Meridian 1

Meridian 1

System engineering

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Standard, release 3.0. This document is reissued to include technical content updates. Due to the extent of the changes revision bars are omitted.

December 31, 1992

Standard, release 4.0. This document is reissued to include information on system option 81 and equipment required for compatibility with X11 release 18. Only new information and changes to technical content are noted by revision bars in the margins.

> **Note:** Product description information is provided in *Meridian 1 system overview* (553-3001-100). That information was formerly duplicated in this document.

April 1, 1993

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June 1999

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About this document

This document provides guidelines for:

— determining the equipment requirements for a system installation

— configuring and assigning equipment in the system

— distributing traffic equally over the system components

— maintaining traffic distribution and equipment utilization levels when adding or removing equipment, or when altering the system configuration

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 Northern Telecom representative and use a configuration tool, such as Autoquote or Meridian Configurator, to fully engineer a system.

Memory values, which vary for each generic of software, are given in *Meridian 1 capacity engineering* (553-3001-149).

References

See the *Meridian 1 planning and engineering guide* for:

— *Meridian 1 system overview* (553-3001-100)

— *Meridian 1 installation planning* (553-3001-120)

— *Meridian 1 power engineering* (553-3001-152)

— *Spares planning* (553-3001-153)

— *Meridian 1 equipment identification* (553-3001-154)

See the *Meridian 1 installation and maintenance guide* for:

- *Meridian 1 system installation procedures* (553-3001-210)
- *Circuit card installation and testing* (553-3001-211)
- *Telephone and attendant console installation* (553-3001-215)

See the *X11 software guide* for an overview of software architecture, procedures for software installation and management, and a detailed description of all X11 features and services. This information is contained in two documents:

- *X11 software management* (553-3001-300)
- *X11 features and services*

See the *X11 input/output guide* for a description of all administration and maintenance programs, and *X11 system messages guide* for information about system messages.

Module configuration

This document contains information about the following modules:

— NT5D21 Core/Network Module

— NT5K11 EEPE Module

— NT6D60 Core Module

— NT8D13 Peripheral Equipment (PE) Module

— NT8D35 Network Module

— NT8D36 InterGroup Module

— NT8D37 Intelligent Peripheral Equipment (IPE) Module

— NT8D47 Remote Peripheral Equipment (RPE) Module

Note: For information on modules that house equipment for specific applications, such as Meridian Mail and Meridian Link, see the document for that application.

Each type of module is available in AC-powered and DC-powered versions (except for the NT5K11 EEPE Module, which is available in DC powered versions only).

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.)

NT5K11 Enhanced Existing Peripheral Equipment module

The NT5K11 Enhanced Existing Peripheral Equipment module is available in international markets only.

The NT5K11 Enhanced Existing Peripheral Equipment (EEPE) module is a DC powered module equipped with an NT5K12 Enhanced Peripheral Equipment (EPEPS) Power Supply. The module supports sixteen peripheral equipment line/trunk cards.

Connections for two NT5K10 Dual Loop (DLB) Buffers and two NT5K09 Quad Density DIGITONE (QDTR) Receivers are at the rear of the module. Each set of DLBs and QDTRs support a section of eight line/trunk cards.

The capacity of the EEPE module is 256 Integrated Voice and Data (IVD) or analog lines. A typical configuration of the module, however, includes a combination of line and trunk cards which provide about 196 lines with the appropriate trunks. The number required per system depends on the system size.

> ***Note:*** The EEPE Module does not support IPE cards. The IPE cards are housed in an NT8D11 CE/PE Module or an NT8D37 IPE Module.

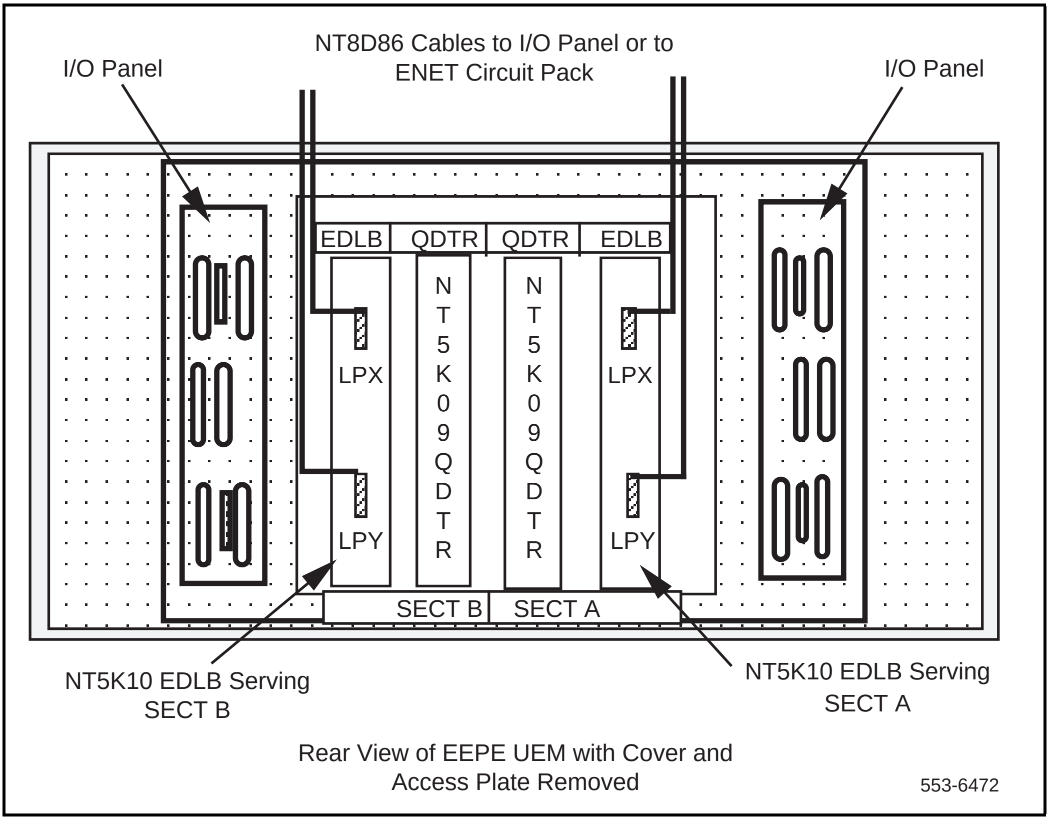
The EEPE Module contains 18 card slots at the front of the cabinet and 4 at the rear of the cabinet.

The rear card slots are divided into sections A and B, each section having two card slots (see Figure 1):

— slot 1: section A and B: NT5K10 Dual Loop Buffer

slot 2: section A and B: NT5K09 Quad Density Digitone Receiver

Figure 1
EEPE rear card slot assignment

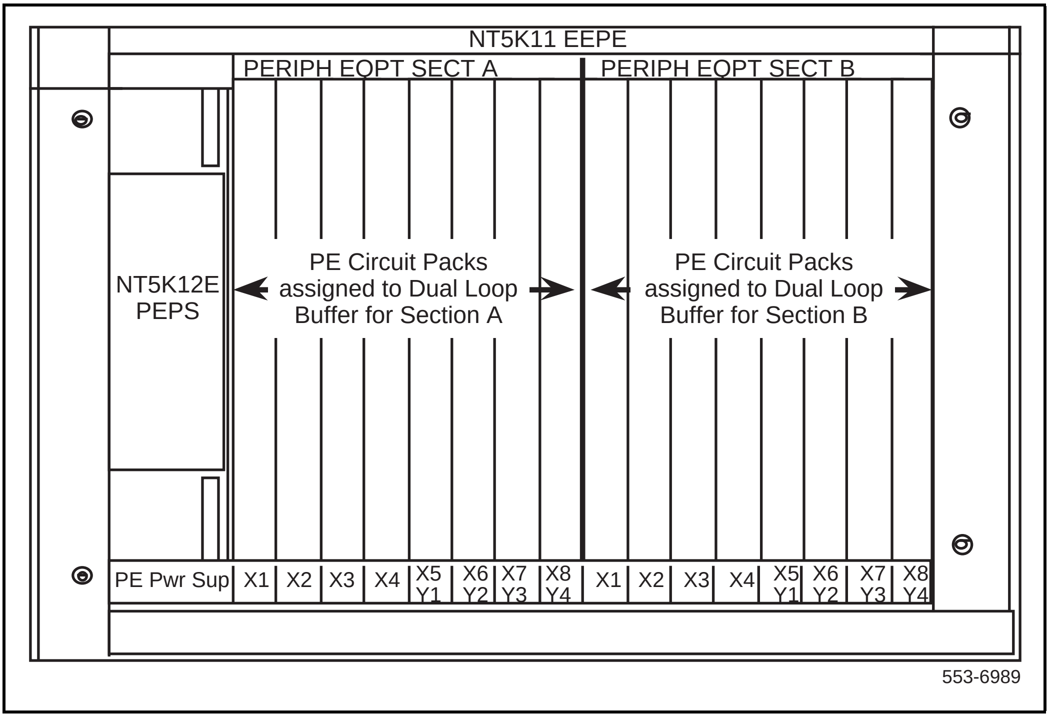


the front card slots (see Figure 2):

— slot 1 and 2: nt5k12 enhanced peripheral equipment power supply

slot 3–18:sl-1 line cards
500-2500 line cards
analog trunk cards

Figure 2
EEPE front card slot assignment



NT5D21 Core/Network Module

This module is used in options 51C, 61C, and 81C with X11 release 21 or higher:

— Option 51C, a single CPU, half-network, requires one Core/Network Module.

— Options 61C and 81C, a dual CPU, full-group 61C system and up to five-group 81C system, requires 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 CPU, memory, and disk drive equipment listed below (see Figure 3):

In the section labeled NET:

— slots 0–7: NT8D04 Superloop Network Card
NT8D17 Conference/Tone and Digit Switch (TDS) Card
QPC414 Network 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

— slot 8: QPC412 InterGroup Switch for 81C and a spare slot for 51C and 61C

— slot 9: QPC412 InterGroup Switch for 81C or QPC471 Clock Controller for options 51C and 61C, if required

— 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 (CNI) Card

— slot 13: NT6D65 Core to Network Interface (CNI) Card for 81C and a spare slot for options 51C and 61C

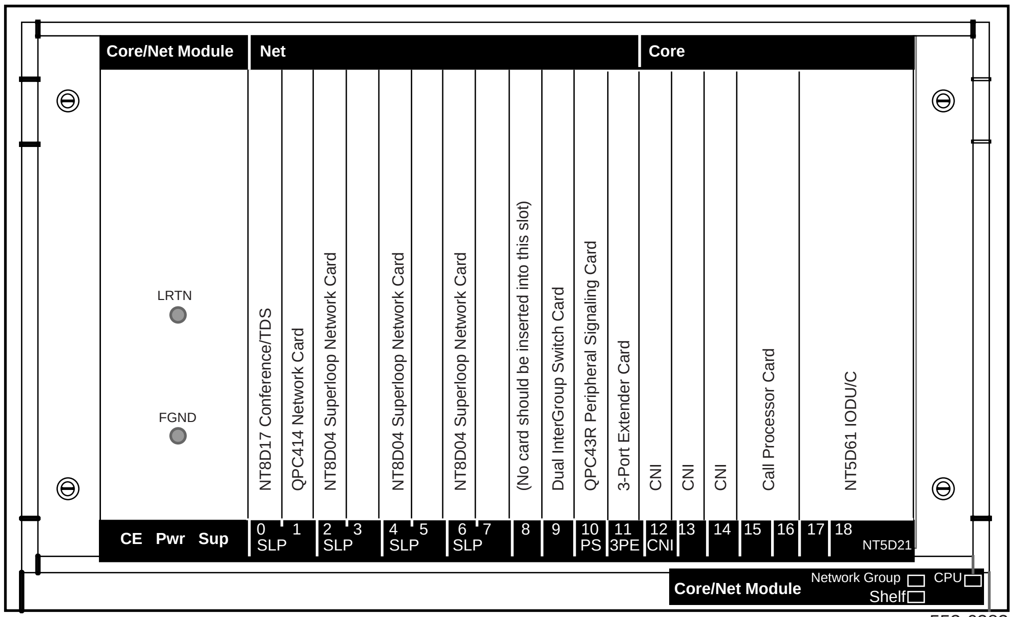
— slot 14: NT6D65 Core to Network Interface (CNI) Card for 81C and a spare slot for options 51C and 61C

— 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.

