System Presentation

Contents

1 Introduction 3
- 1.1 The Technology 4
- 1.2 Flexible Architecture 5
- 1.3 Highly Cost-efficient 5

2 Mobile Data Communication 6
- 2.1 Fixed and Mobile Users 6
- 2.2 Mobitex Radio Communication 6

3 Mobitex Network Structure 8
- 3.1 Small Mobitex Network 8
- 3.2 Large Mobitex Network 9

4 Network Control Centre (NCC) 10
- 4.1 Network Configuration and Performance 10
- 4.2 Maintenance and Fault Management 11
- 4.3 Charging and Account Management 11
- 4.4 Open Interfaces 11

5 Mobitex Switches 12
- 5.1 MX Switch Hardware 12
- 5.2 MOX Software Functionality 13
- 5.3 MHX Software Functionality 13

6 Radio Base Stations 14
- 6.1 BRU3 14
- 6.2 BRU1 15
- 6.3 Frequency Plan 16

7 Subscription Types 17
- 7.1 Terminal Subscriptions 18
  - 7.1.1 Fixed Terminal Subscription 18
  - 7.1.2 Mobile Terminal Subscription 19
- 7.2 Host Group Subscription 20
- 7.3 Personal Subscription 20
- 7.4 Group Subscriptions 21

8 Subscription Services 22
- 8.1 Text/Data/Status/HPDATA Messages 22

8.2 Group Messages 23
8.3 Mailbox 24
8.4 Closed User Groups 25
8.5 Positive Acknowledgement 25
8.6 Back in Coverage (BIC) 25
8.7 Battery-Saving Mode 26
8.8 Network Gateway Interface (NGI) 26
8.9 Mobile Location Positioning 26
8.10 Over the Air Activation of Mobile Terminals (OAA) 26

9 Network Functionality 28
9.1 Activation/Inactivation 28
9.2 Distribution Lists in Messages 29
9.3 Roaming 29
9.3.1 Prioritized Roaming 30
9.4 Electronic Serial Number (ESN) 30
9.5 Message Entry Time/Date 30
9.6 Base Groups 30
9.7 Traffic Controlled Roam Flag 31

10 Communication Interfaces 32
10.1 Fixed Terminal Interfaces 32
10.2 Mobile Terminal Interface 34
10.3 Internal Network Node Interfaces 34

11 Network Configuration 36
11.1 Capacity Expansion 36
11.2 Network Redundancy Configuration 36
11.2.1 Subscription Redundancy 37

12 Operation, Administration and Maintenance 38
12.1 Network Control Centre (NCC) 38
12.1.1 Network Configuration 39
12.1.2 Operation and Maintenance 39
12.1.3 Alarm Handling 39
12.1.4 Recurrent Scripts 40
12.1.5 Subscription Administration 40
12.1.6 Traffic Log Handling 40
12.2 Internal Network Functions 41
12.2.1 Network Software Distribution 41
12.2.2 Online Reconfiguration of Network Nodes 41
12.2.3 Recovery Procedure 41
12.2.4 Congestion Control 42
12.2.5 Autonomous Operation 42
12.2.6 Node Operator (NODOP) 42
12.2.7 Node Software Start-up 43
12.2.8 Alarm Handling 44

12.2.9 Event Statistics....44
13 End-User Availability and Reliability....45
14 Add-on Functionality....46
15 External Gateways....47
15.1 IP Access Server....47
15.1.1 Management and Supervision....47
15.1.2 MDOT....48
15.2 MPAK Router....48
15.2.1 Management and Supervision....48
16 Terminology....49

1 Introduction

Mobitex, previously developed and owned by Ericsson, one of the leading telecommunications companies, is a narrowband wireless technology for dedicated packet-data networks for consumers, mobile professionals and companies in many sectors. In certain respects, Mobitex is similar to the digital cellular technology used for today's mobile phone systems. The network consists of interconnected cells, each served by a radio base station that provides wireless access to the network for mobile users. The base stations and other network nodes are then connected together by fixed links.

Despite these similarities, Mobitex is unique in several respects. Key features of Mobitex are that it is a narrowband technology for wireless data communications that uses packet switching for maximum spectrum efficiency and that it is a dedicated, data-only network based on an open and international standard. For these reasons, Mobitex is a cost-efficient technology for the greatest number of wireless data applications.

Mobitex is designed to meet the requirements of business-critical applications. Mobitex gives people access to information when and where it is needed so that they can act on it in a timely manner.

Mobitex Technology AB is the sole supplier for Mobitex network hardware and software, but terminal equipment and applications are available from several manufacturers, both large multi-national suppliers and smaller local manufacturers. The Mobitex Interface Specification (MIS), which is administered by the Mobitex Association (www.mobitex.org), is an open standard specifying how terminals and applications communicate via the Mobitex network and is available to all. With dozens of networks on five continents, the Mobitex market is very large, yet a single international standard ensures that the same solutions will work in all local markets.

Mobitex has been a de facto standard for many years and is therefore a mature, high quality network. Mobitex Technology AB is committed to continued refinement of the Mobitex products and services and to delivering industry-leading performance in terms of capacity, connectivity, scalability and cost-efficiency.

Chapter 1 and 2 in this document introduce some of the basic concepts in the Mobitex system, with greater detail provided in the following chapters. Chapters 3 to 15 contain more technical descriptions about the Mobitex network architecture, network entities and Mobitex functionalities.

Further information about Mobitex, the MIS and other specifications can be found on the following website:

www.mobitex.com

1.1 The Technology

For those who need to use devices throughout the day to receive instant updates and notifications, the Mobitex wireless data network is always on and instantly accessible. There are no time consuming call setup or data activation procedures, and never any busy signals. Response times are short (typically 3-9 sec.) and access is instantaneous. Because packet switching does not require a dedicated connection, users can remain online at all times, sending and receiving data as required by the application. Users can thus make maximum use of network resources.

Unlike circuit-switched networks that require dedicated connections, packet-data networks are connectionless and inherently more reliable. Mobitex uses techniques to ensure that data packets are always delivered to the receiver, even if some part of the network is temporarily unavailable.

To further enhance reliability, Mobitex uses an extremely robust radio protocol with several sophisticated error-correction techniques to ensure that data is transferred without loss or error.

