DataT•A•C™ Networks

Reference Handbook

MOTOROLA

Mobile Data Division

DataT·A·C Networks

Reference Handbook

The DataTAC Networks Reference Handbook serves as general information regarding Motorola's product line and has been issued for reference purposes only. The information is not intended to detail specific product specifications. If detailed information is required please contact your nearest Motorola representative. Although every effort has been made to correctly identify material, all information is subject to change without notice.

MOTOROLA

Mobile Data Division

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As a pioneer in both radio communications and mobile data communications, Motorola understands the software, hardware, communications protocols, and connectivity issues that are at the heart of mobile data systems. Motorola has been developing and installing mobile data communications products and systems since their inception.

Motorola also understands the user markets. We have developed applications and worked closely with third-party developers to provide solutions to meet the needs of many businesses and services.

Most importantly, Motorola has an existing product designed to meet the needs of the network operator and the network subscriber today: the DataTAC network.

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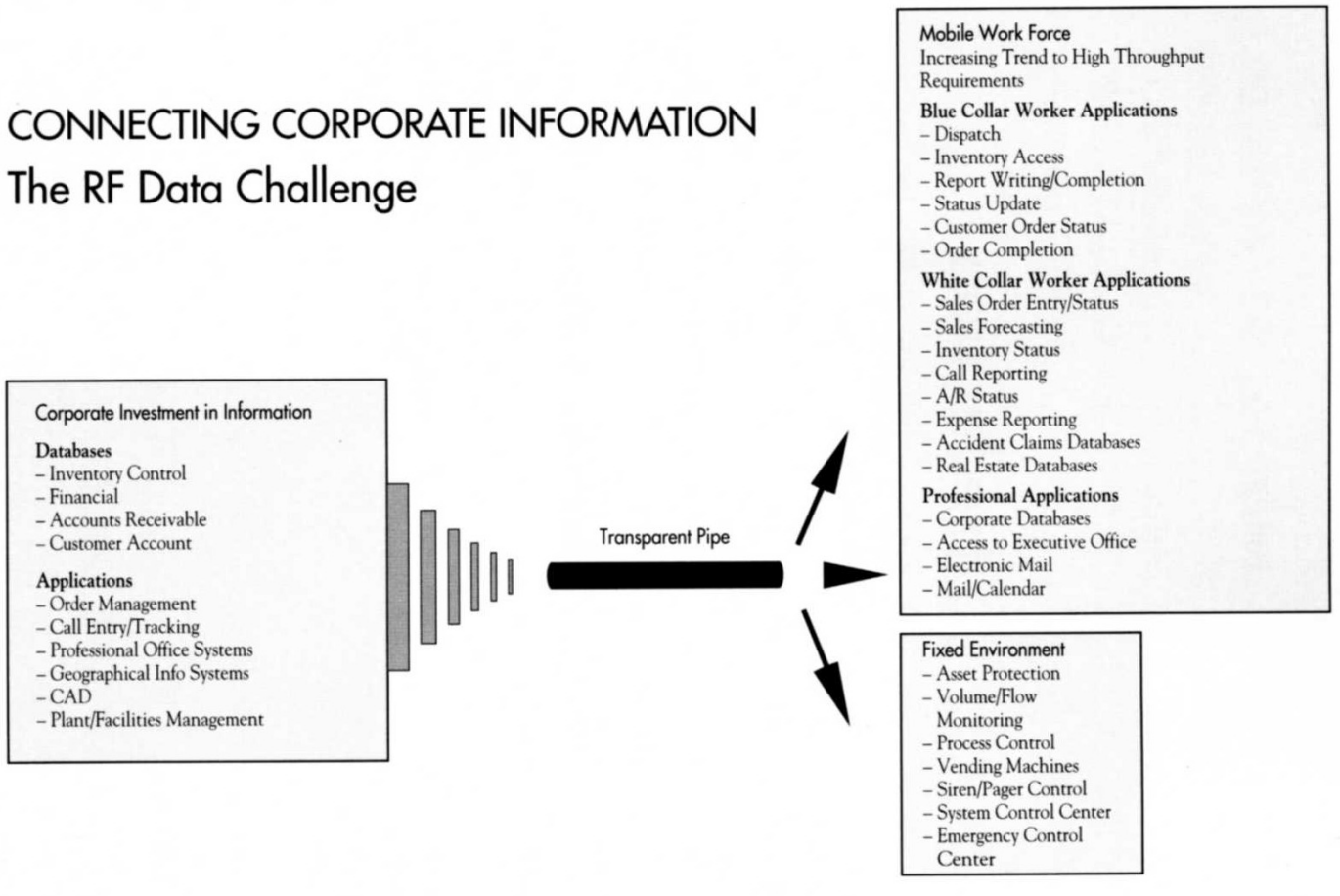
Introduction

CONNECTING CORPORATE INFORMATION
The RF Data Challenge



Introduction

Mobile Data

More than ever before, businesses and individuals are taking advantage of the power that *mobile data* offers: the power to be more effective, the power to compete, and the power to excel.

There are many reasons why.

First and foremost is the fact that the modern work force is mobile. Recent studies show that more than 40% of the work force in industrial countries have mobile jobs.

As well, this mobile work force has at its disposal mobile devices that are more powerful and affordable than ever before. Consumers can take advantage of a wide range of mobile computing products, including:

- Portable, laptop, palmtop, and penpad PCs
- Portable and mobile fax machines
- Portable and mobile radio modems
- Specialized portable and mobile terminals.

The use of mobile data technology is also growing because a company's existing applications and databases can now reach the mobile user. This means mobile data networks give today's businesses the ability to extend their investments in information processing to the mobile world. Applications that have proven themselves well suited to the mobile user include:

- Computer-aided dispatch
- Remote file transfer
- Mobile fax
- Remote order entry
- Database access for:
  - real estate
  - insurance claims
  - inventory
  - order status
- Electronic mail
- Paging
- Vending machines
- Automated teller machines
- Security.

However, underlying the growth in the use of mobile products and applications are the benefits mobile data has always offered businesses and individuals:

- Increased personal flexibility
- Improved customer service
- Increased productivity
- Decreased costs
- Increased profitability
- Better return on investment in telecommunications and information technology (IT)
- Fast, accurate, reliable, and secure communications
- Improved management visibility, control, and planning
- Less paperwork
- More efficient use of resources
- Improved working environment.

The challenge now facing network operators is how to best provide the services required to support the inevitable trend toward mobile connectivity.

The answer is a DataTAC™ network from Motorola.

DataTAC Networks

DataTAC networks provide a simple, cost effective way for businesses to implement a mobile data system.

To date, companies wishing to incorporate mobile data systems into their operations have had to purchase and install a complete end-to-end system, including the application, infrastructure, radio backbone, and mobile terminal devices.

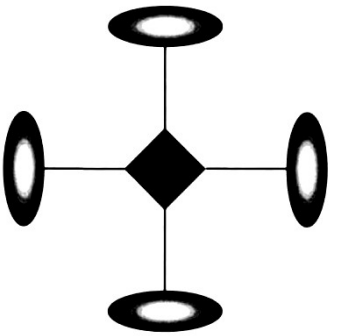
DataTAC provides an effective alternative. DataTAC networks are run by network operators who resell the airtime to end users, either on a usage or monthly charge out basis. For end users this means that implementing a mobile data system now means simply attaching the desired applications to the DataTAC network, and equipping the mobile users with mobile or portable data terminals.

DataTAC and Motorola

With DataTAC network technology, Motorola can provide network operators and users with the systems that are required to meet the stringent demands of the mobile user marketplace.

CHAPTER

1



Network Overview

Contents

Chapter 1 NETWORK OVERVIEW

Features of the DataTAC Network

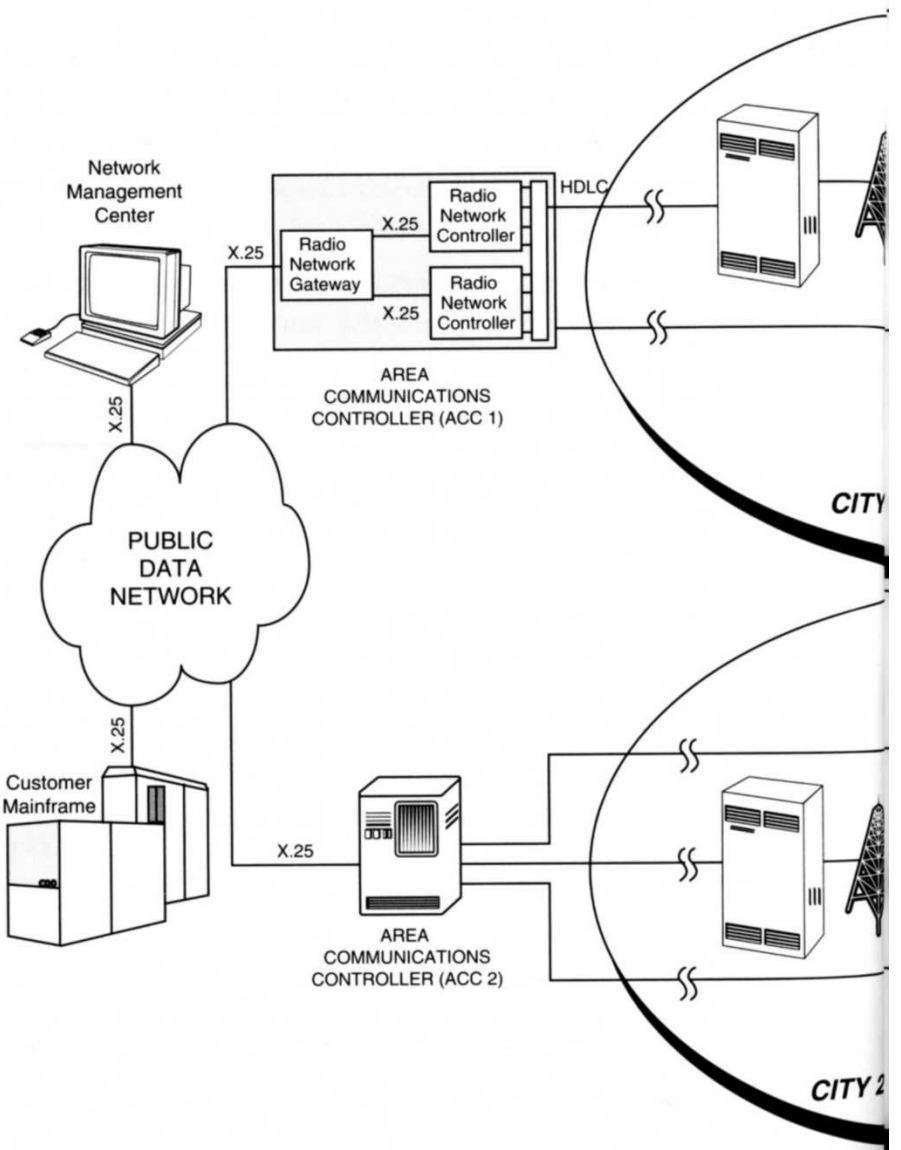
DataTAC is Motorola's most recent Public Mobile Data Network product offering. It has been designed to provide connectivity between applications on fixed hosts and specialized mobile data devices that roam within the operating area of the network.

DataTAC networks are designed to connect to standard X.25 Packet Switched Data Networks (PSDN). This enables applications that are distributed over X.25 networks to extend their reach to mobile users. Figure 1-1 depicts the basic system architecture.

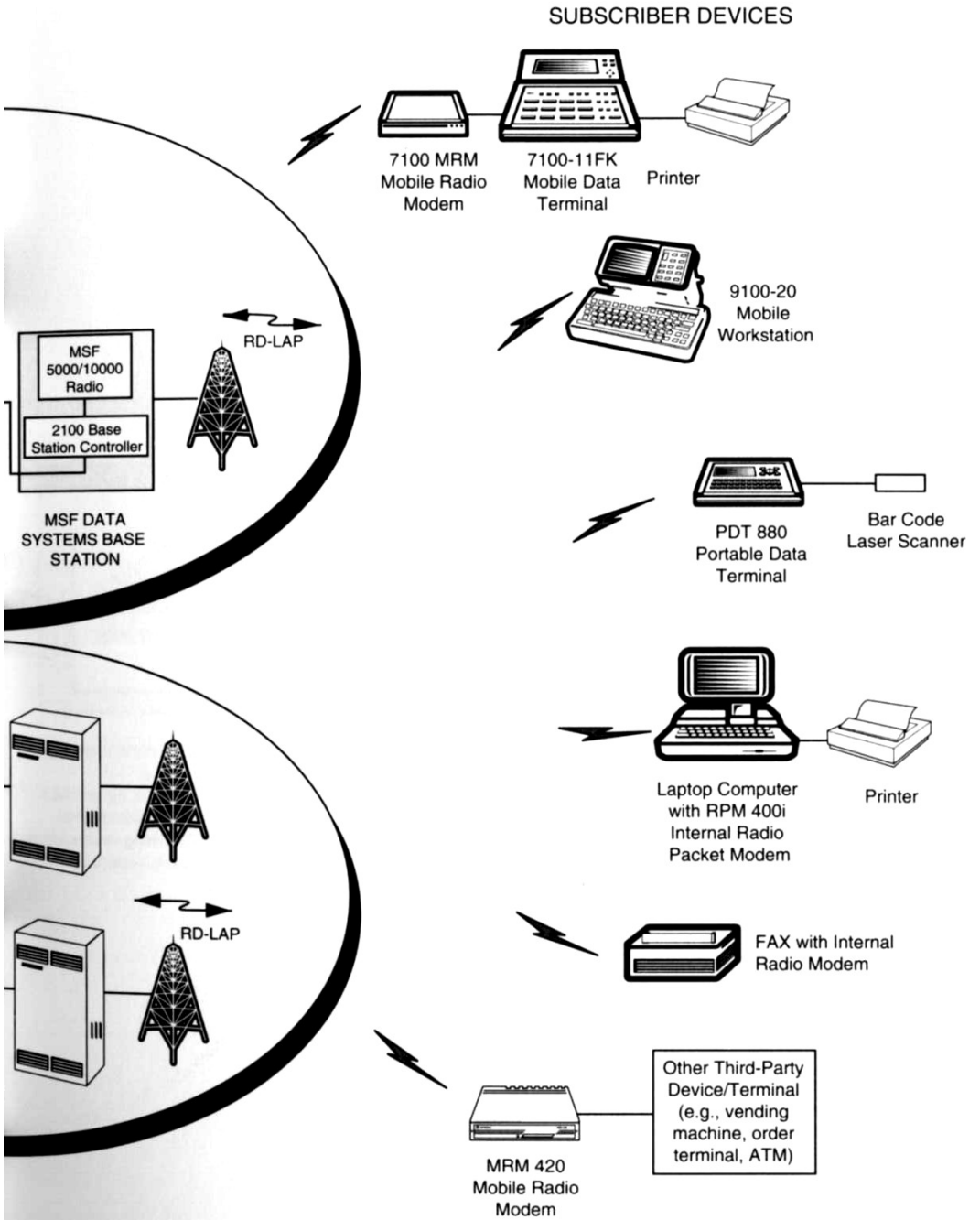
The major features of DataTAC networks include:

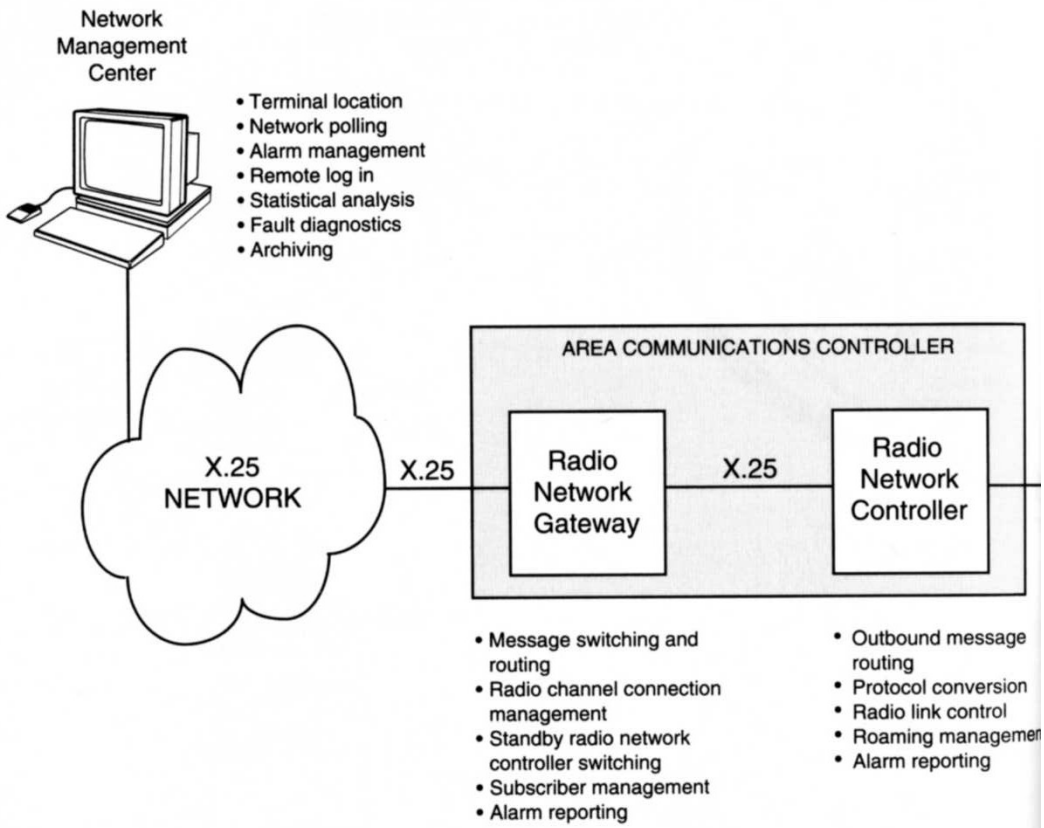
- *Distributed Architecture*
  DataTAC networks are designed to support reliable, high-throughput data over radio. A distributed system design helps to minimize traffic bottlenecks and eliminate single-point network failures. This design philosophy is supported by the use of fault-tolerant computer hardware and redundant hot-standby equipment.
- *Modular Design*
  DataTAC systems permit easy network expansion when either traffic or coverage requirements are increased.
- *Ubiquitous, Efficient, High Radio Channel Throughput*
  Achieving efficient data communications over radio channels poses many challenges. DataTAC networks surmount these with the Radio Data Link Access Protocol (RD-LAP), a Motorola-developed, high-speed radio channel protocol. RD-LAP provides:
  - the highest mobile radio channel data rate available today (up to 19.2 kbps)
  - high channel efficiency using a slotted DSMA channel access method
  - unrestricted and user-transparent roaming throughout the radio network
  - the capability to evolve to future higher speed technology.
- *Extensive Radio Coverage*
  DataTAC networks are designed to support both street and in-building coverage requirements.

- *Comprehensive Network Management*
  Facilities include extensive subscriber database management and on-line diagnostics for all radio sites, and automated alarm reporting management.
- *Simplified Network and Application Attachment*
  DataTAC networks interface directly to X.25 networks. This facilitates an easy extension of existing applications to the mobile network.
- *Commitment to International Standards*
  Motorola understands the importance of international standards and understands the need to support the independent development of products that can operate on public data networks. To this end, the RD-LAP protocol has been opened in Europe. In addition, Motorola is continually creating and enhancing development tools and support programs to assist independent software and terminal vendors.
- *Leading Edge Technology*
  Data system components utilize the most recent developments in DSP, VME, fault-tolerant, and RISC-based technologies coupled with the most sophisticated operating and database systems available today. Furthermore, Motorola's commitment is to continue to use and pioneer the best technologies available to develop and support mobile data networks.

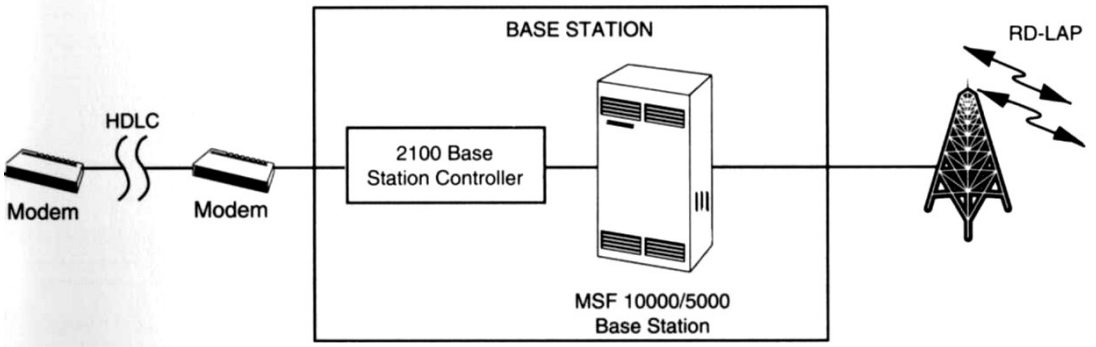


The DataTAC Public Network
System Architecture
Figure 1-1


SUBSCRIBER DEVICES
7100 MRM
Mobile Radio
Modem
7100-11FK
Mobile Data
Terminal
Printer
9100-20
Mobile
Workstation
RD-LAP
MSF
5000/10000
Radio
2100 Base
Station Controller
MSF DATA
SYSTEMS BASE
STATION
PDT 880
Portable Data
Terminal
Bar Code
Laser Scanner
Laptop Computer
with RPM 400i
Internal Radio
Packet Modem
Printer
RD-LAP
FAX with Internal
Radio Modem
Other Third-Party
Device/Terminal
(e.g., vending
machine, order
terminal, ATM)
MRM 420
Mobile Radio
Modem



DataTAC Product Lineup And Functions
Figure 1-2



- Protocol conversion
- Error correction
- Base radio control
- Channel access control
- Statistics and alarm reporting

- Analogue signal modulation/demodulation
- RF transmission/reception
- Alarms

SYSTEM ARCHITECTURE

A DataTAC network is a configuration of the following basic system elements:

- Area Communications Controllers (ACCs)
- A Network Management Center (NMC)
- Data MSF Base Stations
- Mobile subscriber devices.

These elements and their functions are depicted in Figure 1-2. The following discussion describes the basic hardware, interfaces, and functions for each of these DataTAC network products. More detail on each product can be found in Chapters 5 and 6.