Figure 3
NT5D21 Core/Network Module configured as option 81C



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NT6D60 Core Module

This module is used in option 81. Two Core Modules are required.

The Core Module provides 11 card slots for the common control complex (CPU, memory, and mass storage functions) and 8 slots for the network interface cards listed below (see Figure 4):

In the section labeled IF:

— slots 0–3: PRI/DTI card (optional)

— slots 4–5: Reserved for future use

Note: The BTUs on the backplane interfere with a PRI/DTI card in slots 4 and 5.

— slot 6: QPC471 Clock Controller Card minimum vintage H

— slot 7: QPC441 3PE Card minimum vintage F

In the section labeled CORE:

— slots 8–10: NT6D65 Core to Network Interface (CNI) Card

Note: A CNI card must be installed in slot 8, which provides a backplane interface to the 3PE card in this module.

— slots 11–12: spare (can be used for CNI cards)

— slot 13: NT6D6003 Core Bus Terminator (CBT) Card

— slots 14–15: NT9D19 Call Processor Card (see notes 1 and 2, p. 8)
NT5D10 Call Processor Card
NT5D03 Call Processor Card (need for X11 Release 24)

— slots 16–17: NT6D63 I/O Processor (IOP) Card

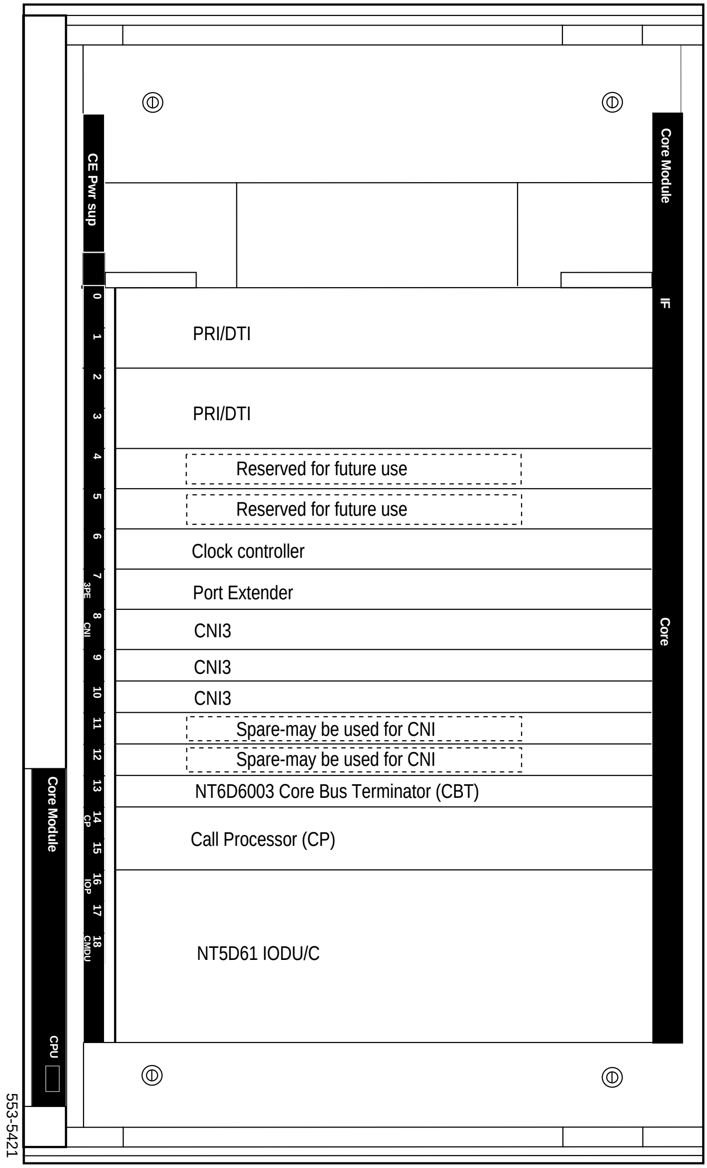
— slot 18: NT6D64 Core Multi Drive Unit (CMDU)

In addition, BTUs are installed between the following slots:

— QPC477A9 between slots 4 and 5

— QPC477B10 between slots 5 and 6

Figure 4
NT6D60 Core Module



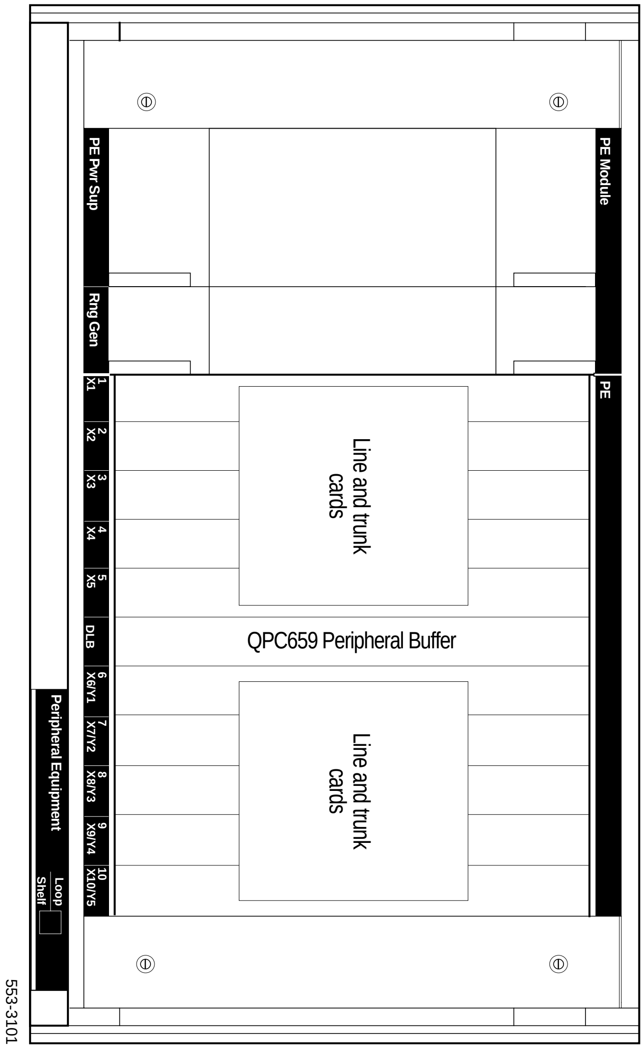
NT8D13 Peripheral Equipment Module

The PE Module houses one QPC659 Dual Loop Peripheral Buffer Card and up to ten PE cards (such as line and trunk cards). The dual loop buffer card is cabled to a QPC414 Network Card.

> ***Note:*** The PE Module does not support IPE cards. IPE cards are housed in NT8D11 CE/PE and NT8D37 IPE Modules.

The dual loop peripheral buffer card must be installed in the card slot labeled DLB (for dual loop buffer). The other slots can house any PE card (see Figure 5).

Figure 5
NT8D13 PE Module



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 and PE 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 6):

— slot 1: QPC441 3PE Card

— slots 2–3: QPC412 InterGroup Switch (IGS) Card

— slot 4: QPC43 Peripheral Signaling Card

— slots 5–12: NT8D04 Superloop Network Card
QPC414 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 option 81C

— 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 (option 21A must be upgraded for compatibility). Figure 7 shows the card slot configuration when the Network Module is used for PRI/DTI expansion.

Figure 6
NT8D35 Network Module

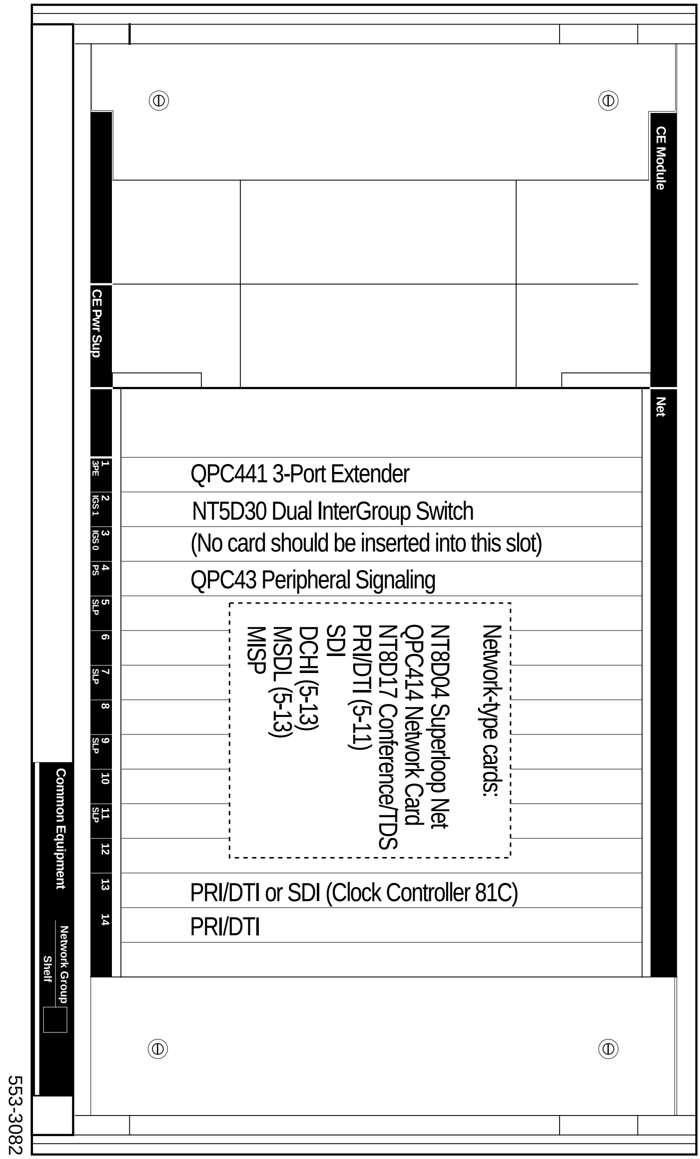
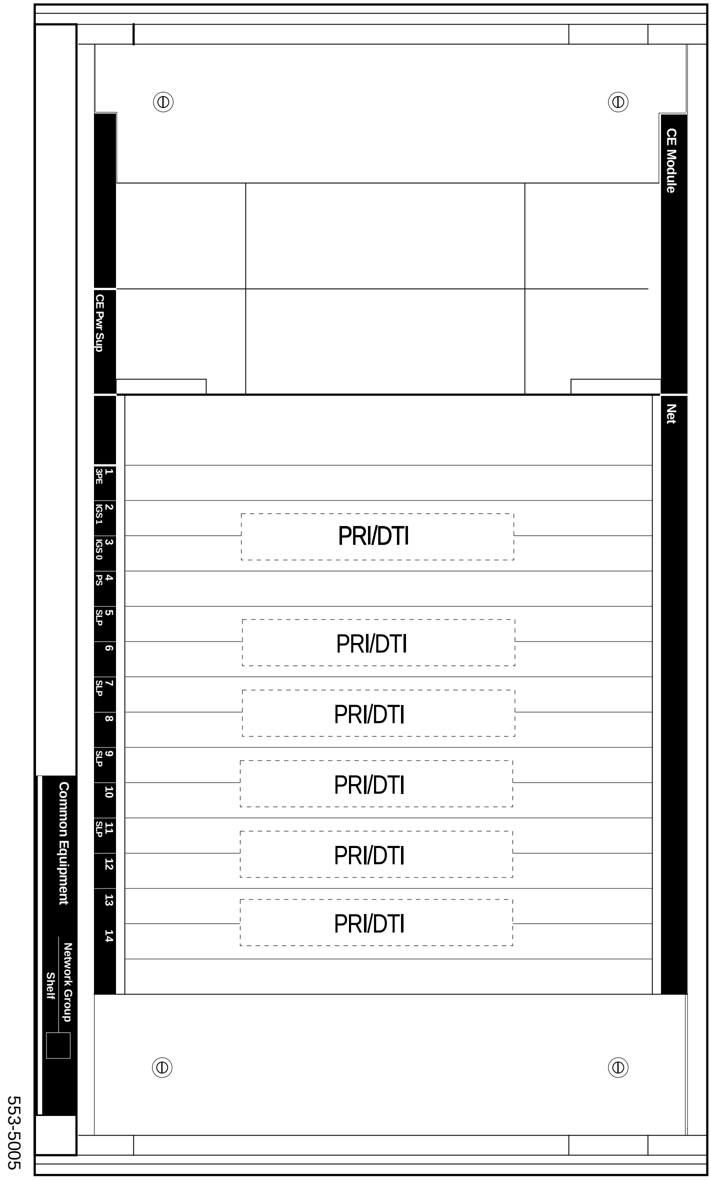