Mobitex also accommodates true push functionality. This means that a host can initiate a transmission to a remote device without a request from the device and that information can be pushed out to the device. This functionality is particularly useful in command-and-control functions and for telemetry and other device-to-device applications.

Even though users are always on-line and may make frequent use of data services throughout the day, power-saving features in the network ensure long battery life. The Mobitex radio protocol includes functions that dramatically reduce the power consumption of portable and handheld devices.

Today mobile professionals often rely on cellular networks for communication. A cellular phone is ideal when people need to talk to each other. However, data communication in a cellular network that is optimized for voice is often inefficient, unreliable and expensive. A dedicated Mobitex wireless data network offers a reliable and cost-efficient alternative. There is no risk that other types of traffic, such as voice, may temporarily be given higher priority or block the network.

These qualities have made Mobitex the preferred technology in many applications in which reliable communications are absolutely essential. Police and rescue services in several countries, for example, have chosen Mobitex and determined through extensive testing that it is a superior and reliable wireless technology for situations in which a communication channel must always be available and message delivery must be guaranteed.

1.2 Flexible Architecture

A Mobitex network can be configured in many ways depending on the applications and services that it is designed to support. In some countries, there are large Mobitex networks providing nationwide coverage with a wide range of business and personal productivity applications and serving hundreds of thousands of users. In other cases, there are small, privately owned Mobitex networks serving a limited area and supporting a single application, such as a public transport system for a city.

The equipment used in a Mobitex network is extremely compact and designed for easy installation and remote operation and maintenance. Radio base stations for wireless data communication can be installed in almost any location, and a small Mobitex network can be deployed and configured in a matter of days.

Another factor contributing to the flexible network architecture is that Mobitex is based on open and international standards. The interfaces used for connecting to the Mobitex network are recognized throughout the industry. Mobitex also provides gateways to the Internet and other public communication networks.

Mobitex is also supported by a wide range of terminal devices. Standard PCs or workstations can serve as fixed terminals used by back-office staff for communication with users in the field. Mobile terminals include wirelessly enabled portable PCs, as well as a large and growing number of handheld devices.

1.3 Highly Cost-efficient

Mobitex is optimized to make highly efficient use of scarce radio spectrum. In fact, a single 12.5 kHz Mobitex channel can support hundreds of users in typical applications. Other technologies, such as GPRS, which is a data overlay for second-generation GSM networks, or WCDMA, which will provide data services in third-generation (3G) wireless networks, require far greater bandwidth, yet support only a small number of users per channel for the equivalent bandwidth usage. For example, a complete Mobitex network can be built within a frequency spectrum of 200 kHz, which is the channel bandwidth required for one base station in the second generation GSM system. For operators facing high costs to acquire radio spectrum, Mobitex's efficient usage of radio spectrum is a key advantage.

Mobitex is also the technology that keeps operation and maintenance costs at a minimum while subscriber numbers increase and revenues grow. Because Mobitex networks consist only of a few types of easily installed components and are based on a simple and highly modular architecture, network management is efficient, inexpensive and flexible.

2 Mobile Data Communication

2.1 Fixed and Mobile Users

The Mobitex system provides wireless access for mobile users and a network that interconnects both mobile and fixed subscribers. Mobitex subscribers can communicate with other subscribers individually or in groups. There are also gateways that connect the Mobitex network with other networks and allow Mobitex subscribers to communicate with external users via email, for example.

Fixed terminals are typically based on a standard PC, a workstation or a database server with a fixed connection to the Mobitex network. A fixed terminal is sometimes called a host system and often functions as a front-end system that provides access to applications and services running on various database and business systems and serving a mobile workforce. Although a subscription is required for connecting a fixed device to the Mobitex network, there may not actually be a physical user.

Mobitex subscribers can use a wide variety of devices. For applications in which the Mobitex equipment is mounted in a vehicle, an onboard computer consisting of a data terminal or a PC plus a separate radio modem is a common configuration. Other mobile data terminals are specially built devices with a built-in radio modem that are often ruggedized and include touch screens. Furthermore, several small handheld wireless devices are available, offering a full range of messaging and PDA (personal digital assistant) applications.

Fixed wireless installations are also common in Mobitex networks. There are many telemetry applications for automatic meter reading or servicing vending machines, for example, that use a mobile data terminal that is installed in a fixed location yet uses the wireless network, rather than a wireline connection, for data communication. Wireless payment or point-of-sale (POS) terminals may also be used in fixed installations for ATMs (Automatic Teller Machines), for example, when fixed lines are not available, too expensive or not sufficiently reliable. Wireless POS terminals also have the advantage that they are truly mobile terminals that can be used at the point of transaction by delivery drivers on sales routes or by vendors in temporary locations, such as exhibitions and sporting events.

2.2 Mobitex Radio Communication

Mobitex is available in three frequency bands, 400 MHz, 800 MHz and 900 MHz, all delivering an 8 kbps data rate.

The communication channels in a Mobitex network have a bandwidth of just 12.5 kHz, meaning that it is a narrowband radio technology. Because an extremely efficient radio protocol is used that is optimized for packet switching, each channel

can support hundreds of users. Mobitex does not necessarily need a continuous frequency band for building the network. It may use any free bands of 12.5 kHz over a wider frequency range.

The protocols specifying how terminals connect to the Mobitex are defined in the Mobitex Interface Specification (MIS), which is administered by the Mobitex Association (www.mobitex.org). There is an open version of this specification that contains all the information required by manufacturers of Mobitex terminal equipment and developers of Mobitex applications. There is also a licensed version that is available only to network operators and Mobitex radio modem developers and which contains additional details about the radio protocol.

The basic unit used for communication in Mobitex is the MPAK (Mobitex packet), which is a data packet or datagram. MPAKs are transmitted over the air using ROSI, the Mobitex radio signaling protocol. In the radio modem or terminal device, the digital bit stream is converted to and from MPAKs using MASC, the Mobitex asynchronous protocol. Details of these protocols are beyond the scope of this document and are available in MIS, the Mobitex Interface Specification.

All signaling and data exchange in the Mobitex network is performed using datagrams, which are self contained packets or message units. In the Mobitex system, packets are either delivered or a negative acknowledgement is received indicating that the data must be re-sent. It is also possible, on a request by the sender, to obtain notification that a packet has been successfully delivered to the destination.

The network keeps track of each user's location, and subscriber information is transferred from one base station to another as the mobile user's location changes in a process called roaming.