Area Communications Controller

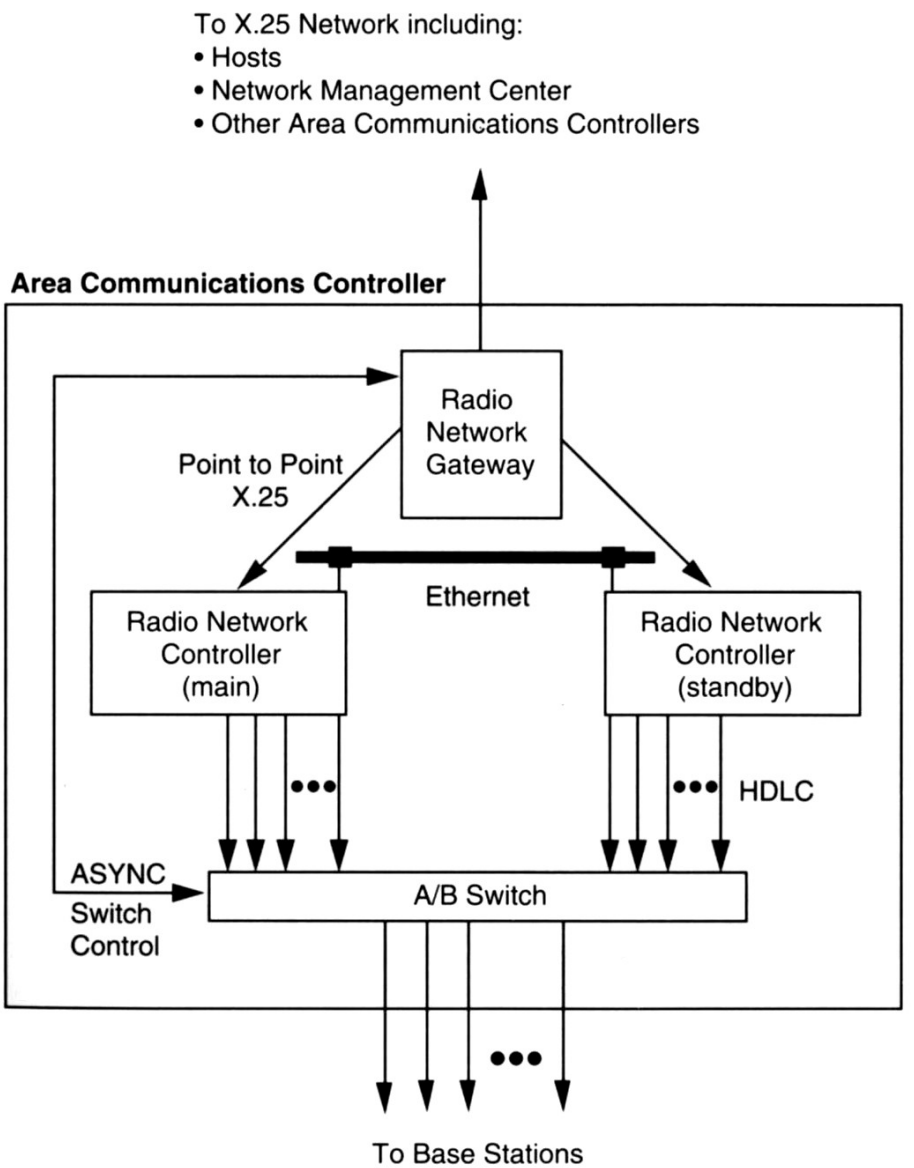
The ACC is the switching node of a DataTAC network, communicating with application hosts via an X.25 packet-switched network at one end, and the radio network at the other. Its major tasks include:

- Message switching and routing; store and forward
- Protocol conversion
- Radio network management, including the management of:
  - mobile terminal sign-on authorization
  - mobile terminal roaming
  - base site control
- Database management, including:
  - collection of session and billing information
  - subscriber management
- Alarm and statistics reporting.

The ACC is comprised of two key elements as depicted in Fig 1-3:

- The Radio Network Gateway (RNG)
- The Radio Network Controller (RNC)

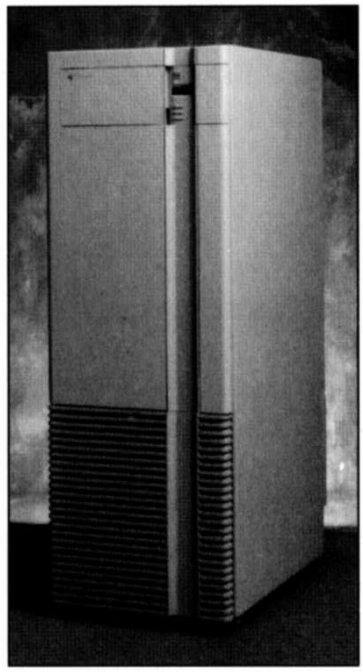
The following discussion describes these two products in more detail.



Area Communications Controller Architecture
Figure 1-3

The Radio Network Gateway (RNG)

The RNG is the component of the ACC that is the interface to the X.25 network and performs the function of a message switch. It also controls some of the connection management of the radio channels, and maintains the network subscriber database.



Radio Network Gateway (RNG)

RNG Hardware

The Motorola Radio Network Gateway is based on a fault-tolerant, Tandem Non-Stop CLX 800 series computer using the Guardian 90 operating system. This computer is characterized by its support of fault-tolerant hardware and software design, together with transaction monitoring, database recovery, and remote diagnostics capability.

The system can be configured with two to sixteen processors, depending upon the processing requirements. All memory and disks are backed up by redundant secondaries which can be automatically switched into operation in the event of a failure of a primary unit.

RNG Functions

Message Switching and Routing

The RNG is responsible for analyzing each message received over both the X.25 network and the radio channel. It determines to which session the message is associated, and then appropriately routes the message to one of the following:

- A host application over the X.25 network
- An RNC for eventual delivery to a mobile terminal over the radio network
- Another RNG over the X.25 network for eventual delivery to a mobile terminal over the radio network
- The Network Management Center over the X.25 network.

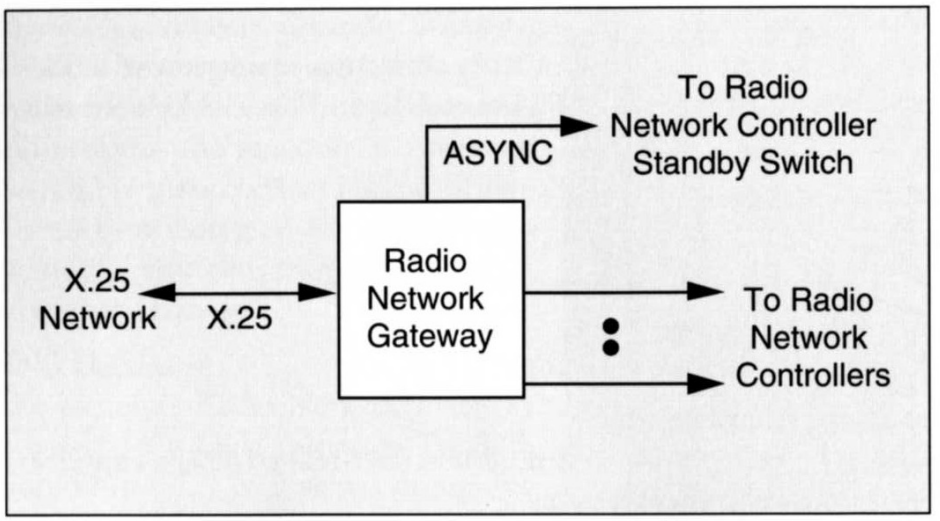
Radio Channel Connection Management
The RNG performs some of the connection management services associated with the RD-LAP's network layer. These include the management of:

- Terminal roaming
- Load balancing
- Mobile terminal configuration modification
- Multi cast call services
- Statistics and error reporting.

Subscriber Management
The RNG maintains a number of subscriber-related databases and services, including the following:

- *Sign-on and Authorizations*
  When the RNG receives a message from a mobile terminal which is not yet signed on to the network, the RNG will initiate a sign-on session with that unit. This will require the mobile terminal to provide valid ID and password information. Upon receipt of valid information, the RNG will permit the subscriber to sign on to the appropriate services.
- *Session Record Billing Collection*
  The RNG will maintain session records for all sessions which are handled by the RNG. The records include session information such as the amount of air time used, the number of bytes of data transmitted, and whether the terminal unit has roamed or not. These records are stored on non-volatile hard disks to ensure that information is not lost even in the event of a system outage. The information is sent to the Network Management Center for further processing by the network operator's own billing computer.

RNG Interfaces
The RNG has four major interfaces (as depicted in Figure 1-4).



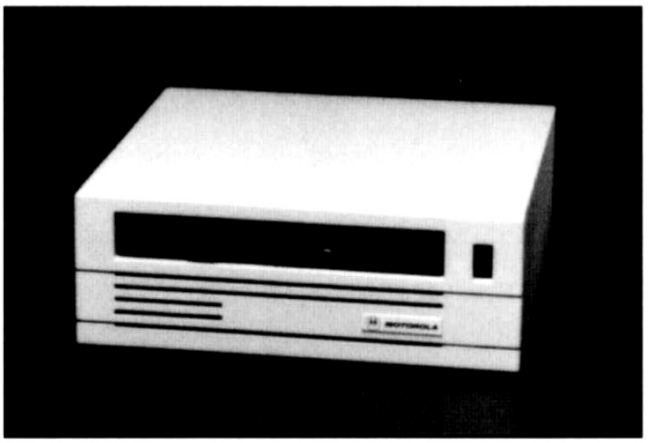
Radio Network Gateway Interfaces
Figure 1-4

- Interface to the X.25 Network
  The RNG supports X.21 and "Triple X" (X.3, X.29, and X.28) interfaces to the X.25 network. The number of physical connections is a configurable parameter which can be adjusted to meet the growing needs of the network.
- Interface to the RNC
  The RNG uses a point-to-point X.25 interface to both the main and standby RNC.
- Interface to the A/B Matrix Switch
  The RNG controls RNC switching through an asynchronous interface to the A/B switch.
- Interface to the Network Management Center
  The RNG interfaces to the Network Management Center via an X.25 PVC, thereby providing a conduit for all network management information collected from within the RNG's domain.

Standby RNC Switching

The RNG is responsible for determining that the active RNC is processing information properly. In the event that an RNC failure is detected, the RNG uses the A/B matrix switch to switch the base sites over to the standby RNC automatically so that normal operation can be resumed promptly.

The Radio Network Controller (RNC)



The Radio Network controller (RNC)

The RNC is the component of the ACC that controls the fixed end of the network. Whereas the RNG is fundamentally an X.25 message switch routing X.21 packets to and from appropriate RNCs, the RNC performs the X.25 to RD-LAP protocol conversion, controls the RD-LAP data link, routes messages to the radio base sites, and controls the radio base sites within its RF domain.

RNC Hardware

The RNC is based on a VME architecture utilizing a Motorola 68030-based control processor with streaming tape drive, hard disk drive, and a configurable number of 68030-based I/O processors. The design is modular in order to accommodate various radio site configurations.

RNC Functions

Outbound Message Routing

The RNC is responsible for routing outbound messages to the correct base station.

Protocol Conversion

The RNC is responsible for converting the outbound messages received from the RNG over the X.25 link into RD-LAP format and encapsulating them into HDLC frames for delivery to the base sites, and vice versa.

Radio Link Control

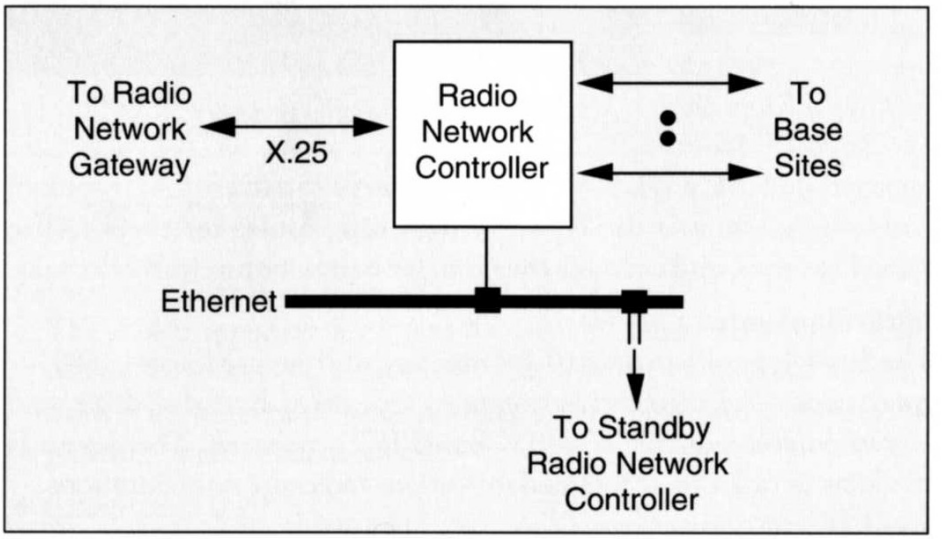
The RNC is responsible for effecting some of the RD-LAP protocol functions. These include:

- Segmentation and re-assembly of data packets
- Packet sequencing
- Error detection and correction
- Radio channel flow control.

Roaming Management
The RNC is responsible for managing the roaming of mobile terminals among the base sites within its control.

Network Management
The RNC hosts a management agent that is used by the Network Management Center to monitor the status of various NMC alarms.

RNC Interfaces
The RNC has three major interfaces (as depicted in Figure 1-5):

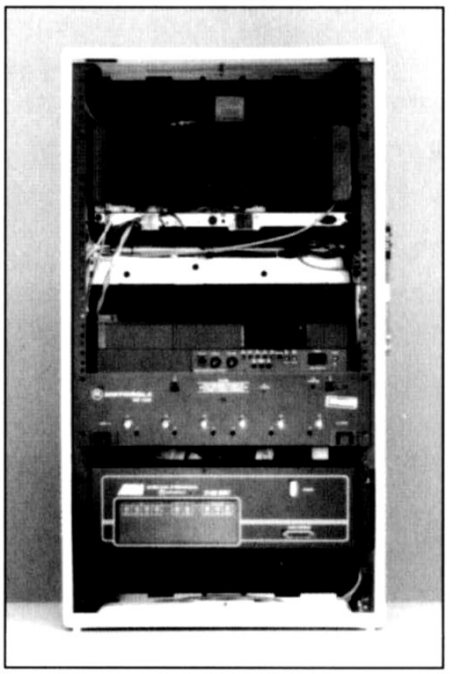


Radio Network Controller Interfaces
Figure 1-5

- Interface to RNG
  The RNC uses a point-to-point X.25 interface to the RNG.
- Interface to the Base Site
  The RNC uses a 9.6 or 19.2 kbps HDLC link to each base site, and can support up to 64 base site links. Normally, the RNC interfaces to the base sites via land line modems and an A/B matrix switch. However, these links can also be implemented through other means such as microwave links.
- Interface to Standby RNC
  Primary and secondary RNCs are connected across a TCP/IP Ethernet link. This interface is used to maintain terminal status in the secondary RNC in the event that an RNC switchover is necessary.

Data MSF Base Station

The Data MSF Base Station is a new product designed specifically to support mobile data communications. It integrates a high-performance data-optimized MSF 10000 or MSF 5000 base station radio with a 2100 BSC Base Station Controller (2100 BSC). It communicates with an ACC via a landline modem or microwave link.



MSF 10000/2100 BSC

2100 Base Station Controller

The 2100 BSC is an intelligent base station controller used for mobile data networks that use RD-LAP protocol. The 2100 BSC is co-located at the base station site with the base station radio, with which it has either a 9.6 or 19.2 kbps interface. It is also connected (usually via modem) to the ACC using a 9.6 or 19.2 kbps HDLC interface. The 2100 BSC's major responsibility is to translate the stream of digital data coming from the ACC into an analogue wave form for transmission over the base radio and vice versa.

The 2100 BSC software has been designed according to a structured architecture, permitting functionality to be provided in an efficient manner, and allowing for future enhancements in later releases of the product. Thus, the 2100 BSC may be installed today and upgraded later to support new features, protocol enhancements, or interfaces to different radios.

Hardware

The 2100 BSC hardware architecture is designed to be compatible with the Motorola VME standard. The enclosure incorporates a custom-designed chassis and is designed specifically for harsh base site environments.

The 2100 BSC functions are performed by a specially designed processor card. The processor card is a VME form factor card which plugs into the chassis and incorporates two separate microprocessors:

- The Motorola 56001 digital signal processor
- The Motorola 68000 microprocessor.

These two processors, with associated support circuitry, are responsible for performing all the base station control, modulation, and demodulation functions.

2100 BSC Functions

Protocol Conversion

The 2100 BSC is responsible for formatting messages correctly for transmission to and from the ACC. This requires the conversion of data packets into their analogue equivalent.

Error Correction Encoding and Decoding

The 2100 BSC is responsible for performing the Trellis encoding and decoding that is part of the RD-LAP protocol specification.

Base Radio Control

The 2100 BSC is responsible for controlling the keying of the base station radio and generating the CW identifier Morse code sequence (if required).

Channel Access Control

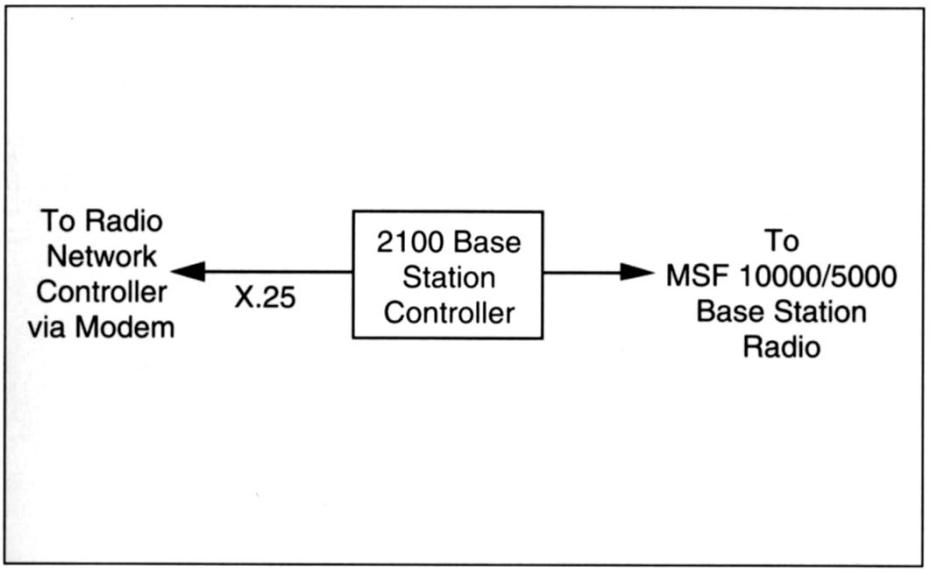
The 2100 BSC is responsible for controlling the slotted DSMA inbound channel contention scheme. When data is detected on the inbound channel, the 2100 BSC sets a channel status symbol on the outbound channel to a busy state.

Operations, Administration, and Maintenance Functions

The 2100 BSC is responsible for collecting all the statistics and alarm messages (from both the base station radio and the 2100 BSC itself) and recording them on RAM disk. The 2100 BSC also hosts a network management agent which is responsible for relaying the information to the Network Management Center.

Interfaces

The 2100 BSC supports two basic interfaces (as depicted in Figure 1-6):



Base Station Controller Interfaces

Figure 1-6

- Interface to the Base Station
  The base station radio interface consists of modulator and discriminator signals as well as radio control, alarm pins and Received Signal Strength Indication (RSSI). The interface allows the 2100 BSC to key the radio, as well as provide numerous control and sensor lines.
- Interface to the ACC
  The ACC interface is usually effected with the use of land line modems. The interface is 9.6 or 19.2 kbps, synchronous, full duplex HDLC.

MSF 10000 and MSF 5000 Base Station Radios

The base station radios used in the DataTAC network's data system station are the MSF 10000 and MSF 5000. These radios have been optimized to provide the level of performance, functionality, and reliability that is required in a shared public data network.

MSF 5000/2100 BSC

Hardware

The MSF 10000 and MSF 5000 base station radios include the following features:

- *State-of-the-Art, 100% Continuous-Duty Transmitter*
  The MSF 10000 and MSF 5000 base station radios feature a completely solid-state design and are capable of being modulated by data at up to 9600 bps while still meeting the bandwidth specifications for a 12.5 kHz-spaced channel, and 19200 bps for a 25 kHz-spaced channel. As well, the transmitter may be continuously keyed without suffering degradation. This is vital for data systems that often experience extremely high levels of outbound traffic.

- *Sensitive Receiver*
  The MSF 10000 and MSF 5000 base station radios boast an extremely sensitive data receiver. This is crucial for achieving the high throughput and coverage requirements of mobile data networks.

- *RSSI Measurement*
  The MSF 10000 and MSF 5000 base station radios have the capability to measure and report the strength of radio signals that deliver inbound data messages.

- *Serviceable Design*
  The MSF 10000 and MSF 5000 base station radios incorporate a modular design to enhance service by use of field replaceable units (FRUs) throughout the station.

Functions

Signal Processing

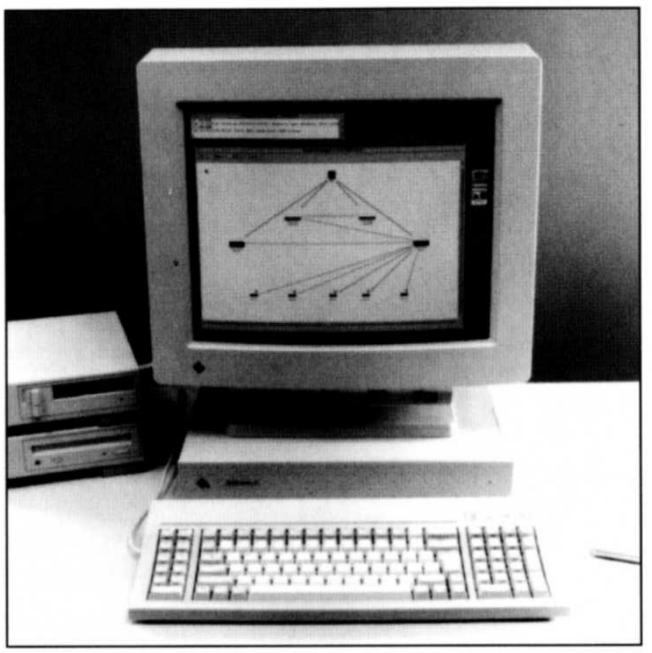
Inbound signals are received over the air from terminal devices and are demodulated and passed through to the 2100 BSC for further processing. In parallel with the signal, the received signal strength is sent to the 2100 BSC. This information is ultimately passed to the area communications controller and is used to determine the optimum site to relay outbound data to the terminal device.

