  — average number of non-key features per digital set is 4.

  Calculations:

  — For every type of set the protected data store size is calculated using basic formula: Number of items × MS per item.

  The following items are included here:

  — 500/2500 telephones

  — ACD telephones

  — M2006/2008 telephones

  — 2216/2616 telephones

  — M2317 telephones

  — M3900 telephones

  — Consoles

  — Add-on Modules

  — Templates

  — Attendants

- DS/VMS access TNs:

  — (Number of Meridian Mail ports + Number of data ports only) × MS per DS/VMS access TN

- Office Data Administration (ODAS):
  - (Number of Meridian Mail ports + Number of data ports only + Total number of sets + Number of analog trunks) × MS for ODAS
- Customers:
  - (Constant term + Number of customers) × MS per customer
- Directory Number (DN) translator

  Assumptions:
  - the two lowest levels in the DN tree have average rate of 8 digits
  - the rest of the DN tree has a structure which provides the lowest possible digit rate for upper levels

  Calculations:
  - (5.8 × Number of DNs) + 2 × (2 × Number of ACD DNs) +
  - (Number of ACD positions + Number of DISA DNs) + (MS per console × Number of consoles) + Number of dial intercom groups
- Dial Intercom Group (DIG) translator:
  - Maximum number of DIGs + 2 × (number of DIGs + Total number of the sets within DIGs)
- Direct Inward System Access (DISA):
  - Number of DISA DNs × MS per DISA DN
- Authorization Code

  Assumption:
  - the length of the authorization code is in the range of 4 through 7

  Calculations:
  - (Number of customers × MS per customer) + (1.47 × Number of authorization codes)

- Speed Call:
  - (Maximum number of Speed Call lists + Number of Speed Call lists) × (3 + 0.26 × Average number of entries per list × DN size)
- Analog trunks:
  - Number of analog trunks × MS per analog trunk
- Trunk Route:
  - Constant term + (Number of trunk routes × MS per trunk route)
- Network:
  - (Number of groups × MS per group) + (Number of local loops × MS per local loop) + (Number of remote loops × MS per remote loop)
- TDS, MF sender, Conference, DTR, Tone Detector:
  - (Number of DTRs × MS per DTR) + (Number of TDSs × MS per TDS)
  - Number of MF senders × MS per MF sender +
  - Number of conference cards × Ms per conference card +
  - Number of TDETs × MS per TDET
- ISDN PRI/PRI2:
  - (Number of D-channels × MS per D-channel) + (Number of PRI trunks + Number of ISL trunks)
- ISDN DTI/DTI2/JDMI:
  - (Number of DTI loops × MS per DTI loop) + (Number of DTI2 loops × MS per DTI2 loop)
- History file:
  - Size for history file buffer

- Basic Alternate Route Selection/Network Alternate Route Selection (BARS/NARS)

  Assumptions:

  — The length of any code = 3

  — The typical structure of the tree for every code (in term of digit rate) is the following:

    – 10-10-10.... - for SPN code

    – 8 -10-10.... - for NXX/LOC code

    – 6-2-10-8-10... - for NPA code

  Calculations:

  — 5684 + 31.21 × number of NPA Codes + 1.06 × Number of NXX Codes + 1.06 × (Number of LOC Codes + Number of SPN Codes) + 2 × Number of FCAS Tables

- ISDN Basic Rate Interface (BRI):

  — Number of MISP boards × MS per MISP board + Number of DSLs × MS per DSL + Number of TSPs × MS per TSP + Number of BRI DNs × MS per BRI DN

- Coordinated Dialing Plan (CDP):

  — Constant term + 3 × Number of steering codes + 8 × Number of route lists + 3 × Total number of entries in route lists

- Call Party Name Display (CPND):

  — Number of trunk routes + Number of consoles + Number of ACD DNs + Number of SL-1 DNs + Number of digital set DNs + Number of Names × (5 + Average length of name) + Number of 1-digit DIG groups × 11 + Number of 2-digit DIG groups × 101

- Feature Group D (FGD) Automatic Number Identification (ANI) Database

  Assumptions:

  — all Numbering Plan Area (NPA) codes designated for BARS/NARS are assumed to be used for ANI also

  — one NPA block is assumed for every fifty NPA codes

  — five NXX blocks are assumed for each NPA block

  — twenty SUB blocks are assumed for each NXX block

  Calculations:

  — 3 × Number of NPA Codes + 658 × Number of NPA codes

- Automatic Call Distribution (ACD) ÷ Network ACD (NACD):

  — Number of ACD DNs × MS per ACD DN + Number of NACD DNs × MS per NACD DN + Number of ACD positions × MS per ACD position + Number of ACD agents + 11 × Number of customers

- Fixed address globals:

  — MS for fixed address globals

Unprotected Data Store

- Telephone. For every telephone type (except BRI telephones) the memory size is calculated as:

  — Number of telephones × MS per item, where MS per item depends on the set type. For example:

    – Number of 2500 telephones × MS per 2500 set

    – Number of telephones with display × MS per display, and so on

- BRI telephones:

  — Constant term + MS per MISP × Number of MISPs + MS per DSL × Number of DSLs + MS per BRI line card × Number of BRI line cards

  where:

- — MISP stands for the Multi-purpose ISDN Signaling Processor
- — DSL stands for the Digital Subscriber Loop

- Analog trunks:
  - — Paging trunks, RAN trunks, Add-on Data Module (ADM), RLA trunks, other analog trunks

  Calculations:
  - — Number of paging trunks × MS per paging trunk
  - — Number of other analog trunks × MS per other analog trunk, and so on
  - — (Number of other analog trunks = Total number of analog trunks – Number of paging trunks – Number of RAN trunks – Number of ADMs – Number of RLAs)

- Trunks (Call Detail Recording [CDR]):
  - — Total number of trunks × MS per trunk

- BRI trunks:
  - — Number of BRI trunks × MS per BRI trunk

- Trunk routes:
  - — (Number of trunk routes × MS per trunk route) + (Total number of trunks ÷16)

  Note: The result of division should be rounded up.

- DTI/DTI2/JDMI:
  - — Number of DTI loops × MS per DTI loop
  - — Number of DTI2 loops × MS per DTI2 loop

- ISDN PRI/PRI2/ISL

  PRI:
  - — Number of D-channels × MS per PRI D-channel + Number of outputs

— Request buffers × MS per output request buffer +

— 2 × (Number of PRI trunks + Number of ISL trunks)

PRI2:

— Number of D-channels × MS per PRI2 D-channel + Number of output

— Request buffers × MS per output request buffer +

— 2 × Number of PRI trunks + Number of ISL trunks

- Teletypes:

— Total number of teletypes × MS per teletype

— Number of CDR links × MS per CDR link

— Number of HS links × MS per HS link

— Number of APL links × MS per APL link

— Number of PMS links × MS per PMS link

— Number of Other links × MS per other link

- For the following items (features) memory size is calculated using the basic formula:

— Number of items × MS per item

where item is one of the following:

— local loops, remote loops, secondary tapes, customer, Tone and Digit Switch, MF sender, Conference card, Digitone receiver, Tone Detector, attendant, Peripheral Signaling card, LPIB, HPIB, background terminal, MSDL card

Note: The size of High Priority Input Buffer = Number of Groups × 32.

- PBXOB and BCSOB:

— Number of Peripheral Signaling Cards × 640

— Number of Peripheral Signaling Cards × 640

- DS/VMS access TNs:
  - — MS per DS/VMS TN × (Number of Meridian Mail Ports + Number of data only ports)
- Application Module Link (AML):
  - — Constant term + Number of AMLs × MS per AML
- Automatic Call Distribution (ACD):
  - — If ACD-C package is not equipped, then memory size for ACD feature is:
    - – Number of ACD DNs × 298 + Number of ACD positions × 34
  - — If ACD-C package is equipped, then additional memory size for ACD-C feature is:
    - – (Number of ACD-C routes × 46) + (Number of ACD-C positions × 42) + (Number of ACD-C DN's + Number of control directory numbers × 80) + (Number of ACD-C trunks + Number of ACD-C CRTs × 30) + (Number of customers with ACD-C package × 240)
- NARS/BARS/Coordinated Dialing Plan (CDP):

  Assumption:
  - — if NTRF package is equipped, then Off Hook Queuing (OHQ) is also equipped

  Calculations:
  - — MS per customer × Number of customers + 2 × (Number of route lists × MS per route list + Number of routes with OHQ × MS per route + Number of NCOS defined × MS per NCOS)
- Call registers:

  Assumptions:
  - — The Call Register Traffic Factor = 1.865
  - — The formula for the calculation of recommended Number of Call Registers depends on traffic load for the system

— 28 CCS per ACD trunk

Calculations:

— Call Registers Memory Size
= Recommended number of call registers × MS per call register

— Snacd
= Number of Calls Overflowed to all target ACD DNs × 2.25 – Number of calls overflowed to local target ACD DNs × 1.8 (0, if the system is not a source node)

— Tnacd
= 0.2 × Number of expected calls overflowed from source (0, if the system is not a target node)

— ISDN CCS = PRI CCS + BRI CCS

– ISDN penetration factor:
p = ISDN CCS ÷ Total Voice Loop Traffic

– ISDN factor
$(1 - p)^2 + [4 \times (1 - p)] \times p + (3 \times p^2)$

— If Total Voice Loop Traffic > 3000 CCS, then:

– Recommended number of call registers = (0.04 × Total Voice Loop Traffic) + (0.18 × Number of ACD incoming trunks) + (Snacd + Tnacd +25) × ISDN factor

— If Total Voice Loop Traffic ≤ 3000 CCS, then:

– Recommended number of call registers = (Number of system equipped ports – Number of ACD incoming trunks – Number of ACD agent sets) × 0.94 + (Number of ACD incoming trunks + Snacd + Tnacd) × ISDN factor

- Fixed address globals and OVL data space:

— MS for fixed address globals + MS for OVL data space

Mass storage size

The system processor program and data are loaded from hard disk and/or floppies. The auxiliary processor operating system, programs, and data for such applications as Meridian MAX, Meridian Mail, Customer Controlled Routing, and Meridian 911 are loaded from tape. The capacities of these media along with brief descriptions of the layouts used for all processor types and applications are discussed in this section.

System processors

Mass Store on the Large Systems (NT5D10, NT5D03 CP cards and CP PII cards).

Software installation and SYSLOAD

Software is loaded to hard disk via an external medium and then SYSLOAD is performed from the hard disk. The software uploading medium is a CD-ROM. The customer database is loaded to the hard disk on a separate floppy, which can be rewritten via a “backup” operation or reread to hard disk via a “restore” operation (LD 43).

The hard disk total capacity is a function of whatever is currently available from the manufacturers. Whatever the total capacity, however, the actual storage capacity available to the system is determined by the disk partitioning into the protected and unprotected area.

IODU/C and MMDU

By means of the IODU/C and MMDU feature, software delivery by CD-ROM to systems. IODU/C and MMDU incorporate a Keycode based S/W installation and feature expansion methodology. Highlights include:

- Software delivery via CD plus single install floppy. This replaces the (large) stack of floppies required to install software in the past.
- Single 1.44MB floppy drive.

The following table provides the expected maximum floppy disk space required (before compression) by Large System databases. These are conservative but realistic estimates; that is, not all sites with the given machine type will have databases as large as shown.

Table 104
Floppy disk space requirements projection for SL-1 customer data (MB)

System	Rls 25	Succession 3.0
Meridian 1 Option 51C	0.53	0.56
Meridian 1 Option 61C	0.88	0.93
Meridian 1 Option 81C <= 5 group system	2.46	2.60
Meridian 1 Option 81C 6-8 group system	3.93	4.17

Auxiliary processors

Currently, auxiliary processors include Meridian MAX, Meridian Mail, Customer Controlled Routing, and Meridian 911. These all incorporate a 155 MB tape drive and a hard disk (either 172 MB, 240 MB or 520 MB). The processor's UNIX® Operating System is loaded to hard disk from one tape, and the application program and data from another. In addition to the operating system and application program and data, the hard disk also accommodates caching areas and third-party applications.

Table 105 lists the various auxiliary processors and shows the sizes of the mass storage media for each. To see the available space on these media, see "Worksheets" on page 405.

Table 105
Mass storage media for the auxiliary processors

Product	System tape	Applications tape	Hard disk	Comments/ projections
Meridian Link Module	155 MB	155 MB	172 MB	These products all use the same system software.
Customer Controlled Routing	155 MB	155 MB	172 MB	
911 Services	155 MB	155 MB	172 MB	
ACD Reporting System MAX4 / MiniMAX	155 MB	155 MB	172 MB	Uses a subset of the available system software.
ACD Reporting System MAX5	155 MB	155 MB	520 MB	
Interactive Voice Response	155 MB	155 MB	240 MB	

Refer to *Meridian MAX Installation* (553-4001-111) for information regarding the auxiliary processors. Refer to *Large System: Installation and Configuration* (553-3021-210) for information regarding Meridian Link/ Customer Controlled Routing.

Software configuration capacities

Maximum configuration capacities are given in Table 106. A system may not be able to simultaneously accommodate all of the maximum values listed due to system limitations on the real time, memory, or traffic capacity.

Table 106
Large System software configuration capacities

Maximum configurations	
Per system:	
— Steps in a hunting group	30
— Speed call lists	8191
— Members per trunk route	254
— Input output devices	16
— Appearances of the same directory number	30
— Number of customers	100
Per customer:	
— Ringing number pickup groups	4095
— Trunk routes	512
— Listed directory numbers (direct inward dialing only)	4
— Lamp field array (may be repeated once on another console)	1
— Consoles	63
Per attendant console:	
— Feature keys: M2250	20
— Incoming call indicators	20
— Trunk group busy indicators: M2250	20
— Additional key/lamp strips	2

Succession 1000M capacities

Table 107 contains a summary of Succession 1000M capacities.