The ease of handover and roaming is important for operations where devices are continuously in motion. Examples include emergency services, job dispatch, messaging and automatic vehicle location, which are operations that are all handled flawlessly by the Mobitex network.

Mobitex supports transparent roaming for data between cells. A Mobitex device automatically locks on to the nearest base station, thus making its location known to the routing system. When the device is moved, it can exchange its packets with another base station, thus maintaining the connection between client and host.

3 Mobitex Network Structure

The Mobitex network features a very flexible and scalable network design, supporting both small and large networks. A network can easily be expanded in size by adding more equipment as the customer base grows or when a larger coverage area is needed.

3.1 Small Mobitex Network

A minimal Mobitex network consists of a few base stations, each serving a radio cell providing coverage of a given area, and a switch, called an area exchange (MOX), that interconnects the base stations and routes traffic. At the top level a network control centre (NCC) is connected to the MOX. The base stations provide wireless access for mobile subscribers, while fixed terminals are connected to the MOX. Access to other networks, such as the Internet, are also provided through the MOX via external gateways.

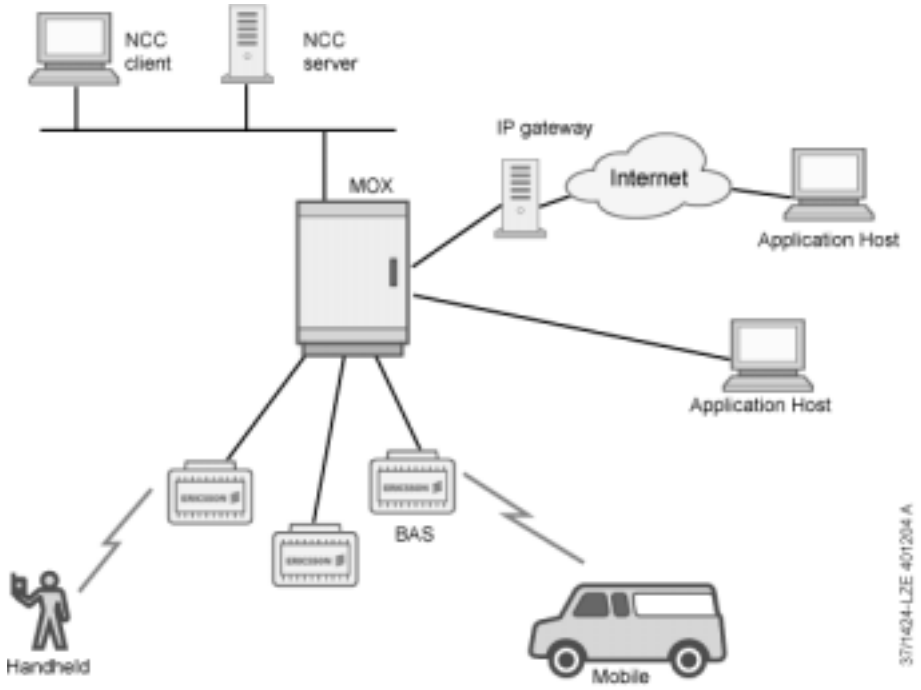

Figure 1 Small Mobitex network structure.

3.2 Large Mobitex Network

Larger Mobitex networks may contain thousands of base stations and many switches divided into several subnetworks. The optimal method for building a large Mobitex network is to use a flat network architecture that consists of several subnetworks.

In the flat network architecture, each subnetwork architecture is similar to the small Mobitex network architecture with a MOX as the top node and base stations below. At the highest level, there is a network control centre (NCC) that is connected to all subnetworks.
.

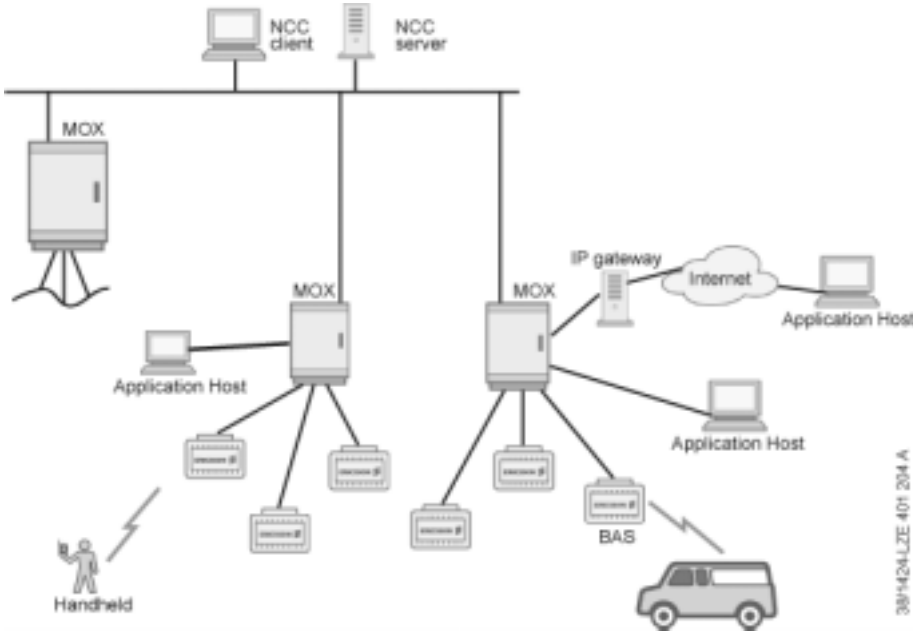

Figure 2 Large Mobitex network structure.

Mobitex also supports a more hierarchical network architecture with several levels of switches. In a hierarchical Mobitex network there are MOXes connecting base stations in one area and higher-level switches called main exchanges (MHX) that route traffic between the MOXes and between the subnetworks. At the highest level, there is a network control center (NCC) that is connected to all subnetworks.

4 Network Control Centre (NCC)

The highest node in a Mobitex network is the Network Control Center (NCC). The NCC contains a database that controls the Mobitex network configuration and defines such elements as subnetworks, nodes, radio channels, line types, data connections and data channels. The NCC allows the operator to efficiently manage all aspects of the network from a single location via a graphical user interface.

The Mobitex Network Control Center is based on an Alpha Server running the Open VMS operating system. It contains an embedded Oracle DBMS (database management system) and proprietary Mobitex Technology software.