Outbound messages are taken from the 2100 BSC in the form of an audio representation of the data which is used to modulate the transmitter for transmission over the air.

Alarms

The base station radio provides alarm reports to the 2100 BSC which processes them and sends them to the Network Management Center.

Network Management Center



Network Management Center

A data network requires a facility to monitor, control, and manage the network. DataTAC networks realize network management with the Network Management Center product, or NMC, which communicates with all the network components across the X.25 public data network. The major function of the NMC is to allow the network operator to:

- Monitor network devices and alarms
- Run diagnostic tests to isolate problems
- Set thresholds and operational modes to tune network performance
- Gather statistics and generate reports.

Hardware

The NMC hardware platform is based on the latest RISC workstation technology. It uses the Sun SPARCstation 2/GX, which includes a 28 Mips processor and 16 MB of RAM. It is equipped with 400 MB of internal disk storage, a GX graphics accelerator board, and a 23 cm color monitor. Also included in the NMC configuration are 644 MB of CD ROM, a 150-MB tape drive, laser printer, line printer, and a backup modem.

Functions

The NMC's basic function is to provide network operators with a graphical user interface which allows them to perform basic network management. These include:

- *Terminal Location Determination*
  The NMC allows the network operator to determine the radio location of a specific terminal.
- *Network Polling*
  The NMC allows the network operator to monitor the configuration of the network and to monitor the correct operation of network devices.
- *Alarm Management*
  The NMC provides network operators with visibility on alarm activity throughout the network.
- *Remote Log-in*
  The NMC allows network operators to establish direct console sessions with network elements such as the RNG or RNC.
- *Statistical Analysis*
  The NMC is responsible for gathering statistics from network devices. Network operators can use this information to provide a view of network performance over a period of time. The NMC also provides a number of tools to assist in the analysis of network trends and assist in planning.
- *Fault Diagnostics*
  The NMC has a diagnostic application that is used to isolate faults when a problem has been detected within the network. Network faults are announced by alarm messages arriving at the NMC, or they may be detected by the network operator from examining the network statistics. Network operators can then isolate the fault down to a site, a device, and if possible, a field replaceable unit. This enables the service personnel to be dispatched to the correct site with the correct replacement parts.
- *Archiving*
  The NMC permits network operators to backup statistics, data, alarm, and database files from disk to tape. After backup, the files can be deleted.

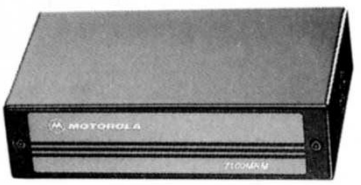
Subscriber Devices

Motorola is the leading supplier of portable and mobile data terminal products for the wireless data market worldwide. Our product portfolio has been developed to address the needs of the public shared networks industry, and it is marketed on a worldwide basis. Some of these products can be used "as is" directly on DataTAC networks, while others are designed to be used in conjunction with other third-party products. The following is a short descriptive list of the existing product line. More detailed product specifications can be found in Chapter 6.

Radio Modems

7100 Mobile Radio Modem

The 7100 Mobile Radio Modem (7100 MRM) is an integrated UHF data radio modem dedicated to the 7100 FK mobile data terminal. The 7100 MRM consists of a radio data modem, frequency synthesized radio module, 6-watt power amplifier, 7100 FK MDT cable, and DIN housing.



7100 MRM

MRM 420 Mobile Radio Modem

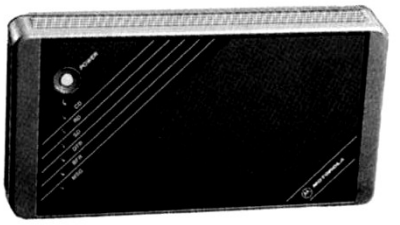
The MRM 420 mobile radio modem (MRM 420) is an integrated radio and data modem operating in UHF sub-bands and designed for use in a mobile vehicle. The MRM 420 is the RF communications link for third-party terminals and laptops communicating over public data networks that use Motorola's RD-LAP protocol. The MRM 420 consists of:

MRM 420

- A data radio modem
- UHF frequency synthesized radio module
- Six-watt power amplifier
- LEDs and DIN housing.

RPM 420e Radio Packet Modem

The RPM 420e radio packet modem (RPM 420e) is a desktop or portable RF communications link for third-party terminals and laptops communicating over public data networks that use Motorola's RD-LAP protocol. The RPM 420e product consists of:



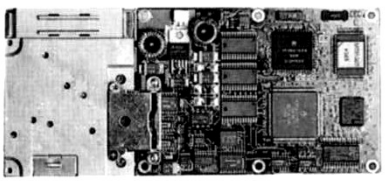
RPM 420e

- Two sets of electronic assemblies
- Synthesized radio module
- Integrated internal antenna
- High-impact plastic housing
- Rechargeable NiCad battery pack
- On/Off switch
- Modem status LEDs
- RS-232 port
- External trickle charger jack.

The housing is designed with the rigidity and strength required of a portable product. It consists of a main housing, back cover, and rechargeable battery pack which are environmentally sealed to protect the electronic components inside.

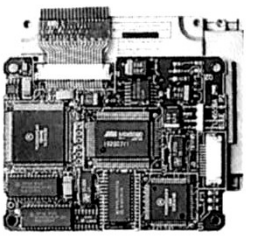
Integrated Radio Packet Modems

Motorola's line of integrated Radio Packet Modems (RPMs) includes the RPM 400i, RPM 405i, RPM 415i, and the RPM 400iPLUS. These products are designed to be integrated into original equipment manufacturers' (OEMs') products, and consist of a radio coupled with the logic required to support the radio channel protocol. All versions of Motorola's integrated RPMs utilize digital signal processing technology.



RPM 400i

More detail on each of the integrated RPMs can be found in Chapter 6.



RPM 405i

Mobile Data Terminals

7100 FK Mobile Data Terminal

The 7100 FK mobile data terminal (7100 FK) is designed for use in a mobile vehicle. It requires the use of a 7100 Mobile Radio Modem (7100 MRM).

7100 FK

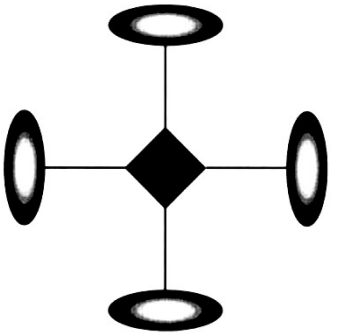
PDT 880 Portable Data Terminal

The PDT 880 Portable Data Terminal (PDT 880) is a self-contained portable data terminal that can be carried alone or in briefcase. The PDT 880 package consists of electronic components, synthesized radio module, integrated low-profile antenna, high-impact plastic housing, rechargeable battery pack, alphanumeric keyboard, liquid crystal display (LCD), and I/O connector. This package is designed to be compact, environmentally rugged, and reliable.

PDT 880

CHAPTER

2



Network Services

Contents

Chapter 2 NETWORK SERVICES

Subscriber Services

DataTAC public networks provide several services to meet the varied needs of the network user. The different types of services available are characterized by the different types of host connectivity that are required to support them. The basic service packages available come in two fundamental types:

- Fleet Service
- Personal Service.

The following discussion describes both these services.

Fleet Service

Fleet Service is designed to provide communications between fleet-oriented computer applications and a fleet of mobile terminal devices. Fleet Service would typically be used by organizations that employ computerized dispatch systems, such as field service, courier, trucking, and transportation companies.

The distinguishing factor in Fleet Service connectivity is that inbound and outbound data to and from all terminals are sent across a single X.25 Permanent Virtual Circuit (PVC) or Switched Virtual Circuit (SVC). The X.25 circuit is terminated at one end by the application host, and at the other end by the ACC (to which all mobiles are registered).

The host application addresses messages to individual terminals by embedding the terminal address and the delivery confirmation status in the user data portion of the X.25 data packet. The remainder of the user data contained in the packet is transparent; it is up to the host and terminal applications to agree on the semantics and syntax of the end-to-end application protocol.

Mobile terminals are associated with a specific fleet via the subscriber database. From the perspective of the X.25 network, the fleet of mobile users appears as a single interworking application whose X.25 address is physically located at the home ACC.

Some of the features provided for users of DataTAC Fleet Service are:

- Group messaging
- Selective messaging
- On-line, ACC-controlled terminal reconfiguration

Personal Service

Personal Service is designed for individual mobile users who desire access to one or more host application or database. Typical uses of DataTAC's Personal Service might include:

- Electronic mail services
- On-line database access
- Remote order entry services.

Personal Service is effected by the establishment of an X.25 SVC between an ACC and the application host computer. As with Fleet Service, the ACC bridges the X.25 service to the radio network, thereby providing end-to-end connectivity between the mobile device and the host.

Personal Service is characterized as a reliable transfer, connection-oriented service, as opposed to a connectionless (datagram) service. A Personal Service SVC is set up for each mobile user session. This is a fully transparent, standard X.25 connection; neither the host computer nor the X.25 network can distinguish the functionality of a mobile user from that of a conventional fixed user.

There are two types of Personal Service, depending upon how the SVC is set up. When a host connection can only be set up via a mobile terminal request, the service is referred to as "Shared Personal Service." If either the host or mobile terminal can be allowed to initiate a session, the service is referred to as "Dedicated Personal Service."

Shared Personal Service

Shared Personal Service is a service that caters to host applications for which sessions can only be initiated by the mobile terminal device (such as database inquiries or remote order entry services). This service is conceptually similar to X.25 network access via a dial-up Packet Assembler/Disassembler (PAD).

In Shared Personal Service, mobile terminal subscribers are not permanently assigned a specific physical network address or network user address (NUA) at the ACC. Rather, the subscriber's NUAs are shared among subscribers and only assigned when needed.

For example, if a Shared Personal Service subscriber requires remote access to an on-line database service, the subscriber's mobile terminal

requests the ACC to establish an X.25 session with the required host. At this time, the mobile terminal is temporarily assigned a NUA at the ACC so the destination host can correctly address and respond to the mobile terminal. In this way, Shared Personal Service subscribers share the available NUAs with other shared service subscribers on a dynamic basis.

The fact that a NUA is not assigned permanently to shared users also implies that subscriber-host sessions can only be initiated by mobile terminals and not by hosts. As well, shared service does not guarantee the same level of network availability that a dedicated network address provides. However, such service is adequate for many host applications, and in most cases, less expensive for the subscriber.

Dedicated Personal Service

Dedicated Personal Service is characterized by the mobile subscriber having a dedicated network address at the ACC associated with the subscriber's mobile terminal. Dedicated Personal Service can, therefore, support applications that require host-initiated sessions (such as paging services). Dedicated service is conceptually similar to services available to fixed terminals that are synchronously connected to an X.25 network.

Dedicated service is also of interest to mobile subscribers who are looking for a more reliable service than Shared Personal Service, as there is no need to wait for available NUAs to be assigned when a communications link (SVC) with a host is desired. Dedicated Personal Service, therefore, buys the subscriber a more secure and available mobile communications service.

Network Roaming

Transparent roaming is a key feature of the public mobile data network. True roaming provides continuous data connectivity between mobile and fixed applications, while allowing mobile devices to roam freely throughout the coverage area without the need to select channels or have any special knowledge of the radio system. It is this feature which permits the DataTAC network to extend the access of fixed applications to mobile users.

The most important features of the roaming function are:

- *Blanket Radio Coverage*
  Radio cells are overlapped to allow terminal units to be in constant radio contact.
- *Session Continuity*
  Through the use of advanced automatic channel selection algorithms, connection disruption is minimized during roaming, and mobile terminals remain in reliable data communications contact with the network.
- *Transparency of the Roaming Connection*
  Once a terminal to host session has been established, fixed applications always address terminal units via a fixed X.25 address. During a connection between a mobile and a fixed application, mobiles may roam between base stations and ACCs without any special action or changes on the fixed application's part.
- *Support for Groups Within the Function*
  The roaming function allows a mobile to continue to receive its group messages while roaming within its 'home' ACC.

Network Security

The term "network security" refers to the security of information within the network and the security of network components from unauthorized use.

Subscriber-level security can be provided via a subscriber validation sequence which occurs each time a user attempts to sign on to the network. This requires the subscriber to provide both an account number and a password prior to the granting of network access. Furthermore,

the network only permits subscribers access to host applications for which they are authorized. Finally, a third level of security can be provided by the host application itself, if desired.

Each element of a DataTAC network is protected against unauthorized service personnel gaining access via dial-in ports. This is achieved by requiring Network Management Center authorization prior to dial-in access and password authorization prior to remote console operation.

Network Accounting

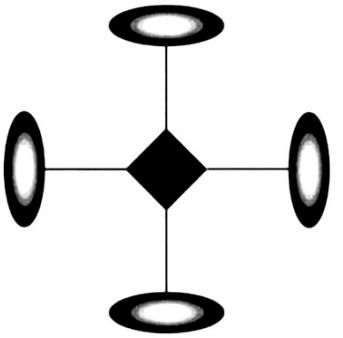
DataTAC's network-use accounting facility provides network operators with the information required to accurately bill network users. Among the types of information that are typically recorded on a per-device basis are:

- The amount of air-time utilized
- Number of bytes of data transmitted
- Time of day
- Location of user
- Applications used.

This information is recorded and stored in protected, non-volatile memory such as battery backed-up RAM and/or disk storage. The data can be ultimately supplied in a variety of media formats, such as magnetic tape, which can be formatted to be suitable for the network operator's billing application.

CHAPTER

3



Network Operation and Management

Contents

Network Management Concepts

The NMC controls a shared network of hardware and software which is distributed over a large, possibly global, geographic area. The network management architecture consists of:

- Managed objects
- Management protocol
- Agents
- NMC programs.

Managed Objects

A managed object or device has information associated with it that is of interest to the network manager. This may be configuration-type information such as baud rates, status information, or performance metrics (e.g., packet counts). The total set of information for a specific device is known as the Management Information Base (MIB) for that device, and is composed of a set of named variables.

Management Protocol

A protocol is required which allows the network management system to both read and set the variables in a device's MIB. Additionally, the management protocol must allow a device to asynchronously report an event (such as a change of state) to the network manager. In order to make the network manager's task possible, the management protocol must be consistent across all devices and device types (managed objects). We refer to such a protocol as the "Standard" network management protocol for the system. The NMC uses the Simple Network Management Protocol (SNMP).

In the public network environment, it is necessary to manage a mixed set of equipment from multiple vendors, all of which may not support the same management protocol. Each vendor will generally support a specific management protocol which is often proprietary. Standardization efforts underway under the OSI Network Management Forum will ultimately address this issue.

Motorola addresses the current lack of a standard network management protocol using proxy agents.

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Agents

An agent is a piece of software that resides in a managed object which implements the management protocol supported by the device. It responds to requests from the network manager and sends asynchronous events as required.

Where a particular device does not support the standard network management protocol, or where the device itself is insufficiently intelligent to be managed directly, a special type of agent known as a 'proxy' agent is required. A proxy agent converts the standard network management protocol into a device-specific management protocol.

Network Manager

The network manager is a set of applications that run on a RISC-based processor, and which collectively provide the functions that permit network operators to manage the devices in the network. The network manager applications make use of the services provided by agents in order to accomplish their tasks.

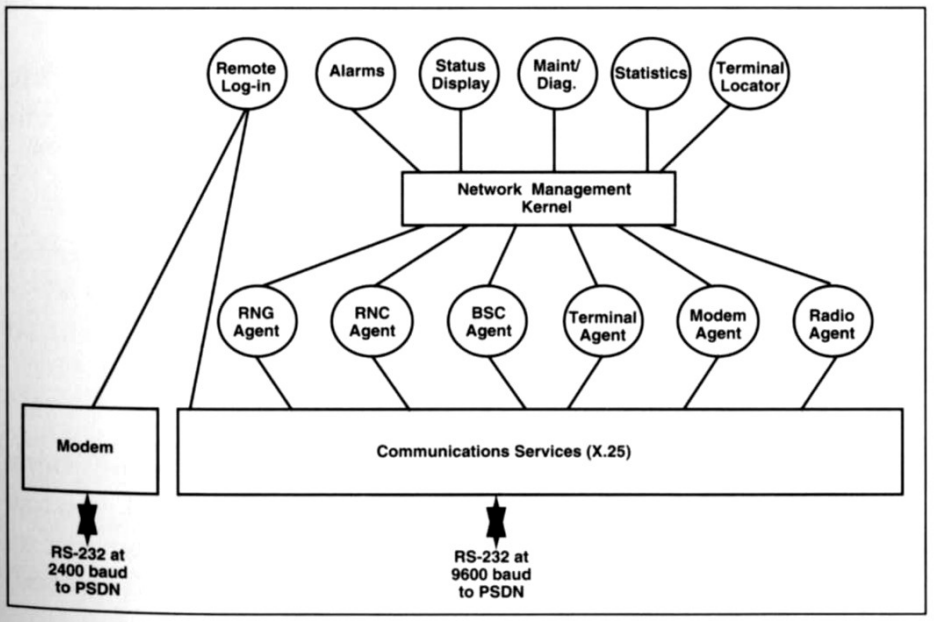
Network Manager Software

The network manager is composed of applications, agents and a network management 'kernel' which ties them all together. (See Figure 3-2.)

Network Management Kernel

The function of the network management kernel is to act as a clearing house for network information. It accepts requests from the manager applications and forwards them to the appropriate agent for execution. When the agent has completed its task, the kernel will notify the invoking manager application of the results.

The second major role for the kernel is to serve as an event notifier for a set of clients. When something occurs in the network, it is deemed to be an event. For instance, the failure of a RNC to 2100 BSC link is of importance to the alarm application, the network status application, and possibly others. Upon startup, these applications would indicate to the kernel that this is an event of which they require notification. Subsequently, if the RNC agent discovers such a fault, it simply passes the event off to the kernel. The kernel is then responsible for notifying all of its subscribers that the event has occurred. Subscribers are not



Network Management Center Software Architecture
Figure 3-2

restricted in how they respond to an event (e.g., ringing a bell, changing the color of the link on the screen, or invoking a diagnostic).

DataTAC's network management kernel is based on Sun Microsystems' SunNet Manager. The kernel communicates with the agents using the standard network management protocol. The standard network management protocol supported by the SunNet Manager is based on remote procedure calls (RPCs). The kernel invokes operations on an agent by means of RPCs.

Proxy Agents

The proxy agents communicate with the higher levels in the network manager using the Standard Management Protocol (SMP). The functions they support are as follows:

- Read an MIB variable
- Set an MIB variable
- Step through a set of MIB variables.

The proxy agents translate these requests into the management protocol that is appropriate for the device they represent, and relay the request to the real agent which executes on the device itself. The proxy agents interface to the X.25 communications layer in order to actually deliver the requests and responses.

If an agent reports an event to its proxy, the proxy agent will translate the event into standard management protocol and forward the event to the kernel.

Communications Services

Communications services provide X.25 services to the proxy agents. This is based on the SunLink X.25 package with extensions to allow multiplexing of X.25 virtual circuits between agents. X.25 virtual circuits may be shared by more than one agent.

Network Management Applications

The network management applications operate under a consistent user interface. The user interface is based on the Open-Look window model running on top of the X11.4 windowing system. This supports multiple, simultaneously active windows which may be freely opened, resized, moved around, or closed into an iconic form.

Context-sensitive menus are used to invoke operations on selected objects. The network management system is centered around a net-

work 'map'. This map is a graphical representation of the network showing the network building blocks and connections between them. The network is shown at multiple levels of detail. The user may 'zoom in' on a selected network component in order to see the underlying subcomponents.

An object which is displayed on the screen may be selected with a mouse. A selected object can then have operations invoked on it. The valid list of operations appear in a context-sensitive menu. When an operation is invoked, a subwindow is opened in which the requested information is displayed. If required, further information is solicited from the user.

Other features of the management application include the ability to print window or screen images, the ability to provide help information that describes NMC commands and operations, and the ability to configure the user interface for several languages.

Network Status Display
The status of all network components (managed objects and links) is displayed on a network map with the status of each component being indicated by the color in which they are drawn. The status is updated in real time. Real time updates are driven by the arrival of events. All elements are additionally polled for status in the background. Further information regarding the state of the components may be requested and displayed in a subwindow.

Alarms
As events are reported, they are forwarded to the alarm application. The alarm application records the event in a file. When the alarm file fills up, it is truncated by deleting the oldest entries. All alarms cause an audible alarm to be sounded and are printed on the line printer as they arrive. A user may browse through the alarms and view a subset of the alarms which can be sorted by device type, arrival time, or priority. The user may indicate that he no longer wants to see a specific alarm again. Alarm lists can be printed.

Alarm Distribution
An important feature in the management of large country-wide networks is the ability to configure the NMCs so that alarms generated by equipment under the control of one NMC can be forwarded to other

NMCs in the network. The network managers can configure the distribution of alarms to both local workstations over a local area network (LAN) as well as to remote workstations over X.25.

One extension of this feature is the ability of the network operator to dedicate a large overhead monitor to the display of all alarms for a specific region, or of all critical alarms for the entire network.

Management of Large Networks

Typically, the management of very large networks has two requirements that cannot be met by a single network management station. First, there must be the ability to have multiple operators sharing management responsibilities in a large center. Second, there must be the ability to have a hierarchy of management for remote regions that may not have the continuous staffing or the same level of expertise that is available in the larger centers.

Regional Control Centers

For a very large network, it may be advantageous to divide the network into separate regions, each of which are controlled by a separate NMC. In terms of network management, the network can be divided based on the number of RNGs controlled by a single NMC. If desired, the network could be divided into regions consisting of a single RNG with a controlling NMC, or one or two large regions made up of multiple RNGs controlled by an NMC.

Multiple Operator Support

The NMC can be configured to allow multiple operators to share the management of a large site by allowing many of the graphical user tools to run on secondary workstations. The applications which locate terminals, perform remote log-ins, execute diagnostic tests, manage alarms, and display statistics can all be made available on one or more secondary workstations while the primary workstation retains control of the network manager application and its database.

Hierarchical Management

There are several facilities that can be used to create hierarchical relationships between multiple NMC regions. First copies of alarms can be forwarded to another region's NMC to ensure continuity of surveillance or centralized logging. NMCs that are distributing alarms to other NMCs retain full control of their regional equipment.