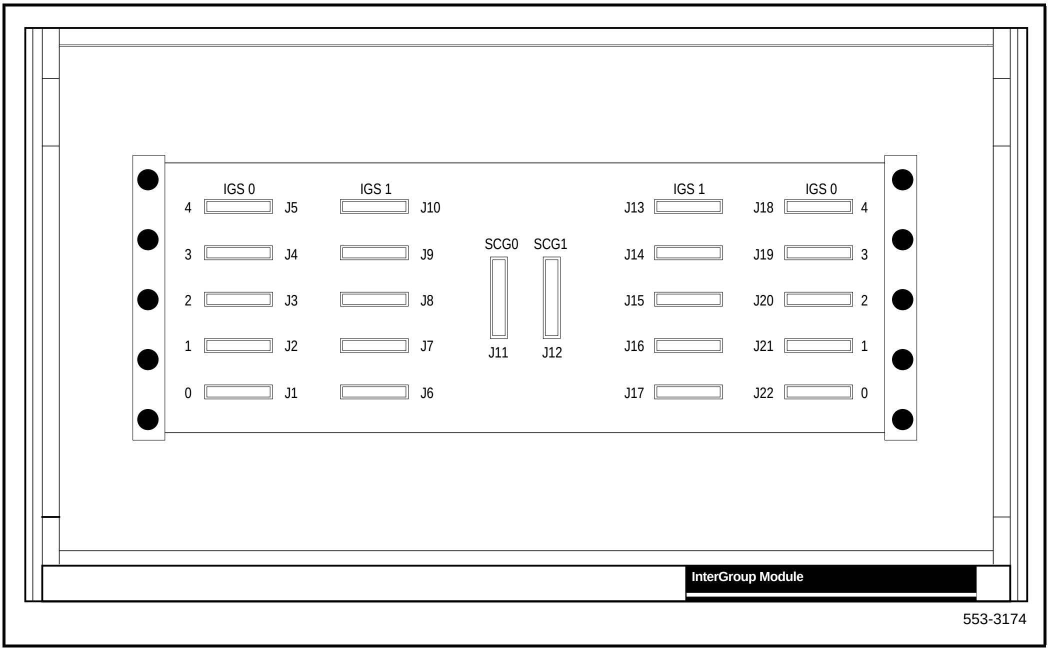
Figure 7
NT8D35 Network Module configured for PRI/DTI expansion



NT8D36 InterGroup Module

This module, used in multi-group systems, houses the QPC417 Junctor Board. Clock controller and intergroup switch cards are interconnected through the junctor board, which provides a path for switching traffic between network groups. Figure 8 shows the connectors in the module.

Figure 8
NT8D36 InterGroup Module



NT8D37 Intelligent Peripheral Equipment Module

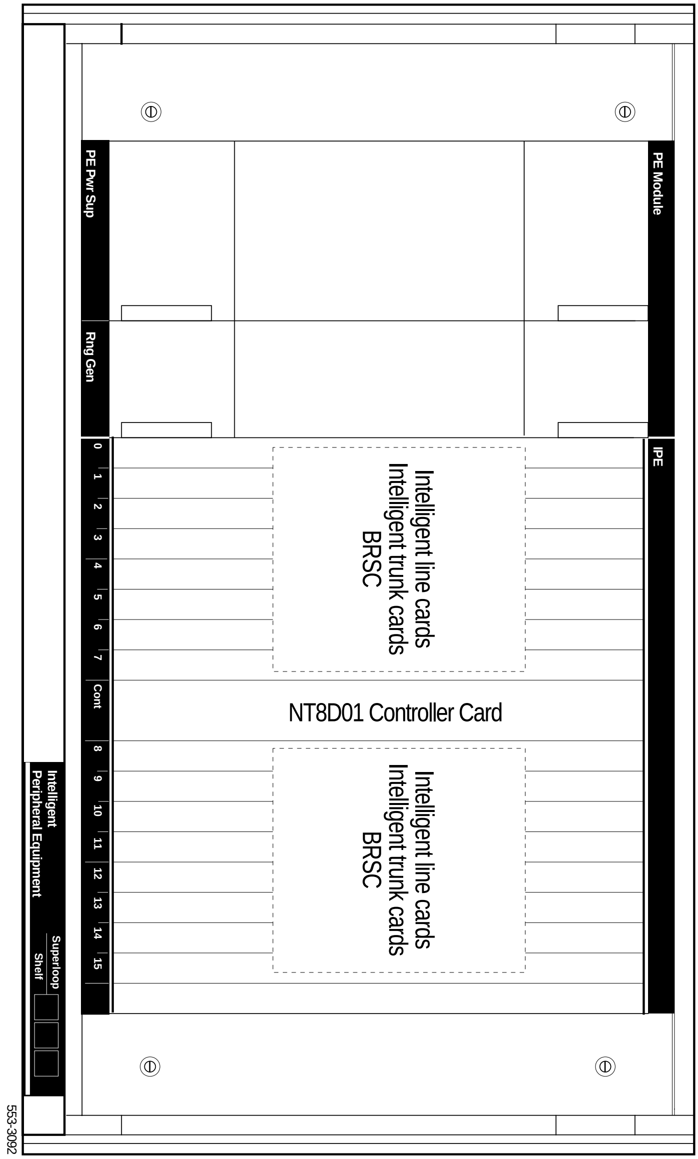
This module can be used in all system options.

The IPE Module houses one NT8D01 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 9).

> ***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.

Figure 9
NT8D37 IPE Module



NT8D47 Remote Peripheral Equipment Module

In conjunction with the NT8D13 PE Module, the RPE Module extends the network-to-peripheral equipment interconnection distance between local and remote sites.

The RPE Module accommodates two network loops. The number of RPE Modules required per system depends on the number of connections required at the remote site.

At the local site, the RPE Module is equipped with QPC63 Local Carrier Buffer Cards. Although they are not related to RPE function, the RPE Module can also house PRI/DTI cards at the local site. At the remote site, the RPE Module is equipped with QPC65 Remote Peripheral Switch Cards.

This module provides 12 card slots for the following cards (see Figure 10 for cards housed at the local end):

— slots 1/11–12: PRI/DTI card (local end only)

— slots 2 and 9: QPC62 1.5 Mbyte Converter Card

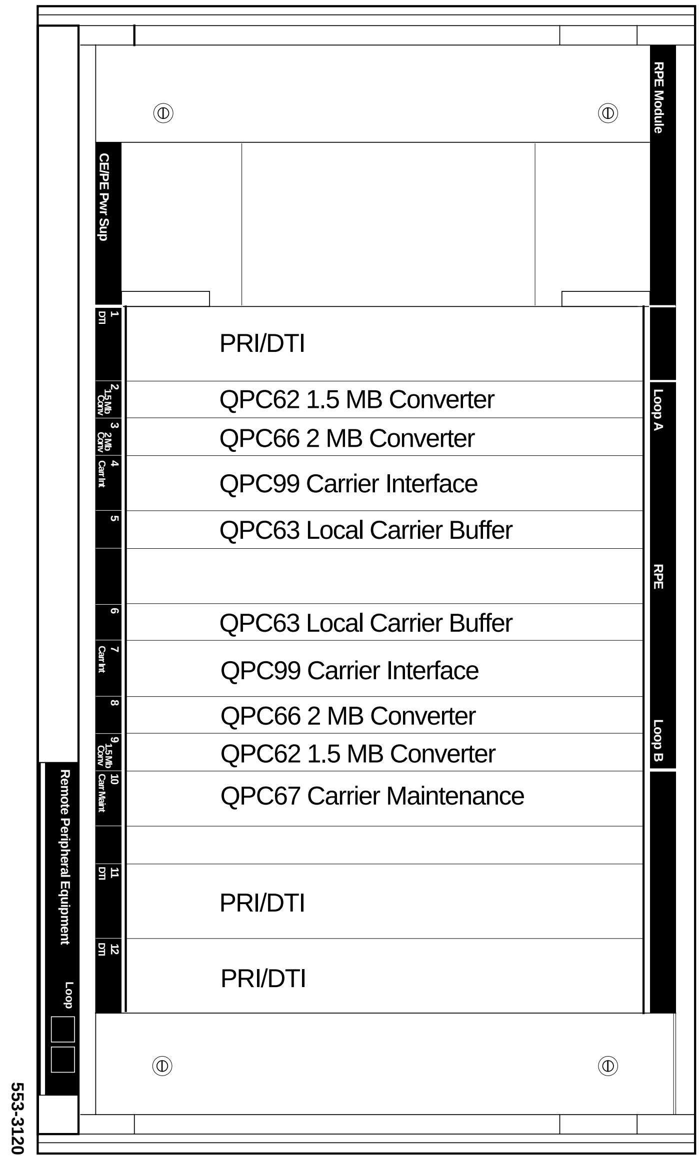
— slots 3 and 8: QPC66 2 Mbyte Converter Card

— slots 4 and 7: QPC99 Carrier Interface Card

— slots 5 and 6: QPC63 Local Carrier Buffer Card (local end)
QPC65 Remote Peripheral Switch Card (remote end)

— slot 10: QPC67 Carrier Maintenance Card

Figure 10
NT8D47 RPE Module—local site



System capacity

Network terminating capacity

The NT8D04 Superloop Network Card provides four network loops grouped as one superloop. One superloop can serve up to two NT8D37 IPE Modules.