Table 107
Succession 1000M capacities summary

Call server	Platform name	Pure TDM	IP access to PSTN	Pure IP no access to PSTN	Mixed	Max VTNs
CP3 CP4	Succession 1000M Half Group	1000	1000	2000	500 TDM 500 IP	8192
CP3 CP4	Succession 1000M Single Group	2000	2000	3000	1000 TDM 1000 IP	8192
CP3 CP4	Succession 1000M Multi Group	10 000	3000	3000	2000 TDM 1000 IP	8192
CP PII	Succession 1000M Single Group	2000	3000	5000	1000 TDM 2000 IP	14 336
CP PII	Succession 1000M Multi Group	16 000	10 000	10 000	8000 TDM 5000 IP	32 760

The following caveats apply to the values in Table 107:

- Requires using Signaling Servers for TPS.
- Meridian Configurator and NTPs are used to calculate practical values pre-configuration.
- Values beyond these limits must be engineered.
- Assumes 8 - 15% digital trunking to PSTN and no applications.

Provisioning

Contents

This section contains information on the following topics:

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Introduction

The values and limits used in this document are not necessarily typical and should not be interpreted as limits of the system capacity. The values should be adjusted to suit the application of a particular system. Consult your Nortel Networks representative and use a configuration tool, such as Autoquote or Meridian Configurator, to fully engineer a system.

To determine general equipment requirements, follow the provisioning steps in the order shown below. (These provisioning methods are based on a non-partitioned system.) Use the worksheets prepared in the previous chapter and the reference tables at the end of this document.

Step 1: Define and forecast growth (p. 384)

Step 2: Estimate CCS per terminal (p. 386)

Step 3: Calculate number of trunks required (p. 391)

Step 4: Calculate line, trunk, and console load (p. 392)

Step 5: Calculate Digitone receiver requirements (p. 393)

Step 6: Calculate total system load (p. 399)

Step 7: Calculate number of network loops required (p. 399)

Step 8: Calculate number of network groups required (p. 401)

Step 9: Calculate number of IPE cards required (p. 403)

Step 10: Calculate number of IPE modules required (p. 404)

Step 11: Provision conference/TDS loops (p. 404)

Step 12: Assign equipment and prepare equipment summary (p. 404)

Step 1: Define and forecast growth

The first step in provisioning a new system is to forecast the number of telephones required at two-year and five-year intervals.

The number of telephones required when the system is placed in service (cutover) is determined by the customer. If the customer is unable to provide a two-year and five-year growth forecast, then an estimate of annual personnel growth in percent is used to estimate the number of telephones required at the two-year and five-year intervals.

Example

A customer has 500 employees and needs 275 telephones to meet the system cutover. The customer projects an annual increase of 5 percent of employees based on future business expansion. The employee growth forecast is:

- 500 employees × 0.05 (percent growth) = 25 additional employees at 1 year
- 525 employees × 0.05 = 27 additional employees at 2 years
- 552 employees × 0.05 = 28 additional employees at 3 years
- 580 employees × 0.05 = 29 additional employees at 4 years
- 609 employees × 0.05 = 31 additional employees at 5 years
- 640 employees × 0.05 = 32 additional employees at 6 years

The ratio of telephones to employees is 275 ÷ 500 = 0.55. To determine the number of telephones required from cutover through a five-year interval, the number of employees required at cutover, one, two, three, four, and five years is multiplied by the ratio of telephones to employee (0.55).

- 500 employees × 0.55 = 275 telephones required at cutover
- 525 employees × 0.55 = 289 telephones required at 1 year
- 552 employees × 0.55 = 304 telephones required at 2 years
- 580 employees × 0.55 = 319 telephones required at 3 years
- 609 employees × 0.55 = 335 telephones required at 4 years
- 640 employees × 0.55 = 352 telephones required at 5 years

This customer requires 275 telephones at cutover, 304 telephones at two years, and 352 telephones at five years.

Each DN assigned to a telephone requires a TN. Determine the number of TNs required for each customer and enter this information in “Network loop balancing” on page 418. Perform this calculation for cutover, two-year, and five-year intervals.

Step 2: Estimate CCS per terminal

Estimate the station and trunk CCS per terminal (CCS/T) for the installation of a system using any one of the following methods:

1 Comparative method

2 Manual calculation

3 Default method

Comparative method

Select three existing systems that have a historical record of traffic study data. The criteria for choosing comparative systems are:

1 Similar line size (+25 percent)

2 Similar business (such as bank, hospital, insurance, manufacturing)

3 Similar locality (urban or rural)

Once similar systems have been selected, then their station, trunk, and intra-CCS/T are averaged. The averages are applied to calculate trunk requirements for the system being provisioned (see the example in Table 108 on page 387).

Table 108
Example of station, trunk, and intra-CCS/T averaging

	Customer A	Customer B	Customer C	Total	Average
Line size	200	250	150	600	200
Line CCS/T	4.35	4.75	3.50	12.60	4.20
Trunk CCS/T	2.60	3.00	2.00	7.60	2.53
Intra CCS/T	1.70	1.75	1.50	4.95	1.65

If only the trunk CCS/T is available, multiply the trunk CCS/T by 0.5 to determine the intra-CCS/T (assuming a normal traffic pattern of 33 percent incoming calls, 33 percent outgoing calls, and 33 percent intra-system calls). The trunk CCS/T and intra-CCS/T are then added to arrive at the line CCS/T (see the example in Table 109).

Table 109
Example of CCS/T averaging when only trunk CCS/T is known (Part 1 of 2)

Trunk type	Number of trunks	Grade of service	Load in CCS	Number of terms	CCS/T
IP Peer H.323 Trunk	11	P.01	169	275	0.61
DID	16	P.01	294	234	1.20
CO	14	P.02	267	234	1.14
Tie	7	P.05	118	215	0.54
Paging	2	10 CCS/trunk	20	207	0.09
Out WATS	4	30 CCS/trunk	120	218	0.54
Note: The individual CCS/T per trunk group is not added to form the trunk CCS/T. The trunk CCS/T is the total trunk load divided by the total number of lines at cutover.					

Table 109
Example of CCS/T averaging when only trunk CCS/T is known (Part 2 of 2)

Trunk type	Number of trunks	Grade of service	Load in CCS	Number of terms	CCS/T
FX	2	30 CCS/trunk	60	218	0.27
Private line	4	20 CCS/trunk	80	275	0.29
			Total: 1128		Total: 4.64

Note: The individual CCS/T per trunk group is not added to form the trunk CCS/T. The trunk CCS/T is the total trunk load divided by the total number of lines at cutover.

From the preceding information, trunk CCS/T can be computed as follows:

Trunk CCS/T = total trunk load in CCS ÷ (number of lines)
= 1128 ÷ 275
= 4.1

Assuming a 33 percent intra-calling ratio:

Intra CCS/T = 4.1 × 0.5 = 2.1,
and
line CCS/T = 4.1 (trunk CCS/T) + 2.1 (intra-CCS/T) = 6.2

Manual calculation

Normally, the customer can estimate the number of trunks required at cutover and specify the grade of service to be maintained at two-year and five-year periods (see Table 110 on page 389). (If not, use the comparative method.)

The number of trunks can be read from the appropriate trunking table to select the estimated usage on the trunk group. The number of lines that are accessing the group at cutover are divided into the estimated usage. The result is the CCS/T, which can be used to estimate trunk requirements.

Example

- Line CCS/T = 6.2
- Trunk CCS/T = 4.1
- 2 consoles = 30 CCS

Table 110
Example of manual calculation of CCS/T

Cutover	Line CCS = 275 × 6.2 = 1705 Trunk CCS = 275 × 4.1 =1128 Subtotal = 2833 Console CCS = 30 Total system load = 2863
2 years	Line CCS = 304 × 6.2 = 1885 Trunk CCS = 304 × 4.1 = 1247 Subtotal = 3132 Console CCS = 30 Total system load = 3162
5 years	Line CCS = 352 × 6.2 = 2183 Trunk CCS = 352 × 4.1 = 1444 Subtotal = 3627 Console CCS = 30 Total system load = 3657

This method is used for each trunk group in the system, with the exception of small special services trunk groups (such as TIE, WATS, and FX trunks).

Normally, the customer will tolerate a lesser grade of service on these trunk groups. Table 111 lists the estimated usage on special services trunks.

Table 111
Estimated load per trunk

Trunk type	CCS
IP Peer H.323 Trunk	30
Tie	30
Foreign exchange	30
Out WATS	30
In WATS	30
Paging	10
Dial dictation	10
Individual bus lines	20

Default method

Studies conducted estimate that the average line CCS/T is never greater than 5.5 in 90 percent of all businesses. If attempts to calculate the CCS/T using the comparative method or the manual calculation are not successful, the default of 5.5 line CCS/T can be used.

The network line usage is determined by multiplying the number of lines by 5.5 CCS/T. The total is then multiplied by 2 to incorporate the trunk CCS/T. However, when this method is used, the intra-CCS/T is added twice to the equation, and the result could be over provisioning if the intra-CCS/T is high.

Another difficulty experienced with this method is the inability to forecast individual trunk groups. The trunk and intra CCS/T are forecast as a sum group total. Examples of the default method and the manual calculation method are shown in Table 112 on page 391 for comparison.

Example

- 275 stations at cutover
- 304 stations at two years
- 352 stations at five years

Cutover	275×5.5 (CCS/T) $\times 2 =$	3025 CCS total system load
Two-year	304×5.5 (CCS/T) $\times 2 =$	3344 CCS total system load
Five-year	352×5.5 (CCS/T) $\times 2 =$	3872 CCS total system load

Table 112
Default method and manual calculations analysis

	Default method	Manual calculations	Difference
Cutover	3025	2863 CCS	162 CCS
Two years	3344	3162 CCS	182 CCS
Five years	3872	3657 CCS	215 CCS

Step 3: Calculate number of trunks required

Enter the values obtained through any of the three previous methods in "Growth forecast" on page 415. Add the calculations to the worksheet. Once the trunk CCS/T is known and a grade of service has been specified by the customer, the number of trunks required per trunk group to meet cutover, two-year, and five-year requirements is determined as shown in the following example.

Example

The customer requires a Poisson 1 percent blocking grade of service (see "Trunk traffic – Poisson 1 percent blocking" on page 464). The estimated trunk CCS/T is 1.14 for a DID trunk group. With the cutover, two-year, and five-year number of lines, the total trunk CCS is determined by multiplying the number of lines by the trunk CCS/T:

Cutover	275 (lines) × 1.14 (trunk CCS/T) =	313.5 CCS
Two-year	304 (lines) × 1.14 (trunk CCS/T) =	346.56 CCS
Five-year	352 (lines) × 1.14 (trunk CCS/T) =	401.28 CCS

Use "Digitone receiver requirements – Model 2" on page 469 to determine the quantity of trunks required to meet the trunk CCS at cutover, two-year, and five-year intervals. In this case:

- 17 DID trunks are required at cutover
- 18 DID trunks are required in two years
- 21 DID trunk are required in five years

Note: For trunk traffic greater than 4427 CCS, allow 29.5 CCS/T.

Step 4: Calculate line, trunk, and console load

Once the quantity of trunks required has been estimated, enter the quantities in "Growth forecast" on page 415 for cutover, two-year, and five-year intervals. This calculation must be performed for each trunk group to be equipped. The total trunk CCS/T is the sum of each individual trunk group CCS/T. This value is also entered in "Growth forecast" on page 415.

Line load

Line load is calculated by multiplying the total number of TNs by the line CCS/T. The number of TNs is determined as follows:

- one TN for every DN assigned to one or more single-line telephones
- one TN for every multi-line telephone without data option
- two TNs for every multi-line telephone with data option

Trunk load

Trunk load is calculated by multiplying the total number of single- and multi-line TNs that have access to the trunk route by the CCS/T per trunk route.

Console load

Console load is calculated by multiplying the number of consoles by 30 CCS per console.

Step 5: Calculate Digitone receiver requirements

Once station and trunk requirements have been determined for the complete system, the DTR requirements can be calculated. The DTRs are shared by all customers in the system and must be distributed equally over all the network loops.

The tables “Digitone receiver requirements – Model 3” on page 470 through “Digitone receiver load capacity – 16 to 25 second holding time” on page 475 are based on models of traffic environments and can be applied to determine DTR needs in most cases. When the system being provisioned does not fall within the bounds of these models or is equipped with any special features, the detailed calculations must be performed for each feature and the number of DTRs must accommodate the highest result.

Special feature calculations include:

- Calculations with Authorization Code (p. 396)
- Calculations with Centralized Attendant Service (p. 397)
- Calculations with Charge Account for Call Detail Recording (p. 397)
- Calculations with Direct Inward System Access (p. 398)

From the appropriate reference table (“Digitone receiver requirements – Model 1” on page 468 through to “Digitone receiver load capacity – 16 to 25 second holding time” on page 475), determine the number of DTRs required and the DTR load for cutover, two-year, and five-year intervals. Record this information in “Total load” on page 416.

The following models are based on some common PBX traffic measurements.