An operator at a receiving NMC can initiate remote log-ins to either the originating region's NMC, RNGs, or RNCs, as appropriate.

For those situations where staffing hours are more limited in one region than in another, or where an operator needs more experienced help, one NMC can take over control of another NMC's network manager applications. This permits a senior operator access to the network database if required. As well, the graphical user tools can be run remotely over a wide area network. However, both of these facilities are only recommended if there is high bandwidth available, typically at least 64 kbps.

Statistics

The statistics package provides a view of the network performance over a period of time. The statistics package allows the user to view the statistical information in two different ways:

- One-time snapshot of the current values
- Continuous polling of the selected statistic at a user-defined rate with the results displayed in a strip chart or bar chart.

Each device type supports a different set of statistics, as described in its MIB definition.

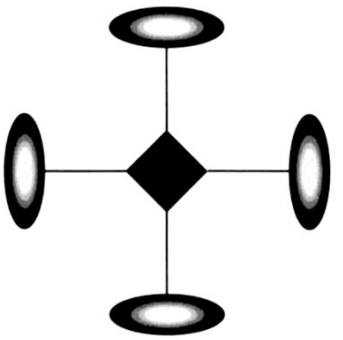
Communications Services

The communications subsystem can be configured to use either SVCs, or PVCs for those circuits which are always required. The switched virtual circuits can be initiated on demand by the NMC or the RNG. If SVCs are used, the subaddress portion of the X.121 address is used to identify the function of the virtual circuit. If PVCs are used, logical channel numbers are assigned to each function.

Remote log-ins which are initiated via operator demand to the RNGs, RNCs, or other possible equipment, always use SVCs.

CHAPTER

4



Network Protocols

Contents

Radio Data Link Access Protocol

Radio data communications require communication protocols that address the specific demands of the radio environment. DataTAC networks utilize an air interface protocol specification referred to as the Radio Data Link Access Procedure (RD-LAP).

Though RD-LAP is basically a link-layer protocol, it is similar to the CCITT Recommendation X.25 in that it details aspects of the lower three layers of the OSI reference model. RD-LAP protocol provides:

- Connection-oriented data-over-radio communications services
- End-to-end connection management within the mobile data network infrastructure
- Error control and recovery
- Flow control
- Diagnostics.

Plus, in order to support mobile communications, RD-LAP provides other connection management and network management services not usually associated with link-layer protocols. A variety of databases resident in the mobile device and network infrastructure are used to support these services.

The following discussion provides a layer-by-layer description of the RD-LAP specification, beginning with Layer 1 (the physical layer), and finishing with Layer 3 (the network layer).

Physical Layer (OSI Layer 1)

The physical layer refers to transmission media and the methodologies used to physically send data from one communications device to another. Within the RD-LAP specification, this pertains to communications between mobile terminals and the network infrastructure. This includes the method of baseband signalling, carrier modulation, the RF channel structure, and a variety of mechanical, electrical, and interface specifications.

Radio Channel

The RD-LAP physical layer specification requires that radio transmissions be over paired, full duplex, narrow band FM radio channels between 400 and 900 MHz. Channel separation can be either 12.5 or 25 kHz.

Typically, the base sites must operate full duplex, while mobile terminal equipment operates in half duplex mode.

The RF carrier is FM-modulated using four-level Gaussian Frequency Shift Keying (FSK). The baud rate of the base band signal can be either 9600 or 19200 bps, depending upon whether the RF channel spacing is 12.5 kHz or 25 kHz, respectively.

Radio Equipment

The RD-LAP specification requires that the fixed and mobile radio equipment utilized in RD-LAP systems meet a variety of specifications pertaining to such items as (but not limited to):

- Transmitter output power
- Transmitter splatter filter
- Transmitter deviation
- Transmitter frequency stability
- Receive-to-transmit transition time
- Transmit-to-receive time
- Out-of-band emissions
- Transmitter anti-streaming
- Receiver sensitivity
- Receiver splatter filter
- Receiver frequency stability
- Phase distortion
- Out of channel emission protection
- Frequency synthesizer lock time constraints
- Frequency reprogramming specifications.

Data Link Layer (OSI Layer 2)

RD-LAP is fundamentally a link-layer peer protocol designed for radio communications, and as such, its major task is to manage the transfer of frames of information from one end of a radio link to another.

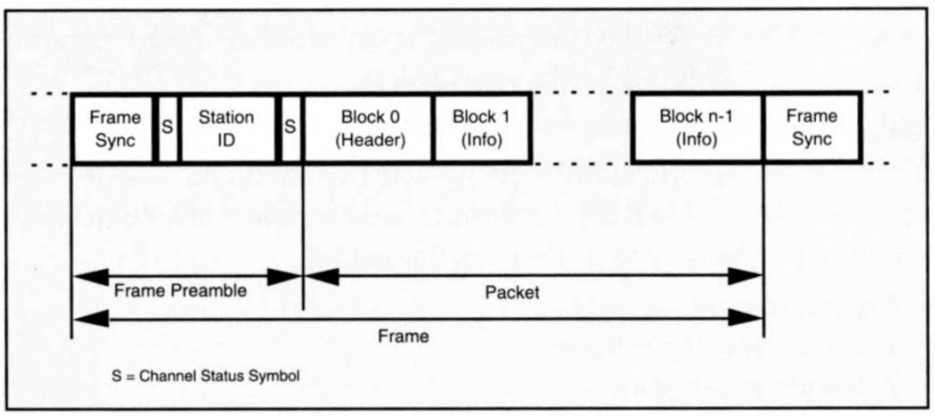
The data link layer portion of the RD-LAP protocol specifies such items as:

- RD-LAP frame format
- Channel access
- Error correction/detection.

The following discussion addresses each of these items.

RD-LAP Frame Format

RD-LAP is an octet-oriented protocol. Except for frame synchronization, all address information, control characters, and data are represented by eight-bit octets (bytes). The frame structure is illustrated in Figure 4-1.



RD-Lap Frame Structure
Figure 4-1

Each frame consists of a frame preamble and a packet. The packet contains user data and end-to-end control information that has been received from higher layers. Packet format is discussed later in this section. The frame preamble is added to the data packet and consists of a frame pattern synchronization (Frame Sync), a Station Identification Block (Station ID Block), and two Channel Status Symbols (CSS).

The Frame Sync identifies the start of a frame. It is created just prior to radio transmission and consists of a specific pattern of four-level symbols.

The Station ID Block is comprised of a number of fields that identify the base station, communications controller, and network system that are associated with the RF link. The Station ID Block is followed by a Cyclic Redundancy Checking (CRC) block check code used for error detection. The error detection specifications for RD-LAP are discussed in the next section.

The CSS is a symbol interleaved throughout the frame which is used to control inbound channel access. Channel access is discussed later in this section.

Link Layer Error Correction/Detection

The RD-LAP protocol specifies that CRC be employed for error detection, and Trellis Coding be employed for Forward Error Correction (FEC).

Cyclic Redundancy Checking

At the data link (or frame) level, a CRC code is applied to the Station ID Block. At the packet level, CRC coding is also applied.

Trellis Coding

At the frame level, Trellis encoding is employed for FEC. Encoding is performed prior to sending the RD-LAP frame to the physical layer for transmission. Each block within the frame preamble and the packet itself is individually encoded.

Trellis coding is performed by serializing the data bits and breaking them into groups of three bits (tri-bits). The tri-bits are passed through a Trellis coding state machine which converts each tri-bit into two, four-level symbols in preparation for transmission across the radio channel using four-level FSK modulation. The resulting symbols are then interleaved. The CSS is inserted at regular intervals of every 22 symbols, prior to transmission.

Channel Access

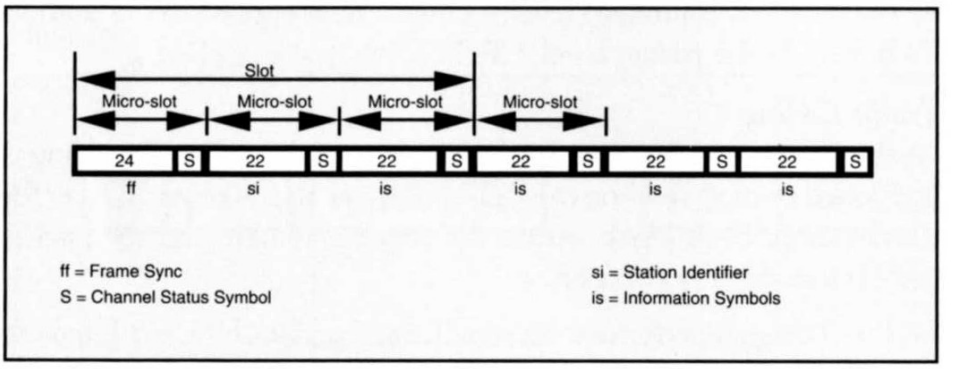
Slotted DSMA

In DataTAC mobile radio systems, a multiple access method is not required for the outbound radio channel, as all outbound transmissions are scheduled in a first-in-first-out (FIFO) manner by the network infrastructure on a per-base station basis. However, for inbound channel access, the RD-LAP protocol uses a contention access method referred to as Slotted Digital Sense Multiple Access (slotted

DSMA). Slotted DSMA allows for extremely efficient collision avoidance contention management control.

In the slotted DSMA contention scheme, the availability of the inbound channel for use by mobile terminals is determined by their periodic observation of CSS that are inserted by the base radio sites into their outbound data streams. Base stations set the CSS to an 'idle' or 'busy' state, depending upon whether they sense that a mobile terminal has already accessed the inbound channel or not. Mobile terminals can only attempt inbound transmissions when the CSS is in the idle state. To increase channel efficiency, the timing of inbound transmissions is also scheduled at specific 'slots' of time.

Figure 4-2 shows the slotted format of outbound data, showing the insertion of the CSS, and the corresponding format of the transmitted RD-LAP frame in radio channel (four-level FSK) symbols.



RD-Lap Outbound Channel Slotting
Figure 4-2

The process whereby a mobile terminal determines the inbound channel status, and accesses this channel, can be summarized as follows:

- If necessary, the mobile terminal finds a Frame Sync pattern so it can synchronize to the outbound channel and find the CSS at the end of the current slot. Before doing so, the mobile terminal waits a random period of time of up to 50 ms in order to distribute the demand for initial access.
- If the channel is busy, the mobile terminal waits for a random period of time and then looks at the CSS at the end of the current

microslot. (The random delay serves to redistribute the subsequent future attempts of multiple mobile terminals to access the channel.)

- If the channel is idle, the mobile terminal commences transmission.

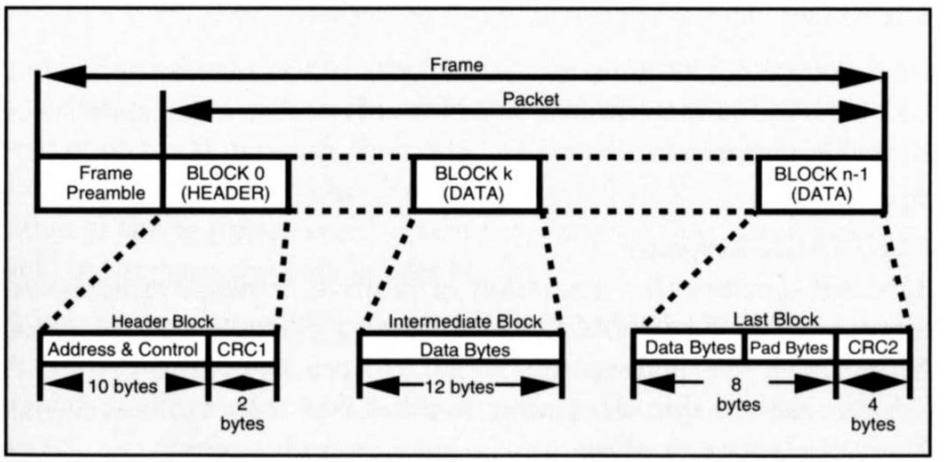
Network Layer (OSI Layer 3)

The RD-LAP network layer is responsible for the transfer of packets of data from one end of a mobile data network connection to another. It is different from Layer 2 transfer of frames in that the latter manages link-to-link transfers of information, whereas Layer 3 manages end-to-end connections. For example, the RD-LAP link layer manages the connection across the radio link from a transmitting device (mobile radio) to a receiving device (base site). Alternatively, the RD-LAP network layer manages the connection from the mobile terminal to the appropriate ACC. (Though the ACC is not necessarily the ultimate destination, as far as the DataTAC network and RD-LAP is concerned, it is. However, being the gateway to the X.25 network, the ACC can then reformat and send the data appropriately, managing end-to-end X.25 connectivity according to X.25 protocol.)

The RD-LAP network layer specification covers such areas as packet format, packet level error detection, flow control, and connection management.

Packet Format

The RD-LAP specification for packet format is depicted in Figure 4-3. It consists of a header block followed by up to 43 data blocks.



RD-Lap Packet Format
Figure 4-3

The header block contains information critical to link management, such as:

- Whether message confirmation is required
- The transmission direction (outbound or inbound)
- Packet format
- Class, type, and status of the packet
- Which service access points the data should be directed to
- The mobile terminal's Logical Link ID
- The number of data blocks in the packet
- The amount of data padding
- Flow control synchronization initialization flag
- Packet sequence numbering
- Logical message sequence numbering
- How much data header information may exist
- CRC code for the block header.

The data portion of the packet consists of up to 43 data blocks, and each data block consists of 12 bytes of data. The final data block may have some padding to ensure 12 bytes in total. The RD-LAP protocol is, therefore, octet-transparent, as data is segmented in regular blocks and the header block specifies the number of data blocks present.

Error Detection

RD-LAP specifies the use of CRC codes for error detection of the packet header block and data blocks.

The header block is appended with a 16-bit CRC code.

Error detection of the packet data blocks is achieved by appending a 32-bit CRC code to the last data block. This code is calculated over all packet data blocks.

Flow Control

ACK/NACK Response

RD-LAP specifies the generation of positive or negative acknowledgements (ACKs or NACKs) to attempted transmission of packets. An ACK is the acknowledgement of successful transmission. A NACK specifies that the packet could not be successfully received. There are a variety of reasons for unsuccessful reception of a data packet, and each reason has an associated NACK:

- Illegal format NACK

- Packet error NACK
- Memory full NACK
- Out-of-logical sequence NACK
- Undeliverable NACK
- Out-of-sequence NACK
- User-not-registered NACK.

CRC Checks

As described in the section on packet formats, the packet/network layer does CRC checks and verifies the integrity of packet header and data blocks.

If the CRC check of the header fails, the packet is discarded.

If the header block is correctly received, but a data block fails the CRC check, the network layer generates a packet error NACK.

If the header block and data blocks are correctly received, the packet layer generates an ACK.

Backward Error Control (BEC)

BEC is achieved through the use of Automatic Repeat Requests (ARQs), whereby retransmissions are automatically sent if the last retransmission is not acknowledged within a fixed time-out period.

Packet Sequencing

In order to facilitate the correct order of data packets, RD-LAP specifies the use of a sliding window protocol with a window size of one, effectively a stop and wait protocol.

RD-LAP specifies that the sender and receiver of a message each have a pair of registers that specify what the expected sequence number for sent or received messages should be. These registers are initialized via a special flag in the data header block. When a packet is to be sent, the value of the sequence number register is copied into the appropriate field in the outgoing data header block.

When the receiving device successfully decodes the packet, it checks to see if the sequence number that was assigned to the packet by its sender matches what the receiver expected to see. If the numbers match, the receiver sends an ACK to the sender of the packet.

If the sequence number is one less than expected, the receiver knows that it has received a duplicate of a message that has already been

received (most likely due to a lost ACK). In this case, the receiver discards the packet and resends an ACK.

If the sequence number is anything other than the above two possibilities, the receiver knows that a packet has been lost. In this case, the network layer must discard the packet and send a packet out-of-sequence NACK to the sender of the packet.

Logical Message Sequencing

When messages that are greater than the maximum packet size are required to be sent, the RD-LAP protocol specifies that the message be segmented into groups of up to 512 bytes. These are each assigned a Logical Message Sequence Number (LMSN) and sent in individual packets to where the LMSN is specified in the data header block. As packets are received, the full message is reconstructed from the numbered packets. If messages are not received in logical order, the appropriate NACK is generated and transmitted to the original sender of the message.

Connection and Network Management

Part of the RD-LAP specification for the network layer includes a variety of connection management services. Some of these services maintain and make use of databases that serve to facilitate connection and network management. Not all of these services are bidirectional, as the mobile environment requires some services to be available in only one direction (outbound or inbound). The following is a brief descriptive list of the connection and network management services used within RD-LAP.

Outbound Connection and Network Management Requests

Channel Markers

A Channel Marker (CM) is an outbound packet that is broadcast periodically by each base site. A CM packet provides mobiles with RF channel information required to facilitate mobile roaming.

Service Authorization Grants

Service authorization grants (or denials) are sent in response to registration requests from mobile terminals and are used to grant or deny network service.

Go-to-Channel Requests

The Go-to-Channel (GTC) request is a load management facility

which is used to effect the movement of individual or groups of mobile terminals from one channel to another.

Idle Data Packets
Idle data packets are generated by base sites when there is no other outbound traffic required. These packets are used by mobile terminals to assess radio channel quality and to identify the radio subnetwork they are currently operating in.

Lost Mobile Terminal Pages
Lost mobile terminal pages are packets sent to identify the radio location of a specific mobile terminal whose radio location is not known by the data network.

MT Configuration Requests
Mobile terminal configuration requests provide the the network operator with the facility to remotely modify configuration parameters within the mobile terminal.

FNE Error Reports
FNE error report packets contain error codes that specify operational abnormalities pertaining to a mobile terminal device's use of network services.

Mobile Terminal Loopback Requests
Mobile terminal loopback request packets are used for network management testing and request the mobile terminal device to acknowledge and return the same data it received.

Mobile Terminal Statistics Requests
Mobile terminal statistics request packets request a mobile terminal device to return data that has accumulated in its traffic statistics database.

Inbound Connection and Network Management Requests
Registration Requests
Registration requests serve the purpose of requesting service authorization from the network and providing mobile terminal devices' updated radio location to the network. Mobile terminal devices send in registration requests when they first power-on, need to re-initialize their radio link, change radio channel, roam into a new radio subnetwork, or wish to provide the network with updated location information.

Mobile Terminal Out-of-Service Reports
The mobile terminal out-of-service report packet is sent when an mobile terminal device is being powered off.

Mobile Terminal Loopback Reports
Mobile terminal loopback requests are defined in the outbound connection management requests.

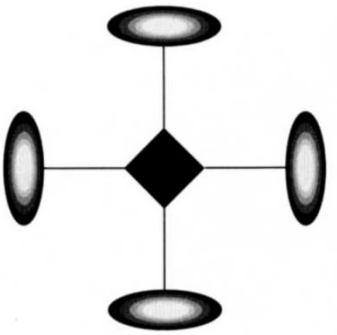
Mobile Terminal Statistics Reports
Mobile terminal statistics reports are defined in the outbound connection management requests.

Multicast Call Services
RD-LAP provides services to user applications that require multicast call services, which is the routing of messages to multiple terminals. The services provided include:

- Group Individual Call
  A group individual call sends a message requiring an acknowledgement to all the mobile terminal devices in a predefined terminal group.
- All Call
  An all call message is a broadcast message not requiring acknowledgement that is transmitted once from every station in the radio network.
- Multicast Call
  A multicast call is similar to an all call message in that the message does not require acknowledgement, except that it is sent only to a specific, predefined terminal group.

CHAPTER

5



Infrastructure Products

Contents

Chapter 5 INFRASTRUCTURE PRODUCTS

Introduction

This chapter of the DataTAC product book provides descriptions of the hardware architecture for the various system elements that comprise a working DataTAC network.

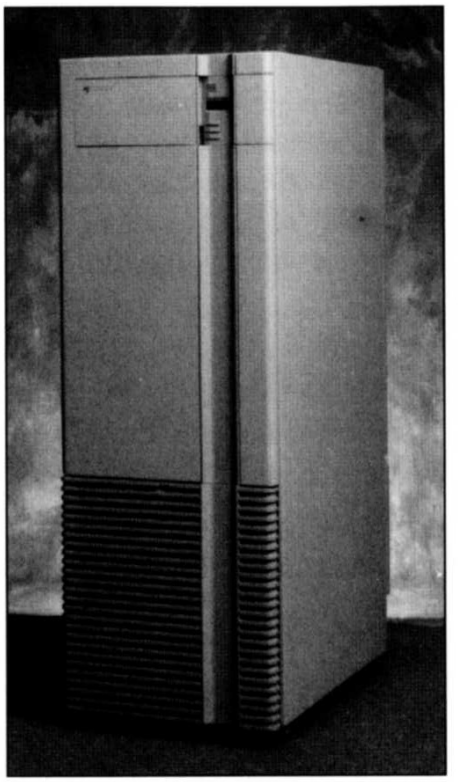
The following system elements are discussed in this chapter:

- Area Communications Controller
  - Radio Network Gateway
  - Radio Network Controller
- Network Management Center
- Data MSF Base Station
  - Base Station Controller
  - Base Station Radio

If desired, more detailed information about these and other products can be made available through your local Motorola representative.

RADIO NETWORK GATEWAY

The RNG hardware platform is based on Tandem's NonStop™ CLX family of computers. The basic RNG uses a CLX820 which is an 800 series processor configured with two CPUs. However, it should be noted that the ultimate configuration is dependent on the actual throughput needs of the individual network for which the RNG is destined.



Radio Network Gateway/RNG

The Tandem NonStop CLX family has the following key features:

- High-performance parallel processors
- Expandable architecture
- Expandable memory
- Multifunction controller
- Communications controllers
- High-performance disk storage
- High-capacity tape backup
- Open reel tape subsystems
- Versatile printer support
- Fault-tolerant hardware and software
- Transaction monitoring and database recovery.

These features will now be discussed in more detail.

High-Performance Processors

The entire processor of each CLX family computer is contained on one board. Each processor comes with on-board memory. All processors communicate via dual interprocessor buses, providing high-performance and hardware fault-tolerance.

CLX family processors feature:

- Two cross-coupled CPUs for continuous fault checking, helping to ensure data integrity

- On-chip scan logic for power-up self-test and superior diagnostic support
- Up to 192 kilobytes of high-speed cache memory for higher throughput
- On-board error-correcting memory
- CMOS VLSI technology for low power consumption
- Maintenance and diagnostic interface to initialize and monitor the processor
- Parallel architecture for transaction-processing power.