A Java-based application called the NMS Client is used as front-end application for configuring the network. The NMS Client communicates with the Alpha Server via a LAN. Older NCC client applications, such as NETREG that runs on a Sun workstation, are still supported.

The NCC communicates with the top nodes in each subnetwork via an IP backbone.

Figure 3 Network Control Centre.

4.1 Network Configuration and Performance

In addition to configuring the network and supporting remote software upgrades, the configuration management system in the Mobitex NCC ensures that subscriber information stored in the nodes is consistent with the NCC database to which the

billing and customer care systems are linked. For network operators who intend to use external billing or customer care systems, open interfaces are available.

Mobitex provides tools that allow network operators to gather statistics and measure network performance, thus enabling hot spots to be identified. Performance parameters, such as number of subscribers, capacity and network design, can then be optimized.

4.2 Maintenance and Fault Management

The NCC software implements a complete set of functions for fault management that allow full control and supervision of all nodes. The fault management functions allow operations personnel to select what parameters should be monitored for each node and under what conditions an alarm should be generated. Received alarms from the network can be distributed and presented on a variety of devices.

Mobitex also includes components that may run powerful event-triggered script files to perform tasks outside the Mobitex network, such as immediately notifying a service engineer via email or an external paging gateway in the case of major faults. It can also trigger operations and maintenance commands directly in the network nodes to automatically correct the faults, thus ensuring uninterrupted service.

4.3 Charging and Account Management

The account management functions in the Mobitex NCC system provide a set of functions that allow the operator to charge subscribers for use of network services. Billing parameters can be defined for network access and utilization that determine which accounting records will be automatically generated from network traffic logs. Account management functions will then convert these records into machine-readable invoice information and/or itemized bills for distribution or further processing by the billing or customer care systems.

Because different applications and subscribers will use the network differently and at varying levels, the NCC supports the operator in defining several sets of tariffs that allow separate charging for network access, capacity utilization, network services and administration. With these options, operators are able to distribute operational costs accordingly and maximize revenue for each subscription type.

4.4 Open Interfaces

The Mobitex Network Control Center provides open interfaces for subscriber management and billing that allow external or third party customer care and billing systems to be used.

5 Mobitex Switches

The Mobitex switch hardware consists of a Mobitex MX Switch. The MX switch can be configured slightly differently, depending on the level at which it will be connected to the network, and the software can be configured to run as a either an area exchange (MOX) or a main exchange (MHX). The MHX configuration is only used in Mobitex networks based on a hierarchical network architecture.

5.1 MX Switch Hardware

The Mobitex MX Switch hardware serves either as a MOX or a MHX for Mobitex networks. It function as a scalable packet-switching node for radio base stations and other exchange units. The MX Switch offers up to 112 physical I/O ports and up to 512 connections to network nodes and fixed terminals. In addition, the switch provides an internal X.25 gateway and TCP/IP connectivity via an optional external gateway. The gateway for TCP/IP connectivity is described in section *15.1 IP Access Server*. The software used by the MX Switch can be downloaded remotely over the network or installed on site.

The standard configuration of an MX intended to be used as a topnode MOX in a flat network architecture includes a Backbone Interworking Unit (BIU), which handles connections to other subnetworks and to the NCC. The BIU consists of an extra CPU card and an extra harddisk and provides an Ethernet connection for communication via the Mobitex IP backbone.

The MX Switch also supervises common alarms for the cabinet, monitors the functional status of its hardware and software and sends status reports to the NCC.

The MX Switch ensures maximum scalability and flexibility in Mobitex networks. It provides redundancy in the case of line or hardware failure. The MX Switch can be used in both small private and large public networks.

The MX Switch is scalable in terms of switching capacity, with three different alternatives; basic capacity, enhanced capacity and high capacity.

Figure 4 Area Exchange/Main Exchange (MX).

5.2 MOX Software Functionality

Radio base stations and fixed terminals are connected to a MOX, which may also provide gateways to other networks. The MOX contains subscription data for all subscribers currently roamed into its branch of the network. It also compiles and forwards billing information and statistics to the NCC. In a flat network architecture the MOX also routes traffic to and from other subnetworks in the Mobitex network and to the NCC via the BIU.

The MOX includes the Mailbox facility, where packets can be temporarily stored for terminals that are switched off or out of coverage.

If a MOX is subordinate to other switches, as is the case in networks that do not use the flat architecture, the BIU hardware is not needed.

5.3 MHX Software Functionality

Networks that are not built with the flat network architecture can also use higher level switches called main exchanges (MHX). The MHX routes traffic between the MOXes, and is normally also a connection point between the subnetwork and the NCC. The MHX contains subscription data for all subscribers currently roamed into its branch of the network.

6 Radio Base Stations

Radio base stations are access nodes for wireless devices and mobile terminals. They are also turning points for mobile-to-mobile traffic within the station's radio coverage area. Each base station serves a single radio cell, which typically has a radius of 1 to 30 kilometers, depending on frequency, type of base station, environmental and other conditions. When connected together by one or more switches, base stations provide an area of coverage for mobile users and determine the capacity of the network or subnetwork. Wireless devices communicate with the nearest base station, but are also able to roam freely from one base station to another as the user's location changes.

6.1 BRU3

The Mobitex radio base station BRU3 is available in different versions for the 400 MHz, 800 MHz and 900 MHz frequency bands. Extremely compact and only slightly larger than a briefcase, the BRU3 is a mini base station for Mobitex networks that is designed to deliver the highest performance over a wide range of operating conditions. The BRU3 is capable to support as many as up to 2,500 mobile terminals. It is suitable for both outdoor and indoor installations and is simple to install and maintain. AC power, battery back-up and a line modem are integrated into the unit. Software can be installed remotely over the network or on site from a portable PC. Built-in functions support automatic supervision and remote configuration of the radio base station.

Figure 5 Radio Base Unit 3 (BRU3).

6.2 BRU1

The Mobitex radio base station BRU1 is a single channel 1 W low power base station for the 900 MHz frequency band. It is scalable in terms of number of subscriptions and provides coverage for 10 to 500 mobile terminals, dependent on software licensing, within a limited area, such as office buildings, shops, workshops, theatres and sport arenas. The BRU1 base station is intended for indoor operation with simple wall mounted installation, integrated Rx/Tx antenna and is powered by a standard 24V AC/DC converter.