Model 1

"Digitone receiver requirements – Model 3" on page 470 is based on the following factors:

- 33 percent intraoffice calls, 33 percent incoming calls, and 33 percent outgoing calls
- 1.5 percent dial tone delay grade of service
- No Digitone DID trunks or incoming Digitone tie trunks

Model 2

"Digitone receiver requirements – Model 4" on page 471 is based on the following factors:

- The same traffic pattern as Model 1
- Digitone DID trunks or incoming Digitone tie trunks
- Poisson 0.1 percent blockage grade of service

Model 3

"Digitone receiver load capacity – 6 to 15 second holding time" on page 472 is based on the following factors:

- 15 percent intraoffice calls, 28 percent incoming calls, and 56 percent outgoing calls
- 1.5 percent dial tone delay grade of service
- No Digitone DID trunks or incoming Digitone tie trunks

Model 4

"Digitone receiver load capacity – 16 to 25 second holding time" on page 475 is based on the following factors:

- the same traffic pattern as Model 3
- Digitone DID trunks or incoming Digitone tie trunks
- Poisson 0.1 percent blockage grade of service

Detailed calculation – Method 1

This method can be used when there are no incoming Digitone DID trunks and the following is assumed:

- Digitone receiver traffic is inflated by 30 percent to cover unsuccessful dialing attempts.
- Call holding time used in intraoffice and outgoing call calculations is 135 seconds if unknown.
- Digitone receiver holding times are 6.2 and 14.1 seconds for intraoffice and outgoing calls, respectively.
- Factor (1 – R) ÷ 2 in (1) outgoing (incoming calls and outgoing calls are equal). R is the intraoffice ratio.

Follow Procedure 2 to complete a detailed calculation using Method 1.

Procedure 2
Detailed calculation – Method 1

1 Calculate Digitone calls:

Intraoffice =
100 × Digitone station traffic (CCS) ÷ call holding time × (R ÷ 2)

Outgoing =
100 × Digitone station traffic (CCS) ÷ call holding time × [(1 – R) ÷ 2]

2 Calculate total DTR traffic:

1.3 × [(6.2 × Intra) + (14.1 × Outgoing)] ÷100

3 Calculate average holding time:

(6.2 × intra) + (14.1 × outgoing) ÷ intra calls + outgoing calls

4 See "Digitione receiver requirement – Poisson 0.1 percent blocking" on page 478 or "Conference and TDS loop requirements" on page 480 and use the answers from steps 2 and 3 to determine the number of DTRs required.

End of Procedure

Detailed calculation – Method 2

This method is used when incoming Digitone trunks are included in the system. This method uses the same assumptions as Method 1, with the DTR holding time assumed to be 2.5 seconds for a DID call.

Follow Procedure 3 to complete a detailed calculation using Method 2.

Procedure 3
Detailed calculation – Method 1

1 Calculate intraoffice and outgoing Digitone calls as shown in step 1 of Method 1:

DID calls =
DID Digitone trunk traffic (CCS) × 100 ÷ call holding time

2 Calculate total DTR traffic:

[(1.3 × 6.2 × intra) + (1.3 × 14.1 × outgoing calls) + (2.5 × DID calls)] ÷ 100

3 See Reference Table 9 on page 478 and use the answer from step 2 to determine the number of DTRs required.

End of Procedure

Calculations with Authorization Code

With Authorization Code, the DTR holding times change from 6.2 seconds to 19.6 seconds for intraoffice calls, and from 14.1 seconds to 27.5 seconds for outgoing calls.

Use the values in steps 2 and 3 of "Detailed calculation – Method 1" on page 395 and step 2 of "Detailed calculation – Method 2" on page 396 to calculate the DTR requirements for a system with the Authorization Code option.

It has been assumed that:

1 all Digitone intraoffice and outgoing calls require authorization;

2 the average number of special services prefix (SPRE) digits is two (the maximum is four);

3 the average number of Authorization Code digits is 10 (the range is 1 to 14 digits); and,

4 the average DTR holding time is 13.4 seconds.

Calculations with Centralized Attendant Service

This method determines the DTR requirements for the main location of a system equipped with the CAS option. It has been assumed that:

1 all attendant calls presented through release link trunks from a remote PBX require DTRs;

2 the average number of digits dialed is four; and,

3 the average DTR holding time is 6.2 seconds.

Procedure 4
Determining DTR requirements

1 Calculate the attendant calls from the remote PBX:
100 × attendant traffic from the remote (CCS) ÷ attendant work time (in seconds)

2 Add the attendant calls to the intraoffice calls calculated in step 1 of “Detailed calculation: Method 1” and proceed with the remaining calculations of Method 1.

End of Procedure

Calculations with Charge Account for Call Detail Recording

The DTR holding time for outgoing calls changes from 14.1 seconds to 20.8 seconds.

Apply this change to steps 2 and 3 of “Detailed calculation – Method 1” on page 395 and step 3 of “Detailed calculation – Method 2” on page 396 to determine the DTR requirements for a system with the Charge Account for CDR option.

It has been assumed that:

1. fifty (50) percent of Digitone outgoing calls require a charge account;
2. the average number of SPRE digits is two (maximum is four);
3. the average number of digits in the account number is 10 (the range is 2 to 23 digits); and,
4. the average DTR holding time is 13.4 seconds (see "Digitione receiver requirement – Poisson 0.1 percent blocking" on page 478).

Calculations with Direct Inward System Access

This method is used when a system is equipped with the DISA feature. It has been assumed that:

1. DISA calls come through DISA trunks or DID trunks;
2. seventy-five (75) percent of DISA calls require a security code;
3. the average number of digits in the security code is four (the range is one to eight); and,
4. the DISA DTR holding time is 6.2 seconds.

Procedure 5
Determining DTR requirements

1. Calculate the number of DISA calls:
   100 × DISA traffic ÷ call holding time
2. Calculate the DISA DTR traffic:
   6.2 × DISA calls ÷ 100
3. Add this traffic to step 2 of "Detailed calculation: Method 2" and proceed with the remaining calculations of Method 2.

End of Procedure

Step 6: Calculate total system load

Total the line, trunk, console, and DTR load for each customer to get the total load figure for each customer for cutover, two-year, and five-year intervals. Enter this figure in "Total load" on page 416 and "Network loops" on page 417.

Step 7: Calculate number of network loops required

The system network loop requirement is the total of all individual customer loops and superloops required. The number of network loops and superloops required is calculated for each customer for cutover, two-year, and five-year intervals. Network loops and superloops are provisioned at cutover based on the two-year loop requirement figure.

To determine the number of superloops required, first separate the traffic supported by QPC414 Network Cards: data line cards, RPE, and PRI/DTI. The remaining traffic (including DTR traffic) must be engineered for superloops.

Number of superloop network cards or number of superloops
= traffic to be handled by superloop network ÷ 2975

These figures are based on an 85 percent utilization level. Round the value obtained to the next higher number.

Non-blocking configuration with superloop network

For non-blocking applications (or a non-blocking part of the system), provide one superloop for every 120 TNs. Generally, each line or trunk is one TN, but an integrated voice and data line is two TNs (assuming the data port is configured). Application processors such as CallPilot and MICB require a TN for each port. Succession Media Card requires 1 TN for each DSP port.

Blocking configuration with superloop network

For applications where blocking is allowed, one superloop can serve up to 512 lines (1024 TNs). The actual number of lines depends on the traffic requirement of the lines.

QPC414 Network Cards

The traffic carried by QPC414 Network Cards includes data, RPE, and PRI/DTI traffic (which includes both data and voice traffic).

Provide separate loops for RPE and PRI/DTI traffic. Based on 85 percent utilization, calculate the number of loops required as follows:

1 Number of loops
= traffic to be carried by QPC414 Network Cards ÷ 560

2 Number of QPC414 Network Cards
= number of loops ÷ 2

Note: Round the value obtained to the next higher number.

PRI/DTI cards

The PRI and DTI cards provide the interface between the system switch and T-1/DS-1 digital transmission trunks. Digital trunks are offered in a group of 24 trunks. Table 113 on page 401 lists the number of PRI/DTI cards required when PRI/DTI traffic is known.

The Line-side E1 Interface card (LEI) is an IPE line card that provides a cost-effective, all-digital connection between E1 compatible terminal equipment (such as voice mail systems, voice response units, trading turrets, etc.) and the system. In this application it will provide 30 ports.

Note: The number of PRI/DTI loops is the same as the number of PRI/DTI cards.

Table 113
Number of cards required when PRI/DTI traffic is known

Number of cards	CCS for 24-port T1	CCS for 30-port E1
1	1-507	1-675
2	508-1201	676-1565
3	1202-1935	1566-2499
4	1936-2689	2500-3456
5	2690-3456	3457-4427
6	3457-4231	4428-5409
7	4232-5015	5410-6403
8	5016-5804	6404-7428

For non-blocking applications, the Ring Again feature must be provided since blocking may occur at the far end of the trunk.

The PRI/DTI cards can be installed in any module except IPE Modules. After all essential cards are configured, estimate the available slots for PRI/DTI.

Step 8: Calculate number of network groups required

Compute the number of network groups based on the total number of loops required (excluding conference/TDS loops). Record the network groups in "Network loop balancing" on page 418. Use Table 114 on page 402 and the following equation to find the number of network groups required:

Total number of loops
= (4 × the number of superloop network cards)
+ (2 × the number of QPC414 Network Cards)

Table 114
Number of network groups based on total number of loops required

Number of network groups	Number of loops
1	28
2	56
3	84
4	112
5	140
6	168
7	196
8	224

Note: Use “Network loops” on page 417. Install a multiple-group system if the total number of loops required exceeds 28.

Note: Based on the criteria above, installing a multiple group system initially is more cost-effective than converting to a multiple group system (from a single-group system) between the two-year and five-year intervals.

For Succession 1000M Multi Group and Meridian 1 Option 81C CP PII use Table 115 to calculate the number of NT6D65 or NTRB34 cCNI Cards needed to support the network groups.

Table 115
cCNI configurations (Succession 1000M Multi Group and Meridian 1 Option 81C CP PII)

Number of network groups supported	Required number of cCNI cards
1 (group 0)	1
2 (group 1)	1
3 (group 2)	2
4 (group 3)	2
5 (group 4)	3
6 (group 5)	3
7 (group 6)	4
8 (group 7)	4

Step 9: Calculate number of IPE cards required

In "IPE card calculations" on page 419, enter the number of DTRs required (from "Total load" on page 416). Use a separate worksheet for cutover, two-year, and five-year intervals.

Using information from "Growth forecast" on page 415, enter the number of single-line telephone TNs, multi-line telephone TNs, and trunk TNs required at cutover, two-year, and five-year intervals (for all customers) in "IPE card calculations" on page 419.

Divide each entry by the number of TN assignments for each card, round up to the next higher figure, and total the number of cards required.

Calculate the number of IPE cards separately.

Step 10: Calculate number of IPE modules required

The number of peripheral equipment modules provided at cutover is based on the two-year estimate of peripheral equipment cards required and an 85 percent utilization level.

The maximum capacity of an IPE Module is 256 integrated voice and data or analog lines; however, a typical configuration includes a combination of lines, trunks, and DTRs, which provides up to 160 lines.

Divide the number of peripheral equipment cards required at two years by 8.5, round to the next higher number, and enter this value in “IPE card calculations” on page 419.

To compute the number of peripheral equipment modules, divide the total number of line, trunk, and DTR cards required at two years by 13.6 and round to the next higher number. Enter this value in “IPE card calculations” on page 419.

Calculate the number of IPE Modules required.

Step 11: Provision conference/TDS loops

Conference/TDS loops are provisioned according to the two-year figure for the number of network loops required. All systems must be equipped with a minimum of two conference and two TDS loops.

See Table 112 on page 391 and Table 113 on page 401 to determine conference/TDS loop requirements. Enter these figures in “Conference and TDS loop requirements” on page 420.

Step 12: Assign equipment and prepare equipment summary

Use “Equipment summary” on page 421 to record the equipment requirements for the complete system at cutover. Assign the equipment. The equipment summary may have to be updated as a result of assignment procedures. Use the finalized equipment summary to order the equipment for the system.

Appendix A: Worksheets

List of worksheets

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Introduction

The worksheets in this appendix give examples of information needed to do traffic and equipment engineering. However, more detailed information is needed to fully engineer a system. Consult your Nortel Networks representative and use a configuration tool, such as Autoquote or Meridian Configurator, to fully engineer a system.

Each of the following subsections contains a worksheet with which the system engineer can assess the total system impact of a given configuration on the specified capacity. These worksheets implement the algorithms described in “System capacities” on page 295. The result of the worksheet is a number or set of numbers, in the units of the capacity being assessed. A simplified table of capacity limits is given to provide easy determination of feasibility and the size of system required.

Worksheet 1: Load balancing

LOAD BALANCING

CUSTOMER ____________________ DATE ________

One sheet for the complete system.

Total system load = ________ CCS

Voice loops required = ________

IPE/PE modules required = ________

Average CCS per module = $\frac{\text{Total system load CCS}}{\text{IPE modules required}}$ = ________ CCS

Average CCS per loop = $\frac{\text{Total system load CCS}}{\text{Voice loops required}}$ = ________ CCS

LOOP NUMBER	SHELVES ASSIGNED	CCS PER LOOP	CCS PER SHELF

553-5366

Worksheet 2: Circuit card distribution

CIRCUIT CARD DISTRIBUTION

CUSTOMER ______________________________ DATE __________

One sheet for the complete system.

Divide the total number of a card type by the total number of IPE modules to arrive at a cards-per-module number.

CARD TYPE	QUANTITY	TOTAL IPE MODULES	CARDS PER MODULE

553-5367

Worksheet 3: Multiple appearance group assignments

MULTIPLE APPEARANCE GROUP (MAG) ASSIGNMENTS
CUSTOMER ____________________ DATE __________
One sheet for the complete system.