Expandable Memory

Each CLX processor memory subsystem can be upgraded in the field by the customer.

A fully-configured 16-processor CLX 800 system supports 512 megabytes of memory. In addition to providing physical memory, the 32-bit addressing of the Guardian 90 operating system permits data access to a gigabyte of virtual memory per processor.

Multifunction Controller

The CLX multifunction controller provides high-performance, versatile system I/O support. It manages a network port, asynchronous communications, the Remote Maintenance Interface (RMI), and disk and tape devices.

Each multifunction controller provides:

- Two cross-coupled M68000 series microprocessors and a multitasking kernel for maximum throughput and control of system devices
- Dual Small Computer System Interface (SCSI) buses for high data integrity and integration of low-cost, high-performance disk and tape drives
- Two asynchronous lines for flexible operation
- One bit-synchronous port for network connection (X.25 or Expand™ networks)
- Maintenance and diagnostic buses for continuous fault monitoring and diagnosis
- Remote maintenance interface hardware and software for fault reporting and analysis (this subsystem can communicate automatically with a Tandem online support center for expert diagnosis).

Multiprotocol Communications Controller

The Tandem 3605 communications controller supports up to four

high-speed data communications lines. Each line can be configured separately, which allows bit-synchronous, byte-synchronous, and asynchronous communications to operate on the controller simultaneously. Each of the four Communications Line Interface Processors (CLIPs) offers 64 kilobytes of memory for downloading separate protocols.

High-Performance Disk Storage

The NonStop CLX family uses 5 1/4-inch high-density internal disk drives with embedded SCSI controllers for high performance and low cost. These drives are available in two configurations: the 300-megabyte (formatted capacity) 4220 and the 648-megabyte (formatted capacity) 4230. The 4230 includes 32 kilobytes of cache to provide superior sequential read performance.

Because each Tandem drive is a separate module, a fault in one drive does not stop the others of the system. If service is required, an entire drive module—including power supply and cooling fan — can be quickly replaced without system downtime.

The internal disk drive of CLX systems are mirrored, which offers two advantages. Read operations can select whichever disk is not busy, thereby reducing access time. And if one disk fails, the mirrored volume remains operational, ensuring continuous access to your data. Disks can be unmirrored if so desired.

Also available are Tandem's™ V80 and XL80™ external disk subsystems. The V80 is designed with a high ratio of access arms per gigabyte for access-intensive applications and is available in unformatted capacities of up to 2.7 gigabytes. The compact XL80 provides the most cost-effective storage in terms of gigabytes per square foot of floorspace, with available capacities of up to 9 gigabytes (unformatted).

Both subsystems use Tandem's Intelligent Peripheral Interface standard to provide parallel data transfer capability. They connect to the CLX system via fiber-optic cables. This gives you great flexibility in locating the devices because they can be placed up to 100 meters from the system cabinet.

High-Capacity Tape Backup

Each CLX system comes standard with a Tandem 5126 half-inch cartridge tape drive. The easy-to-use 5126 is compatible with the stand-alone 5122 cartridge used with other NonStop systems, so you can exchange tapes between different systems and reduce operations costs.

Each cartridge offers up to 128 megabytes of storage, yet is small enough to fit in the palm of your hand.

Open-reel Tape Subsystems
Tandem offers a choice of two compact, low-cost, open-reel streaming tape subsystems for interchanging data between the CLX family and other systems.

The 5160 tape subsystem reads and writes at 1,600 bpi on standard half-inch, nine-track tape, with streaming capabilities of 125 ips. The 1,600 bpi data recording format makes the 5160 an economical tape subsystem for interchanging media.

The dual-density 5170 tape subsystem reads and writes on half-inch, nine-track tape at 1,600 bpi (Phase Encoded) and 6,250 bpi (Group Coded Recording). In Group Coded Recording mode, the 5170 provides nearly four times the data storage capacity per reel and a nearly 400 percent increase in maximum burst data transfer rates compared with the 5160 or 5170 running in Phase Encoded mode. You can store up to 46 megabytes of unformatted data on standard 2,400-foot reels in Phase Encoded mode and up to 180 megabytes in Group Coded Recording mode.

Data transfer rates vary according to block size, file size, system load, and configuration.

Versatile Printer Support

The 3601 universal interface and printer controller connects high-speed parallel printers and other parallel devices to CLX systems.

The 3601 links a wide variety of devices that support the Dataproducts long-line and short-line interfaces, including Tandem's 5515, 5516, and 5518 printers.

NonStop CLX family systems also support a wide variety of laser and impact printers.

Features for Continuous Data Availability and Integrity

Like all NonStop systems, the CLX family features a fault-tolerant architecture designed to meet the rigorous demands of online transaction processing and message switching applications. Both hardware and software were created for fault-tolerant operation, so they work together to ensure the continuous availability of your data and the integrity of all your transactions.

Fault-Tolerant Hardware

Each CLX system contains multiple processors, a dual interprocessor bus, a dual-ported controller, and multiple power supplies. If a system component fails, the corresponding component automatically takes over to complete the function. The defective module can be repaired or replaced online without shutting down the system, so vital transactions continue to be processed.

To ensure availability in the event of a power supply failure, CLX systems use independent power supplies. System memory is preserved during a power outage via battery backup modules. Each system cabinet is equipped with two power supplies, each of which powers one processor and provides redundant power to the I/O controllers. The power monitor in the integrated maintenance/diagnostic subsystem continuously checks the power supplies for correct operation. It also monitors the cabinet environment and reports its status to the remote maintenance interface.

Fault-Tolerant Software

Tandem's Guardian 90 operating system provides fault-tolerant software to complement this fault-tolerant hardware. In managing a NonStop CLX system, Guardian 90 derives maximum computing power from all processors at all times. There are no idle backup units. To vastly improve throughput, the workload can be spread over several processors, and I/O processing operations can be performed in parallel.

Transaction Monitoring and Database Recovery

The distributed data capability of the Guardian operating system combines with additional Tandem software products to provide data integrity across a worldwide network.

Tandem's Transaction Monitoring Facility (TMF™) protects your distributed data from the effects of incomplete transactions, system failures, or network failures. After a transaction updates one node of a distributed database, TMF attempts to update all other relevant nodes; if that is not possible, it backs out the transaction at all nodes.

Tandem's Remote Duplicate Database Facility (RDF™) ensures rapid disaster recovery for your database by letting you maintain a current, online copy of all or part of the database at another site. The presence of the backup is transparent to the application. If you are running TMF, not a line of application code has to be changed to implement RDF.

Tandem Non-Stop CLX Computers Specifications

Transaction benchmark test	
ET1 debit/credit transactions	5.75 TPS
Guradian release used	C30
Cache size	192 KB
On-board RAM (with error-correction code)	16 or 32 MB
Virtual address space	1 GB
I/O channel speed	4.4 MB/s

Main Memory

Physical memory	
Standard (per processor)	16 MB
Maximum (per processor)	32 MB
Upgrades to	32 MB
Memory cycle time	
Read	53.4 ns/byte
Write	45.8 ns/byte
Memory bandwidth	
Read	18.7 MB/s
Write	21.9 MB/s
Battery backup time	5.0 hrs for16 MB 5.0 hrs for 32 MB

Multifunction Controller

Processor	Two cross-coupled 10-MHz 68010
Memory	512 KB RAM
Processor I/O channel	Dual-ported connections
Disk/tape I/O bus	Two SCSI buses per controller
Disk/tape I/O bus speed	Each bus at 1.5 MB/s
Disk/tape devices	Supports maximum of six internal and one external device per multifunction controller pair
Maintenance processor	Includes dual maintenance diagnostic bus connections
Remote maintenance port	Synchronous dial-up port (1200 to 2400 baud rate)
Asynchronous port	Two RS-232 or current loop
Network port	One RS-232 (for Expand, X.25, Expand over X.25)
Controller baud rates	Up to 64 kilobits/s for bit-synchronous Up to 19.2 kilobits/s for asynchronous

Communications Controllers

3605 communications controller	Supports up to four line Up to 64 kilobits/s for bit-synchronous Up to 19.2 kilobits/s for byte-synchronous Up to 19.2 kilobits/s for asynchronous RS-232, RS-449, or X.21 electrical interfaces available

RADIO NETWORK CONTROLLER

This section describes the hardware components of the Radio Network Controller (RNC).

Radio Network Controller

Radio Network Controller Description

The RNC provides a data communications interface between RF networks of numerous mobile devices and one or more RNGs.

The RNC consists of Motorola application software operating on Motorola and third-party VME bus equipment.

The RNC controls the flow of data transmissions between the mobile radios and the RNG(s) and is directed by commands and messages generated by the RNG. It supports up to 64 base site links.

Hardware Overview

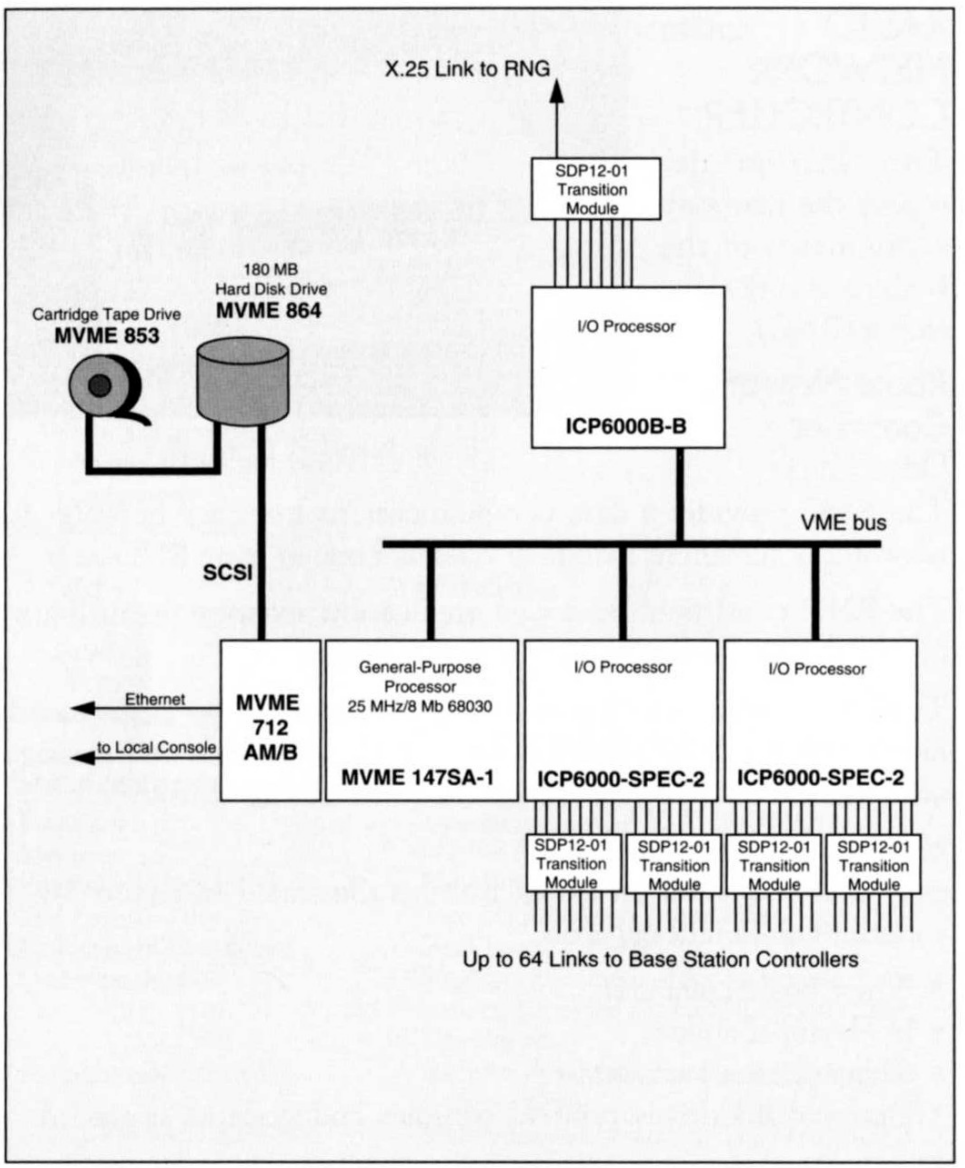
A typical configuration for an RNC is illustrated in Figure 5-1. It contains four functional areas:

- Single board computer
- I/O board computer
- Chassis/power/packaging
- Optional disk drives, printers, consoles, and modems, as needed.

The RNC design is based upon Motorola's families of VME components. It is designed for flexibility and takes advantage of the power and features of the 32-bit MC68030 microprocessor.

The MVME 147SA-1 single board computer has a 25 MHz MC68030 microprocessor, 8 MB of Dynamic RAM, 4 MB of EPROM, 2 kB of BBRAM, a SCSI interface, an Ethernet interface, and four RS-232C serial ports.

The ICP6000 I/O processors have a 16 MHz 68020 Central Processing Unit (CPU) with 1 MB of RAM and 16, full duplex, synchronous communications ports with Direct Memory Access (DMA) on both



Radio Network Controller
Typical Hardware Configuration
Figure 5-1

communications ports with Direct Memory Access (DMA) on both the transmit and receive channels.

The chassis provides the housing for the system components, a power supply, cooling fans, and ac power control.

The primary interface between operators and the RNC is a local terminal. The terminal provides interactive control of the communications, diagnostics, and recording alarm conditions.

An X.25 connection provides an I/O interface for optional remote diagnostic capability.

RNC Interfaces

RNG Interface

The RNC uses an X.25 Packet Layer Protocol (PLP) point-to-point interface to the Radio Network Gateway (RNG). The RNC is the DCE and the RNG is the DTE.

The data link is via LAP-B protocol.

The physical interface is an RS-422 serial connection.

Base Site Interface

The RNC is connected with the 2100 BSC equipment via 9.6 or 19.2 kbps HDLC line, depending on the radio channel speed. The protocol is RD-LAP.

Standby RNC Interface

The primary and secondary (or 'standby') RNCs are connected via an Ethernet interface.

RNC Hardware Components

MVME 147SA-1 Processor

The MVME 147S processor is a complete 25 MHz 68030 microcomputer system. The module has shared on-board RAM (8 MB), four RS-232 serial ports, and a Centronics-protocol printer port. The module provides an SCSI bus controller with DMA, floating-point processor, tick timer, watchdog timer, and time-of-day clock calendar with battery backup. In addition, the CPU includes 2 kB of static RAM with battery backup, 4 MB ROM, and an A32/D32 VME bus interface with system controller functions.

MVME 712A Transition Module

The MVME 712A is the interface between the MVME 147S module and the peripheral devices. Each system includes a P2 adapter module and cable for connecting the MVME 147S and the MVME 712A.

The MVME 712A has four DB9 serial connectors, one 25-pin connector for a parallel port, and a Telco modular jack.

MVME 712B Transition Module

The MVME 712B is similar to the MVME 712A described previously, except that it only contains one SCSI port and one Ethernet communications port.

ICP6000 Communications Controller

The ICP6000 is a 16 MHz, 68020 single-board computer dedicated to processing communications-related data. It is self-contained with CPU, 1 MB RAM, ROM, a 32-channel DMA controller, and I/O-circuitry for up to 16 EIA-232 ports. The RNC contains three of these controllers.

SDP12-01 Synchronous I/O Transition Module

This transition module connects a communications controller to two, high-density, 62-pin connectors.

MVME 864, 180 MB Hard Disk Drive

The MVME 864 is a 5 1/4-inch Winchester drive with 180 MB capacity. It has an SCSI controller built in. The RNC has one MVME 874 hard disk drive.

MVME 853 5 1/4-Inch 150 MB Cartridge Tape Drive

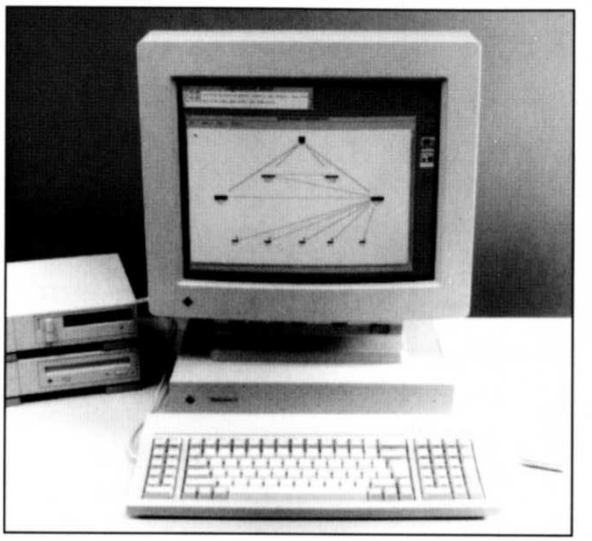
The MVME 853 is a 5 1/4-inch cartridge tape drive with 150 MB capacity. It has an SCSI controller built in. The RNC has one MVME 853 cartridge tape drive.

NETWORK MANAGEMENT CENTER

NMC Hardware Components

The Network Management Center uses the following equipment (see Figure 5-2):

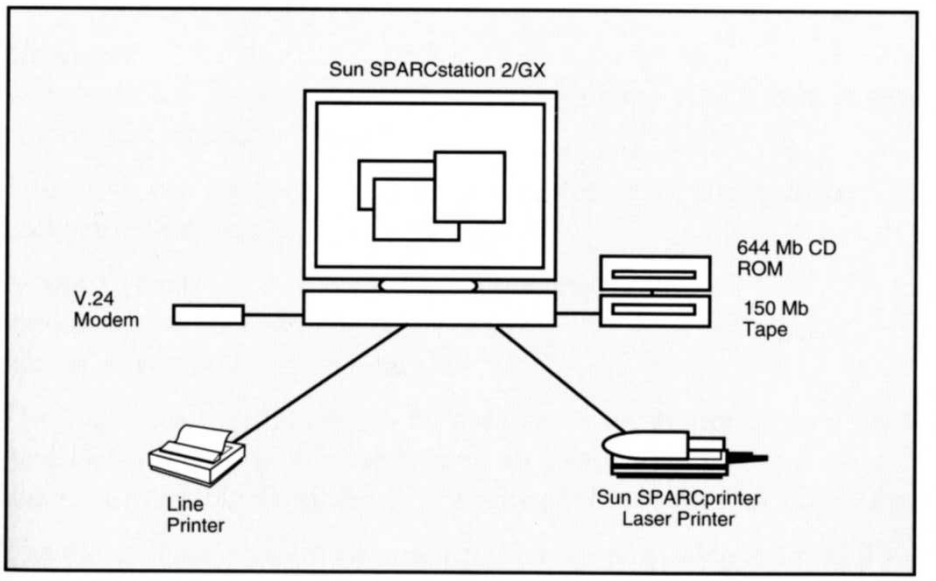
- Sun SPARCstation 2/GX
- 644 MB CD ROM
- 150 MB tape drive
- V.24 modem
- SPARCprinter
- Line printer.



Network Management Center

Sun SPARCstation 2/GX

The SPARCstation 2/GX is the most current generation of desktop workstations from Sun Microsystems. It is a 28 Mips processor with 32 MB of RAM. It is equipped with 848 MB of internal disk storage, a GX graphics accelerator board, and a 19-inch Trinitron color monitor.



Network Hardware
Figure 5-2

644 MB CD ROM

The CD ROM is required to load new versions of the Sun system software. It has an SCSI interface.

150 MB Tape Drive

The tape drive is an SCSI interface cartridge tape unit used with 3M-type cartridges. It is required to do backups of the disk and to load new versions of NMC software onto the system.

V.24 Modem

The V.24 modem is a 2400 baud Hayes-compatible modem which is used as a backup if the X.25 network link fails. It is used to connect to RNGs or RNCs to establish console sessions.

SPARCprinter

The SPARCprinter is a laser printer used for printing screen information, graphs, or any other reports. It can print 12 pages per minute in monochrome.

Line Printer

The line printer is a dot matrix, RS-232 interface device. It is used to print alarms or other events which arrive at the NMC. The printer can print up to 132 columns on 8.5 X 11-inch, continuous-feed paper.

2100 BASE STATION CONTROLLER

This section describes the hardware components and configuration of the 2100 Base Station Controller (2100 BSC).

2100 BSC

BSC Hardware Components

The 2100 BSC is made up of the following major components:

- Enclosure (chassis and top cover)
- Front panel
- Back panel
- Backplane
- Processor card
- AC power supply or DC power supply
- Fan.

Enclosure

The enclosure houses the VME bus backplane, VME cards, power supply, and internal wiring.

The VME bus backplane has three slots for up to three cards. The backplane slot designations are as follows.

- Slot 1 (top): 2100 BSC processor card
- Slot 2: Spare (option)
- Slot 3 (bottom): Spare.

The 2100 BSC enclosure can be configured for mounting in a standard 19-inch rack, a rack cabinet, or on a tabletop. Two sizes of rack slides are available for attachment to the enclosure for rack mounting.

The dimensions of the enclosure for tabletop mounting are H14.15 x W43.18 x D22.35 cm (H5.57 x W17.0 x D8.8 inches). The dimensions of the enclosure for rack mounting are H14.15 x W48.26 x D22.35 cm. The minimum depth clearance for cabling is 3.1 cm.

Front Panel

The front panel allows access to the power switch and the connector for the system console. It also provides a display window for card-mounted, light-emitting diode indicators (LEDs). The LEDs indicate the operating status of the 2100 BSC processor card.

For a description of the LED indicators, see Operation, in this section.

Back Panel

The back panel is used for connections to external devices. Refer to External Connectors, following this section, for a description of each connector on the back panel.

Backplane Connector

The backplane connector of the 2100 BSC connects to the boards mounted in the VME bus and to the external connectors on the back panel.

Processor Card

The 2100 BSC processor card is installed in the top slot (Slot 1) of the VME bus backplane. It converts the HDLC signal from the RNC to RD-LAP protocol for transmission over the RF network. It also provides all base station controls, an alarm interface, and timing.

The architecture of the processor card is based on two processors:

- Control Processor: 16/32-bit MC68HC000-based microprocessor
- Digital Signal Processor (DSP): XSP56001.

Each processor has its own RAM memory. The processors communicate with one another through a host interface. The control processor has 128 kB RAM with NiCad battery backup and 512 kB EPROM. The DSP has 32 K words of RAM memory.