The BRU1 offers two connectivity alternatives that may reduce the cost for connectivity, either X.25 protocol via a serial communication port or XOT (X.25 over TCP/IP) over an IP network via an Ethernet port. Software can be installed remotely over the network or on site from a portable PC. Built-in functions support automatic supervision and remote configuration of the radio base station.

Figure 6 Radio Base Unit 1(BRU1).

6.3 Frequency Plan

The Mobitex network is not restricted to the use of certain frequency bands, sub-bands, or channels with fixed duplex spacing. This means that any available frequency in a supported frequency band can be assigned to Mobitex.

This unrestricted frequency planning assumes a channel numbering plan based on a 12.5 kHz channel spacing. To specify a radio channel in Mobitex, both a frequency band (0-7) and a channel number (0-8191) are required. Each channel number represents a single frequency. To define a duplex channel, both channel numbers must be specified. In one example on the 900 MHz band, the channel number pair 602/3722 corresponds to the duplex pair 897.5250/936.5250 MHz.

These numbers are specified in a channel numbering and frequency plan that is unique for each operator. Note that while regulatory authorities in each country allocate the frequency bands and channels used by Mobitex, the frequency band and channel numbers in this plan are only meaningful within the Mobitex network and that they do not correspond to the channel numbers assigned by the authorities.

Mobitex supports frequency re-use so that the number of required frequencies is kept to a minimum. The absolute minimum number of frequencies needed for coverage when building a Mobitex network is 7 channel pairs. However, a minimum of 15 channel pairs is recommended. Cell-planning is highly dependent on geographical and environmental conditions, which means that the number of required channel pairs may differ in different locations. When adding additional radio cells for higher capacity, the required number of channel pairs will increase.

7 Subscription Types

The following types of Mobitex subscriptions are available:

- Mobile terminal subscription (MOB)
- Fixed terminal subscription (FST)
- Group subscription (GRP)
- Personal subscription (PER)
- Host group subscription (HG).

All Mobitex subscriptions are given a unique identity using a Mobitex subscription number (MAN). The MAN number is a 24-bit number, which allows a maximum of 16,777,215 subscriptions. However, this is not the maximum number for all Mobitex networks, since certain ranges of MAN numbers may be reused in different networks and regions. The Mobitex Operators Association administers a numbering plan and has made recommendations on the use of MAN numbers.

Information about the subscription and the associated services is stored in both the network nodes and the terminal. Subscription information stored in the network nodes consists of various components as described below.

Definition of the subscription and its services, including:

- Subscription type
- Subscription number
- Group numbers

Technical data about the terminal equipment, including:

- Radio frequencies
- Low power capability

This is static information that the network operator registers in the NCC when establishing an account for a new subscriber.

Dynamic subscription information is stored in the network nodes and includes:

- Roaming information for traffic routing
- Subscriber status
- Personal subscriptions logged in to a terminal

7.1 Terminal Subscriptions

7.1.1 Fixed Terminal Subscription

Fixed terminals, which are typically PCs, workstations or other computers, allow stationary users or automated database applications to communicate with mobile users over the Mobitex network. In many applications, a fixed terminal is used by a dispatcher and may also provide connectivity to a host system accessed by mobile users from the field.

A fixed terminal subscription is always associated with equipment connected to the Mobitex network using leased lines, an X.25 packet switched network, or via an external gateway. Fixed terminals are connected to the area exchange (MOX).

Fixed terminals using X.25 may be connected using either the Mobitex network layer protocol or by using the Mobitex X.25 gateway service through an X.25 network. The following interfaces for fixed terminals are supported by the network:

- X.25 - Mobitex
- X.25 Gateway
- MDOT (When connected via the external gateway, IP Access Server)
- MASC (Asynchronous protocol for support of legacy fixed terminals)

For a brief description of these interfaces, please refer to chapter *10 Communication Interfaces*, or the *Mobitex Interface Specification (CSH 109 08)* for more detailed information.

Figure 7 Example of fixed subscriber equipment.

7.1.2 Mobile Terminal Subscription

A mobile terminal subscription is always associated with a specific mobile terminal or radio modem. Mobile terminals communicate with the radio base stations using a radio link protocol.

Terminal equipment for the Mobitex network is available in many different form factors to meet widely varying application requirements. These range from self-contained radio modems with a separate PC used as a data terminal to small handheld devices with an integrated radio modem. There are also OEM radio modems that can be integrated in any type of device to obtain wireless communication. Radio modem power also varies, depending on the frequency band, from 10 W for vehicle-mounted radio modems to 2 W for portable and handheld devices that are often used indoors.

Mobile terminal equipment for Mobitex is often customized for specific applications and employs a ruggedized design that can withstand demanding field conditions. Many devices have touch screens and are waterproof and shock resistant, for example. Although there are many examples of customized devices for dispatching and field service applications, these devices are most often based on a standard PC architecture and a standard operating system, meaning that they can run not only a customized wireless application, but also standard PC applications.

Wireless point-of-sale (POS) terminals for Mobitex are a notable exception. These devices are designed as dedicated sales terminals and in many cases based on existing products in which the modem for wireline communications has been replaced by a wireless modem. They are used as mobile payment terminals, but can also be installed in fixed locations where a wireline connection is unavailable or more expensive.

In recent years, handheld devices have become a popular type of mobile terminal equipment for Mobitex and fueled explosive subscriber growth in many networks. These devices range from tiny wireless handhelds that are designed for wireless interactive messaging and email to wireless PDAs (personal digital assistants) that include calendar, phone book and notebook applications and full-featured Pocket PCs with integrated radio modems for wireless data communication.

In addition to wireless messaging and email, this new generation of handheld devices for Mobitex offers a platform for custom applications. Today there are literally hundreds of applications for these devices ranging from internet content services, news services, wireless banking and stock trading to customized applications for virtually every type of mobile worker, including insurance and real estate agents, taxi drivers, couriers and field service technicians.

Figure 8 Example of mobile subscriber equipment.

7.2 Host Group Subscription

The Host Group is a special subscription type in the Mobitex network that allows a single subscription to appear simultaneously at multiple locations in the network. This can be used to provide redundant connections to application hosts, and also to distribute the traffic load in the network.

A host group subscription supports several simultaneous connections on fixed terminals, meaning that a host group subscription can be logged in on several fixed terminals at the same time.