LOOP #	LOOP #	LOOP #	LOOP #	LOOP #
MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN
MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN
MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN
MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN
MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN	MAG # Single-line TN Multi-line TN
CARDS Single-line ___ Multi-line ___	CARDS Single-line ___ Multi-line ___	CARDS Single-line ___ Multi-line ___	CARDS Single-line ___ Multi-line ___	CARDS Single-line ___ Multi-line ___

553-4054

Worksheet 4: Station load balancing

STATION LOAD BALANCING

CUSTOMER________________________________ DATE ___________

One sheet required for the complete system.

Total single-line TNs to be assigned	______________
Less number of single-line TNs assigned to MAG	– ______________
Equals number of single-line TNs not in MAG	= ______________

$$\frac{\text{Single-line TNs not in MAG}}{\text{Total IPE modules}} = \_\_\_\_\_\_\_\_ \text{ Number of single-line TNs not in MAG Assigned per module}$$

Total multi-line TNs to be assigned	______________
Less number of multi-line TNs assigned to MAG	– ______________
Equals number of multi-line TNs not in MAG	= ______________

$$\frac{\text{Multi-line TNs not in MAG}}{\text{Total IPE modules}} = \_\_\_\_\_\_\_\_ \text{ Number of multi-line TNs not in MAG Assigned per module}$$

553-5372

Worksheet 5: Multiple appearance group record

MULTIPLE APPEARANCE GROUP (MAG) RECORD

CUSTOMER ____________________________ DATE ____________

One worksheet per system.

MAG NUMBER	LOOP NUMBER	DN	STATUS DESIGNATOR	TELEPHONE TYPE	DEPT.

553-4059

Worksheet 6: Circuit card to module assignment

CIRCUIT CARD TO MODULE ASSIGNMENT

CUSTOMER________________________________ DATE ____________

One table for each IPE shelf in the system.

	TOTAL CARDS	CCS LOAD

LOOP # ________ MODULE # ________

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type															

LOOP # ________ MODULE # ________

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type															

LOOP # ________ MODULE # ________

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type															

LOOP # ________ MODULE # ________

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type															

LOOP # ________ MODULE # ________

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Type															

553-5369a

Worksheet 7: Terminal number assignment

TN ASSIGNMENT RECORD

CUSTOMER ______________________ DATE ____________

LOOP # ________ MODULE # ________ GROUP # ________

CARD POS __________ CARD POS __________ CARD POS __________

CARD TYPE __________ CARD TYPE __________ CARD TYPE __________

UNIT	DN	RTMB	CUST
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			

UNIT	DN	RTMB	CUST
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			

UNIT	DN	RTMB	CUST
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			

DN = Directory Number, RTMB = Route Member Number (trunks)

553-5368

Worksheet 8: System assignment plan

SYSTEM ASSIGNMENT PLAN

CUSTOMER____ DATE ___________

One sheet for each equipment voice loop.

LOOP #: ____________ GROUP #: __________

Modules equipped	______________
Trunks working	______________
Trunks equipped	______________
Consoles	______________
DTRs	______________
Single-line TNs	______________
Multi-line TNs	______________
MAGs assigned	______________
Load capacity	______________

RECOMMENDED ASSIGNMENT PLAN ___________________________

553-5370

Worksheet 9: Growth forecast

GROWTH FORECAST

CUSTOMER ______________________ DATE __________

One sheet for each customer and one sheet for the system as a whole.

	CUTOVER	2-YR	5-YR	CCS/T
CONSOLES				
TELEPHONES:				
Single-line TNs				
Multi-line TNs				
TRUNKS:				
2-way				
1-way in				
1-way out				
IP Peer H.323 Trunks				
DID				
Tie				
CCSA				
InWATS				
OutWATS				
FX				
Private line				
Dial dictation				
Paging				
RAN				
AIOD				
DTI				
E&M 2W				
E&M 4W				

Line CCS/T ________

Total trunk CCS/T ________

Intra-CCS/T ________

553-4041

Worksheet 10: Total load

LINE, TRUNK, AND CONSOLE USAGE

CUSTOMER ______________________ DATE ________

One sheet for each customer for cutover, 2-year, and 5-year interval.
One sheet for the system cutover, 2-year, and 5-year interval.

LINE USAGE:

Single-line TNs ________ X ________ CCS/T = ________ CCS

Multi-line TNs ________ X ________ CCS/T = ________ CCS

TOTAL LINE LOAD = ________ CCS

TRUNK USAGE:

Trunk route	Number of TNs accessing route		CCS/T per trunk route		Total CCS load per trunk route	
______	____________	X	________	=	____________	CCS
______	____________	X	________	=	____________	CCS
______	____________	X	________	=	____________	CCS
______	____________	X	________	=	____________	CCS
______	____________	X	________	=	____________	CCS
______	____________	X	________	=	____________	CCS
______	____________	X	________	=	____________	CCS

TOTAL TRUNK LOAD = ____________ CCS

CONSOLE USAGE:

Number of consoles ________ X 30 CCS = ________ TOTAL CONSOLE LOAD

DIGITONE RECEIVERS:

Table ______ Number of DTRs ______ TOTAL DTR LOAD ________ CCS

TOTAL LOAD ________ CCS

553-4042

Worksheet 11: Network loops

NETWORK LOOP CALCULATION

CUSTOMER ______________________________ DATE __________

One sheet for each customer. One sheet for the complete system.

	Total load		CCS per load		Number of loops	Round to next highest number
Cutover	________	÷	________	=	________	________
2-year	________	÷	________	=	________	________
5-year	________	÷	________	=	________	________

Number of network loops required at 2 years = ____________

Number of network groups required at 2 years (use table below) = ____________

Number of network groups	Maximum number of voice loops	Without Digitone trunks 744/560 CCS/loop	With Digitone trunks 720/540 CCS/loop
1	28	20 832 / 15 680	20 160 / 15 120
2	56	41 664 / 31 360	40 320 / 30 240
3	84	62 496 / 47 040	60 480 / 45 360
4	112	83 328 / 62 720	80 640 / 60 480
5	140	104 160 / 78 400	100 800 / 75 600
6	168	124 992 / 94 080	120 960 / 90 720
7	196	145 824 / 109 760	141 120 / 105 840
8	224	166 656 / 125 440	161 280 / 120 960

Note 1: The table above is based on an 85 percent utilization level.

For superloops, the *maximum* CCS/loop is 875 without Digitone trunks, 848 with Digitone trunks. Using the 85 percent utilization level, the CCS/loop is 744 without Digitone trunks, 720 with Digitone trunks.

For regular loops, the *maximum* CCS/loop is 660 without Digitone trunks, 560 with Digitone trunks. Using the 85 percent utilization level, the CCS/loop is 560 without Digitone trunks, 540 with Digitone trunks.

Note 2: At high traffic levels the CPU capacity needs to be calculated to determine whether there is sufficient capacity to process the given load.

553-AAA5361

Worksheet 12: Network loop balancing

BALANCING NETWORK LOOPS OVER NETWORK GROUPS

CUSTOMER____ DATE ___________

One sheet for the complete system.

CUSTOMER	NETWORK GROUP 0	NETWORK GROUP 1	NETWORK GROUP 2	NETWORK GROUP 3	NETWORK GROUP 4	NETWORK GROUP 5	NETWORK GROUP 6	NETWORK GROUP 7

553-AAA0359

Worksheet 13: IPE card calculations

IPE CARD CALCULATIONS

CUSTOMER____ DATE ____________

One for the complete system at cutover, 2-year, and 5-year interval.

NUMBER OF:	CUTOVER	2-YR	5-YR
Digital line cards = Digital line cards plus number of M2250 consoles x 6			
Analog line cards = Analog ports ÷ 16			
Analog message waiting line cards = Analog ports with message waiting ÷ 16			
Universal trunk cards = CO/DID/RAN/paging trunks ÷ 8			
2-W E&M/DX/paging trunks ÷ 2			
E&M trunk cards = E&M/paging/dictation trunks ÷ 4			
VGMC cards =			
Application cards =			
TOTAL CARDS			

IPE MODULE CALCULATIONS:

Use the total cards required at 2 years to determine the number of IPE Modules to be provisioned at cutover.

IPE Modules required = Total cards (round to next higher number) ÷ 8.5

NUMBER OF IPE MODULES REQUIRED AT CUTOVER ______________

553-AAA0360

Worksheet 14: Conference and TDS loop requirements

CONFERENCE AND TDS LOOP REQUIREMENTS

CUSTOMER__________________________________ DATE __________

One sheet for the complete system.

CONFERENCE LOOP REQUIREMENTS:

Conference loops are provisioned according to the 2-year network loop requirements.

Conference loops required = ______________

TONE AND DIGIT LOOP REQUIREMENTS:

Tone and digit loops are provisioned according to the 2-year network loop requirements.

Tone and digit loops required = ______________

553-4046

Worksheet 15: Equipment summary

EQUIPMENT SUMMARY

CUSTOMER________________________ DATE __________

One sheet for the complete system.

	QUANTITY	BASED ON
Line and trunk cards		Cutover
DTR loops		2 year
Unprotected memory cards		2 year
Protected memory cards		2 year
Conference loops		2 year
TDS loops		2 year
CPUs		Cutover
IPE modules		2 year
Network loops (except conference and TDS)		2 year
Network groups		2 year
Voice Gateway Media Cards		2 year
Succession Signaling Servers		2 year
Application cards		2 year

553-AAA0361

Worksheet 16: Network loop traffic capacity

	Column A				Column B (Loops)
TDS/CON Loops	One card (2 loops) per Network Module*				___________
BLOCKING:					
XNET Loop	Admin. Sets		______ × 6 =	______CCS	
	Non-ACD trunks	+	______ × 26=	______CCS	
	Subtotal	=		______÷ 875	=_______(N_{0x})
NON_BLOCKING:					
XNET	Agent Sets		__________		
	Supervisor Sets	+	__________		
	ACD Analog and RAN Trunks	+	__________		
	Subtotal	=	_______÷ 30		=________(N_1)
DTI Trunks		=	_______÷ 24		=_______(N_{2d})
PRI Trunks			__________		
		+	2		
		=	_______÷ 24		=_______(N_{2p})
Music Ports		=	_______÷ 30		=_______(N_{31})
MM/MIVR/HEVP/Call Pilot			_______÷ 24		=_______(N_{32})
Total loops (Sum of entries under column B)					=________(N_L)

Note: All calculations should be rounded up to the next integer.

*Iterative procedure may be needed if the number of network modules required was not correctly estimated at the outset.

Conclusion:

N_L <= 16 Succession 1000M Half Group, Option 51C
16 < N_L <= 32 Succession 1000M Single Group, Option 61C
32 < N_L <= 160 Succession 1000M Multi Group, Option 81C

160 <N_L <256 Succession 1000M Multi Group, Option 81C/FNF

Worksheet 17: Physical capacity

The procedure for card slot calculation for Succession 1000M Half Group, Meridian 1 Options 51C, and Succession 1000M Single Group, Meridian 1 Option 61C CP PII is different. Users should make a first guess as to which system is the right candidate for the application. Otherwise, both worksheets must be filled out.

Worksheet 17
Card slot calculation for Succession 1000M Single Group, Meridian 1 Option 61C (Part 1 of 2)

	Column A (Loop/card)		Column B (Slots)
TDS/CON	One/Network Module*		=__________
MUSic Loop	One TDS/CON provides one MUSic		=_____(N_{31})
NT8D04 XNET	Blocking Loops	________(N_{0x})	
	Non-blocking Loops	+________(N_1)	
	Subtotal	=__________ ÷ 4	=_____(Sx)
NT5D12 DDP	2 DTI/PRI loops per slot		
NT5D97 DDP2	2 DTI2/PRI2 loops per slot		
NT6D80 MSDL	4 DCH ports or SDI ports per slot		
NT1P61 FNET	1 superloop per slot		
NT5D64 MCR	1 superloop per slot		
NTRB53 Clock Controller	1 slot per system		
I/O cards**	Must be $\geq S_x$		=__________
QPC720 DTI/PRI	$= 2 \times N_2$, if no NT8D35 module; else = 0		=__________
Total # of card slots (sum of entries under column B)			=______(S_c)

Worksheet 17
Card slot calculation for Succession 1000M Single Group, Meridian 1 Option 61C (Part 2 of 2)

	Column A (Loop/card)	Column B (Slots)
Conclusion: $S_c \le 7$ Option 51C $7 < S_c \le 16$ Option 61C $16 < S_c$ Option 81C		
Note: All calculations should be rounded up to the next integer. A negative loop number should be set to zero. *Iterative procedure may be needed, if the number of modules to use was not clear at the outset. **Refer to Table 5 on page 61 to find the number of I/O cards needed for applications.		