The processor card interfaces to the VME bus through a VME interface chip, and supports 24 address lines and 16 data lines. This interface, together with the spare slot(s) in the VME chassis, allow for future upgrades which require additional processing power.

Communication to the system console and the RNC is handled through a Serial Communication Controller (SCC) chip.

There are 32 parallel I/O signals which control the base station, detect faults, and sense alarms and other outputs from the base station.

Nine parallel output lines connected to LED drivers control the front panel LED lights.

Power Supply

The 2100 BSC is preconfigured to use either AC or DC power. DataTAC systems are normally supplied with DC-powered 2100 BSC. This allows the 2100 BSC to be powered by the main MSF base station power supply. The power supply is housed in its own enclosure and installed in the right-hand corner of the 2100 BSC enclosure (as seen from the front).

AC Power Supply

The power input to the 2100 BSC using an AC power supply is 90 to 264 VAC (50 to 60 Hz). The 2100 BSC uses a standard three-prong line cord for the AC input power.

DC Power Supply

The 2100 BSC is designed for operation from the 12 V standby power system of the base station. The operational range extends from 9.5 to 14.0 VDC. The lower limit of 9.5 V allows for a 1-volt drop across the feed lines to the base radio from the battery.

Fan

A fan, installed in the chassis next to the VME bus backplane, provides cooling for the 2100 BSC hardware.

External Connectors

This section describes the following external connectors of the 2100 BSC, including the electrical specifications of the ports:

- DC power input (option)
- 110 VAC/220 VAC power input
- Base station
- Local system console
- External leased line modem.

DC Power Input

If the 2100 BSC is configured for DC power, this port connects the 2100 BSC to a 12 V power supply.

110 VAC/220 VAC Power Input

If the 2100 BSC is configured for AC power, this port connects the 2100 BSC to a 90 to 264 VAC (50 to 60 Hz) power supply.

Base Station

This port connects the 2100 BSC to the base radio and carries base station control parallel I/O signals and baseband modulator and discriminator signals. All signals connect to P2 of the 2100 BSC processor card through back panel connector P2.

This is a DB-25 female connector.

System Console

This DCE port connects the 2100 BSC to a computer terminal or other intelligent testing device which operates in a 9600 baud, asynchronous, full duplex mode, and is configured as a DTE device. The signals are RS-232 compatible.

This is a DB-25 female connector.

External Leased Line Modem

This port connects the 2100 BSC to the RNC via modems. The 2100 BSC operates in a 9600 or 19200 bps, synchronous, full duplex mode, and is configured as a DTE device. Depending on whether the clock source is the 2100 BSC or an external modem, a jumper on the 2100 BSC processor card is used to select TXC or ETXC.

All signals are RS-232 compatible.

This is a DB-25 male connector.

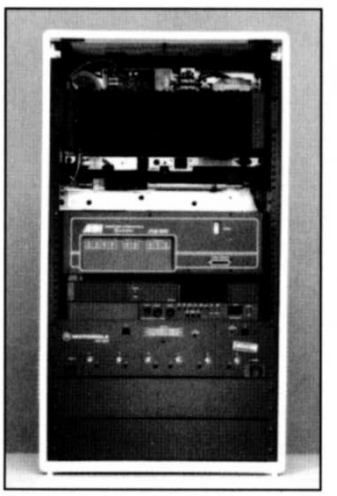
MSF 10000 AND MSF 5000 BASE RADIO

The MSF 10000/5000 base radios are self-contained, completely solid state, microprocessor-controlled stations. Transmit and receive frequencies are generated and controlled by frequency synthesizers. RF output power levels are available in high power and low power models.

MSF 10000/2100 BSC

All MSF 10000 and MSF 5000 base radios provide the following standard features:

- Microprocessor station control
- Transmit/Receive frequency synthesis
- Wide operating temperature range: from -30°C to +60°C (-22°F to +140°F)
- Solid-state, easily serviceable, modular design
- Extensive self diagnostics
- Variable communication channel parameters (on a per channel/mode basis)
- High performance, continuous-duty transmitter
- A junction box mounted on the side of the station to make all system interconnections
- Station design includes RF shielding and filtering to meet FCC Industrial Class A specifications
- The power supplies are ferro-resonant power supplies which offer enhanced immunity to power line transients
- All assemblies may be serviced, removed, and/or replaced through the front door of the station cabinet
- Many software options are available to configure the station to operate in a variety of systems, without additional hardware requirements.



MSF 5000/2100 BSC

MSF 10000 Base Station (UHF) Specifications

General	
Frequency Range (MHz)	403 to 440, 435 to 470
Channel Spacing (kHz)	12.5, 20, 25
Mode of Operation	Simplex/semi duplex/full duplex
Number of Channels	
Conventional	four standard
Trunking	one standard Up to 156 programmable
Modulation	FM
Antenna Impedence	50
Frequency Stability (kHz)	±1.0
Operating Temperature	-30°C to +60°C
Transmitter	
RF Output (watts, variable)	1 to 6, 7 to 15, 20 to 40, 35 to 75, and 50 to 110
Maximum Deviation (kHz)	±2.5 (12.5 kHz), ±4.0 (20 kHz), ±5.0 (25 kHz)
Spurious (dBm)	
Radiated	-36 (100 kHz to 2 GHz), -30 (>2 GHz)
Conducted	-36 (100 kHz to 2 GHz), -30 (>2 GHz)
Audio Response	6 dB per octave per CEPT/FTZ
Audio Distortion (%)	5 @ 1000 Hz
Adjacent Channel Power, CEPT, (dB)	-70
Maximum Channel Separation (MHz)	6.1
Duty Cycle	Exceeds all existing specifications for continuous duty
Receiver	
Sensitivity (µV)	
20 dB S/N	.50 (20/25 kHz channel spacing)
12 dB SINAD	.25
Adjacent Channel Selectivity (dB)	90 (25 kHz), 85 (20 kHz), 80 (12.5 kHz)
Spurious Rejection (dB)	90
Intermodulation (dB µV EMF)	80
Maximum Channel Separation (MHz)	2
Hum and Noise (dB)	-50 (-45 for 12.5 kHz)
Spurious Emissions (nW)	
Radiated	2 (30 MHz to 1 GHz) 20 (1 to 4 GHz)
Conducted	2 (100 kHz to 2 GHz) 20 (1 to 4 GHz)
Audio Output (dBm)	+11 maximum (600 Ohm) for 60% maximum deviation @ 1 kHz

MSF 10000 cont.

Auto Response (dB)	6 dB per octave deemphasis per CEPT/FTZ
Audio Distortion (%)	5 @ 1000 Hz
Power Supply	
Nominal Voltage (VAC)	110/120/220/240, -20 to +10%, 50 or 60 Hz option for battery charging with emergency reverting
Power Consumption (W) (Ratings for High Power Stations)	
DC Power (12 VDC)	
Standby	25
Transmit	425
AC Power	
Standby	75
Transmit	550

MSF 5000 Base Station 800 MHz Specifications

Transmitter		
Frequency		851 to 869 MHz
RF Power		
Output Range:		Standard 35 to 15 Watts 75 to 35 Watts 150 to 75 Watts
Output Impedence:		50 Ohms
Frequency Stability: (for temp. and voltage variation):		± 0.0001% from -30°C to +60°C.
Isolation:		STD: -20 dBc @ ±25 kHz with C876: -70 dBc @ ±25 kHz
Deviation:		851 to 866 MHz 866 to 869 MHz
	Clear:	±5 kHz for 100% @ 1000 Hz ±4 kHz for 100% @ 1000 Hz
	Coded:	±4 kHz for 100% @ 1000 Hz ±2.4 kHz for 100% @ 1000 Hz
Antenna Connectors:		Transmit Type "N" Female Receive Type "N" Female Reference Input Type "BNC"
Audio Sensitivity		-35 dBm to +11 dBm variable conventional -20 dBm to +11 dBm variable trunked
Conducted Spurious and Harmonic Emissions		- 90 dBc @ 110 watts
FM Hum and Noise		-50 dB for 300 to 3000 Hz bandwidth with 750 µ sec de-emphasis ref. 1000 Hz tone @ 3.0 kHz deviation
Audio Responses: (clear mode)		+1.3 dB from 6 dB per octave preemphasis 300 to 3000 Hz referenced to 1000 Hz at line input

MSF 5000 cont.

Audio Distortion: (clear mode)	Less that 2% @ 1000 Hz; @ 3.0 kHz deviation
Receiver	
Frequency	806 to 824 MHz
Channel Spacing:	25 kHz
Selectivity EIA SINAD:	-90 dB @ ±25 kHz
Receiver Sensitivity:	0.25 µV 12 dB Sinad, 0.5 µV 20 dBQ
Off Channel Acceptance:	±2 kHz Minimum
Frequency Stability (for temp. and voltage variation):	±0.0001% from -30°C to +60°C
Intermodulation EIA SINAD:	-85 dB
Spurious and Image Rejection:	-100 dB
Audio Characteristics: (clear mode)	+1, -3 dB from 6 dB per octave deemphasis 400 to 3000 Hz bandwidth at line output
Audio Distortion: (clear mode)	Less than 3% distortion at 1000 Hz
FM Hum and Noise	-50 dB for 300 to 3000 Hz bandwidth with 750 µ sec deemphasis ref. 1000 Hz tone @ 3.0 kHz deviation
RF Input Impedence:	50 Ohms

MSF 5000 Base Station (UHF 403 to 475 MHz) Specifications

Transmitter	
Frequency	403 to 475 MHz
RF Power Output Range:	6 to 3 Watts 15 to 7 Watts 40 to 20 Watts 75 to 35 Watts 110 to 50 Watts 225 to 110 Watts
Transmit Bandwidth:	Standard -6.1 MHz With 675 Option - 1.0 MHz With 677 Option - 1.0 MHz
Output Impedence:	50 Ohms
Frequency Stability (for temp. and voltage variation):	± 0.0002% from -30°C to +60°C.
Isolation:	STD: -30 dBc @ ±25 kHz with C676: -70 dBc @ ±25 kHz
Deviation:	
Clear:	±5 kHz for 100% @ 1000 Hz
Coded:	±4 kHz for 100% @ 1000 Hz
Antenna Connectors:	
Base Station	Type "UHF"
Repeater Station	Transmit Type "N", Receive Type "N"

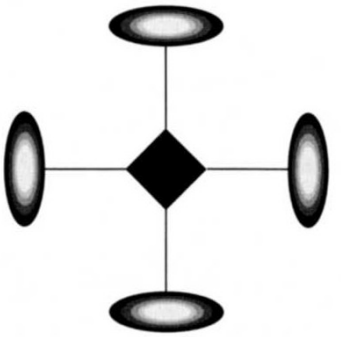
MSF 5000 cont.

Audio Sensitivity	-35 dBm to +11 dBm variable conventional -20 dBm to +11 dBm variable trunked
Conducted Spurious and Harmonic Emissions	-90 dBc
FM Hum and Noise	-55 dB for 300 to 3000 Hz bandwidth ref. 1000 Hz tone @ 3.0 kHz deviation
Audio Responses:	+1.3 dB from 6 dB per octave preemphasis
(clear mode)	300 to 3000 Hz referenced to 1000 Hz at line input
Audio Distortion (clear mode):	Less that 2% @ 1000 Hz; @ 3.0 kHz deviation
Emission Designators:	14K0F3E, 15K0F2D, 16K0F1D, 20K0F1E
Receiver	
Frequency	403 to 475 MHz
Channel Spacing:	25 kHz
Selectivity EIA SINAD:	-100 dB @ ±25 kHz
Transmit Bandwidth:	Standard -2.0 MHz With 675 Option - 2.0 MHz With 677 Option - 2.0 MHz
Receiver Sensitivity:	0.35 µV 12 dB Sinad, 0.5 µV 20 dBQ
Off Channel Acceptance:	±2 kHz Minimum
Frequency Stability (for temp. and voltage variation):	±0.0002% from -30°C to +60°C
Intermodulation EIA SINAD:	-90 dB
Spurious and Image Rejection:	-110 dB
Audio Characteristics:	+1, -3 dB from 6 dB per octave deemphasis
(clear mode)	400 to 3000 Hz bandwidth at line output
Audio Distortion: (clear mode)	Less than 3% distortion at 1000 Hz
FM Hum and Noise	-55 dB nominal for 300 to 3000 Hz bandwidth ref. 1000 Hz tone @ 3.0 kHz deviation
RF Input Impedence:	50 Ohms

Build A C

CHAPTER

6



Subscriber Products

Contents

Chapter 6 SUBSCRIBER PRODUCTS

This section describes the modem and specialized terminal devices currently in Motorola's DataTAC portfolio. These descriptions represent the current state of the DataTAC portfolio, including existing as well as planned products.

Product Strategy

Motorola is the leading supplier of portable and mobile data terminal products for the wireless data market worldwide. A product portfolio has been developed to address the needs of the public shared networks industry. This portfolio is being marketed on a worldwide basis.

Motorola's current products mark the beginning of a new generation in RF data communications through the advent of highly efficient radio channel protocols, Digital Signal Processing (DSP) modem implementation, high performance compact radio modules, advanced semiconductor technology, and industrial design.

Motorola's product portfolio is designed to address the widest possible end user requirements through a diverse and flexible offering. Portable data terminals are available for applications requiring the most compact possible form factor and maximum portability. Mobile data terminals offer the vehicle-bound user a more generous form factor with complete keyboard. Several modem products have also been developed to untether existing computer users and to provide network access to a much broader family of products. These modems are available in three categories; portable, mobile, and OEM subassembly. The former two are used depending on whether the user desires portable or mobile-based network connectivity. The OEM subassembly (or 'integrated') modem is marketed to existing computer vendors for complete integration into their product line.

Central to Motorola's approach is a new device architecture built around the concept of a Network Terminating Unit (NTU). The NTU is a defined architectural element with the sole responsibility of managing the real time communications for a subscriber device. This includes the control and modulation of the radio as well as link layer protocol responsibilities. The purpose of the NTU is to isolate the application portion of the terminal from the burden of real time communications handling. By doing so, the application is freed to address application issues and the path to more powerful distributed processing is enhanced.

As mentioned, Motorola is also in the midst of developing a new family of mobile and portable data products. These products will continue to demonstrate Motorola's expertise at highly innovative products where ruggedization and end user design are critical.

Future generations of products will continue to build on the strengths which have come from over 60 years of product development: innovative and highly advanced application of RF data technology, terminal ruggedization, and high levels of product quality. In addition to these strengths, Motorola plans to develop more powerful data terminals to align with the trend to distributed processing. This will include adoption of industry standard computer operating systems to maximize applications development through third-party software developers. Motorola has placed a significant emphasis on industrial design consistent with a worldwide competitive trend based on product styling and ergonomic appeal. End user interfaces will move beyond the traditional character oriented display and keyboard user entry to more powerful and intuitive user interfaces. Continued emphasis on smaller and lighter portable terminals will also result as semiconductor and battery technologies are driven to new levels.

OEM Strategy

Motorola strongly believes in the potential of third-party computer vendors in the public shared networks business.

Motorola is making a strong commitment to OEM manufacturers of terminal products. Motorola actively distributes modem subsystems to interested third-party manufacturers for distribution to a worldwide market. The OEM strategy is directed to leverage the enormous momentum of the laptop, notebook, and palmheld personal computer market. Motorola's efforts have resulted in several major computer vendors offering mobile data system compatible terminals. This exciting new channel for terminal products will ensure the broadest possible portfolio to the end user and strong competitive activity through natural market interaction.

The final analysis should indicate a bright future for end user devices for public shared network users. The combined impact of Motorola's technological innovations with an aggressive product plan leading well into the decade, and the unleashing of numerous third-party vendors, ensure a healthy product family to build this new industry.

DISTRIBUTION COMMITMENT

Motorola has many years of experience in implementing private and public shared data systems and has come to understand the critical elements of network operator success. This success is based on, among other things, a rich product portfolio, applications connectivity, and efficient distribution channels. Distribution channels merit special attention since they dictate commercial success more so than technological factors. Motorola is committed to a strong direct distribution presence as well as many forms of indirect distribution through Original Equipment Manufacturers (OEM), Independent Software Vendors (ISV), and Value Added Resellers (VAR).

As the mobile data market develops, Motorola will continue to cultivate many indirect channels through the licensing of ISVs and other VARs as resellers of terminal products. The familiarity of these firms with specialized vertical markets will ensure a stronger relationship with the market. Finally, the OEM program will unleash a broad array of new subscriber devices and their established distribution networks.

SUBSCRIBER PRODUCTS

Mobile Data Terminals

PDT 880 Portable Data Terminal

PDT 880

The PDT 880 Portable Data Terminal (PDT 880) provides host computer access to users on the move. The PDT 880 is a completely self-contained portable data terminal which can be carried alone, or in a briefcase. The PDT 880 combines an electronic data terminal with RF data radio technology. It features advanced component technologies in its microprocessor, memory, digital signal processing, synthesized radio, and integral low profile antenna. Packaging incorporates advances in semiconductor components, keyboard and display, encased in a convenient self-contained package designed to meet the rigorous requirements of daily use in industry.

To support a wide variety of needs, three customer applications, as well as an application development, are available from Motorola. TX, the most common application used, is a forms-oriented application which accepts user defined 'fill-in-the-blank' forms to simplify structuring the information to be displayed, entered and transmitted to the system. Ease of database inquiry and updating is a key feature of TX. Audible alerts, prompts, and indicators permit the operator to concentrate on the job at hand, not the terminal. The use of TX with customer-designed forms is possible with Motorola's FormsGen system which allows customers to define their own forms on a PC and upload them to the PDT 880.

Messaging and commercial database services are addressed by Motorola's MG and GT (X.25 PAD) applications respectively, both of which also operate over the RD-LAP network protocol.

Sophisticated users may elect to develop their own terminal applications with Motorola's 'C' Development System. Available as an option, this system allows applications programmers to go beyond the bounds of fill-in-the-blank forms-oriented messaging and substitute

their own custom applications into the PDT 880 without concern for network protocol issues.

Terminal Overview

The PDT 880 package consists of electronic components, synthesized radio module, integrated low profile antenna, high impact plastic housing, rechargeable battery pack, alphanumeric keyboard, Liquid Crystal Display (LCD), and I/O connector. This package is designed to be compact, environmentally rugged, and reliable.

The housing is designed with the rigidity and strength required of a portable terminal product. It consists of a main housing, rechargeable battery pack, and a back cover all environmentally sealed to protect the electronic components inside.

The electronics for the terminal are contained on two PC boards and a synthesized data radio module. The top board is dedicated to the LCD display, driver circuits, and the keyboard switch matrix. The main board contains:

- The applications microprocessor
- The communications digital signal processor
- Flash EPROM for the Core 12™ operating system
- End user applications
- Predetermined forms, message storage RAM
- Power control circuitry.

This dual processor architecture allows for independent processing of user applications while managing the real time RF communications environment. The synthesized radio module employs performance tested RF technology to meet the demanding requirements of efficient 9600 bps data transmission and fully complies with regulatory standards.

The main battery module consists of rechargeable nickel-cadmium (NiCad) cells and fits into the back of the housing. External contacts are provided at the bottom to the housing for recharging the battery with the optional desktop charger. A wall mount trickle charger is available which connects to the side of the portable terminal.

'Keep-alive' circuitry is provided to allow data stored in RAM and the real time clock to be maintained (for up to two hours) during the process of replacing the main battery, or when the main battery is discharged.

PDT 880 Portable Data Terminal Specifications

General	
Physical	
Size	H116 x W221 x D48 mm
Weight	1200 g
Color	Dark grey, MMDD#370
Packaging	Spill-proof case made of ABS thermoplastic
Electrical	
Battery Type	Rechargeable, removable Nickel-Cadmium
Battery Voltage	7.5 V, 1200 mA/hr
Battery Life	4 to 5 hour typical usage
Charging Current (trickle charger)	130 mA typical
Operating Current (typical values)	130 mA typical
Powered Down	1 mA
Receiving	285 mA @ 7.5 V (software dependent)
Transmitting	2.4 A @ 7.5 V
External Connections	
Serial I/O	DB-9 (female) RS-232C subset connector (TXD, RXD, RTS, CTS, GND)
Environmental	
Temperature	
Normal Operating	-20°C to +60°C
Storage	-25°C to +65°C
Relative Humidity	90% non-condensing at 40°C (Motorola 12M05019A86 Section 7.3)
Vibration and Shock	Meets or exceeds Motorola 12M05000D65 Class A'
Electrostatic Discharge	15 kV with no catastrophic failures 10 kV with no effect
Regulatory	
EMI/RFI	VDE 0871 'Class B'
Radio	MPT1326 UK#FTZ 17 TR20-19 Germany
Options and Accessories	
Spare Battery Pack	Motorola MTN4000A
One hour Desktop Charger	Motorola PLN7596A
Desktop Charger Transformers:	
(220 to 240 VAC)	Motorola MDPN4018A
(110 to 120 VAC)	Motorola MDPN4019A
AC Power Cord (U.K.)	Motorola MDKN4022A
16-hour Wall Charger (220 to 240VAC)	Motorola PLN7596A
16-hour Wall Charger (110 to 120VAC)	Motorola MDPN4021A

PDT 880 cont.

Bar Code Light Pen	Motorola MTN4858
Bar Code Scanner	Symbol LS 8520
DE9 Unterminated Cable	NKN6379
Forms Generation Tool (PC based)	Inquire
OS Configuration Tool	Inquire
C Development Kit	Inquire
GT Application	Inquire
MG Application	Inquire

HARDWARE DESCRIPTION

Electronic Design

68HC11F1 processor running at 2.0 MHz.	
Flash EPROM Storage	512 kB
Data RAM Storage	128 kB with factory option for 256 kB
Note: All data RAM is battery backed up	
EEPROM (internal to 68HC11)	512 B
Time of day clock.	
56001 Digital Signal Processor running at 19.6608 MHz	
96 kB DSP RAM (32 kB x 24 bits).	
Motorola 3000 Multi-Function VLSI Chip	Parallel I/O Interrupt controller Keyboard scanner
Motorola 5500 Multi-Function VLSI Chip	Memory mapper Memory address generation DSP I/F DSP clock generation Reset circuitry General I/O

DISPLAY AND INDICATORS

Display

Type	Super twist backlit LCD
Backlighting	EL panel
Contrast	Minimum 4:1 6:1 at room temperature
Resolution	8 lines by 40 characters per line
Character Set	Standard ASCII characters
Character Size	6 by 8 dot matrix
Character Attributes	Normal, blink

Indicators

Message Indicator	LED
Buzzer	PC-mounted audio transducer, tone adjustable

Keyboard

Main Keys	QWERTY/QWERTZ keyboard (factory option), elastomer membrane with tactile feedback

PDT 880 cont.