A message from a mobile terminal is sent to only one host group member, and it is sent to the host group member at the closest network path from the sender. If this member is inactive, the network sends the message on to the next host group member. The advantage is that the mobile terminal only needs to know one receiving MAN, i.e. the Host Group MAN.

7.3 Personal Subscription

A personal subscription is associated with a person, not with a piece of equipment or a terminal, making it useful for subscribers who often use different terminals and when several subscribers use the same terminal. One example is a public transport application with many buses in which drivers can log in on the Mobitex network from any bus using their personal subscription number.

The personal subscription requires a login procedure. A login message always includes a password and notifies the network that a user with a personal subscription is logging in on a specific terminal. The network considers the subscription

transferred to this terminal until the subscriber either logs off from the terminal or logs in on another terminal. A user with a personal subscription may only be logged in on one terminal at a time. The subscriber can be logged in on both fixed and mobile terminals.

7.4 Group Subscriptions

Several terminal subscribers in a network can form a group where all the members can be reached with a message addressed to one single subscription number, the group number. The message is broadcast on the radio link addressed to all mobile terminal group members. Any mobile or fixed subscription can be a member of up to 15 different group subscriptions.

A message to a group subscription is distributed within a geographically limited area called a search area. The search area is defined when defining the group subscription and up to eight base stations or fixed terminals can be included in the search area.

For more information about the group subscription, refer to section *8.2 Group Messages*.

8 Subscription Services

Mobitex offers subscription services that vary according to the subscription type. By choosing a subscription type and customizing terminals, subscribers can thus create a communications system that matches their requirements. The services for each type of subscription depend on the network configuration and are made available to the user by the operator when the subscription is created or modified using the subscription management functions in the NCC. Subscription services are described in the following sections.

8.1 Text/Data/Status/HPDATA Messages

The data in the information portion of a text message is reserved for the user. The information portion must be coded according to the international ASCII standard, ISO 646 or equivalent national versions. Additions can be made to accommodate various national standards. The maximum size of a text message is 512 characters of user information.

Data packets can be used instead of text packets when transferring information in formats other than ASCII. In contrast to text packets, the information component in data packets may be coded by the individual terminal application. A data message can consist of a maximum of 512 octets of user information.

A status message consists of a numerical code between 0 and 255, providing for 256 different status messages. These are coded by the subscriber and reduce transfer time and the traffic charges.

A dispatching application provides an excellent example of the usefulness of status messages. Although the mobile data terminal in the vehicle needs to be able to display messages that include such information as the address for the next pick up, there are normally only a few pre-defined driver responses, such as Request accepted, Busy or Off duty. Status messages are ideal for this purpose and can be pre-coded in a customized terminal so that the driver can respond by pressing a single button.

HPDATA (higher protocol data) packets contain a field that can specify the type of data that is included in the user data. This can be used to route packets to different applications in the terminal, for example, depending on the type of data being sent, or to specify if a transport protocol is used, for example. A transport protocol is usually used when an application needs to send data that exceeds 512 bytes. The data can be split up into several packets with maximum size of 512 bytes. A number of higher-level protocols have been defined for Mobitex and are widely supported by the operator community.

8.2 Group Messages

A number of terminal subscriptions in a network can be assigned a group subscription number in addition to their individual terminal subscription numbers. This service rationalizes the work of dispatch center personnel when sending an identical message to several subscriptions.

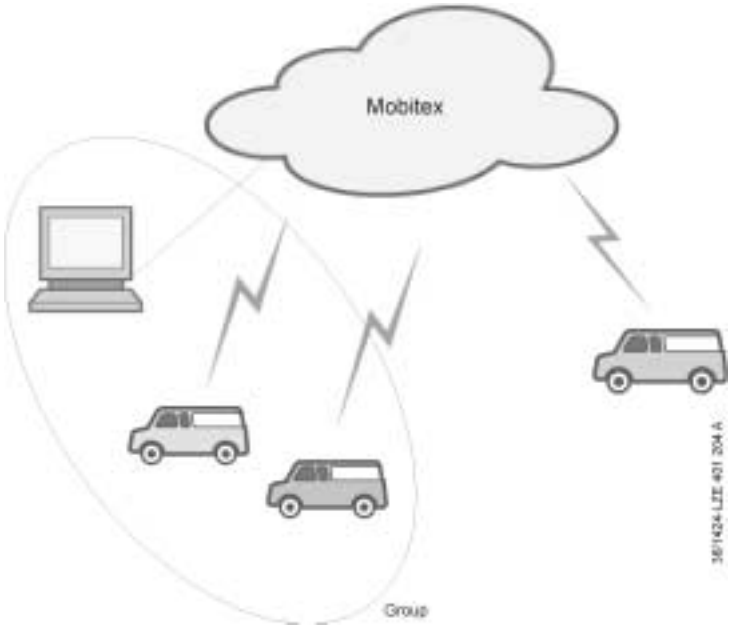

Figure 9 Group Message.

A group message can only be broadcast to terminals in a limited geographical area, which is defined by specific radio base stations and the fixed terminals used by the group. Up to eight radio base stations or FSTs can be defined for a group.

Since there is no acknowledgement from any of the receivers of a group call, any unit that is out of radio coverage area, exposed to interference or switched off, will not receive the message or call. Group messages are repeated by the radio base station to improve the probability of receipt by the mobile unit.

8.3 Mailbox

If the receiver of a Mobitex message cannot be reached and the receiver subscribes to the network mailbox service, the message will be stored in a network mailbox in the MOX, if the sender has requested this service. A copy of the message, indicating that the message was put in the mailbox, will be returned to the sender. When the receiver is active again on the network, the mailbox is emptied and the contents are delivered to the subscriber. The subscriber also receives notification when a message has been stored in the network mailbox. The mailbox service can be ordered by the sender for each individual message by using a subscription flag in the message header.

Figure 10 Mailbox service.

8.4 Closed User Groups

Closed User Group (CUG) is a service used by subscriber groups in a network that do not wish to communicate with other subscribers outside the CUG. Subscribers within a closed user group cannot receive packets from, or send packets to, subscribers outside the group. It is possible for a subscriber to be a member of up to eight different closed user groups at the same time. Closed User Groups provide a very high level of security, since this functionality is built into the network, and are often used by police forces, for example.