Worksheet 17
System power consumption worksheet

Module	Quantity		Power Consumption (watts)		
NT6D44	______	×	400	=	______
NT8D34	______	×	300	=	______
NT8D35	______	×	270	=	______
NT8D37	______	×	460	=	______
Pedestals	______	×	50	=	______
			Total power	=	

Worksheet 18: Succession Media Card calculation

Worksheet 18
Succession Media Card calculation (Part 1 of 2)

Input constants	**Input configuration data**
R_I – intraoffice calls ratio R_T – tandem calls ratio I – incoming calls to total calls ratio O – outgoing calls to total calls ratio P – IP calls to total calls ratio V – H.323 Trunk calls to total trunk calls ratio Hold times in seconds for set to set, trunk to trunk, set to trunk, trunk to set	Number of analog sets Number of digital sets Number of IP phones Number of Virtual trunks (estimated)
SMC Calculation Procedure	
(1) TDM set CCS	= (Number of analog sets + Number of digital sets) × _____ CCS/set
(2) IP set CCS	= Number of IP sets × ______ CCS/set
(3) Total line CCS	= (1) + (2)
(4) TDM trunk CCS	= Number of TDM trunks × ____ CCS/trunk
(5) H.323 Trunk CCS	= Number of VTs × ____ CCS/trunk
(6) Total trunk CCS	= (4) + (5)
(7) Total system CCS (TCCS)	= (3) + (6)
(8) Weighted Average Hold Time (WAHT)	= $(R_I \times AHT_{SS}) + (R_T \times AHT_{TT}) + (I \times AHT_{TS}) + (O \times AHT_{ST})$
(9) Total calls (TCALL)	= 0.5 × TCCS × 100 ÷ WAHT

Worksheet 18
Succession Media Card calculation (Part 2 of 2)

Input constants	Input configuration data
(10) Calls require DSP resources (C_{DSP})	= (a) + (b) + (c) + (d) + (e) + (f)
— (a) Intraoffice IP-TDM set calls	= TCALL × R_I × 2 × P × (1 – P)
— (b) Tandem VT-TDM trunk calls	= TCALL × R_T × 2 × V × (1 – V)
— (c) IP set to TDM trunk calls	= TCALL × O × P × (1 – V)
— (d) TDM set to VT calls	= TCALL × O × (1 – P) × V
— (e) VT trunk to TDM set calls	= TCALL × I × V × (1 – P)
— (f) TDM trunk to IP set calls	= TCALL × I × (1 – V) × P
(11) DSP CCS (CCS_{DSP})	= C_{DSP} × WAHT ÷ 100
(12) # SMC required	= CCS_{DSP} ÷ 794
(13) DSP channels for applications	= (a) + (b) + (c) + (d) + (e)
— (a) CallPilot	= Number of CallPilot ports × P
— (b) MIRAN	= Number of MIRAN ports × P
— (c) MICB	= Number of MICB ports × P
— (d) Conference	= Number of CON. loops × 30 × P
— (e) BRI	= SILC cards × 16 × P
(14) Total DSP channels	= (12) × 32 + (13)
(15) Total SMC	= Roundup((14) ÷ 32)

Worksheet 18
H.323 Trunk calculation

Call Type	Calculation formula
(1) H.323 Trunk calls (C_{VT})	(a) + (b) + (c) + (d) + (e)
— (a) Tandem VT-TDM trunk calls	TCALL × R_T × 2 × V × (1 – V)
— (b) IP to VT calls	TCALL × O × P × V
— (c) TDM set to VT calls	TCALL × O × (1 – P) × V
— (d) VT to DSP set calls	TCALL × I × V × (1 – P)
— (e) VT to IP set calls	TCALL × I × V × P
(2) VT CCS (CCS_{VT})	C_{VT} × WAHT ÷ 100
(3) Number of VTs	Roundup(CCS_{VT} ÷ 794 × 32)
(4) VT traffic in erlangs	Roundup(CCS_{VT} ÷ 36) use this for LAN/WAN bandwidth calculation

Note: If the calculated VT number differs from the original estimated VT significantly (>15%), the user is recommended to use the new VT number and repeat the calculation procedure to yield a more accurate SMCs and VTs.

Worksheet 19: Real time calculation

Worksheet 19
Real time calculation with IP/VT applications (Part 1 of 2)

Input constants	Input configuration data
From Worksheet for DSP calculation	
Total calls (TCALL)	$= 0.5 \times TCCS \times 100 \div WAHT$
Intraoffice IP-IP calls	$= TCALL \times R_I \times P^2$
Penetration factor pf1	$= R_I \times P^2$
Intraoffice IP-TDM calls	$= TCALL \times R_I \times 2 \times P \times (1 - P)$
Penetration factor pf2	$= R_I \times 2 \times P \times (1 - P)$
Intraoffice TDM-TDM calls	$= TCALL \times R_I \times (1 - P)^2$
Penetration factor pf3	$= R_I \times (1 - P)^2$
Tandem VT - TDM calls	$= TCALL \times R_T \times 2 \times V \times (1 - V)$
Penetration factor pf4	$= R_T \times 2 \times V \times (1 - V)$
Tandem TDM - TDM calls	$= TCALL \times R_T \times (1 - V)^2$
Penetration factor pf5	$= R_T \times (1 - V)^2$
IP set- VT calls	$= TCALL \times O \times P \times V$
Penetration factor pf6	$= O \times P \times V$
IP set- TDM calls	$= TCALL \times O \times P \times (1 - V)$
Penetration factor pf7	$= O \times P \times (1 - V)$
TDM set- VT calls	$= TCALL \times O \times (1 - P) \times V$
Penetration factor pf8	$=O \times (1 - P) \times V$
TDM set - TDM trunk calls	$= TCALL \times O \times (1 - P) \times (1 - V)$
Penetration factor pf9	$= O \times (1 - P) \times (1 - V)$

Worksheet 19
Real time calculation with IP/VT applications (Part 2 of 2)

Input constants	Input configuration data
VT to TDM set calls	= TCALL × I × V × (1 – P)
Penetration factor pf10	= I × V × (1 – P)
VT -IP set calls	= TCALL × I × V × P
Penetration factor pf11	= I × V × P
TDM trunk - IP set calls	= TCALL × I × (1 – V) × P
Penetration factor pf12	= I × (1 – V) × P
TDM trunk - TDM set calls	= TCALL × I × (1 – V) × (1 – P)
Penetration factor pf13	= I × (1 – V) × (1 – P)
Weighted average penetration factor (PF)	= (f1 × pf1) + (f2 × pf2) +...+ (f12 × pf12) + (f13 × pf13)
Error term (basic features: forward/ transfer/conference /waiting)	0.2
Symposium real time impact (EBCsym)	= Symposium calls × 5.74
CallPilot real time impact (EBCcp)	= CallPilot calls × 1.66
System real time EBC (System EBC)	= TCALL × (1 + PF + error term) + EBC_{SYM} + EBC_{CP} + EBC (other major applications)
CPU utilization in % CPP, or CP4, or CP3	= System EBC ÷ 315 000 × 100 for CPP or = System EBC ÷ 100 800 × 100 for CP4 or = System EBC ÷ 72 000 × 100 for CP3

Worksheet 20: Memory size

Software Release: ___________

Worksheet 20
Memory size (Memory in SL-1 words) (Part 1 of 6)

Feature	**Usage**	**×**	**PDS factor***	**=**	**Memory****
Fixed Address Globals	1	×	________	=	________
500/2500 telephones*		×	________	=	________
M2006 telephones*					
M2216/2616 telephones*					
M2317 telephones*					
M3900 telephones					
M3901 telephones					
M3902 telephones					
M3903 telephones					
ACD telephones					
Consoles					
Add-on Modules					
Templates					
Displays					
DS/VMS Access TNs:					
— Meridian Mail Ports					
— Data Only Ports					

* See “Protected Memory for Phone Sets: Detail” on page 452.

Worksheet 20
Memory size (Memory in SL-1 words) (Part 2 of 6)

Feature	Usage	×	PDS factor*	=	Memory**
ISDN BRI:					
— MISP cards					
— DSLs					
— TSPs		×	________	=	________
— BRI Line cards		×	________	=	________
— Analog trunks		×	________	=	________
Trunk Routes:					
— Constant term	1				
— Trunk routes					
ISDN PRI/PRI2/ISL:					
— D-channels					
— PRI trunks					
— ISL trunks					
ISDN DTI/DTI2/JDMI:					
— DTI Loops					
— DTI2 Loops					
DISA DN’s		×	________	=	________
Network:					
— Groups		×	________	=	________
— Local Loops		×	________	=	________
— Remote loops		×	________	=	________

Worksheet 20
Memory size (Memory in SL-1 words) (Part 3 of 6)

Feature	Usage	×	PDS factor*	=	Memory**
ODAS:					
— Meridian Mail Ports		×	________	=	________
— Data Only Ports		×	________	=	________
— Sets (total number)		×	________	=	________
— Analog Trunks		×	________	=	________
Customers:					
— Constant Term	1	×		=	
— Number of Customers		×		=	
Tone and Digit Switch		×		=	
MF Sender		×		=	
Conference Card		×		=	
Digitone Receiver		×		=	
Tone Detector		×		=	
		×		=	
DN Translator:					
— DNs		×	5.8	=	________
— ACD DNs		×	4	=	________
— ACD Positions		×	2	=	________
— DISA DNs		×	2	=	________
— Consoles		×		=	________
— Dial Intercom Groups		×	1	=	________

Worksheet 20
Memory size (Memory in SL-1 words) (Part 4 of 6)

Feature	Usage	×	PDS factor*	=	Memory**
DIG translator:					
— Maximum number of DIGs	_______	×	1	=	________
— DIGs	_______	×	2	=	________
— Number of Sets within DIGs	_______	×	2	=	________
Authorization Code:					
Constant Term	1	×	________	=	________
Authorization Codes		×	1.52	=	________
History File	1	×		=	
FGD ANI Database:					
— Constant Term	1	×		=	
— NPA Codes		×		=	
CDP:					
— Constant Term	1	×	________	=	________
— Steering Codes		×	3	=	________
— Route lists		×	8	=	________
— Number of Entries in Route Lists		×	3	=	________

Worksheet 20
Memory size (Memory in SL-1 words) (Part 5 of 6)

Feature	Usage	×	PDS factor*	=	Memory**
CPND:					
— Trunk Routes	_______	×	1	=	________
— Consoles	_______	×	1	=	________
— ACD DNs	_______	×	1	=	________
— Digital Set DNs	_______	×	1	=	________
— CPND Names	_______	×	20	=	________
— 1 digit DIG Groups	_______	×	11	=	________
— 2 digit DIG Groups	_______	×	101	=	________
ACD/NACD:					
— ACD DNs		×		=	
— NACD DNs		×		=	
— ACD Positions		×		=	
— ACD Agents		×	1	=	_______
— Customers		×	11	=	________

Worksheet 20
Memory size (Memory in SL-1 words) (Part 6 of 6)

Feature	Usage	×	PDS factor*	=	Memory**
BARS/NARS:			5884		
— Constant term	1	×	31.21	=	_________
— NPA Codes	________	×	1.06	=	_________
— NXX Codes	________	×	1.06	=	_________
— LOC Codes	________	×	1.06	=	_________
— SPN Codes	________	×	2	=	_________
— FCAS Tables	________	×		=	_________
Total PDS Impact (add up the Memory column) ____________SL-1 words					

*From Table 20 on page 443.

**SL-1 words of data store are 2 bytes in size. One SL-1 word of data occupies and entire SL-1 word of memory, even if the word size for the CP type is greater than 2 bytes. For example, one 2-byte SL-1 data word uses up one 4-byte word of Large System memory.

UDS Calculation

Worksheet 20
UDS calculation (Memory in SL-1 words) (Part 1 of 7)

Feature	Usage	×	UDS factor**	=	Memory**	Reference
Fixed Addr. Globals & OVL data	1	×		=		
500/2500 telephones		×		=		
i2004		×		=		
i2050		×		=		
M2006/2008 telephones		×		=		
M2016/2216/2616 telephones		×		=		
M2317 telephones		×		=		
M3900		×		=		
M3901		×		=		
M3902		×		=		
M3903		×		=		
M3904		×		=		
Consoles		×		=		
Add-on-Modules		×		=		
Displays		×		=		
DS/VMS access TNs						
Meridian Mail Ports		×		=		
Data Only Ports		×		=		

Worksheet 20
UDS calculation (Memory in SL-1 words) (Part 2 of 7)

Feature	Usage	×	UDS factor**	=	Memory**	Reference
ISDN BRI telephones:						
— Constant Term						
— MISP boards						
— DSLs	1					
Analog Trunks:						
— RAN Trunks		×		=		
— RLA Trunks		×		=		
— RLA Trunks		×		=		
— AUTOVON Trunks		×		=		
— ADM		×		=		
— Other Analog trunks		×		=		
Trunks (CDR)		×	9	=		
BRI Trunks		×		=		
Trunk Routes:						
— Trunk Routes		×		=		
— Trunks (total)		×	0.063	=		
DTI/DTI2/JDMI:						
— DTI Loops		×		=		
— DTI2 Loops		×		=		

Worksheet 20
UDS calculation (Memory in SL-1 words) (Part 3 of 7)

Feature	Usage	×	UDS factor**	=	Memory**	Reference
PRI/PRI2:						
— D-channels (PRI)		×		=		
— D-channels (PRI2)		×		=		
— Output Request Buffers		×	5	=		
— PRI Trunks		×	2	=		
— ISL Trunks			2	=		
Teletypes:						
— Teletypes (total)		×		=		
— CDR links		×		=		
— HS Links		×		=		
— APL Links		×		=		
— PMS Links		×		=		
— Other Links		×		=		

Worksheet 20
UDS calculation (Memory in SL-1 words) (Part 4 of 7)

Feature	Usage	×	UDS factor**	=	Memory**	Reference
Local Loops						
Remote Loops						
Secondary Tapes						
Customers						
Tone and Digit Switch		×				
MF Sender		×				
Conference Cards		×		=		
Digitone receiver		×		=		
Tone Detector		×		=		
Attendants		×		=		
Peripheral Signaling cards		×		=		
Background Terminals		×		=		
MSDL Cards		×		=		
LPIB		×	4	=		
HPIB (number of Groups)		×	128	=		
PBXOB (number of PS Cards)		×	640	=		
BCSOB (number of PS Cards)		×	640			
AML:						
— Constant Term		×				
— AML Links	1	×		=		