Network traffic 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 percent of the incoming terminating calls, provided the called line is free

— the loss of no more than 1 percent of the originating outgoing calls in the system, provided an idle trunk is available

— the loss of no more than 1 percent of the intra-office calls, provided the called line is free

— no more than 1.5 percent of originating calls with more than a 3-second wait for dial tone

— the loss of no more than 1 percent of tandem calls, provided an idle outgoing trunk is available

Memory capacity

Memory capacity varies with system type. Memory requirements depend on the system size and features available. To calculate memory requirements, refer to *Meridian 1 capacity engineering* (553-3001-149).

Table 1
Memory capacity for options 51C, 61C, 81, 81C (Part 1 of 2)

System option	X11 release	Mbytes
61C	19	24 (with an NT6D66 CP card)
51C, 61C	20	24, 48(NT6D66 CP card)
51C, 61C	21	48 (NT6D66 CP card)
51C, 61C	22	48 (NT6D66 or NT9D19 CP card) 64 (NT9D19 CP card)
51C, 61C	23	48 (NT6D66 CP card) 48, 64, 96 (NT9D19 CP card) 48, 64, 80, 112 (NT5D10 CP card)
51C, 61C	24	48 (NT6D66 CP card) 48, 64, 96 (NT9D19 CP card) 48, 64, 80, 112 (NT5D10 CP card) 48, 64, 80, 112, 128 (NT5D03 CP card)
81	18 and 19	24
81, 81C	20	48

Table 1
Memory capacity for options 51C, 61C, 81, 81C (Part 2 of 2) (Continued)

System option	X11 release	Mbytes
81, 81C	21 and 22	48, 64, 96
81, 81C	23	48 (NT6D66 CP card) 64, 96 (NT9D19 CP card) 48, 64, 80, 112 (NT5D10 CP card)
81, 81C	24	48 (NT6D66 CP card) 64, 96 (NT9D19 CP card) 48, 64, 80, 112 (NT5D10 CP card) 48, 64, 80, 112, 128 (NT5D03 CP card)

System limits

Table 2 lists the system limit parameters defined in software.

Table 2
System limits

Parameters	21A	21	21E	51	51C	61	61C	71	81, 81C
Low-priority input buffers	96 to 1000	96 to 1000	96 to 1000	96 to 1000	96 to 5000	96 to 1000	96 to 5000	96 to 1000	96 to 5000
High-priority input buffers	16 to 1000	16 to 1000	16 to 1000	16 to 1000	16 to 5000	16 to 1000	16 to 5000	16 to 1000	16 to 5000
500-type telephone output buffers	16 to 1000	16 to 1000	16 to 1000	16 to 1000	16 to 5000	16 to 1000	16 to 5000	16 to 5000	16 to 5000
Number of call registers	26 to 2047	26 to 2047	26 to 2047	26 to 2047	26 to 20000	26 to 2047	26 to 20000	26 to 5000	26 to 20000

Software configuration capacities

Maximum configuration capacities are given in Table 3. 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 3
Software configuration capacities

Maximum configurations	51C	61C	81/ 81C
Per system:			
— steps in a hunting group	30	30	30
— speed call lists	8191	8191	8191
— members per trunk route	254	254	254
— input output devices	16	16	16
— appearances of the same directory number	30	30	30
— number of customers	100	100	100
Per customer:			
— ringing number pickup groups	4095	4095	4095
— trunk routes	512	512	512
— listed directory numbers (direct inward dialing only)	4	4	4
— lamp field array (may be repeated once on another console)	1	1	1
— consoles	63	63	63
Per attendant console:			
— feature keys			
M1250	10	10	10
M2250	20	20	20
— incoming call indicators	20	20	20
— trunk group busy indicators	16	16	16
M1250	20	20	20
M2250	2	2	2
— additional key/lamp strips			

Configuration guidelines

This section provides general rules for system configuration. The worksheets referenced in this section are provided at the end of this document.

Column configuration

Columns are numbered from 0 to 63 (the column containing CPU 0 must be Column 0). At installation, number all columns to the left of column 0 consecutively, starting with column 1. The first column to the right of column 0 is then numbered after the last column on the left of column 0. Any other columns to the right are then numbered consecutively (see Figure 11). Note that as the system expands, column numbering may become more random.

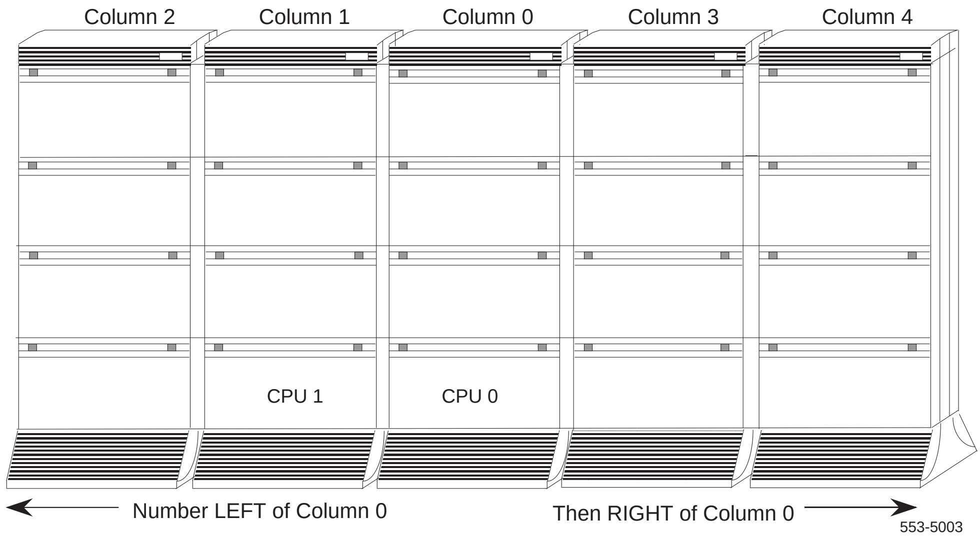
> ***Note:*** Modules containing the CPU equipment should always be placed in the first two tiers of Meridian 1 system columns.

A column can contain up to four modules; however, some or all columns can be configured with fewer than four modules. The modules in each column are numbered from 0 to 3, starting from the bottom.

Cabling between network components and peripheral equipment modules (IPE or PE) can be routed externally, such as between rows, through input/output (I/O) panels or electromagnetic interference (EMI) filters.

Cabling between other types of modules, such as CPU Modules, must remain within the Meridian 1 columns. All vertically routed internal cables must be routed on the right side of the column (facing the column) to avoid possible interference from the power supplies in the modules.

Figure 11
Column numbering



The possible positioning for modules in each column is highly flexible. However, the conventions described here are generally followed when a system is initially configured, and there are a few cooling and cabling constraints.

IPE/PE 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 12):

— 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.

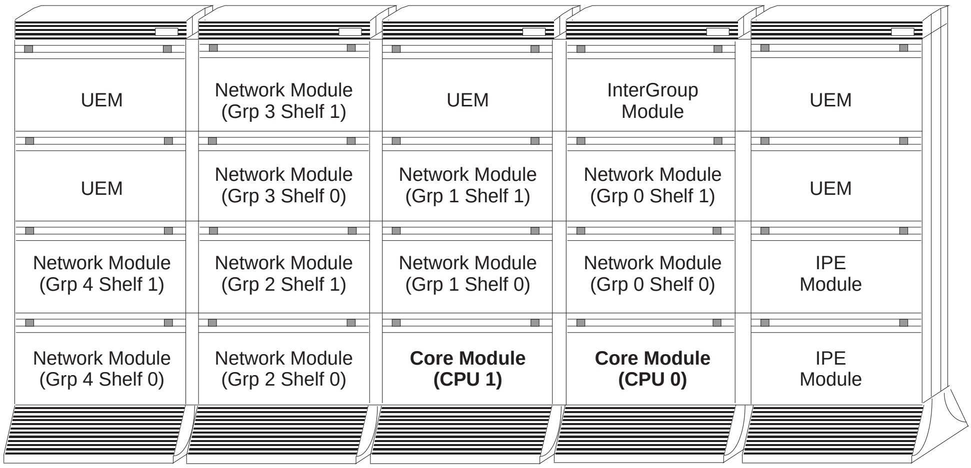
— The modules that house group 0 are located in column 0; the modules that house group 1 are located in column 1.

— Additional network groups are added to the left of the CPU columns.

InterGroup Modules

The InterGroup Module, used in multi-group systems,is generally located at the top of its column (see Figure 12). The InterGroup Module is typically placed in Column 0, but it can be placed in Column 1 instead.

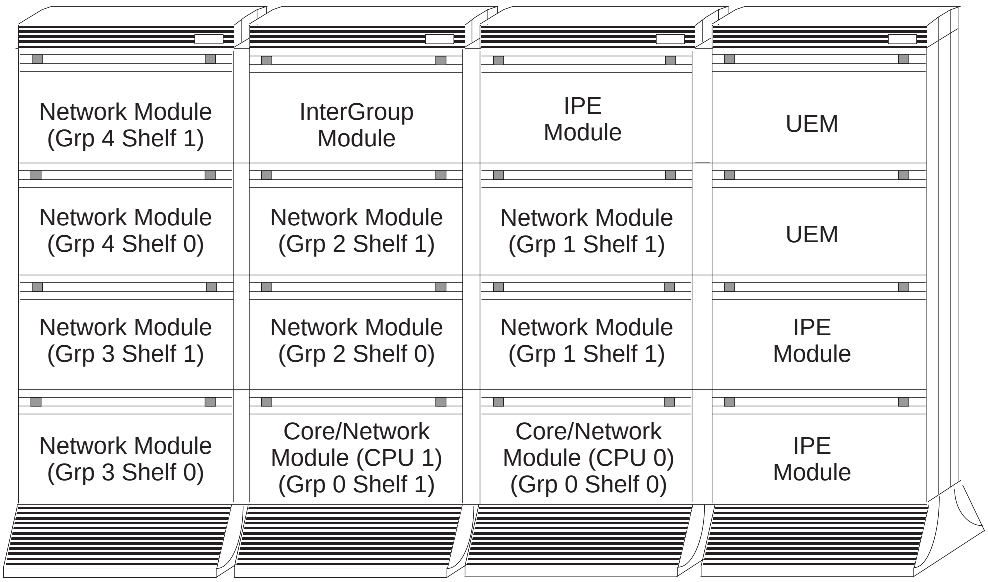
Figure 12
Option 81 with five network groups



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.

Figure 13 shows an option 81C system, Core Modules in option 81 (Figure 12) are replaced by Core/Network Modules. Option 81C also provides one network group (Group 0) by the two Core/Network Modules. This allows replacement of Network Modules for Group 0 with IPE Modules for lines expansion.