8.5 Positive Acknowledgement

The positive acknowledgement service provides a confirmation to the sending terminal that a packet has been sent to and acknowledged by the receiving terminal. When the receiving terminal acknowledges the message, the network sends a copy of the message to the originator.

The positive acknowledgement service can be used when a fixed terminal, mobile, personal or host group subscription requests this service using the positive acknowledgement subscription flag in the packet.

For a mobile terminal subscription (MOB), the positive acknowledgement is generated by the radio base station when a link layer acknowledgement has been received from the mobile terminal.

8.6 Back in Coverage (BIC)

The Back in Coverage Notification service (BIC) enables user applications to be notified when a specific subscription is back in coverage. This means that repeated attempts to communicate with subscriptions that are out of coverage may be eliminated.

If an application host sends a packet to a mobile subscription that is currently out of coverage or switched off, and storage of the packet in the receiver’s mailbox is not allowed, the packet will be returned to the application host with a traffic state indicating that the packet was not transferred. In this case the application host can request back in coverage notification by sending a BIC packet to the mobile subscription. The network will then notify the application host when the subscription is back in coverage again.

The BIC packet itself is never sent to the mobile terminal, instead link layer frames are used for pinging the mobile terminal.

8.7 Battery-Saving Mode

The Mobitex radio protocol includes functions that dramatically reduce the power consumption of portable and handheld devices. The battery-saving radio protocol allows a terminal to go into a low power sleep mode and wake up at regular intervals to receive packets. For example, the low power operation extends battery life for handheld devices up to three weeks on a standard AA battery. A mobile terminal subscribing to this service can alternate between this mode and the normal mobile mode. Further details are available in the *Mobitex Interface Specification (CSH 109 08)*.

8.8 Network Gateway Interface (NGI)

An external network can be connected to a Mobitex network through an FST. When a packet is not delivered correctly within a Mobitex network, the packet is returned to the sender. If the packet is sent to the external network instead and the routing of the packet fails there, the packet cannot be routed back to the sender because the MOX to which the FST (i.e.the gateway to the external network) is connected does not accept packets with other traffic states than "OK".

However, if an FST is configured as a Network Gateway Interface FST, packets that are unsuccessfully delivered in the external network can be returned to the originator within the Mobitex network, with traffic state set to a state other than "OK".

8.9 Mobile Location Positioning

The Mobile Location In User Traffic (MLUT) functionality makes it possible for application hosts (FST or HG subscription) to request the approximate geographic location of a mobile subscription. The location is defined as the base station to which the mobile terminal is currently roamed.

The location information is transferred to the application host by replacing the time stamp field in the user data MPAK with the location information in user packets it receives from mobile terminals. The application host is fully responsible for enabling or disabling this function.

8.10 Over the Air Activation of Mobile Terminals (OAA)

In the Mobitex system, subscriptions for new mobile terminals can be allocated automatically over the Mobitex network using the OAA (Over the Air Activation) function. A mobile terminal that supports OAA can obtain a unique subscription (MAN) number and then activate itself.

This eliminates the need for pre-programming OAA-compatible mobile terminals with unique MANs. It is also possible to reclaim a unique MAN from a mobile terminal, thus preventing the terminal from using the Mobitex network.

The OAA functionality only includes network support for Over the Air Activation. For a complete activation system, a host application connected to the Mobitex network and the NCC is required.

9 Network Functionality

The Mobitex network provides a transparent communication link between subscribers' terminal equipment. To ensure maximum capacity and the highest possible performance and availability, the following network functions were given priority when the network was designed:

- Minimizing traffic overhead on the radio link
- Automatic roaming
- Efficient traffic routing
- Making essential services available to all users, regardless of subscription type.
- Distributed database to minimize the impact if a node is out of service.

In most wireless communications systems, the radio link is a bottleneck. To minimize the load on the radio link, no attempts are made to send packets to subscribers whose equipment is switched off or out of radio coverage.

Traffic is routed using a minimum of network nodes. To achieve this, the network keeps track of all mobile terminals so that packets can be automatically routed to the correct radio base station.

9.1 Activation/Inactivation

To avoid unnecessary transmission attempts to terminals that are switched off, the terminals notify the network with an inactivation packet when they are switched off. When they are switched on again, an activation packet is sent to the network.

If a mobile terminal loses radio contact with the network, it automatically sends an activation packet when radio contact is re-established, in the same way as at start-up. Packets sent to a subscriber that is inactive can be stored in the network mailbox or returned to the sender.

Portable radio modems in battery-saving mode that have been inactivated by the network because of a number of unsuccessful down-link packet transactions are automatically activated when radio contact is re-established.

9.2 Distribution Lists in Messages

If the subscriber needs to send a message to several subscribers who are not members of the same group subscription, the distribution list function may be used.

The sender includes the subscription numbers of all the receivers (maximum 7) when sending the message to the Mobitex network. The Mobitex network then makes the necessary number of copies of the message and transfers them as individual packets to the receivers on the list.

9.3 Roaming

When a mobile terminal moves from one radio coverage area to another, the ROAM packet is sent from the mobile to the new radio base station. This signal initiates a roaming and authentication procedure. The Mobitex network will transfer the subscription information from the previous radio base station to the new one.

Figure 11 Mobile moving between two radio base stations.

Note that the Mobitex roaming procedure is different than that used in most cellular networks for mobile telephony. In Mobitex, it is the mobile terminal, not the network, that initiates the roaming procedure. This ensures that the mobile terminal will not lose contact with the network when roaming to a new base station, as may occur during a handover in a cellular network, and that the network will always be available.

9.3.1 Prioritized Roaming

Prioritized Roaming functionality enables the operator to deploy "hot spot" base stations to meet communication needs of a growing customer fleet.

When a mobile terminal roams into a new radio base station, it receives a list of neighboring base stations. In ordinary roaming, the mobile roams in to the base station with the highest signal strength. With *Prioritized Roaming* the mobile selects a base station to roam into based on both signal strength and the priority that the operator has set for the base station.

Prioritized Roaming requires that the mobile terminal has implemented support for this function.

9.4 Electronic Serial Number (ESN)

The Electronic Serial Number (ESN) is a security functionality that allows the network operator to protect the system from unauthorized terminals. The ESN for each subscription is stored both in the mobile terminal and in the radio base station into which the terminal has roamed. The network compares the two numbers and if the terminal ESN is determined to be illegal, the terminal is blocked and is unable to communicate with the network or send and receive data.