RADIO SPECIFICATIONS

General

Frequency Range	
Tx	413 to 423 MHz
Rx	423 to 433 MHz
Antenna Bandwidth	10 MHz
Channel Spacing	12.5 kHz
Channel Capacity	32 active channels

Power Requirements

Standby Current	60 mA
Transmit Current	2.2 A

Transmitter

Power Output	
Effective Radiated Power	1 W
Frequency Stability	±2.5 ppm, -30° to +60°C
Emissions	-36 dBm 0.1 to 1,000 MHz
(spurious and harmonic)	-30 dBm 1000 to 2,000 MHz
Frequency Spread	10 MHz
Transmitter Turn-on Time	5 ms
Modulation	direct FM

Receiver

Data Sensitivity (0.01 BER)	-111 dBm (12.5 kHz) RD-LAP protocol
Adjacent Channel Selectivity	60 dB
Spurious and Image Rejection	70 dB
Intermodulation Rejection	65 dB
Frequency Spread	10 MHz
Modulation Acceptance BW	8 kHz
Receiver Sensitivity Performance (worst case, longest physical packet)	
Static	-114 dBm
80 km/hr faded	-97 dBm

Radio Channel Control

Automatic Channel Selection	Terminal automatically scans available frequency pairs and selects one meeting acceptable channel quality criteria.

Communication and Contention Configuration

Protocol Specification	RD-LAP, Motorola Document No. MDS-AIS1001-O
Data Rate	9600 bps
Modulation	Four-level FSK
Radiated Bandwidth Conformance	FTZ 17 TR20-19 July 1988 I-ETS[A] version 3.3.1 mod 1

Environmental Specifications

The PDT 880 has been designed to operate in many environments. Listed in the following paragraphs is a synopsis of the environmental factors which were considered and a brief discussion on how the PDT 880 is designed to meet each factor.

Temperature

The PDT 880 operates over a wide temperature range and can be stored in severe conditions. The PDT 880 is designed to operate from -20° to +60°C (with slower LCD display performance at extremely low temperatures). In addition to performance at high temperature, the PDT 880 will not contribute to a fire if exposed. The PDT 880's case material is an impact resistant thermoplastic which is fire retardant.

Drop/Vibration

The PDT 880 has been designed to operate normally after a four-foot drop to concrete on any of its surfaces.

7100 FK Mobile Data Terminal

7100 FK

The 7100 Full Keyboard Mobile Data Terminal (7100 FK) is a ruggedized vehicle-mounted mobile data terminal. The 7100 FK functions as a mobile data terminal hosting terminal resident applications for the end user. Data communications is achieved by pairing the 7100 FK with a 7100 Mobile Radio Modem (7100 MRM) using an asynchronous 9600 bps interface. Together, these components establish a wireless communications link with the fixed end system.

The 7100 FK offers a full QWERTY (QWERTZ style for Germany) keyboard terminal coupled with an eight-line by 40-character LCD display. The compact terminal is mounted directly in a vehicle through one of a number of mounting schemes. The terminal has been ruggedized for use in harsh vehicle environments.

To support a wide variety of customer needs, three customer applications are available from Motorola as well as a user development system: TX application is the most common application used. TX is a forms-oriented application which accepts user-defined 'fill-in-the-

blank' forms to simplify structuring the information to be displayed, entered, and transmitted to the system. Ease of database inquiry and updating is a key feature of TX. Audible alerts, prompts, and indicators permit the operator to concentrate on the job at hand, not the terminal. The use of TX with customer designed forms is possible with Motorola's FormsGen system which allows customers to define their own forms on a PC and upload them to the 7100 FK.

Messaging and commercial database services are addressed by Motorola's MG and GT (X.25 PAD) applications respectively, both of which also operate over the network protocol.

Sophisticated users may elect to develop their own terminal applications with Motorola's 'C' Development System. Available as an option, this system allows applications programmers to go beyond the bounds of fill-in-the-blank forms-oriented messaging and substitute their own custom applications into the 7100 FK without concern for network protocol issues.

7100 Mobile Data Terminal Specifications

GENERAL

Physical	
Size	H191 x W268 x D89 mm
Weight	2500 g
Color	Dark grey, MMDD#370
Packaging	Spill-proof case made of ABS thermoplastic
Electrical	
Power Requirements	123.6 VDC ±15% typical 8.5 VDC to 16 VDC maximum
External Connections	
Serial I/O	DB-9 RS-232C connector (TXD, RXD, RTS, CTS, GND)
Environmental	
Temperature	
Normal Operating	-20°C to 60°C
Storage	-40°C to 80°C
Relative Humidity	90% non-condensing at 40°C (Motorola 12M05019A88)
Vibration and Shock	Meets or exceeds Motorola 12M80973A16 and 12M80951T58
Electrostatic Discharge	15 kV with no catastrophic failures 10 kV with no effect

7100 MDT cont.

Regulatory	
EMI/RFI	VDE 0871 'Class B'
HARDWARE DESCRIPTION	
Electronic Design	
Dual 68HC11 processor running at two different speeds	
EPROM Storage	256 kB (socketed)
Forms Storage (optional)	64 kB
Data RAM Storage	32 kB
Optional Slot	128 kB EPROM or 32 kB RAM
Parameter EEPROM	512 B
Display and Indicators	
Display	
Type	Supertwist LCD
Backlighting	LED
Contrast	minimum 6:1 at room temperature
Resolution	8 lines by 40 characters
Character Set	Standard ASCII characters
Character Size	6 by 8 dot matrix
Character Attributes	Normal, blink
Indicators	
Message Indicator	LED
Buzzer	PC-mounted audio transducer
Controls	
View Angle	Adjustable control knob to adjust display view angle (contrast)
Backlighting	Adjustable control knob to control LED backlight level
Keyboards	
Main Keys	QWERTY or QWERTZ membrane keyboard, tactile feedback, domed backlit keycaps
Status Keys	14 general-purpose keys for specific applications (e.g., emergency key)
Operating Life	>10 million operations
Radio Modem Interface	
Protocol Specification	Formatted 9600 synchronous data stream (must be used with 7100 Mobile Radio Modem)
Electrical	RS-232C DB-25 connector

Terminal Overview

The 7100 FK package consists of electronic components, high-impact plastic housing, full alphanumeric QWERTY (QWERTZ available in Germany) keyboard, status keyboard, Liquid Crystal Display (LCD) and I/O connectors. This package is designed to be compact, environmentally rugged, and highly friendly.

The electronics for the terminal are contained on five PC boards. The top board is dedicated to the LCD display and driver circuits. Another board is the main keyboard for the elastomer keypads and LED backlighting electronics. A third board is used for the auxiliary keyboard. The main board contains the applications microprocessor, communications processor, personality module, the clock chip, EPROM for Core 12™ operating system, end-user applications, predetermined forms and message storage RAM. A final circuit board is dedicated to power supply, I/O buffering and control, and RS-232C functions.

'Keep-alive' circuitry is provided to allow data stored in RAM and the real time clock to be maintained during brief periods of power interruption (during vehicle cranking).

Modems

7100 Mobile Radio Modem

The 7100 Mobile Radio Modem (7100 MRM) is an integrated UHF data radio modem for mobile applications. The 7100 MRM is the communications subsystem dedicated to the 7100 FK and contains all of the electronics and intelligence to sustain RF communications with the fixed end communications system. The 7100 MRM features advanced component technologies in its microprocessor, memory, digital signal processing, synthesized radio and amplifier, all packaged as an offering for the commercial market place. Installation of the 7100 MRM is facilitated by a compact DIN-sized chassis suitable for in-dash mounting.

7100FK with 7100 MRM

Radio Modem Overview

The 7100 MRM consists of a radio data modem, frequency synthesized radio module, 6 watt power amplifier, 7100 FK MDT cable, and DIN housing. This package is designed to be compact, environmentally rugged, and highly reliable.

The housing is designed as a vehicular-mounted product able to contend with a harsh operating environment. It consists of a single main chassis and DIN-mounting capability along with back connections for power, antenna and communications.

The electronics for the radio modem are found on a modem PC board; radio electronics are contained in the radio module and power amplifier circuity is contained in the power amplifier section. The modem PC board contains a supervisory microprocessor, communications digital signal processor, flash EPROM for Core 12™ operating system, message buffer RAM, power control circuitry and RS-232C I/O drivers. The synthesized radio module employs performance tested RF technology required for 9600 bps data transmission and to comply with ETSI standards. The power amplifier section provides the additional power amplification necessary to perform in a mobile network design.

7100 Mobile Radio Modem Specifications

GENERAL

Frequency Range	Tx 413 to 423 MHz Rx 423 to 433 MHz
Channel Spacing	12.5 kHz
Channel Capacity	32 channels
Power Requirements	13.6 VDC ±15%

PHYSICAL

Size	H44 x W168 x D128 mm DIN Standard
Weight	1200 g
Color	Black
Packaging	Cast aluminum chassis with cover

ELECTRICAL

Power Requirements	13.6 VDC ±15% typical

EXTERNAL CONNECTIONS

Serial I/O	High Density, 15-pin D connector RS-232C connector (TXD, RXD, RTS, CTS, GND, DCD, DSR, DTR, DCD)
Antenna	BNC
Power	2-pin polarized Cannon connector

Environmental

Temperature	
Normal Operating	-20°C to 60°C
Storage	-40°C to 80°C
Relative Humidity	90% non-condensing at 40°C
Vibration	Meets or exceeds Motorola 12M80973A16 and 12M80951T58

HARDWARE DESCRIPTION

Logic Design

68HC11 processor running at 1.8 MHz	
Flash EPROM Storage	256 kB on logic board
Data RAM Storage	128 kB on logic board
Note: All data RAM is battery backed up.	
EEPROM	512 B
56001 Digital Signal Processor running at 19.6608 MHz	
Motorola 5500 multi-function VLSI Chip	Memory manager SSI ASI Parallel I/O

Transmitter

Power Output	6 W (factory adjustable 1 to 10 W)
Frequency Stability	±2.5 ppm, -30° to +60°C (spurious and harmonic)
Emissions	-36 dBm 0.1 to 1,000 MHz -30 dBm 1.0 to 2,000 MHz
Frequency Spread	10 MHz

7100 MRM cont.

Transmitter Turn On Time	5 ms
Modulation	Direct FM, four-level FSK
Receiver	
Data Sensitivity (0.01 BER)	-111 dBm (12.5 kHz) RD-LAP protocol
Adjacent Channel Selectivity	60 dB
Spurious and Image Rejection	70 dB
Intermodulation Rejection	65 dB
Frequency Spread	10 MHz
Modulation Acceptance BW	8 kHz
Radio Modem Interface Connection	
Protocol Specification	Formatted 9600 bps synchronous data stream (must be used with 7100 MDT)
Electrical	DB-15 (female) RS-232 subset connector (TXD, RXD, RTS, CTS, GND, DTR, DSR, DCD)
Receiver Sensitivity Performance (worst-case, longest physical packet)	
Static	-114 dBm
80 km per hour Faded	-97 dBm
Radio Channel Control	
Automatic Channel Selection (ACS)	Terminal automatically scans available frequency pairs and selects one meeting acceptable channel quality criteria
Communications and Contention Configuration	
Protocol Specification	RD-LAP, Motorola Document No. MDS-AIS1001-O
Data Rate	9600 bps
Modulation	Four-level FSK
Radiated Bandwidth Conformance	FTZ 17 TR20-19 July 1988 I-ETS(A) Version 3.3.1 mod 1

Mobile Radio Modem 420

MRM 420

The Mobile Radio Modem 420 (MRM 420) is an integrated mobile radio/data modem operating in UHF subbands. The MRM 420 is the RF communications link for third-party terminals and laptops communicating over DataTAC Networks. The MRM 420 contains all of the electronics and intelligence necessary to sustain RF communications with the fixed end communications system. The MRM 420 features advanced component technologies in its microprocessor, memory, digital signal processing, synthesized radio and RF power amplifier, all packaged as an offering for the commercial market place. Installation of the MRM 420 follows the European norm of adopting a compact DIN-sized chassis suitable for in-dash mounting.

Radio Modem Overview

The MRM 420 consists of a data radio modem, UHF frequency synthesized radio module, 6-watt power amplifier, LEDs and DIN housing. This package is designed to be compact, environmentally rugged, and highly reliable.

The housing is designed as a vehicular-mounted product able to contend with a harsh operating environment. It consists of a single main chassis and DIN mounting capability along with back connections for power, antenna and communications.

The electronics for the radio modem are found on a modem PC board, radio electronics are contained in the radio module and power amplifier circuity is contained in the power amplifier section. The modem PC board contains a supervisory microprocessor, communications digital signal processor, flash EPROM for Core 12™ operating system, message buffer RAM, power control circuitry and RS-232C I/O drivers.

Of primary interest is the use of DSP (Digital Signal Processing) in the MRM 420 which allows hardware independence of the protocol. This is a significant feature allowing the MRM 420 to be tailored to

Mobile Radio Modem 420 Specifications

GENERAL

Frequency Range	
Tx	413 to 423 MHz or 450 to 470 MHz
Rx	423 to 433 MHz
Channel Spacing	12.5 kHz
Channel Capacity	32 channels
Power Requirements	13.6 VDC ±15%

PHYSICAL

Size	H44 x W168 x D128 mm DIN standard
Weight	1200 g
Color	Black
Packaging	Cast aluminum chassis with cover

ELECTRICAL

Power Requirements	13.6 VDC ±15% typical

EXTERNAL CONNECTIONS

Serial I/O	High Density, 15-pin D connector RS-232C connector (TXD, RXD, RTS, CTS, GND, DCD, DSR, DTR, DCD)
Antenna	BNC
Power	2-pin polarized Cannon connector

ENVIRONMENTAL

Temperature	
Normal Operating	-20°C to 60°C
Storage	-40°C to 80°C
Relative Humidity	90% non-condensing at 40°C
Vibration	Meets or exceeds Motorola 12M80973A16 and 12M80951T58

HARDWARE DESCRIPTION

Logic Design

68HC11 processor running at 1.8 MHz.	
Flash EPROM Storage	256 kB on logic board
Data RAM Storage	128 kB on logic board
Note: All data RAM is battery backed up.	
EEPROM	512 B
56001 Digital Signal Processor running at 19.6608 MHz.	
5000 multi-function VLSI chip	Memory manager SSI ASI parallel I/O

Transmitter

Power Output	6 W (factory adjustable 1 to 10 W)
Frequency Stability	±2.5 ppm, -30° to +60°C. (spurious and harmonic)

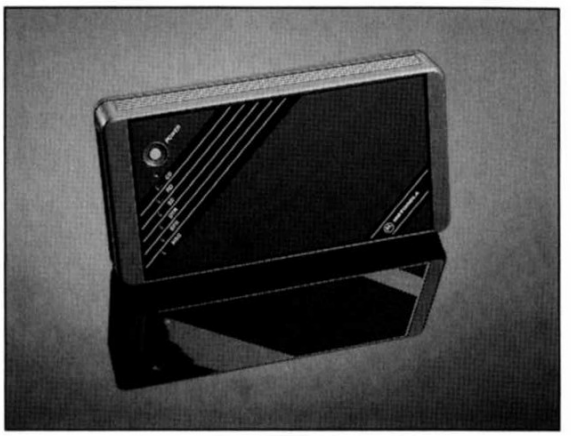
MRM 420 cont.

Emissions	-36 dBm 0.1 to 1000 MHz -30 dBm 1.0 to 2000 MHz
Frequency Spread	10 MHz
Transmitter Turn On Time	5 ms
Modulation	Direct FM, four-level FSK
Receiver	
Data Sensitivity (0.01 BER)	-111 dBm (12.5 kHz) RD-LAP protocol
Adjacent Channel Selectivity	60 dB
Spurious and Image Rejection	70 dB
Intermodulation Rejection	65 dB
Frequency Spread	10 MHz
Modulation Acceptance BW	8 kHz
Indicators	
Modem Status	LEDs PWR, CD, RD, SD, BFR, DSR, DTR
Buzzer	Audio transducer, tone adjustable
Keys	
ON/OFF	Elastomeric membrane
Radio Modem Interface Connection	
Protocol Specification	RS-232
Electrical	DB-15 (female) RS-232 subset connector (TXD, RXD, RTS, CTS, GND, DTR, DSR, DCD)
Data Rate (modem/device)	9600 bps
Receiver Sensitivity Performance (worst case, longest physical packet)	
Static	-114 dBm
80 km per hour Faded	-97 dBm
Radio Channel Control	
Automatic Channel Selection [ACS]	Terminal automatically scans available frequency pairs and selects one meeting acceptable channel quality criteria
Communications and Contention Configuration	
Protocol Specification	RD-LAP, Motorola Document No. MDS-AIS1001-O
Data Rate	9600 bps (RD-LAP)
Modulation	Four-level FSK
Radiated Bandwidth Conformance	FTZ 17 TR20-19 July 1988 I-ETS(A) version 3.3.1 mod 1

different RF systems, (e.g., RD-LAP 9.6 kBaud or MMP 4800 kBaud) with only a different download (software downloading can be performed through the RS-232 port without disassembly of the unit). The synthesized radio module employs performance-tested RF technology required for 9600 bps data transmission and to comply with ETSI standards. The power amplifier section provides the additional power amplification necessary to meet mobile radio specifications.

The MRM 420 is easy to operate and provides functionality and connectivity similar to an asynchronous dial-up telephone modem. Standard modem configuration and functionality is performed using an expanded 'Hayes'-like command set (recognizes the RF environment in place of land line connectivity). Third-party device connectivity is through a back plane, condensed, 15-pin communications port supporting an RS-232 interface. "Off-the-shelf" communications programs such as Procom and Crosstalk can be used to facilitate interactions between the modem and third-party devices.

RPM 420e Radio Packet Modem



The RPM 420e radio packet modem is the RF communications link for third-party terminals and laptops communicating over Public Data Networks that use Motorola's RD-LAP protocol. It combines an electronic data modem with RF data radio technology packaged for desktop or portable use. The RPM 420e contains all the electronics, power and intelligence needed for RF communications with the fixed end communications system. Features include advanced component technologies in its microprocessor, memory, digital signal processing, synthesized radio, integrated antenna and RF power amplifier, all packaged for the commercial market place.

The RPM 420e is easy to operate, with the functionality and connectivity of an asynchronous dial-up telephone modem. Standard modem functionality is performed by the Hayes AT command (both for control and configuration), and a single communications port supporting an RS-232 subset (e.g., standard 9-pin). The RPM 420e allows virtually any computing device that can communicate asynchronously via a telephone modem to operate in a wireless environment. "Off-the-shelf" communications programs such as Procom or Crosstalk facilitate interactions between the computing device and the modem.

The RPM 420e is completely self-contained in a rugged, high-impact plastic package. All electronics, radio, and antenna are contained internally. A high-capacity, removable NiCad battery is held in a recess in the bottom case. External connections are provided through the RS-232 communications port and a DC power port for battery trickle charging. Direct user interface is provided through an ON/OFF key and modem status LEDs. The RPM 420e internal electronics are DSP based (Digital Signal Processor), allowing hardware protocol independence. This is a significant feature allowing the RPM 420e to operate in different RF systems (i.e., RD-LAP 9600 baud or MMP 4800 baud) with only

a different software download (software downloading can be performed through the RS-232 port without disassembly of the unit).

Radio Modem Overview

The RPM 420e product consists of:

- Two sets of electronic assemblies
- Synthesized radio module
- Integrated internal antenna
- High impact plastic housing
- Rechargeable NiCad battery pack
- ON/OFF switch
- Modem status LEDs
- RS-232 port
- External trickle charger jack.

The housing is designed with the rigidity and strength required of a portable product. It consists of a main housing, back cover, and rechargeable battery pack which are environmentally sealed to protect the electronic components inside.

The electronics for the radio modem are contained on two printed circuit boards and a synthesized data radio module. The top board is dedicated to the user interface (e.g. ON/OFF switch and modem status LEDs). The main board contains the applications microprocessor, the communications digital signal processor, flash EPROM for program storage (protocol specific), RAM for message and configuration storage, plus clock, power control, and interface circuitry. The dual processor architecture allows for independent processing of modem functions while managing the real time RF communications environment. The synthesized radio module employs performance-tested RF technology designed to meet the demanding requirements of high-bit-rate data transmission and to comply with strict regulatory requirements.

The battery pack consists of rechargeable nickel-cadmium (NiCad) cells and fits snugly into the back housing. External contacts are provided at the bottom of the pack for recharging the battery while in the RPM, using the optional desktop charger. A wall-mount trickle charger, which connects directly to the side of the RPM, is also available.

"Keep-alive" circuitry is provided to allow data stored in RAM to be maintained (for up to two hours) during the process of replacing the battery pack, or when the battery pack is discharged.

Environmental Specifications

The RPM 420e has been designed to operate in many environments. Listed in the following paragraphs is a synopsis of the environmental factors which were considered and a brief description of how the RPM 420e is designed to meet each factor.

Temperature

The RPM 420e operates over a wide temperature range and can be stored in more severe conditions. The RPM 420e is designed to operate from -30 to +60°C and allow storage temperature of -55 to +85°C. In addition to enduring high temperature environments, the RPM 420e will not contribute to a fire if exposed. The RPM 420e's case material is an impact resistant thermoplastic which is fire retardant.

Drop

The RPM 420e has been designed to operate after a 4-foot drop to concrete on any of its surfaces.

Water/Rain

The RPM 420e is environmentally sealed and is water resistant.

ESD

The RPM has been designed to operate after severe static discharge to any of its external elements.

Radio Packet Modem 420e Specifications

GENERAL

Physical	
Size	H116 x W221 x D48 mm
Weight	1.1 kg
Color	Dark grey
Packaging	Spill-proof case made of ABS thermoplastic
Electrical	
Battery Type	Rechargeable, removable Nickel-Cadmium
Battery Voltage	7.2 V, 1200 mA/hr
Battery Life	6 hours typical usage
Charging Current	130 mA typical
Operating Current (typical values)	
Powered down	1 mA
Receiving	180 mA
Transmitting	2.1 A
External Connections	
Serial I/O	DB-9 (female) RS-232 subset connector (Rx, Tx, DTR, DSR, RTS, CTS, DCD), Asynchronous, 300, 1200, 2400, 4800, and 9600 baud

RPM 420e cont.