Figure 13
Option 81C with five 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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I/O access

System option 81

The system architecture assigns multiple address-mapped I/O spaces, one per network group, for accessing I/O devices. The I/O bus is extended to each network group through cables from secondary shrouds on the Core Module backplane to QPC441 3PE Cards in Network Modules. The backplane shrouds interface with the two ports on each NT6D65 CNI Card.

CNI configuration (options 51C, 61C, and 81C)

In the NT9D11 Core/Network module, port 0 is dedicated to group 0, and the CNI card must be installed in slot 12. This is because the option 61C is a single-group system and the option 51C is a half-group system.

In option 81C, the NT5D21 Core/Network Module supports up to three CNI cards in card slots 12, 13, and 14. In new systems the CNI card in slot 12 usually supports group 0, the CNI card in slot 13 supports groups 1 and 2, and the CNI card in slot 14 supports groups 3 and 4 for a total of five groups. In upgraded systems that may not be the case.

> ***Note:*** Network groups configuration is flexible. Any CNI port may support any given network group, however, for ease of maintenance, associate network groups and CNI ports in a logical sequence. Refer to Table 4 for a typical CNI port assignment and the associated network group. Port 0 of the CNI in slot 12 and the 3PE card are hard wired at the module's backplane.

The NT5D21 Core/Network Module is also used in options 51C and 61C with X11 release 21 and higher. Again, port 0 is dedicated to group 0, and the CNI card must be installed in slot 12. This is because the option 61C is a single group system and option 51C is a half-group system.

CNI configuration (option 81)

In the NT6D60 Core Module, port 0 on the NT6D65 CNI Card in slot 8 is preconfigured as "group 5." This is not equivalent to a network switching group (groups 0–4). "Group 5" extends the interprocessor bus through the CNI card in slot 8 to the 3PE card in slot 7 in the interface section of the module.

There are two ports on each CNI card. However, if only one CNI card is equipped, only one network group is supported. This is because the CNI card must be installed in slot 8 and Port 0 is dedicated to “group 5.” Only Port 1 can support a network switching group. Therefore, to support two network groups, two CNI cards are required. To support three network groups, still only two CNI cards are required, because one port is available in slot 8 and two ports are available on the second CNI card.

In a typical configuration, there are three CNI cards for five network groups (see Table 4) in each Core and Core/Network Module.

Table 4
Typical CNI configurations (options 81 and 81C)

Option 81C CNI card slot / port	Option 81 CNI card slot / port	Network group supported
—	CNI 8 / Port 0	Core bus extender (preconfigured as “group 5”)
CNI 12/ Port 0	CNI 8 / Port 1	Group 0
CNI 12/ Port 1	CNI 9 / Port 0	Group 1
CNI 13/ Port 0	CNI 9 / Port 1	Group 2
CNI 13/ Port 1	CNI 10 / Port 0	Group 3
CNI 14 / Port 0	CNI 10 / Port 1	Group 4

Note: You do not have to configure both ports on a CNI card.

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 two types of network cards available are:

— the NT8D04 Superloop Network Card which provides four loops per card grouped together in an entity called a superloop

— the QPC414 Network Card which provides two loops per card

On most Meridian 1 system options, network loops are organized into groups. A system is generally configured as one of the following:

— a half-group system which provides up to 16 loops

— a full-group system which provides up to 32 loops

— a multiple-group system which provides up to 160 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 14). 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.

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

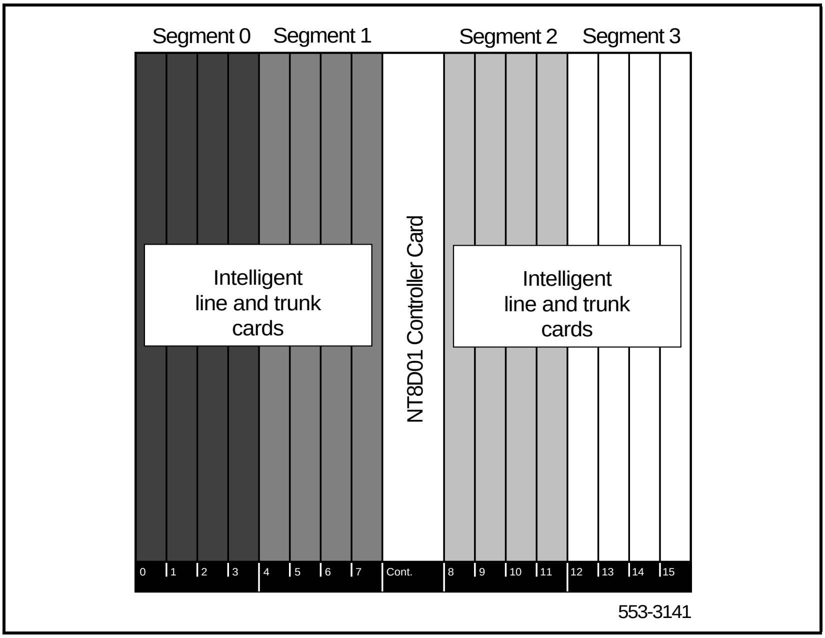
— four segments per superloop

— eight segments per superloop

— one segment per superloop/three segments per another superloop

— two segments per superloop/six segments per another superloop

Figure 14
Superloop segments in the IPE Module

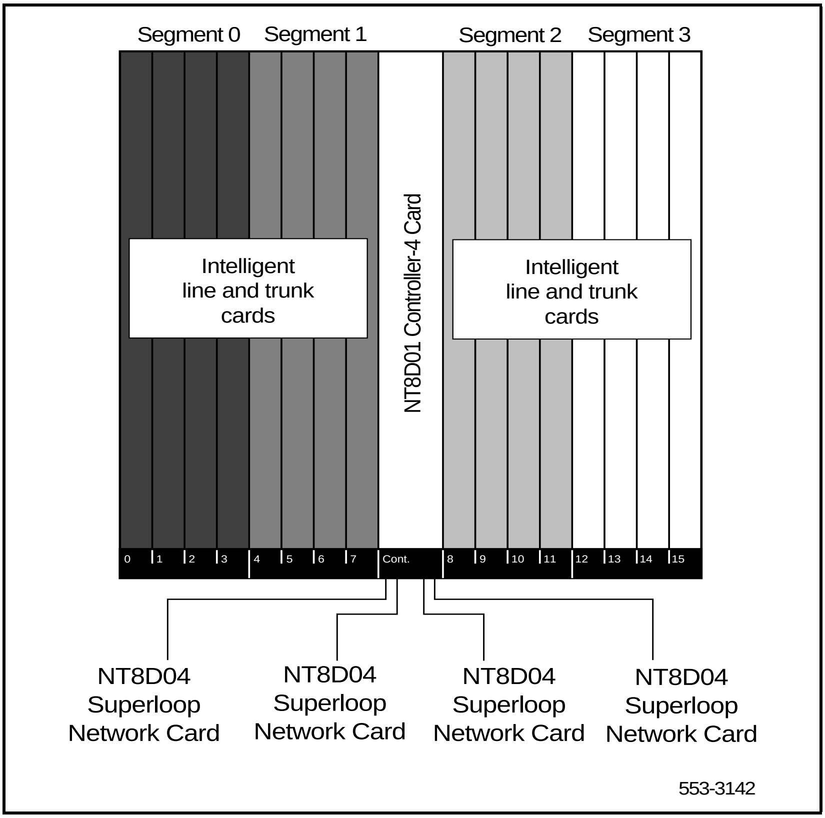


One segment per superloop

A configuration of one segment per superloop requires four superloop network cards and one NT8D01 Controller-4 Card (see Figure 15).

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 nonblocking environment (120 traffic timeslots to 128 TNs).

Figure 15
One segment per superloop



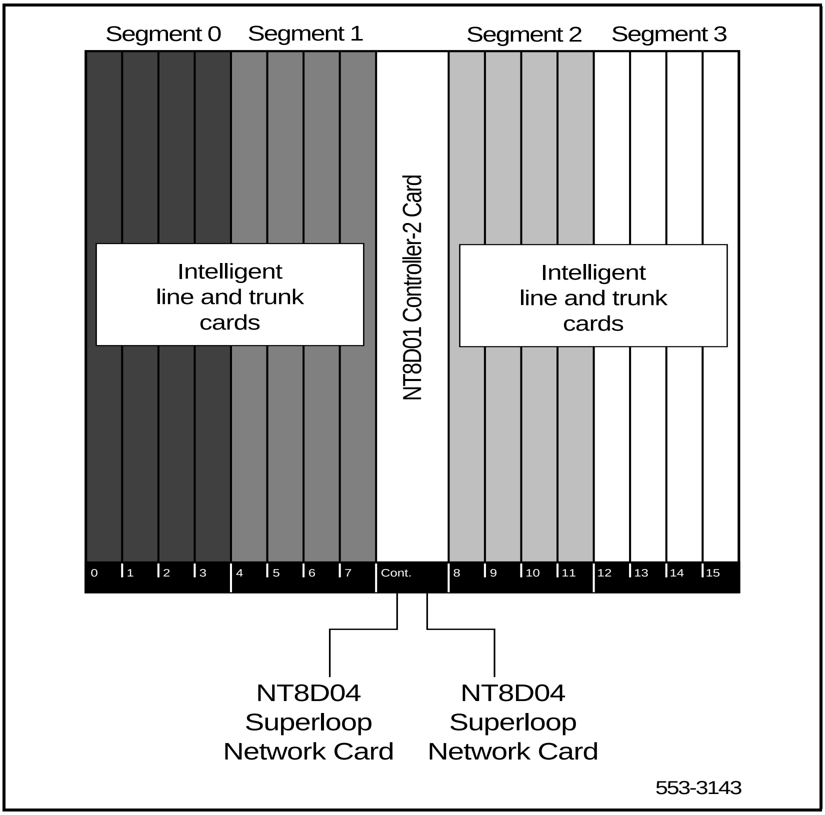
Two segments per superloop

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

If the segments are equipped with analog line cards and trunk cards, this configuration provides a virtual nonblocking 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 16
Two segments per superloop



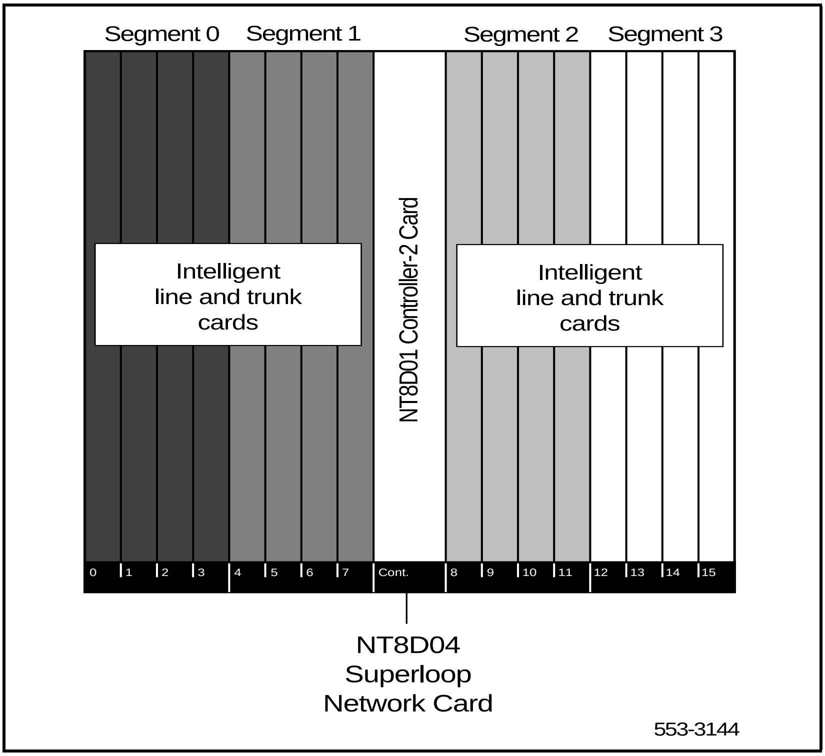
Four segments per superloop

A configuration of four segments per superloop requires one superloop network card and one NT8D01 Controller-2 Card (see Figure 17).