Worksheet 20
UDS calculation (Memory in SL-1 words) (Part 5 of 7)

Feature	Usage	×	UDS factor**	=	Memory**	Reference
ACD:						
— ACD DNs		×	298	=		
— ACD Positions		×	34	=		
— ACD-C: (add'l memory)						
— ACD-C routes		×	46	=		
— ACD-C Positions		×	44	=		
— ACD-C DN's		×	80	=		
— ACD-C Customers		×	240	=		
— ACD-C Trunks		×	1	=		
— ACD CRT		×	30	=		
BARS/NARS/CDP:						
— Customers		×	216	=		
— Route Lists		×	90	=		
— Routes with OHQ		×	20	=		
— NCOS defined		×	24	=		

Worksheet 20
UDS calculation (Memory in SL-1 words) (Part 6 of 7)

Feature	Usage	×	UDS factor**	=	Memory**	Reference
Call Registers:						
ISDN Fact						
Number of Calls Overflowed to all Target ACD DN's (A)						
Number of Calls Overflowed to Local Target DN's (B)		×	1	=		L
Number of expected Calls overflowed from source (C)		×	2.25	=		A
Snacd+Tnacd (= A + B + C)		×	-1.8	=		B
Number of CR's (Traffic >3000)		×	0.2	=		C
Total voice loop traffic (CCS)		×	1	=		D
ACD Inc. Trunks		×	0.04	=		E
Number of CR's (=(D+E+F)*L)		×	0.18	=		F
Number of CR's (Traffic <=3000)		×	1	=		G
System equipped ports		×	0.94	=		I
ACD Inc. Trunks		×	0.06	=		J
ACD Agent Sets		×	-0.94	=		K
Number of CR's (=(D+I+J+ K)*L)						
***Memory for Call Registers		×	1	=		

Worksheet 20
UDS calculation (Memory in SL-1 words) (Part 7 of 7)

Feature	Usage	×	UDS factor**	=	Memory**	Reference
Total PDS Impact (add up the Memory column) ___________SL-1 words						
*From Table 20 on page 446.						
**SL-1 words of data store are 2 bytes in size. One SL-1 word of data occupies and entire SL-1 word of memory, even if the word size for the CP type is greater than 2 bytes. For example, one 2-byte SL-1 data word uses up one 4-byte word of Large System memory.						
***Use only the last line from the Call Registers Part. **Call register count should still remain below the recommended maximum for the machine type and memory type configured.**						

PDS factors

Worksheet 20
PDS factors (Units in SL-1 words) (Part 1 of 3)

Feature	Units
Fixed Address Globals	11 019
500/2500 telephones*	57
CLASS sets	57
M2006/2008 telephones*	104
M2216/2616 telephones*	114
M2317 telephones*	130
M3900 telephones	130
ACD telephones	16
Add-on-Modules	32
Templates	16
Consoles	236
DS/VMS Access TNs	14.5
ISDN BRI:	
— MISP cards	542
— DSLs	153
— TSPs	180
— BRI DNs	47
Analog Trunks	54
* See “Protected Memory for Phone Sets: Detail” on page 452.	

Worksheet 20
PDS factors (Units in SL-1 words) (Part 2 of 3)

Feature	Units
Trunk Routes:	
— Constant term	1024
— Trunk Routes	238
ISDN PRI/PRI2/ISL:	
— D-channels	137
ISDN DTI/DTI2/JDMI:	
— DTI Loops	70
— DTI2 Loops	153
DISA DNs	18
Network:	
— Groups	49
— Local Loops	91
— Remote Loops	95
ODAS	3
Customers:	
— Constant Term	1000
— Customers	502
Tone and Digit Switch	2
MF Sender	2
Conference Card	2
Digitone Receiver	12
Tone Detector	3

Worksheet 20
PDS factors (Units in SL-1 words) (Part 3 of 3)

Feature	Units
DN Translator (Consoles)	125
Author. Code (Custom.)	199
FGD ANI Database:	
— Constant Term	43
— NPA Codes	547
CDP (Constant Term)	637
ACD/NACD:	
— ACD DNs	92
— NACD DNs	174 src 115 dest
— ACD Positions	30

UDS factors

Worksheet 20
UDS factors (Units in SL-1 words) (Part 1 of 3)

Feature	Units
Fixed Address Globals	27 948
500/2500 telephones	43.5
M2006/2008 telephones	68
M2216/2616 telephones	99
M2317 telephones	90.25
M3900 telephones	109
i2004 telephones	92
i2050 telephone	68
Consoles	141
Add-on-Modules	24
Displays	2
DS/VMS access TNs	16.5
ISDN BRI telephones:	
— Constant Term	298
— MISP cards	2270
— DSLs	264
— BRI line cards	96

Worksheet 20
UDS factors (Units in SL-1 words) (Part 2 of 3)

Feature	Units
Analog Trunks:	
— RAN trunks	74
Broadcast RAN trunks	
— RLA Trunks	46
— AUTOVON Trunks	156
— ADM	162
— Other Analog Trunks	151
Trunk Routes	198
BRI trunks	148
DTI/DTI2 JDMI:	
— DTI Loops	109
— DTI2 Loops	97
PRI/PRI2:	
— D-channels (PRI)	836
— D-channels (PRI2)	850
Teletypes:	
— Teletypes (total)	2085
— CDR links	128
— HS links	143
— APL links	311
— PMS links	130
— Other links	512
Local loops	69
Remote loops	93
Secondary Tapes	539

Worksheet 20
UDS factors (Units in SL-1 words) (Part 3 of 3)

Feature	Units
Customers	243
Tone and Digit Switch	59
MF Sender	59
Conference Cards	191
Digitone receiver	12
Tone Detector	12
PS Cards	59
Background terminals	96
MSDL cards	1395
AML (CSL):	
— Constant term	147
— AML Links	510
Call Registers	225

Default call register and buffer settings

Worksheet 20
Default call register and buffer settings (Part 1 of 2)

Generic Machine Type	61C CP PII / Succession 1000M Single Group	81C CP PII / Succession 1000M Multi Group
HPIB	3500	3500
LPIB	3500	3500
500B	2000	2000
SL1B	255	255
NCR	20 000	25 000
MGCR	25	25
CSQI	255	255
CSQO	255	255
Prompt Switch AML		
T1	4	4
T2	10	10
T3	5	5
N1	128	128
N2	8	8
K	7	7

Worksheet 20
Default call register and buffer settings (Part 2 of 2)

Generic Machine Type	61C CP PII / Succession 1000M Single Group	81C CP PII / Succession 1000M Multi Group
Prompt Switch VAS		
SECU	yes	yes
INTL	1	1
MCNT	1400*	1400*

Note 1: MCNT must be reduced to 300 if CCR and/or Meridian Link applications are used.

Note 2: In a system with MM.AML, ML and CCR, add the number of CSQI and CSQO to the CR requirement obtained from feature impact calculations.

Note 3: The above buffer estimation was based on relatively conservative scenarios which should cover most practical applications in the field. However, since most mathematical models deal with “average traffic”, so do the models. When traffic spikes occur, buffer overflow could still happen. In that case, you should raise the buffer size somewhat, depending on the availability of Call Registers (CRs). The maximum number of buffers allowed for CSQI and CSQO is 25% of NCR or 4095, which ever is less.

The buffer limit is the maximum number of CRs which can be used for that function out of the total CR pool. If the designated number is larger than needed, and there are still spare CRs, the unused CRs will not be tied up by this specific function. Therefore, there is little penalty of over stating the limit of buffer size (we might run out of CRs, if limits are not properly sets). As long as the system has a relatively large memory (CRs), a more generous allocation of buffers that the number recommended above is not discouraged.

For example, with a Large System Call Center (Max 25 000 CRs) using many applications (Meridian Mail, ML, CCR), it would be a good idea to set the CSQI/CSQO to a higher value (even up to the limit of 4095).

The above recommendation provides a relative requirement of various buffers. It should be viewed as a minimum buffer size needed to cover most applications under the constraint of a tight memory availability. When increases are to be made, they should be proportional to the above values except CSQI/CSQO which is relatively independent of other buffers and can be increased without affecting others.

Computing memory used

Worksheet 20
Memory used – Large System with NT5D10, NT5D03, CP PII CP cards

Memory item	×	Factor	Operation	Reference
PDS words	×	pf bytes/word	+	Notes 1 and 2
UDS words	×	pf bytes/word	+	Note 3
Code MB	×	1024 × 1024 bytes/MB	+	Note 4, Note 6
Patching and OS overhead MB	×	1024 × 1024 bytes/MB	+	Note 4
OS dynamic heap MB	×	1024 × 1024 bytes/MB	+	Note 4
		Sum	_____bytes	
	×	1.10		Note 5

Note 1: PDS is protected data store, as computed using Table 20 on page 430.

Note 2: PF is the packing factor—the number of bytes of memory occupied by a single SL-1 data word. For Option 61C/51C, pf = 4.

Note 3: UDS is Unprotected data store, as computed using Table 20 on page 436.

Note 4: These fields are taken from “Equipment summary” on page 421 and “Physical capacity” on page 423.

Note 5: A 10% margin is included to account for differences between releases and other variations too detailed for the scope of this document.

Note 6: For CP3,4 Processor , compute DRAM used (EPROM is for code and is not affected by user. DRAM is for data.) by performing all the calculations in the table except “Code”.

Determining whether system memory is adequate

Determine the amount of system memory by using Table 100 on page 366. Convert this quantity to bytes (x 1,024 x 1,024). In order for the system to have adequate memory for its feature load, Available memory minus Memory used must be greater than zero.

Protected Memory for Phone Sets: Detail

The protected data blocks for the various set types use varying amounts of memory according to what keys/features are configured on the set. The memory requirements shown in the tables above show only a “typical” (as determined by looking at a sampling of sites) size for the given set type. The tables below can be used to arrive at a precise memory requirement if the details of the feature configurations are known. The maximum size permitted for any set’s protected data block is 512 words.

PBX sets

The size of the protected line block for PBX sets is determined from the following (sizes are in SL-1 words):

Worksheet 20
Size of protected line block for PBX sets (Units in SL-1 words)

Feature	SL-1 Compool Variable(s)	Units
Basic Line Block	PPBXBLOCK (words 0-23)	24
Template Area	PBX_TEMPL_AREA (words 24-511 of PPBXBLOCK)	0-487
Card Block Component	1/4 PCARDBLOCK (= 10/4)	2.50

The key layout portion of the template requires:

$(4 + nf) \div rs$ words

where “nf” is the number of features defined for the set, and “rs” is the number of sets sharing the same template.

In addition to the basic line block, each feature requires extra data space as follows (sizes are in SL-1 words):

Worksheet 20
Data space requirements for PBX set features (Units in SL-1 words) (Part 1 of 2)

Feature	SL-1 Compool Variable(s) and/or comment	Units
ACD	P_ACD_KEY_DATA	17
Associate Set (AST)		2
Authcode	.AUTH_TEMPL_SIZE = .NAUT_MAX(6) * (((.AUTH_LEN_MAX(14) - 1)>>2) + 1)	6-24
Automatic Wakeup	HM_STRUCT	8
Call Forward Number	CFW_STRUC (4-24 digits/4)	1-8
Call Park	CALL_PARK_STRUC	2
Call Party Name Display	PBX_NAME_ENTRY	1
CFCT		2
CFNA/Hunting Number	CFNA_ENTRY	4
Dial Intercom Group	PBX_DIG_STRUC	2
DN	PBX_DN_STRUC	3
EFD DN	EFD_STRUC	4
EHT DN	EHT_STRUC	4
Enhanced Hot Line DN	((Number of digits in DN) ÷ 4) + 1 : 4 – 36 digits	2-10
FAXS	FAXS_BLK	17
FFC SCP PASS	FFC_SCPW_STRUC	2
Hot Line DN	((Number of digits in DN) ÷ 4) + 1 : 4 – 36 digits	2-10
HUNT	HUNT_STRUC	4
Internal Call Forward		19

Worksheet 20
Data space requirements for PBX set features (Units in SL-1 words) (Part 2 of 2)

Feature	SL-1 Compool Variable(s) and/or comment	Units
Last Number Redial	Number of digits in LNR DN ÷ 4 : (4 – .MAX_LNR_SIZE = 32) ÷ 4	1-8
Manual Line		2
Message Center DN		2
Message Registration	MR_SET_METER	1
Offhook Interdigit Index	OHAS_INDEXES	1
Pretranslation Enhancement	1/2 word (for 255 calling groups)	1/2
SCI/CCOS/RMS		2
Speed Call Controller	SPEED_CALL_STRUC	1
Speed Call User	SPEED_CALL_STRUC	1
Stored Number Redial	# digits in SNR DN / 4 : (4 – .MAX_SNR_DIGITS = 32) ÷ 4	1-8
System Speed Call User	SPEED_CALL_STRUC	1
Tenant Number	TENANT_NUMBER	1

Digital sets

The size of the protected line block for SL-1 sets is determined from the following (Units are expressed in SL-1 words):

Worksheet 20
Size of protected line block for Meridian 1 sets (Units in SL-1 words)

Feature	SL-1 Compool Variable(s)	Units
Basic Line Block	PBCSBLOCK (words 0-45)	46
Template Area	BCS_DATA (words 46-511 of PBCSBLOCK)	0–466
Card Block Component	1/4 PCARDBLOCK (9/4)	2.25