Environmental	
Temperature	
Normal Operating	-30 to +60°C
Storage	-55 to +85°C
Relative Humidity	0 to 90% non condensing at 40°C
Vibration	2 x RS-316
Drop	4 feet on concrete, all axis
ESD	15 kV without catastrophic failure, 10 kV with no effect
Regulatory	
EMI/RFI	FCC Part 15J Class B
Radio	MPT 1326 (U.K.) ETS (A) (VDE 0871 Class B, D OC RSS119, FTZ 17 TR20-19 July 1988)
Options and Accessories	
Spare Battery Pack	Motorola MTN4000A
One-hour Desktop Charger	Motorola PLN7596A
Desktop Charger Transformers	
220 to 240 VAC	Motorola MDPN4018A
110 to 120 VAC	Motorola MDPN4019A
AC power cord (U.K.)	Motorola MDKN4022A
16-hour Wall Charger	
220-240VAC	Motorola PLN7596A
110-120VAC	Motorola MDPN4021A
HARDWARE DESCRIPTION	
Electronic Design	
68HC11F1 processor running at 2.0 MHz.	
Flash EPROM Storage	512 kB
Data RAM Storage	128 kB with factory option for 256 kB
Note: All data RAM is battery backed up.	
EEPROM (internal to 68HC11)	512 B
Time-of-day Clock.	
56001 Digital Signal Processor running at 19.6608 MHz	
96 kB DSP RAM (32 kB x 24 bits).	
Motorola 3000 Multi-Function VLSI Chip	Parallel I/O Interrupt controller
Motorola 5500 Multi-Function VLSI chip	Memory mapper Memory address generation DSP I/F DSP clock generation Reset circuitry General I/O
Indicators	
Modem Status	LEDs PWR, CD, RD, SD, BFR, DSR, DTR
Buzzer	Audio transducer, tone adjustable

RPM 420e cont.

Keys	
ON/OFF	Elastomeric membrane
RADIO SPECIFICATIONS	
General	
Frequency Range	413 to 423 MHz or 450 to 470 MHz (factory option)
Antenna Bandwidth	10 MHz
Channel Spacing	12.5 kHz
Channel Capacity	32 active channels
Power Requirements	
Standby Current	60 mA
Transmit Current	2.2 A
Transmitter	
Power Output	3 W
Effective Radiated Power	1 W
Frequency Stability	± 2.5 ppm, -30° to +60°C
Emissions	-36 dBm 0.1 to 1000 MHz
(spurious and harmonic)	-30 dBm 1000 to 2000 MHz
Frequency Spread	10 MHz
Transmitter Turn-On Time	5 ms
Modulation	Direct FM
Receiver	
Data Sensitivity (0.01 BER)	-111 dBm (12.5 kHz) RD-LAP protocol
Adjacent Channel Selectivity	60 dB
Spurious and Image Rejection	70 dB
Intermodulation Rejection	65 dB
Frequency Spread	10 MHz
Modulation Acceptance BW	8 KHz
Receiver Sensitivity Performance (worst case, longest physical packet)	
Static	-114 dBm
80 km per hour faded	-97 dBm
Radio Channel Control	
Automatic Channel Selection	Terminal automatically scans available frequency pairs and selects one meeting acceptable channel quality criteria.
Communications and Contention Configuration	
Protocol Specification	RD-LAP, Motorola Document # MDS-AIS1001-O
Data Rate	9600 bps
Modulation	Four-level FSK
Radiated Bandwidth Conformance	FTZ 17 TR20-19 July 1988 I-ETS(A) Version 3.3.1 mod 1, FCC Part 90, DOC RSS119 and MPT1326

Integrated Radio Packet Modems

Motorola has developed a line of integrated Radio Packet Modems (RPMs). Specifically targeted at Original Equipment Manufacturers (OEMs), these integrated RPMs have been designed to provide connectivity to a DataTAC network for third-party equipment such as laptop computers, palmtop computers, and notepad computers.

Integrated radio packet modems can be identified by a lower case "i" in the product name (for example, the RPM 405i). All integrated RPMs consist of two functional blocks: the radio, and the necessary logic to support the radio channel protocol. In the case of a DataTAC network, the logic section of the RPM converts an asynchronous data stream of zeros and ones into the RD-LAP protocol. This takes care of subscriber ID, error detection and correction, channel access contention, etc. The radio then transmits and receives the information using radio frequencies. All versions of the integrated radio packet modems utilize digital signal processor (DSP) technology. This allows the radio channel protocol to be upgraded via a change to software in the RPM.

New software can be downloaded to the RPM via the data terminal equipment (DTE) port on the RPM. This allows for software upgrades without the removal of the integrated modem from the OEM device. To further facilitate easy upgrading, all integrated RPMs utilize flash programmable read-only memory (PROM) to store the software. Flash PROM is specifically designed to allow the program to be erased and reprogrammed without the requirement of removal or special programming equipment.

As these devices have been designed to be integrated into another device, the "i" family of RPM's communicate at TTL levels through the DTE port. This is in contrast to RS-232 voltage levels found in external or mobile radio packet modems. The DTE interface is an asynchronous interface with one start bit, seven or eight data bits, and one to two stop bits. Minimally, a three-wire interface consisting of send data, receive data, and signal ground can be utilized, while the interface implements a full 9-pin standard (including RTS, CTS, DTR, DSR, CD, and RI).

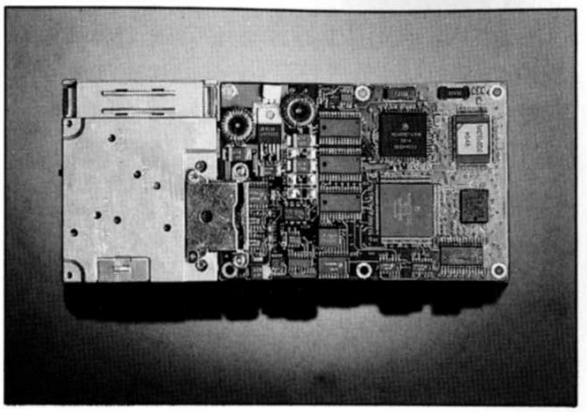
Power must be supplied and controlled to the RPM from the OEM device. The OEM also has the responsibility for integration including

antenna design, electromagnetic interference (EMI) considerations, housing the RPM, etc.

For DataTAC networks, the integrated line of modems consists of the following products.

RPM 400i

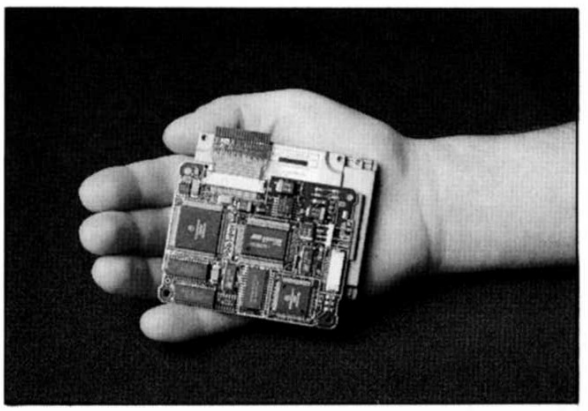
This was the first integrated radio packet modem produced by Motorola. It incorporates a 56001 DSP and 68HC11 processors. With 128 kB of flash PROM and 32 kB of RAM, the RPM 400i is available at 800 MHz.



RPM 400i

RPM 405i

The second integrated modem in the RPM family is the RPM 405i. The key difference between the RPM 400i and the RPM 405i is that the RPM 405i's logic board is 66% smaller than the RPM 400i logic board. The reduction in size was specifically implemented so that the RPM 405i could be more easily integrated into smaller palmtop and notebook computers. The RPM 405i is available in 800 MHz.



RPM 405i

The RPM 405i also uses the more advanced MC56156 DSP processor. The higher levels of integration in the 56156 allow for greater reliability through reducing total parts count.

The RPM 405i has 256 kB flash versus 128 kB flash found on the RPM 400i. The increased memory will allow for greater expansion of functionality in the future.

RPM 415i

The RPM 415i has the same logic board as the RPM 405i. The major difference is that the RPM 415i is available with a UHF radio 403 to 470 MHz. This device is primarily targeted at European markets.

RPM 400iPLUS

The RPM 400iPLUS is an upgraded version of the RPM 400i. Utilizing a 56156 DSP in place of the 56001 DSP found in the RPM 400i, the RPM 400iPLUS has 256 kB of flash PROM. The RPM 400iPLUS has the same physical dimensions as the RPM 400i and is available in 800 MHz.

RPM 410iPLUS

The RPM 410iPLUS is the UHF version of the RPM 400iPLUS.

CHAPTER

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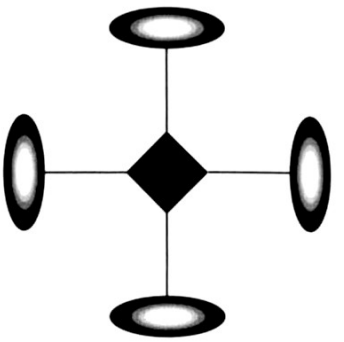


Installation, Training and Support Services

Contents

Chapter 7 INSTALLATION, TRAINING AND SUPPORT SERVICES

Installation, Training and Support Services

Motorola offers network operators a broad spectrum of engineering and project managements services on an on-going basis on the premise that the relationship between Motorola and a network operator is an on-going investment for both parties. This requires an integrated approach to customer service, from the initiation of a network installation agreement through to the long-term support and maintenance of the network.

Project Management

From a project standpoint, Motorola assembles a dedicated team of experienced engineering, project management, and technical professionals. This team is led by a project manager responsible for managing all required activities, from installation of the network through to sign-off and commercial operation. The project manager acts as the primary coordinating individual in the Motorola organization and works with the network operator's designated personnel to establish specifications, set and monitor schedules, and manage the logistics of network installation and commissioning. The project manager has full responsibility for contract administration and negotiates changes in scope necessary to satisfy the particular business requirements of the network operator.

Project Engineering

The systems engineering team is drawn from one of the most experienced data systems engineering groups in the world. The senior systems engineer has full accountability for end-to-end system design, capacity analysis and system sizing. The engineering team is also responsible for system factory staging, system tuning and optimization in the field, and final system functional and performance testing.

List of Available Services

The following list highlights some of the major services offered by Motorola.

Systems Engineering

Services available include:

- Identification of Special System Requirements
- Architecture Configuration
  - Licensing Restrictions
  - Spectrum Requirements
  - Load Capacity Analysis
  - Redundancy Analysis
- Radio Network Design
  - RF Coverage Prediction
  - Site Equalization
  - Environmental Compatibility Calculations
  - Receiver Desensitization Calculations
  - Intermodulation Interference Analysis
  - Effective Receiver Sensitivity Considerations /Measurements
  - Antenna Selection
  - RF Multicoupling System Design
  - Lightning and Surge Protection
  - Equipment Redundancy Design
  - Standby Power System Design
- Network Implementation
  - RF Coverage Testing
  - Load Capacity Testing
  - Link Verification Testing
  - Functionality Testing
  - Installation Inspections
  - Site Optimization
  - Site Documentation
  - On-Site Training
  - System Commissioning
- System Operation
  - Sign On/Sign Off
  - Types of Transactions
  - System Load Distribution

Mechanical Engineering

Services available include:

- Base Equipment Mounting
- Terminal Mounting
  - Location
  - Vibration
  - Strength
  - Safety
- Terminal Base Design
- Product Packaging
- Temperature and Environment
- Fluids Shielding
- Keycaps/Labeling

Software Engineering

Services available include:

- System Operation
- Host Interface
- Applications Software Supplier
- Software Configuration
- Software Enhancements
- Software Design
- Software Development

Contract Administration

Services available include:

- Project Manager Liaison
- Prime Contractor Liaison
- Subcontractor Liaison
- Agreement on Implementation Document
- Compliance
- Host Software Suppliers
- Delivery Point
- Bonds
- Insurance
- Milestone Payments
- Terms of Acceptance
- Reporting
- Auditing
- Software Documentation and Service
- Delivery Schedule
- Location of Installation
- Definition of Contract

System Integration

Services available include:

- Base Radio Interfacing and Cabling
- Mobile Radio Interfacing and Cabling
- Installation Locations
- Installation Scheduling
- System Cabling
- Mode of System Operation

Customer Service

Services available include:

- Warranty Service
- System Support Agreements
- Unit, Module or Component Level Service
- Local Service Presence
- Customer Expertise
- Training Course Requirements
  - User Training
  - Repair and Maintenance Training

Training Courses

Motorola is committed to helping network operators successfully operate and maintain their networks by making available comprehensive training courses in network operation, management and administration, and maintenance.

Training course development is done by professional educators, and technical accuracy is ensured by development engineers. Each network operator's needs are analyzed and met by customizing the core training material to match the specific requirements. The training material is then translated, and the training is delivered in the network operator's native language.

The instructors are Motorola, Mobile Data Division's systems engineers and technicians who have thorough product/system knowledge and good verbal communications skills. The instructors are supported by training and subject matter experts who assist them when required.

The training courses are held on-site and the lecture-based sessions are complimented with practical hands-on workshops. Typically, the training is held at the end of the installation stage so that immediately upon completion, the participants will be able to put what has been learned into practise.

The network operator is responsible for providing training facilities and course participants. To maximize the benefit of each training session, the participants should have the required prerequisites, and they should be the individuals who will ultimately perform the learned tasks.

The following courses are recommended training for the operation, management and administration, and maintenance of the network:

- Network Operations
- Network Management and Administration
- Network Maintenance.

Optional courses that the network operator may consider are:

- System Overview
- Network Applications Programming
- Radio Site Installation, Configuration, and Maintenance.

Course descriptions are on the pages that follow.

Network Operations Course

Purpose

The purpose of this course is to give the network operations personnel a complete and practical understanding of how the network operates and the tasks necessary to operate the network.

Audience

This course will be given to network operations personnel who will be performing daily and routine operational tasks.

Prerequisite Skills/Knowledge

- Computing operation experience and knowledge of:
  - basic data entry skills
  - disk storage and file concepts
  - printer operation
  - tape drive operation
  - data communications terminology and concepts
  - data network terminology and concepts.
- Recommended third-party training or equivalent experience:
  - Sun OS for Users: Open Windows.

Objectives

By the end of the course, the participants will be able to:

- Log into the NMC and RNG
- Operate a mobile terminal to access a test host
- Add customer records to the RNG
- Add and delete subscriber units
- Add and delete application hosts
- Query terminal and host status information
- Monitor the network to ensure normal operation
- Run diagnostic tests on the network
- Escalate troubles to the proper channels for resolution
- Produce standard reports
- Backup and archive the NMC and RNG.

Duration

The training course is three days long and is a combination of lecture and hands-on training.

All course materials and manuals are included in the course.

Network Management and Administration Course

Purpose

The purpose of this course is to give the network management and administrative personnel a detailed understanding of how the network operates and the tasks necessary to manage and administer the network and its databases.

Audience

This course will be given to network personnel who will be performing network managerial and administrative tasks.

Prerequisite Skills/Knowledge

- Network Operations Course
- Knowledge and familiarity with relational databases
- Experience with database management and administration
- Recommended third-party training or equivalent experience:
  - Sun System Administration
  - SunNet Manager
  - Tandem System Administration
  - Tandem System Manager

Objectives

By the end of the course, the participants will be able to:

- Install software for the NMC, RNG, and RNC
- Configure the NMC
- Maintain the NMC files and databases
- Maintain the RNG files and databases:
  - customer records
  - subscriber information
  - application host information
  - terminal and host configuration information
  - accounting and billing information
- Add, delete, or change security passwords
- Monitor the network to ensure normal operation
- Use local and remote console to access the RNG, RNC, and BSC
- Escalate troubles to the proper channels and monitor the fault resolution
- Gather statistics on the network usage
- Analyze the network performance
- Produce standard reports.

Duration

The training course is four days long and is a combination of lecture and hands-on training.

All course materials and manuals are included in the course.

Network Maintenance Course

Purpose

The purpose of this course is to give maintenance personnel the ability to perform network problem recognition, diagnosis, and fault resolution to a unit level. That is, to troubleshoot the network and determine where the problem is, then resolve it.

Audience

This course will be given to network personnel who will be performing network maintenance tasks.

Prerequisite Skills/Knowledge

There are areas in the network that require very different skills.

Maintenance of the radio site equipment requires RF technical education and experience, including experience with communications monitoring equipment. The radio site equipment is not covered in detail in this course.

The area communications controllers require computer hardware and software maintenance experience including X.25 packet-switched network protocol experience and the use of protocol analyzers.

Software upgrade installation and installation of archived files within disaster recovery procedures will require prerequisite knowledge and experience with operations of mini and mainframe computer systems.

Objectives

By the end of the course, the participants will be able to:

- Install NMC, RNG, and RNC software
- Shut down the NMC, RNG, RNC software processes
- Install backup software or archived files for the NMC and RNG
- Start up the NMC, RNG, and RNC software processes
- Monitor the network to ensure normal operation
- Recognize network problems and diagnose the network to the unit level
- Check configuration files, switches and jumpers, and I/O lines and circuits
- Use local and remote consoles to run diagnostics on the RNG and RNC
- Perform a variety of tests, including loopback tests.

Duration

The training course is three days long and is a combination of lecture and hands-on training.

All course materials and manuals are included in the course.

System Overview Course

Purpose

The purpose of this course is to give the audience a high-level understanding (to a level of detail dependent upon audience) of:

- Purpose of the network
- What components make up a network
- The function of each component
- The data flow between the components
- The end-user applications.

Audience

This course will be given to a number of different audiences either as a stand-alone course for the management of the network owner or as an introduction to:

- Networks Operation
- Networks Management and Administration
- Networks Maintenance.

Prerequisite Skills/Knowledge

There are no prerequisites for this course.

Objectives

By the end of the System Overview Course the participants will be able to:

- Name the benefits of the network
- Identify the components that make up the network
- Describe the function of each component in the network
- Draw a general data flow network diagram
- List five of the possible applications that are on the network.

Duration

The training course is a half-day long.

All course materials are included in the course.

Radio Site Installation, Configuration and Maintenance Course

Purpose

The purpose of this course is to provide the participants with the ability to install, configure, and maintain the radio site equipment at a unit level.

The radio site equipment includes the base site radio, base station controller, and base site modem.

Audience

The course should be attended by personnel who will be performing installation or maintenance on the base site equipment and their supervisors. There is a maximum limit of five participants per course.

Prerequisite Skills/Knowledge

It is essential that the people performing base site installation or maintenance have RF experience, including the use of communications monitors.

Description

This course includes:

- System overview
- Installation procedures
- Configuration procedures
- Fault recognition, diagnostics, and resolution.

Duration

The training course is one day long and is a combination of lecture and hands-on training.

All course materials and manuals are included in this course.

Network Application Programming Course

Purpose

The purpose of this course is to provide the participants with the ability to develop host and terminal applications or front-end processors for the DataTAC network.

Audience

The course should be attended by personnel who will be designing or writing host and terminal applications or will be training others to develop applications.

Prerequisite Skills/Knowledge

Participants attending the course should have experience with real time, multi-tasking systems' programming and be familiar with communications protocols.

Description

This course includes:

- System overview
- Network RF characteristics
- Link-level framing
- Message protocol
- Host applications
- Subscriber device applications
- Network services to applications.

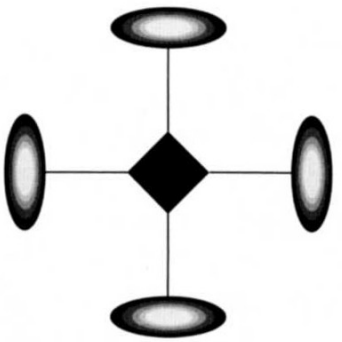
Duration

This training course is three days long.

All course materials and manuals are included in this course.

CHAPTER

8



Motorola's Mobile Data Division

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Chapter 8 MOTOROLA'S MOBILE DATA DIVISION

MOTOROLA

Motorola, Inc., headquartered in Schaumburg, IL, USA is one of the world's leading manufacturers of electronic equipment, systems and components for worldwide markets. Motorola products include two-way radios, mobile and portable data terminals and communications systems, cellular telephones and systems, pagers, integrated circuits and discrete semiconductors, defense and aerospace electronics, automotive and industrial electronic equipment, and information processing and handling equipment.

Paul V. Galvin founded the company in 1928 as the Galvin Manufacturing Corp. in Chicago. Under the brand name 'Motorola', the company successfully commercialized car radios, as well as home radios and police department radios. The name of the company was changed to Motorola, Inc. in 1947, at which time the company entered government work and opened a research laboratory in Phoenix, Arizona, to explore solid-state electronics.

Motorola, Inc. expanded into international markets in the 1960s and began shifting its focus away from consumer electronics. In the mid-1970s, Motorola, Inc. began to concentrate its energies on high-technology markets in commercial, industrial, and government fields. By the early 1980s, Motorola, Inc.'s communications and semiconductor operations each contributed about one-third of the company's total revenues, indicative of fundamental strengths in electronic technologies at both the component and equipment levels.

Motorola places particular emphasis on product quality, customer satisfaction, and the training and continued education of employees at all levels to improve manufacturing, marketing, and technical skills.

Mobile Data Division

The Mobile Data Division of Motorola, is a world leader in the field of mobile data communications. Mobile Data Division (MDD) manufactures and markets products and systems that take advantage of opportunities in data-over-radio technology and focuses on providing solutions that bridge information systems, data communications, and radio networks for businesses around the world.

Today, Mobile Data Division systems are installed in over 200 cities around the world. Traditionally, the division's expertise has focussed on providing mobile data solutions to the field service, government and transportation markets. More recently, the major efforts of the division have focussed on responding to the increasing importance of shared data networks, such as the ARDIS and Coverage Plus networks in the United States, the Mobidata network in Canada, the Hutchison Mobile Data networks in Hong Kong and the U.K., and the Deutsche Bundespost network in Germany.

Mobile Data Division headquarters are in Richmond, British Columbia, Canada.

COMMITMENT TO DEVELOPMENT OF INTERNATIONAL STANDARDS

Motorola is fully committed to participating in the development of international standards for mobile communications.

Motorola is a full participant in ETSI RES 6, and is currently working closely with Working Group 3 to define the European Mobile Digital Trunking Radio Standard (MDTRS), and Working Group 4 to develop standards for data-only systems. As well, Motorola provides representation for ANSI and CCITT/CCIR efforts.

DataT•A•C™ Networks

Reference Handbook

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