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 17
Four segments per superloop



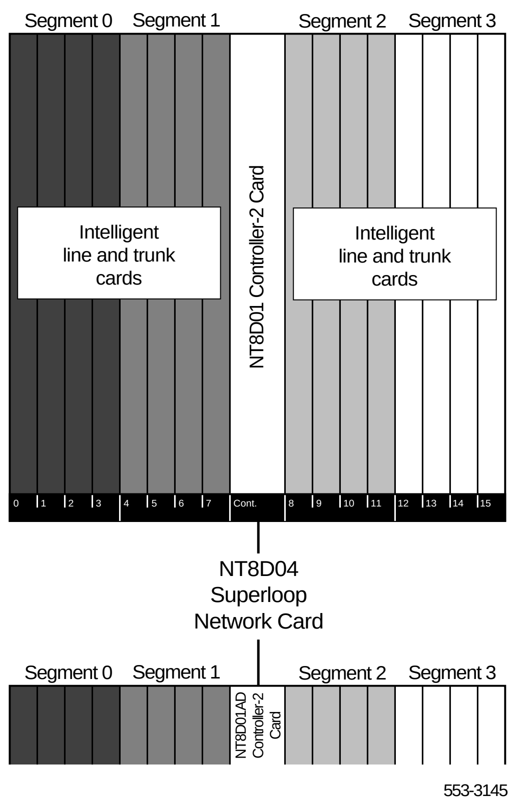
Eight segments per superloop

A configuration of eight segments per superloop requires one superloop network card and two NT8D01 Controller-2 Cards (see Figure 18).

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 18
Eight segments per superloop



One segment per superloop/three segments per another superloop

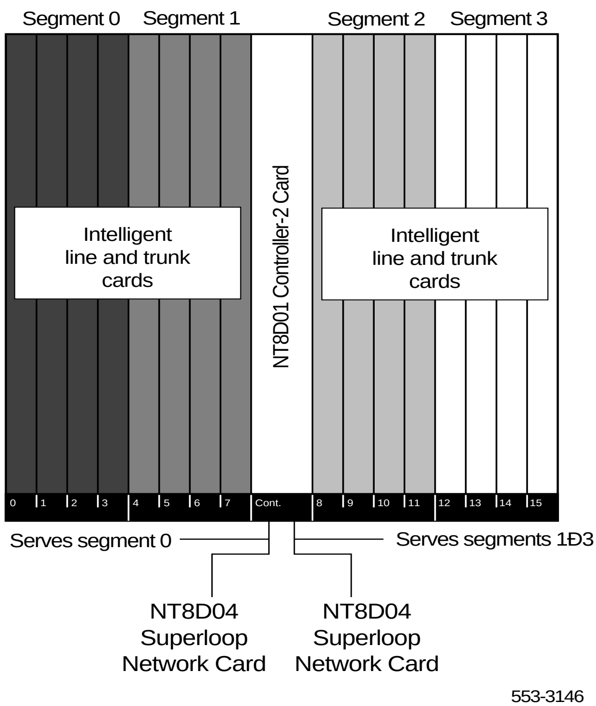
A configuration of one segment per superloop/three segments per another superloop requires two superloop network cards and one NT8D01 Controller-2 Card (see Figure 19).

This configuration provides:

— a virtual nonblocking environment (120 traffic timeslots to 128 TNs) for the single segment served by the first superloop

— a medium concentration of TNs to timeslots for the three segments assigned to the additional superloop

Figure 19
One segment per superloop/three segments per superloop



Two segments per superloop/six segments per another superloop

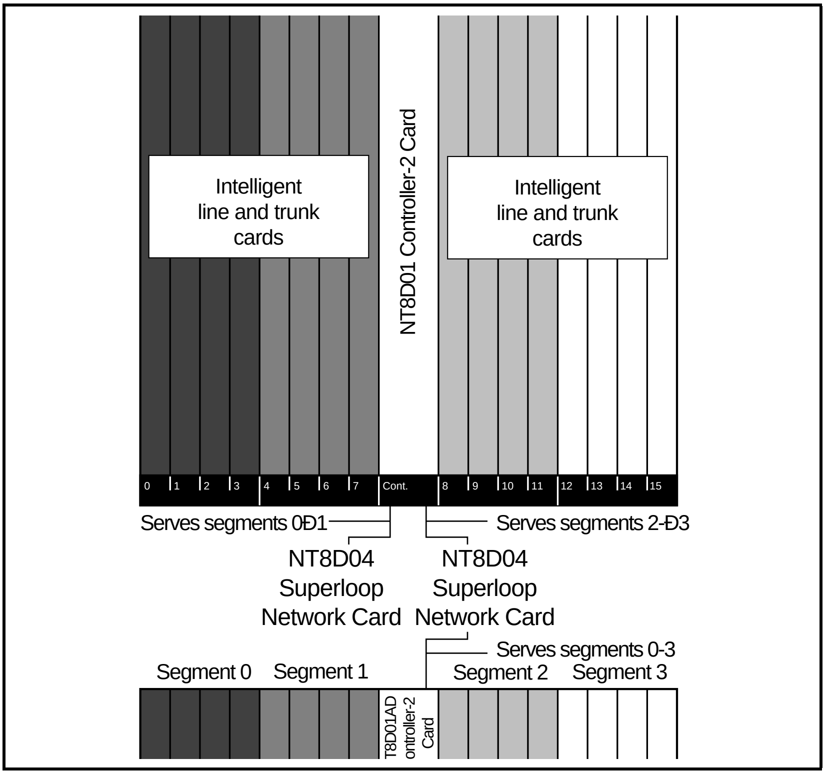
A configuration of two segments per superloop/six segments per another superloop requires two superloop network cards and two NT8D01 Controller-2 Cards (see Figure 20).

This configuration provides:

— a virtual nonblocking 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)

— a medium concentration of TNs to timeslots for the six segments assigned to the additional superloop

Figure 20
Two segments per superloop/six segments per superloop



IPE configuration

As described in “Network configurations,” 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.

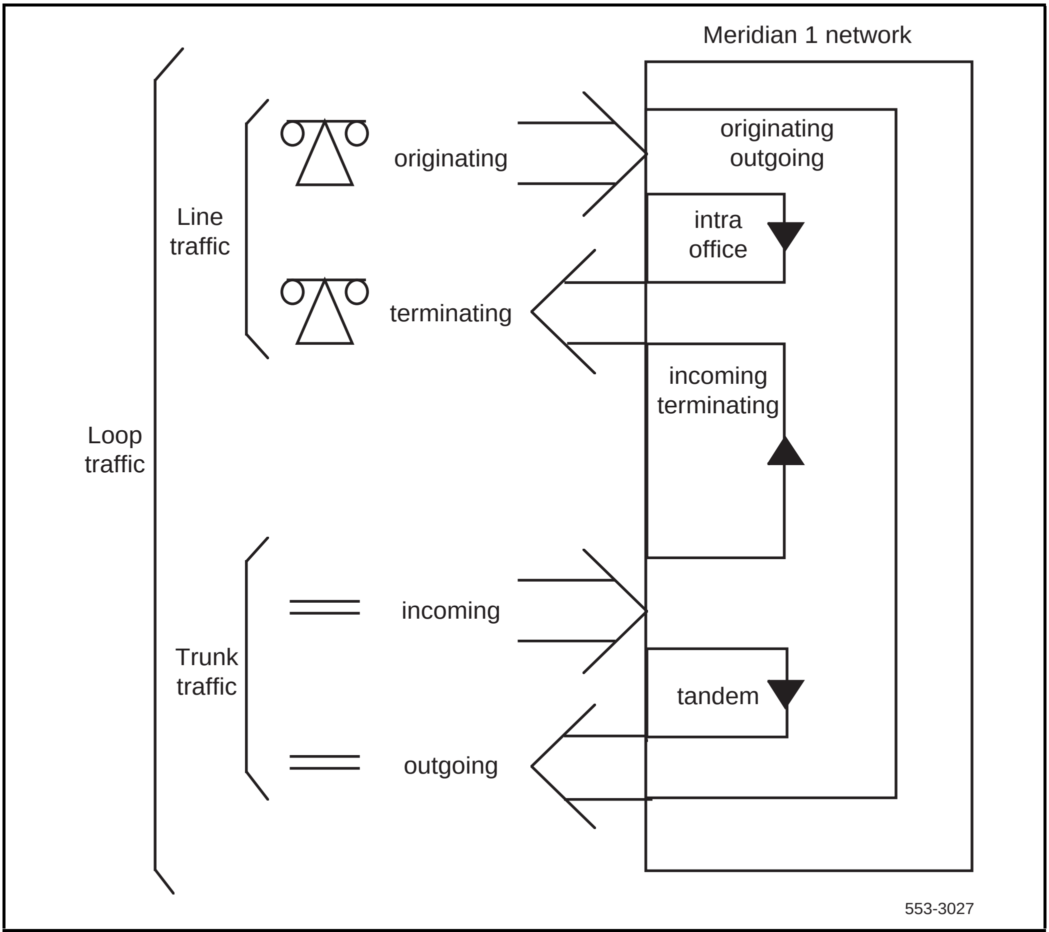
For traffic purposes in options 21A, 21, or 21E, the network/DTR card is typically assigned to serve 96 lines, 32 trunks, and 8 DTR ports (10 IPE cards total) even though it has higher traffic capacity.

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.

Traffic configuration

The traffic distribution when considering individual customer or system traffic is shown in Figure 21.

Figure 21
Traffic distribution



Traffic definitions

The following list gives definitions for traffic terminology used in determining the provisioning requirements of a Meridian 1 system:

- CCS = Hundred call seconds is the unit in which amounts of telephone traffic are measured. One call that lasts for 100 seconds equals one CCS.
- Line CCS = Incoming terminating CCS + originating outgoing CCS + terminating intra-office CCS + originating intra-office CCS
- I/O = Intra-office traffic in CCS
- Intra-office Ratio (R) = Terminating intra-office CCS + originating intra-office CCS ÷ line traffic in CCS
- Loop CCS = Line CCS + incoming terminating + originating outgoing
or
= Line CCS x (2–R)
- Total line CCS = Total loop CCS ÷ (2–R)
- Total trunk CCS = Total line CCS x (1–R)
or
= Total loop CCS x (1–R) ÷ (2–R)
- Total intra-office capacity (terminating + originating) = Total loop CCS x R ÷ (2–R)
- Total I/O CCS = Total loop capacity x R ÷ (2-R)
- 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
- InterGroup CCS = The measure of traffic flow between two network groups in systems with more than one network group

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 Meridian 1 can be configured as a partitioned or nonpartitioned 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 nonpartitioned system, all customers, trunks, lines, consoles, and Digitone receivers are spread over all loops and modules. A nonpartitioned system provides the following advantages:

- fewer traffic loops are required
- fewer peripheral equipment (IPE and PE) 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 A.