The key layout portion of the template for the SL-1 basic set requires (4 + the number of key lamp strips × 10) ÷ rs words where rs equals the number of sets sharing the same template. For digital sets, the requirement is as follows:

- M2006 = 10 + (number of non-key features) ÷rs
- M2008 = 10 + (number of non-key features) ÷ rs
- M2216 = 20 + 30 × (number of AOM) + (number of non-key features) ÷ rs
- M2616 = 20 + 30 × (number of AOM) + (number of non-key features) ÷ rs
- M2317 = 34 + (number of non-key features) ÷ rs
- M3900 = 34 + (number of non-key features) ÷ rs
- i2004 = 20 + (number of non-key features) ÷ rs
- i2050 = 20 + (number of non-key features) ÷ rs

where:

- rs is the number of sets sharing the same template
- number of AOM equals number of add-on modules

In addition to the basic line block requirement, each feature requires extra data space as follows (Units are expressed in SL-1 words):

Worksheet 20
Data space requirements for Meridian 1 set features (Units in SL-1 words) (Part 1 of 6)

Feature	SL-1 Compool Variable(s), service change format, and/or comment	Units
ACD Agent and ID Key	.acd_agent p_acd_key_data KEY xx ACD xxxx(xxx)* yyyy(yyy) *(xxx) - up to 7 digs w/DNXP pkg	17
ACD Display Calls Waiting Key	acd_dwc_ext KEY xx DWC yyyy(yyy)	2
ACD Agent Key (for supervisor)	acd_agt_ext KEY xx AGT yyyy(yyy)	2
ACD Enable Interflow Key	acd_eni_ext KEY xx ENI yyyy(yyy)	2
ACD Night Service DN	acd_nsvc_struc KEY xx NSVC yyyy(yyy)	2
Associate Set (AST)	bcs_ast_struc AST xx yy	3
Authcode (non-key)	.auth_templ_size (6) * (((.AUTH_LEN_MAX (14) - 1)>>2)+1) AUTH n xxxx	6-24
Autodial Key	(4-32 digits/4) .max_adl_size = 31 KEY xx ADL yy (zzzz)	1-8
Busy/Forward Status Key	bfs_struct KEY xx BFS tn	1
Call Forward Key	cfw_struc : (.cfw_default (4) or (.MAX_CFW_SIZE=31 + 1)digits/4)	1-8
No Hold Conference and Autodial	(same as autodial) KEY xx CA yy zzzz	1-8

Worksheet 20
Data space requirements for Meridian 1 set features (Units in SL-1 words) (Part 2 of 6)

Feature	SL-1 Compool Variable(s), service change format, and/or comment	Units
No Hold Conference and Direct Hotline	(htl_dn_size + 3 >>2) + wordoffset(bcs_hot_ter_dn) = (3:34)>>2 + 4 = 4-12 KEY xx CH D yy xxxx	4-12
No Hold Conference and Hotline List	wordoffset(bcs_hot_ter_dn) = 4 KEY xx CH L yyyy	4
No Hold Conference and Speed Call	speed_call_struc KEY xx CS yyyy	1
Dial Intercom Group Key	bcs_dig_struc KEY xx DIG xxxx yy R/V	2
DID Route Control	BCS_DRC_STRUC KEY xx DRC yyy	1
Group Call Key	bcs_grcal_entry KEY xx GRC yy	1
Hotline - One Way, Two Way or Intercom	(htl_dn_size + 3 >> 2) + wordoffset(bcs_hot_ter_dn) = 3:34>>2 + 4 = 4-12 KEY xx HOT D dd yyyy(yyy) KEY xx HOT D dd num DN m KEY xx HOT D nn x...x yyyy(yyy) KEY xx HOT I dd num m	4-12
Hotline - One Way or Two Way List	wordoffset(bcs_hot_ter_dn) KEY xx HOT L bbb KEY xx HOT L bbb yyyy(yyy)	4
Internal Call Forward Key	.cfw_default (1) or ((#digs(31) - 1)/4 + 1) : max 8 .max_cfw_size=31 KEY xx ICF 4-(16)-31 xxxx	1-8
Loudspeaker	bcs_dn_struc KEY xx LSPK yyyy	4

Worksheet 20
Data space requirements for Meridian 1 set features (Units in SL-1 words) (Part 3 of 6)

Feature	SL-1 Compool Variable(s), service change format, and/or comment	Units
Multiple Call Non-ringing DN Key	bcs_dn_entry KEY xx MCN yyyy(yyy)	4
Multiple Call Ringing DN Key	bcs_dn_entry KEY xx MCR yyyy(yyy)	4
Message Registration Key	mr_set_meter KEY xx MRK	1
Message Waiting Key	mwc_entry KEY xx MWK yyyy(yyy)	4
Call Park Key	call_park_struc KEY xx PRK	2
Private Line Non-ringing Key	bcs_dn_entry KEY xx PVN yyyy	4
Private Line Ringing Key	bcs_dn_entry KEY xx PVR yyyy	4
Stored Number Redial Key	.max_rdl_size (31): (1+#saved dn digs(3-31))/4 + 1 KEY xx RDL (yy)	2-8
Ringing Number Pickup Key	bcs_rnpg_entry KEY xx RNP	1
Radio Paging	bcs_dn_entry KEY xx RPAG	4
Speed Call Controller Key	speed_call_struc KEY xx SCC yyyy	1
Single Call Non-ringing DN	bcs_dn_entry KEY xx SCN yyyy	4
Single Call Ringing DN	bcs_dn_entry KEY xx SCR yyyy	4

Worksheet 20
Data space requirements for Meridian 1 set features (Units in SL-1 words) (Part 4 of 6)

Feature	SL-1 Compool Variable(s), service change format, and/or comment	Units
Speed Call User Key	speed_call_struc KEY xx SCU yyyy	1
Signaling Key	bcs_dn_entry KEY xx SIG yyyy(yyy)	4
System Speed Call Controller Key	speed_call_struc KEY xx SSC yyyy	1
System Speed Call User Key	speed_call_struc KEY xx SSU uu	1
Voice Call Key	bcs_dn_entry KEY xx VCC yyyy	4
Non-key Features		
Data Equipment Mode (flex voice/data tn)	dtm_struc DEM DTE (DCE)	1
Flexible CFNA DN for External Calls	efd_struc EFD xxxx	4
Hunt DN for External Calls	eht_struc EHT xxxx	4
Flexible Call Forward No Answer	afdn_struc FDN xxxx	4
Offhook Alarm Security DN Index for Forced Out ofSservice	ohas_indexes FSVC (0) - 9	1
Hunt DN (chain) for Internal Calls	hunt_struc HUNT xxxx	4
Alternate Hunt DN (chain) for Internal Calls	ahnt_struc AHNT xxxx	4

Worksheet 20
Data space requirements for Meridian 1 set features (Units in SL-1 words) (Part 5 of 6)

Feature	SL-1 Compool Variable(s), service change format, and/or comment	Units
Alternate Hunt DN for External Calls	aeht_struc AEHT xxxx	4
Alternate Flexible CFNA DN for External Calls	aefd_struc AEFD xxxx	4
Number of Key Lamp Strips	1 word per KLS in range KLS 1-7	1-7
Last Number Redial Size	.lnr_default(4) or ((xx+1)/4) LNRS xx (4-(16)-32)	1-8
Second DN Sharing Voice Mailbox	bcs_dn_struc SECOND_DN xxxx(xxx)	3
Station Control Password	ffc_scpw_struc SCPW xxxxx	2
Tenant	tenant_number TEN 1-511	1
Template area users for which commands are implicit or entered outside of LD 11		
Ringing Change Key	supp_features	5
Notification Key Lamp	nkl_data	1
Hospitality Data	hsp_set_data	2
Hotel/Motel Info	hm_struct	8
Campon Priorities	povr_struc	1
Sar Group	save_bcs_sgrp	1
Boss-Secretary Filtering - boss	boss_struc	3

Worksheet 20
Data space requirements for Meridian 1 set features (Units in SL-1 words) (Part 6 of 6)

Feature	SL-1 Compool Variable(s), service change format, and/or comment	Units
Boss-Secretary Filtering - sec'y	sec_struc	1
Call Party Name Display	PBX_NAME_ENTRY	1
FAXS	FAXS_BLK	17
Xdata Unit Downloadable Parameters	xdata_sc_parms	2

Worksheet 21: Mass Storage size (auxiliary processors)

This table shows available space on auxiliary processor storage media.

Worksheet 21
Mass storage space available on auxiliary processors

Product name	System tape (155 MB)		Applications tape (155 MB)		Hard disk		
	MB Used	MB Avail	MB Used	MB Avail	MB Used	MB Avail	Disk Size
Meridian Link Module	38	117	6.5	148.5	44.5	127.5	172
Customer Controlled Routing	38	117	10.5	144.5	48.5	123.5	172
911 services	38	117					
Meridian MAX4 MiniMAX	25	130	28	127	82	90	172
Meridian MAX5	45	110	25	130	123	397	520
Interactive Voice Response	45	110	75	80	155	85	240

Appendix B: Reference tables

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Trunk traffic – Poisson 1 percent blocking

Reference Table 1
Trunk traffic – Poisson 1 percent blocking (Part 1 of 2)

Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS
1	0.4	31	703	61	1595	91	2530	121	3488
2	5.4	32	732	62	1626	92	2563	122	3520
3	15.7	33	760	63	1657	93	2594	123	3552
4	29.6	34	789	64	1687	94	2625	124	3594
5	46.1	35	818	65	1718	95	2657	125	3616
6	64	36	847	66	1749	96	2689	126	3648
7	84	37	876	67	1780	97	2721	127	3681
8	105	38	905	68	1811	98	2752	128	3713
9	126	39	935	69	1842	99	2784	129	3746
10	149	40	964	70	1873	100	2816	130	3778
11	172	41	993	71	1904	101	2847	131	3810
12	195	42	1023	72	1935	102	2879	132	3843
13	220	43	1052	73	1966	103	2910	133	3875
14	244	44	1082	74	1997	104	2942	134	3907
15	269	45	1112	75	2028	105	2974	135	3939
16	294	46	1142	76	2059	106	3006	136	3972
17	320	47	1171	77	2091	107	3038	137	4004
18	346	48	1201	78	2122	108	3070	138	4037
19	373	49	1231	79	2153	109	3102	139	4070
20	399	50	1261	80	2184	110	3135	140	4102

Note: For trunk traffic greater than 4427 CCS, allow 29.5 CCS per trunk.

Reference Table 1
Trunk traffic – Poisson 1 percent blocking (Part 2 of 2)

Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS
21	426	51	1291	81	2215	111	3166	141	4134
22	453	52	1322	82	2247	112	3198	142	4167
23	480	53	1352	83	2278	113	3230	143	4199
24	507	54	1382	84	2310	114	3262	144	4231
25	535	55	1412	85	2341	115	3294	145	4264
26	562	56	1443	86	2373	116	3326	146	4297
27	590	57	1473	87	2404	117	3359	147	4329
28	618	58	1504	88	2436	118	3391	148	4362
29	647	59	1534	89	2467	119	3424	149	4395
30	675	60	1565	90	2499	120	3456	150	4427

Note: For trunk traffic greater than 4427 CCS, allow 29.5 CCS per trunk.

Trunk traffic – Poisson 2 percent blocking

Reference Table 2
Trunk traffic – Poisson 2 percent blocking (Part 1 of 2)

Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS
1	0.4	31	744	61	1659	91	2611	121	3581
2	7.9	32	773	62	1690	92	2643	122	3614
3	20.9	33	803	63	1722	93	2674	123	3647
4	36.7	34	832	64	1752	94	2706	124	3679
5	55.8	35	862	65	1784	95	2739	125	3712
6	76.0	36	892	66	1816	96	2771	126	3745
7	96.8	37	922	67	1847	97	2803	127	3777
8	119	38	952	68	1878	98	2838	128	3810
9	142	39	982	69	1910	99	2868	129	3843
10	166	40	1012	70	1941	100	2900	130	3875
11	191	41	1042	71	1973	101	2931	131	3910
12	216	42	1072	72	2004	102	2964	132	3941
13	241	43	1103	73	2036	103	2996	133	3974
14	267	44	1133	74	2067	104	3029	134	4007
15	293	45	1164	75	2099	105	3051	135	4039
16	320	46	1194	76	2130	106	3094	136	4072
17	347	47	1225	77	2162	107	3126	137	4105
18	374	48	1255	78	2194	108	3158	138	4138
19	401	49	1286	79	2226	109	3190	139	4171
20	429	50	1317	80	2258	110	3223	140	4204

Note: For trunk traffic greater than 4533 CCS, allow 30.2 CCS per trunk.

Reference Table 2
Trunk traffic – Poisson 2 percent blocking (Part 2 of 2)

Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS
21	458	51	1348	81	2290	111	3255	141	4237
22	486	52	1374	82	2322	112	3288	142	4269
23	514	53	1352	83	2354	113	3321	143	4302
24	542	54	1441	84	2386	114	3353	144	4335
25	571	55	1472	85	2418	115	3386	145	4368
26	562	56	1503	86	2450	116	3418	146	4401
27	627	57	1534	87	2482	117	3451	147	4434
28	656	58	1565	88	2514	118	3483	148	4467
29	685	59	1596	89	2546	119	3516	149	4500
30	715	60	1627	90	2578	120	3548	150	4533

Note: For trunk traffic greater than 4533 CCS, allow 30.2 CCS per trunk.