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 5 and the following equation to find the number of network groups required:

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

Table 5
Loop number assignment

Number of groups	Loop assignments
1	28
2	56
3	84
4	112
5	140

Peripheral equipment card distribution

Use Worksheet B to determine the total number of each type of IPE and PE card (line, trunk, DTR) for each IPE and PE Module.

Use Worksheets C and D to determine the number of multiple appearance groups (MAGs) assigned to each loop (use Worksheet E 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 (card slot 1 in each PE 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.

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.

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.

500/2500 telephones

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

Assigning card slots

Use Worksheet F 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 PE Modules, card slot 1 is reserved for high-priority signaling. 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 G to record the terminal number (TN) assignments. TN 0000 cannot be used on superloop 0. Therefore, assign loop 0 to a QPC414 Network Card.

Ongoing configuration

Ongoing assignment plan

Use the initial assignment records to complete an assignment plan for each equipped network loop in the system (see Worksheet H). 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 and should be used in addition to worksheets 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 *X11 features and services* for information on obtaining and manipulating data in the system.

Provisioning guidelines

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 Northern Telecom 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 guidelines in the order shown below. (These provisioning methods are based on a nonpartitioned 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
Step 2	Estimate CCS per terminal
Step 3	Calculate number of trunks required
Step 4	Calculate line, trunk, and console load
Step 5	Calculate DTR requirements
Step 6	Calculate total system load
Step 7	Calculate number of superloops required
Step 8	Calculate number of network groups required
Step 9	Calculate number of peripheral equipment cards required
Step 10	Calculate number of peripheral equipment modules required
Step 11	Provision conference/TDS loops
Step 12	Calculate memory requirements
Step 13	Assign equipment and prepare equipment summary

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 x 0.05 (percent growth) = 25 additional employees at 1 year

— 525 employees x 0.05 = 27 additional employees at 2 years

— 552 employees x 0.05 = 28 additional employees at 3 years

— 580 employees x 0.05 = 29 additional employees at 4 years

— 609 employees x 0.05 = 31 additional employees at 5 years

— 640 employees x 0.05 = 32 additional employees at 6 years

The ratio of telephones to employees is 275/500, which equals 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 x 0.55 = 275 telephones required at cutover

— 525 employees x 0.55 = 289 telephones required at 1 year

— 552 employees x 0.55 = 304 telephones required at 2 years

— 580 employees x 0.55 = 319 telephones required at 3 years

— 609 employees x 0.55 = 335 telephones required at 4 years

— 640 employees x 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 Worksheet I. 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:

— comparative method

— manual calculation

— default method

Comparative method

Select three existing systems that have a historical record of traffic study data. The criteria for choosing comparative systems are:

— similar line size (+25 percent)

— similar business (such as bank, hospital, insurance, manufacturing)

— similar locality (urban or rural)

Once similar systems have been selected, their station, trunk, and intra-CCS/T are averaged. The averages are then applied to calculate trunk requirements for the system being provisioned (see the example in Table 6).

Table 6
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	3.0	2.0	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 7).

Table 7
Example of CCS/T averaging when only trunk CCS/T is known

Trunk type	Number of trunks	Grade of service	Load in CCS	Number of terms	CCS/T
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
FX	2	30 CCS/trunk	60	218	0.27
Private line	4	20 CCS/trunk	80	4	20.00
			Total: 956		Total: 23.79

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) = 959/234 = 4.1

Assuming a 33 percent intra-calling ratio:

intra CCS/T = 4.1 x 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 8). (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 8
Example of manual calculation of CCS/T

Cutover	Line CCS = 275 x 6.2 =	1705	
	Trunk CCS = 275 x 4.1 =	1128	
	Subtotal =	2833	
	Console CCS =	30	
	Total system load =		2863
2 years	Line CCS = 304 x 6.2 =	1885	
	Trunk CCS = 304 x 4.1 =	1247	
	Subtotal =	3132	
	Console CCS =	30	
	Total system load =		3162
5 years	Line CCS = 352 x 6.2 =	2183	
	Trunk CCS = 352 x 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 9 lists the estimated usage on special services trunks.

Table 9
Estimated load per trunk

Trunk type	CCS
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 10 for comparison.

Example

- — 275 stations at cutover
- — 304 stations at two years
- — 352 stations at five years

Cutover	275 x 5.5 (CCS/T) x 2 =	3025 CCS total system load
Two-year	304 x 5.5 (CCS/T) x 2 =	3344 CCS total system load
Five-year	352 x 5.5 (CCS/T) x 2 =	3872 CCS total system load

Table 10
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 Worksheet I. 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 Reference Table 1 on page 96). 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) x 1.14 (trunk CCS/T) =	313.5 CCS
Two-year	304 (lines) x 1.14 (trunk CCS/T) =	346.56 CCS
Five-year	352 (lines) x 1.14 (trunk CCS/T) =	401.28 CCS

Use Reference Table 2 on page 98 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 Worksheet I 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 Worksheet I.

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.

Reference Tables 3 through 6 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.

Some special features are:

- Authorization Code
- Centralized Attendant Service (CAS)
- Charge Account for Call Detail Recording (CDR)
- Direct Inward System Access (DISA)
- Integrated Messaging System Link

> ***Note:*** Go to "DTR/Feature calculations" on page 71 for more information on these features.

From the appropriate reference table (Reference Tables 3 through 6), determine the number of DTRs required and the DTR load for cutover, two-year, and five-year intervals. Record this information in Worksheet J.

The following models are based on some common PBX traffic measurements.

Model 1

Reference Table 3 on page 100 is based on the following factors:

- 33 percent intra-office 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

Reference Table 4 on page 101 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

Reference Table 5 on page 102 is based on the following factors:

- 15 percent intra-office 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

Reference Table 6 on page 103 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 intra-office and outgoing call calculations is 135 seconds if unknown.

— Digitone receiver holding times are 6.2 and 14.1 seconds for intra-office and outgoing calls, respectively.

— Factor (1 – R)/2 in (1) outgoing (incoming calls and outgoing calls are equal). R is the intra-office ratio.

Follow the procedure below for detailed calculation Method 1.

1 Calculate Digitone calls:

Intra-office =
100 x Digitone station traffic (CCS) ÷ call holding time x (R ÷ 2)

Outgoing =
100 x Digitone station traffic (CCS) ÷ call holding time x [(1–R) ÷ 2]

2 Calculate total DTR traffic:

1.3 x [(6.2 x Intra) + (14.1 x Outgoing)] ÷100

3 Calculate average holding time:

(6.2 x intra) + (14.1 x outgoing) ÷ intra calls + outgoing calls

4 See Reference Table 7 or 8 and use the answers from steps 2 and 3 to determine the number of DTRs required.

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 the procedure below for detailed calculation Method 2.

1 Calculate intra-office and outgoing Digitone calls as shown in step 1 of Method 1:

DID calls =
DID Digitone trunk traffic (CCS) x 100 ÷ call holding time

2 Calculate total DTR traffic:

[(1.3 x 6.2 x intra) + (1.3 x 14.1 x outgoing calls) + (2.5 x DID calls)] ÷ 100

3 See Reference Table 9 on page 108 and use the answer from step 2 to determine the number of DTRs required.

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 Worksheets J and K.

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. For options 21A, 21, and 21E, exclude the traffic carried by the ten IPE cards in the CE/PE Module before computing the number of superloop network cards.

Nonblocking configuration with superloop network

For nonblocking 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).

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 11 lists the number of PRI/DTI cards required when PRI/DTI traffic is known.

Note: The number of PRI/DTI loops is the same as the number of PRI/DTI cards.

Table 11
Number of cards required when PRI/DTI traffic is known

PRI/DTI traffic (CCS)	Number of PRI/DTI cards
1–507	1
508–1201	2
1202–1935	3
1936–2689	4
2690–3456	5
3457–4231	6
4232–5006	7
5007–5781	8
over 5781	provide 8 plus one PRI/DTI for each 774 CCS in excess of 5781 CCS
Note: In a Network Module, if two network slots are available but not next to each other, the network cards can be moved to create a 2-inch slot for a PRI/DTI card.	

For nonblocking applications, the Ring Again feature must be provided since blocking may occur at the far end of the trunk.

Since a PRI/DTI card physically occupies two network slots, multiply the number of PRI/DTI cards by two to obtain the required number of slots.

The PRI/DTI cards can be installed in any module except IPE and PE Modules. After all essential cards are configured, estimate the available slots for PRI/DTI. If not enough slots are available for all PRI/DTIs required, a Network Module can be added to the system to house the PRI/DTI cards required.

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 Worksheet L. Use Table 12 and the following equation to find the number of network groups required:

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

Table 12
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
Note: Use Worksheet K. 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 options 81 and 81C, use Table 13 to calculate the number of NT6D65 CNI Cards needed to support the network groups.

Table 13
CNI configurations (options 81 and 81C)

Number of network groups supported	Required number of CNI cards	Optional number of CNI cards
“group 5” (bus extender)	1 (slot 8 port 0)	(required)
1 (group 0)	1	2
2 (group 1)	2	3
3 (group 2)	2	up to 4
4 (group 3)	3	up to 5
5 (group 4)	3	up to 5

Step 9: Calculate number of IPE/PE cards required

In Worksheet M, enter the number of DTRs required (from Worksheet J). Use a separate worksheet for cutover, two-year, and five-year intervals.

Using information from Worksheet I, 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 Worksheet M.

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 and PE cards separately.

Step 10: Calculate number of IPE/PE 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 Worksheet M.

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 Worksheet M.

Calculate the number of IPE and PE 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 Reference Tables 10 and 11 to determine conference/TDS loop requirements. Enter these figures in Worksheet N.

Step 12: Calculate memory requirements

Use Worksheets O through Q to calculate memory requirements. Use the two-year figure for telephones, consoles, and trunks for the calculation. Add 10 percent to the total memory requirements.

> ***Note 1:*** Real-time memory requirements must be calculated using the data in *Capacity Engineering* (550-3001-149).
>
> ***Note 2:*** This step does not apply to options 51C, 61C, 81, and 81C because there is no variable number of memory cards; the memory function is performed by the NT6D66 or NT9D19 Call Processor Card.

Step 13: Assign equipment and prepare equipment summary

Use Worksheet R 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.

DTR/Feature calculations

Calculations with Authorization Code

With Authorization Code, the DTR holding times change from 6.2 seconds to 19.6 seconds for intra-office 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" and step 2 of "Detailed calculation: Method 2" to calculate the DTR requirements for a system with the Authorization Code option.

The following is assumed:

— all Digitone intra-office and outgoing calls require authorization

— the average number of special services prefix (SPRE) digits is two (the maximum is four)

— the average number of Authorization Code digits is 10 (the range is 1 to 14 digits)

— 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. The following is assumed:

— all attendant calls presented through release link trunks from a remote PBX require DTRs

— the average number of digits dialed is four

— the average DTR holding time is 6.2 seconds

Use the procedure below to determine DTR requirements.

1 Calculate the attendant calls from the remote PBX:

100 x attendant traffic from the remote (CCS) ÷ attendant work time (in seconds)

2 Add the attendant calls to the intra-office calls calculated in step 1 of “Detailed calculation: Method 1” and proceed with the remaining calculations of Method 1.

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” and step 3 of “Detailed calculation: Method 2” to determine the DTR requirements for a system with the Charge Account for CDR option.

The following is assumed:

— 50 percent of Digitone outgoing calls require a charge account

— the average number of SPRE digits is two (maximum is four)

— the average number of digits in the account number is 10 (the range is 2 to 23 digits)

— the average DTR holding time is 13.4 seconds (see Reference Table 7 on page 104)

Calculations with Direct Inward System Access

This method is used when a system is equipped with the DISA feature. The following is assumed:

— DISA calls come through DISA trunks or DID trunks

— 75 percent of DISA calls require a security code

— the average number of digits in the security code is four (the range is one to eight)

— the DISA DTR holding time is 6.2 seconds

Use the procedure below to determine DTR requirements.

1 Calculate the number of DISA calls:

100 x DISA traffic ÷ call holding time

2 Calculate the DISA DTR traffic:

6.2 x DISA calls ÷ 100

3 Add this traffic to step 2 of “Detailed calculation: Method 2” and proceed with the remaining calculations of Method 2.

Calculations with Integrated Messaging Service Link

This method is used when a system is equipped with Integrated Messaging Service Link. The following is assumed:

— only messaging calls from 2500-type telephones require DTR service

— there is a 50-50 split of originating and terminating calls and 135 seconds average call holding time (step 1 next page)

— 50 percent of the calls from 2500-type telephones are intra-PBX calls (step 2 next page)

— the average time a caller listens to an announcement is 4 seconds (step 4 next page)

— if not known, assume the actual number of 2500-type telephones to be 60 percent of total lines

Use the procedure below to determine the DTR requirements.

1 Calculate originating calls from 2500 telephones:

calls from 2500 telephones = CCS/line x 100 x number of 2500 telephones/(2 x 135) = A

2 Calculate intra-PBX calls from 2500 telephones:

intra-PBX 2500-telephone calls = A x 0.5 = B

3 Calculate calls requiring service of DTR:

calls to DTR = B x 0.5 = C, where 0.5 is the portion of B that goes to the messaging service

4 Calculate traffic (CCS) to DTR:

messaging CCS to DTR = C x 4/100

5 Add messaging CCS to the total DTR traffic to determine overall DTR requirements.

Worksheets

The worksheets provided give examples of information needed to do traffic and equipment engineering. However, more detailed information is needed to fully engineer a system. Consult your Northern Telecom representative and use a configuration tool, such as Autoquote or Meridian Configurator, to fully engineer a system.

Memory values, which vary for each generic of software, are given in *Meridian 1 capacity engineering* (553-3001-149).

Worksheet A: 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 = $\frac{\text{Total system load CCS}}{\text{IPE/PE modules required}}$ = ________ 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 B: 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/PE modules to arrive at a cards-per-module number.

CARD TYPE	QUANTITY	TOTAL IPE/PE MODULES	CARDS PER MODULE

553-5367

Worksheet C: 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 D: 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 = ________________

$$\frac{\text{Single-line TNs not in MAG}}{\text{Total IPE/PE modules}} = \_\_\_\_\_\_\_\_\_\_$$ 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 = ________________

$$\frac{\text{Multi-line TNs not in MAG}}{\text{Total IPE/PE modules}} = \_\_\_\_\_\_\_\_\_\_$$ Number of multi-line TNs not in MAG Assigned per module

553-5372

Worksheet E: 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 F: Card assignment

CIRCUIT CARD TO MODULE ASSIGNMENT

CUSTOMER______________________________ DATE ____________

One table for each PE shelf in the system.

LOOP # ________ MODULE # ________

											TOTAL CARDS	CCS LOAD
Position	1	2	3	4	5	6	7	8	9	10		
Type												

LOOP # ________ MODULE # ________

Position	1	2	3	4	5	6	7	8	9	10		
Type												

LOOP # ________ MODULE # ________

Position	1	2	3	4	5	6	7	8	9	10		
Type												

LOOP # ________ MODULE # ________

Position	1	2	3	4	5	6	7	8	9	10		
Type												

553-5369

Worksheet G: Terminal number assignment

TN ASSIGNMENT RECORD

CUSTOMER ______________________ DATE __________

One sheet for each IPE/PE module in the system.

LOOP # ________ MODULE # ________ GROUP # ________

CARD POS	CARD TYPE	UNIT	DN	RTMB	CUST	CARD POS	CARD TYPE	UNIT	DN	RTMB	CUST
1		0				6		0			
		1						1			
		2						2			
		3						3			
		4						4			
		5						5			
		6						6			
		7						7			
2		0				7		0			
		1						1			
		2						2			
		3						3			
		4						4			
		5						5			
		6						6			
		7						7			
3		0				8		0			
		1						1			
		2						2			
		3						3			
		4						4			
		5						5			
		6						6			
		7						7			
4		0				9		0			
		1						1			
		2						2			
		3						3			
		4						4			
		5						5			
		6						6			
		7						7			
5		0				10		0			
		1						1			
		2						2			
		3						3			
		4						4			
		5						5			
		6						6			
		7						7			

DN = Directory Number, RTMB = Route Member Number (trunks)

553-5368

Worksheet H: 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 I: 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				
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 J: 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 K: 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

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.

553-5361

Worksheet L: 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

553-4051

Worksheet M: Peripheral equipment modules

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			
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 ________________

553-5363

Worksheet M: Peripheral equipment modules (continued)
PE card calculations

PE CARD CALCULATIONS

CUSTOMER ______________________ DATE __________

One for the complete system at cutover, 2-year, and 5-year interval.

NUMBER OF:	CUTOVER	2-YR	5-YR
DTR cards			
Digital line cards			
Consoles			
AIOD trunks			
500-type telephone TNs ÷ 4			
CO/FX/WATS/private line trunks ÷ 2			
2-W E&M/DX/paging trunks ÷ 2			
Loop signaling/DID trunks ÷ 2			
Dictation trunks ÷ 2			
RAN trunks ÷ 4			
4-W E&M/DX trunks ÷ 2			
TOTAL CARDS			

PE MODULE CALCULATIONS:

Use the total cards required at 2 years to determine the number of PE Modules to be provisioned at cutover.

PE Modules required = Total cards (round to next higher number) ÷ 8.5

NUMBER OF PE MODULES REQUIRED AT CUTOVER __________

553-5362

Worksheet N: 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 = ______________

ESTIMATED REAL TIME USAGE (ERTU) CALCULATION:

$$\text{ERTU} = \frac{\text{Total line load} \times 100 \times T}{150 \times 2} / 2100 = \text{Percent utilization of CPU real time}$$

Legend:

Total load	=	the sum of total line load and total trunk load of the 2-year figure, in CCS
T	=	the average processing time for a call in seconds (using 1.2 s for option 21 and 0.24 s for options 51, 61, and 71); these are average numbers for a featured call
150	=	the average holding time in seconds
2520	=	the rated capacity (70% loading) of the CPU in seconds
2	=	the total originating and terminating traffic is divided by 2 to account for only call originations

553-4046

Worksheet O: Unprotected memory calculations

Note: This calculation does not apply for options 61C, 81, and 81C.

UNPROTECTED MEMORY CALCULATIONS

CUSTOMER ______________________________ DATE __________

One sheet for the complete system.

	ITEMS	WORDS	TOTAL
Fixed amount of storage			
Single-line TNs			
Multi-line TNs			
Add-on-modules			
Network groups			
Trunk units			
Consoles			
Customer groups			
Trunk routes			
Network loops (excluding conference)			
RPE loops			
Intergroup pairs			
Peripheral signaling cards (IPE and PE)			
SDI ports			
TDS loops			
MFS loops			
Conference cards			
DTR loops			
Call registers			
Low-priority input buffers			
High-priority input buffers			
Single-line telephone output buffers			
Multi-line telephone output buffers			

TOTAL WORDS __________

Memory card code __________

Capacity __________ k words (1k = 1024)

Unprotected memory cards required __________

Memory card addresses required __________

553-5364

Worksheet P: Protected memory calculations

Note: This calculation does not apply for options 61C, 81, and 81C.

PROTECTED MEMORY CALCULATIONS

CUSTOMER ______________________ DATE __________

One sheet for the complete system.

	ITEMS	WORDS	TOTAL
Fixed amount of storage			
Single-line TNs			
Multi-line TNs			
Add-on modules			
Network groups			
Trunk units			
Consoles			
Customer groups			
Trunk routes			
Code restricted trunk routes			
Network loops (excluding conference)			
DTR loops			
Speed call head table			
Speed call lists (10 numbers)			
Speed call lists (50 numbers)			
TDS loops			
Conference loops			
History file			

TOTAL __________

ADD 10% __________

TOTAL WORDS __________

Memory card code __________

Capacity __________ k words (1k = 1024)

Unprotected memory cards required __________

Memory card addresses required __________

553-4048

Worksheet Q: Program store calculations

Note: This calculation does not apply for options 61C, 81, and 81C.

PROGRAM STORE CALCULATIONS

CUSTOMER ______________________________ DATE __________

One sheet for the complete system.

PROGRAM NAME	STORAGE IN k (1k = 1024 words)
Basic	
Overlay area	
Read-only memory	

Memory card code __________

Total from table __________ k

Total x 1024 __________ words

Capacity __________ k words

Unprotected memory cards required __________

Memory card addresses required __________

553-4049

Worksheet R: 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
Call registers		2 year
Low-priority input buffers		Cutover
High-priority input buffers		Cutover
Single-line output buffers		Cutover
Multi-line output buffers		Cutover
CPUs		Cutover
IPE and PE modules		2 year
Network loops (except conference and TDS)		2 year
Network groups		2 year

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Reference tables

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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
21	426	51	1291	81	2215	111	3166	141	4134

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
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.

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.

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.

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.

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.

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.

Reference Table 7
Digitone receiver load capacity—6- to 15-second holding time (Part 1 of 2)

Average holding time in seconds	6	7	8	9	10	11	12	13	14	15
Number of DTRs										
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

Note: Load capacity is measured in CCS.

Reference Table 7
Digitone receiver load capacity—6- to 15-second holding time (Part 2 of 2)

Average holding time in seconds	6	7	8	9	10	11	12	13	14	15
Number of DTRs										
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.

Reference Table 8
Digitone receiver load capacity—16- to 25-second holding time (Part 1 of 2)

Average holding time in seconds	16	17	18	19	20	21	22	23	24	25
Number of DTRs										
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
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

Note: Load capacity is measured in CCS.

Reference Table 8
Digitone receiver load capacity—16- to 25-second holding time (Part 2 of 2)

Average holding time in seconds	16	17	18	19	20	21	22	23	24	25
Number of DTRs										
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
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.

Reference Table 9
Digitone receiver requirements—Poisson 0.1 percent blocking

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
21	346	46	1003
22	370	47	1030
23	395	48	1058
24	419	49	1086
25	444	50	1115

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

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.

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