Digitone receiver requirements – Model 1

Reference Table 3
Digitone receiver requirements – Model 1

Number of DTRs	Max. number of Digitone lines	DTR load (CCS)	Number of DTRs	Max. number of Digitone lines	DTR load (CCS)
2	7	2	17	1181	319
3	33	9	18	1244	336
4	69	19	19	1348	364
5	120	33	20	1455	393
6	179	49	21	1555	420
7	249	68	22	1662	449
8	332	88	23	1774	479
9	399	109	24	1885	509
10	479	131	25	1988	537
11	564	154	26	2100	567
12	659	178	27	2211	597
13	751	203	28	2325	628
14	848	229	29	2440	659
15	944	255	30	2555	690
16	1044	282			

Note: See “Step 5: Calculate Digitone receiver requirements” for Model 1 assumptions.

Digitone receiver requirements – Model 2

Reference Table 4
Digitone receiver requirements – Model 2

Number of DTRs	Max. number of Digitone lines	DTR load (CCS)	Number of DTRs	Max. number of Digitone lines	DTR load (CCS)
2	2	2	17	843	253
3	21	7	18	920	276
4	52	15	19	996	299
5	90	27	20	1076	323
6	134	40	21	1153	346
7	183	55	22	1233	370
8	235	71	23	1316	395
9	293	88	24	1396	419
10	353	107	25	1480	444
11	416	126	26	1563	469
12	483	145	27	1650	495
13	553	166	28	1733	520
14	623	187	29	1816	545
15	693	208	30	1903	571
16	770	231			

Note: See “Step 5: Calculate Digitone receiver requirements” for Model 2 assumptions.

Digitone receiver requirements – Model 3

Reference Table 5
Digitone receiver requirements – Model 3

Number of DTRs	Max. number of Digitone lines	DTR load (CCS)	Number of DTRs	Max. number of Digitone lines	DTR load (CCS)
2	5	2	17	862	319
3	22	9	18	908	336
4	50	19	19	983	364
5	87	33	20	1062	393
6	132	49	21	1135	420
7	180	68	22	1213	449
8	234	88	23	1294	479
9	291	109	24	1375	509
10	353	131	25	1451	537
11	415	154	26	1532	567
12	481	178	27	1613	597
13	548	203	28	1697	628
14	618	229	29	1781	659
15	689	255	30	1864	690
16	762	282			

Note: See “Step 5: Calculate Digitone receiver requirements” for Model 3 assumptions.

Digitone receiver requirements – Model 4

Reference Table 6
Digitone receiver requirements – Model 4

Number of DTRs	Max. number of Digitone lines	DTR load (CCS)	Number of DTRs	Max. number of Digitone lines	DTR load (CCS)
2	4	2	17	683	253
3	18	7	18	745	276
4	41	15	19	808	299
5	72	27	20	872	323
6	109	40	21	935	346
7	148	55	22	1000	370
8	193	71	23	1067	395
9	240	88	24	1132	419
10	291	107	25	1200	444
11	340	126	26	1267	469
12	391	145	27	1337	495
13	448	166	28	1405	520
14	505	187	29	1472	545
15	562	208	30	1543	571
16	624	231			

Note: See “Step 5: Calculate Digitone receiver requirements” for Model 4 assumptions.

Digitone receiver load capacity – 6 to 15 second holding time

Reference Table 7
Digitone receiver load capacity – 6 to 15 second holding time (Part 1 of 3)

Number of DTRs	Average holding time in seconds									
	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0
2	3	2	2	2	2	2	2	2	2	2
3	11	10	10	9	9	9	9	8	8	8
4	24	23	22	21	20	19	19	19	18	18
5	41	39	37	36	35	34	33	33	32	32
6	61	57	55	53	52	50	49	49	48	47
7	83	78	75	73	71	69	68	67	66	65
8	106	101	97	94	91	89	88	86	85	84
9	131	125	120	116	113	111	109	107	106	104
10	157	150	144	140	136	133	131	129	127	126
11	185	176	170	165	161	157	154	152	150	148
12	212	203	196	190	185	182	178	176	173	171
13	241	231	223	216	211	207	203	200	198	196
14	270	259	250	243	237	233	229	225	223	220
15	300	288	278	271	264	259	255	251	248	245
16	339	317	307	298	292	286	282	278	274	271
17	361	346	335	327	320	313	310	306	302	298

Note: Load capacity is measured in CCS.

Reference Table 7
Digitone receiver load capacity – 6 to 15 second holding time (Part 2 of 3)

Number of DTRs	Average holding time in seconds									
	6	7	8	9	10	11	12	13	14	15
18	391	377	365	356	348	342	336	331	327	324
19	422	409	396	386	378	371	364	359	355	351
20	454	438	425	414	405	398	393	388	383	379
21	487	469	455	444	435	427	420	415	410	406
22	517	501	487	475	466	456	449	443	438	434
23	550	531	516	504	494	487	479	472	467	462
24	583	563	547	535	524	515	509	502	497	491
25	615	595	579	566	555	545	537	532	526	521
26	647	628	612	598	586	576	567	560	554	548
27	680	659	642	628	618	607	597	589	583	577
28	714	691	674	659	647	638	628	620	613	607
29	746	724	706	690	678	667	659	651	644	637
30	779	758	738	723	709	698	690	682	674	668
31	813	792	771	755	742	729	719	710	703	696
32	847	822	805	788	774	761	750	741	733	726
33	882	855	835	818	804	793	781	772	763	756
34	913	889	868	850	836	825	812	803	795	787
35	947	923	900	883	867	855	844	835	826	818
36	981	957	934	916	900	886	876	866	857	850

Note: Load capacity is measured in CCS.

Reference Table 7
Digitone receiver load capacity – 6 to 15 second holding time (Part 3 of 3)

Number of DTRs	Average holding time in seconds									
	6	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
37	1016	989	967	949	933	919	909	898	889	881
38	1051	1022	1001	982	966	951	938	928	918	912
39	1083	1055	1035	1015	999	984	970	959	949	941
40	1117	1089	1066	1046	1029	1017	1002	990	981	972

Note: Load capacity is measured in CCS.

Digitone receiver load capacity – 16 to 25 second holding time

Reference Table 8
Digitone receiver load capacity – 16 to 25 second holding time (Part 1 of 3)

Number of DTRs	Average holding time in seconds									
	16	17	18	19	20	21	22	23	24	25
1	0	0	0	0	0	0	0	0	0	0
2	2	2	2	2	2	2	2	2	2	2
3	8	8	8	8	8	8	8	8	8	8
4	18	18	18	18	18	17	17	17	17	17
5	31	31	31	30	30	30	30	30	30	29
6	47	46	46	45	45	45	45	44	44	44
7	64	63	63	62	62	62	61	61	61	60
8	83	82	82	81	80	80	79	79	79	78
9	103	102	101	100	100	99	99	98	98	97
10	125	123	122	121	121	120	119	119	118	118
11	147	145	144	143	142	141	140	140	139	138
12	170	168	167	166	165	164	163	162	161	160
13	193	192	190	189	188	186	185	184	184	183
14	218	216	214	213	211	210	209	208	207	206
15	243	241	239	237	236	234	233	232	231	230
16	268	266	264	262	260	259	257	256	255	254
17	294	292	290	288	286	284	283	281	280	279

Note: Load capacity is measured in CCS.

Reference Table 8
Digitone receiver load capacity – 16 to 25 second holding time (Part 2 of 3)

Number of DTRs	Average holding time in seconds									
	16	17	18	19	20	21	22	23	24	25
18	322	319	317	314	312	311	309	308	306	305
19	347	344	342	339	337	335	334	332	331	329
20	374	371	368	366	364	361	360	358	356	355
21	402	399	396	393	391	388	386	385	383	381
22	431	427	424	421	419	416	414	412	410	409
23	458	454	451	448	445	442	440	438	436	434
24	486	482	478	475	472	470	467	465	463	461
25	514	510	506	503	500	497	495	492	490	488
26	544	539	535	532	529	526	523	521	518	516
27	573	569	565	561	558	555	552	549	547	545
28	603	598	594	590	587	584	581	578	576	573
29	631	626	622	618	614	611	608	605	602	600
30	660	655	651	646	643	639	636	633	631	628
31	690	685	680	676	672	668	665	662	659	656
32	720	715	710	705	701	698	694	691	688	686
33	751	745	740	735	731	727	724	721	718	715
34	782	776	771	766	761	757	754	750	747	744
35	813	807	801	796	792	788	784	780	777	774
36	841	835	829	824	820	818	814	810	807	804

Note: Load capacity is measured in CCS.

Reference Table 8
Digitone receiver load capacity – 16 to 25 second holding time (Part 3 of 3)

Number of DTRs	Average holding time in seconds									
	16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
37	872	865	859	854	849	845	841	837	834	831
38	902	896	890	884	879	875	871	867	863	860
39	934	927	921	914	909	905	901	897	893	890
40	965	958	952	945	940	936	931	927	923	920
Note: Load capacity is measured in CCS.										

Digitione receiver requirement – Poisson 0.1 percent blocking

Reference Table 9
Digitone receiver requirements – Poisson 0.1 percent blocking (Part 1 of 2)

Number of DTRs	DTR load (CCS)	Number of DTRs	DTR load (CCS)
1	0	26	469
2	2	27	495
3	7	28	520
4	15	29	545
5	27	30	571
6	40	31	597
7	55	32	624
8	71	33	650
9	88	34	676
10	107	35	703
11	126	36	729
12	145	37	756
13	166	38	783
14	187	39	810
15	208	40	837
16	231	41	865
17	253	42	892
18	276	43	919
19	299	44	947
20	323	45	975

Reference Table 9
Digitone receiver requirements – Poisson 0.1 percent blocking (Part 2 of 2)

Number of DTRs	DTR load (CCS)	Number of DTRs	DTR load (CCS)
21	346	46	1003
22	370	47	1030
23	395	48	1058
24	419	49	1086
25	444	50	1115

Conference and TDS loop requirements

Reference Table 10
Conference and TDS loop requirements

Network loops required at 2 years	TDS loops required	Conference loops required
1–12	1	1
13–24	2	2
25–36	3	3
37–48	4	4
49–60	5	5
61–72	6	6
73–84	7	7
85–96	8	8
97–108	9	9
109–120	10	10

Digitone receiver provisioning

Reference Table 11
Digitone receiver provisioning (Part 1 of 3)

DTR CCS	DTR ports	DTR CCS	DTR ports
1–2	2	488–515	24
3–9	3	516–545	25
10–19	4	546–576	26
20–34	5	577–607	27
35–50	6	608–638	28
51–69	7	639–667	29
70–89	8	668–698	30
90–111	9	699–729	31
112–133	10	730–761	32
134–157	11	762–793	33
158–182	12	794–825	34
183–207	13	826–856	35
208–233	14	857–887	36
234–259	15	888–919	37
260–286	16	920–951	38
287–313	17	952–984	39
314–342	18	985–1017	40
343–371	19	1018–1050	41
372–398	20	1051–1084	42
399–427	21	1085–1118	43
428–456	22	1119–1153	44
457–487	23	1154–1188	45

Reference Table 11
Digitone receiver provisioning (Part 2 of 3)

DTR CCS	DTR ports	DTR CCS	DTR ports
1189–1223	46	1961–1995	68
1224–1258	47	1996–2030	69
1259–1293	48	2031–2065	70
1294–1329	49	2066–2100	71
1330–1365	50	2101–2135	72
1366–1400	51	2136–2170	73
1401–1435	52	2171–2205	74
1436–1470	53	2206–2240	75
1471–1505	54	2241–2275	76
1506–1540	55	2276–2310	77
1541–1575	56	2311–2345	78
1576–1610	57	2346–2380	79
1611–1645	58	2381–2415	80
1646–1680	59	2416–2450	81
1681–1715	60	2451–2485	82
1716–1750	61	2486–2520	83
1751–1785	62	2521–2555	84
1786–1802	63	2556–2590	85
1821–1855	64	2591–2625	86
1856–1890	65	2626–2660	87
1891–1926	66	2661–2695	88
1926–1960	67	2696–2730	89

Reference Table 11
Digitone receiver provisioning (Part 3 of 3)

DTR CCS	DTR ports	DTR CCS	DTR ports
2731–2765	90	2941–2975	96
2766–2800	91	2976–3010	97
2801–2835	92	3011–3045	98
2836–2870	93	3046–3080	99
2871–2905	94	3081–3115	100
2906–2940	95	3116–3465	101
Note: Provisioning assumes an 11-second holding time.			

Appendix C: Glossary

AML

Application Module Link

CCAR

Call Capacity Reporting Feature (TFS004)

CCR

Customer Controlled Routing

CCAR

Enhanced Call Capacity Reporting Feature (TFS004)

CDR

Call Detail Recording

CE

Common Equipment

CSL

Command and Status Link

EPE

Enhanced Peripheral Equipment

HER

Host Enhanced Routing

HEVP

Host Enhanced Voice Processing

HSL

High Speed Link

IPE

Intelligent Peripheral Equipment

MISP

Multi-purpose ISDN Signaling Processing (card)

MIVR

Meridian Interactive Voice Response

ML

Meridian Link

MSDL

Multi-purpose Serial Data Link (card)

MUS

Music on hold

RAN

Recorded Announcement (trunk)

TDS/CON

Tone and Digit Switch/Conference (card)

UEM

Universal Equipment Module

XNET

Superloop Network Card, a card in IPE

XUT

Extended Universal Trunk (card)

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Meridian 1, Succession 1000M

Large System

Planning and Engineering

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