9.5 Message Entry Time/Date

When a message is received by the network, the current network time is stored in the network layer header of the message. This can be used to show how long a message has been stored in the mailbox, for example.

Note that the message entry time will not be presented to hosts that have enabled the MLUT function. See section *8.9 Mobile Location Positioning*.

9.6 Base Groups

Base Group functionality increases the capacity in the cell area. To achieve this, the permissible number of radio base stations in the cell has been increased, and the traffic load between the base stations is automatically and uniformly distributed.

Basically, a group of radio base stations with as similar coverage areas as possible is designated as a Base Group, in which the individual radio base stations are members. A Base Group can contain up to eight members, each supplying a radio channel.

9.7 Traffic Controlled Roam Flag

The Traffic Controlled Roam Flag function makes it possible to limit the number of subscribers on a radio base station with high traffic load, thus maintaining a certain throughput of traffic.

When the traffic load increases to a predefined level, which may be configured, the roam flag transmission on the system channel will be disabled. This will prevent further mobile terminals from roaming into the radio base station, while mobile terminals already roamed in still have access to the radio base station.

When the traffic load decreases below another predefined level, the roam flag transmission will be enabled again, thus allowing mobile terminals to roam in to the radio base station again.

10 Communication Interfaces

This chapter describes both the internal and the external network communication interfaces. There are three main communication interfaces:

- Network node interfaces
- Fixed terminal interfaces
- Mobile terminal interfaces

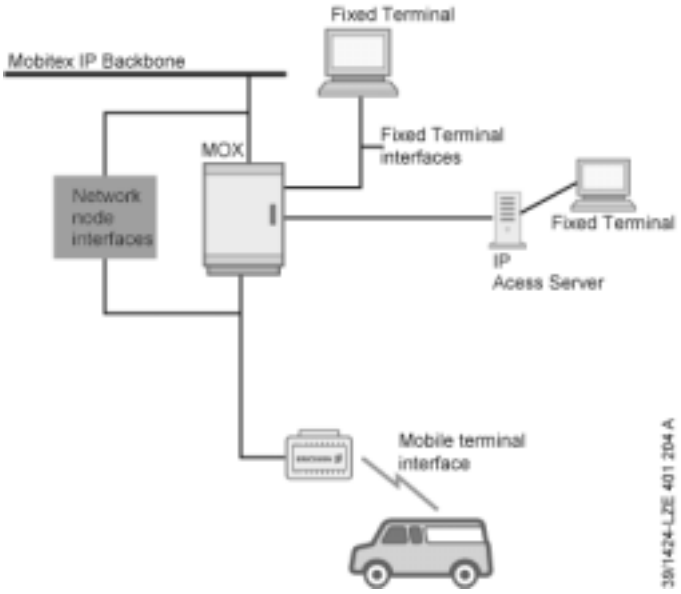

Figure 12 Communication interfaces.

All data exchange within Mobitex takes place by using datagram messages. A datagram can be transmitted over several different kind of bearers, and different parts of the network may use different bearers for the transmission of datagrams. For details about external communication interfaces see the *Mobitex Interface Specification (CSH 109 08).*

10.1 Fixed Terminal Interfaces

Fixed terminals connected to Mobitex communicate with the network at the link layer and physical levels according to one of the interfaces described below. The choice of interface depends on existing interfaces, cost considerations and other subscriber requirements.

X.25	The X.25 interface is a synchronous interface designed according to CCITT recommendation X.25. The CCITT recommendation X.21 bis is used for the physical layer.
X.25 gateway	The X.25 gateway provides connectivity for X.25 applications without the need to implement the Mobitex network layer protocol. The X.25 gateway in Mobitex offers two levels of services: the Basic service and the Transport service. The Basic service can be described as mapping the user data parts between Mobitex network layer packets and X.25 packets. Messages are restricted to up to 512 octets of user data, if delivery in the correct order is to be guaranteed. The Transport service offers additional functionality by using a transport protocol between the mobile terminal and the X.25 gateway. The transport protocol uses HPDATA packets with a specific protocol identifier. The transport protocol provides the ability to transfer messages longer than 512 octets between the mobile and the X.25 host through the gateway.
MDOT	The MPAK Datagram over TCP/IP (MDOT) interface provides IP connectivity for application hosts via the external Gateway IP Access Server (See section *15.1 IP Access Server*). The MDOT protocol is defined in MIS.
MASC	The Mobitex Asynchronous Communication (MASC) interface provides support for legacy application hosts. MASC is a specially designed Mobitex asynchronous interface for packet processing. CCITT recommendation V.24 is used for the physical layer and the MASC interface is used for the link layer.

10.2 Mobile Terminal Interface

The radio protocol used in Mobitex ensures a reliable and efficient transmission path between the mobile terminal and the radio base station. The Mobitex link layer radio protocol that is used between radio modems and base station, is called ROSI and is described in detail in the Mobitex Interface Specification (CSH 109 08).

To ensure high transmission reliability and reduce retransmissions on the radio link, Mobitex uses several techniques as described below.

Data sent over the radio link is coded with Hamming and Cyclic Redundancy Check (CRC) codes to obtain error detection and error correction capabilities.

Interleaving is used to decrease the probability of packet loss due to burst errors that may be common in a radio environment. The radio base stations also uses smart soft-decision methods to increase the performance and sensitivity for signals received by the base station at low signal strengths.

If any part of a packet has been corrupted over the radio link and could not be corrected by the channel coding algorithms, it is not necessary to retransmit the complete packet. Instead Mobitex uses a selective Automatic Repeat reQuest (ARQ) mechanism that only requests repetition of the parts of the message that have been corrupted. This ensures that bandwidth requirements remain low, even when retransmissions are necessary.

10.3 Internal Network Node Interfaces

Network node communication can use leased lines, X.25 networks or dial-up PSTN connections. Dial-up PSTN connections are mainly intended for redundancy purposes. The network nodes communicate using the X.25 protocol, but today there are many methods for transporting X.25 data over another bearer by using an appropriate external router. For example X.25 data can be transferred over Frame Relay networks, IP networks, or almost any other kind of network.

The BRU1 base station also has built in capabilities to handle XOT connections (X.25 over TCP/IP), i.e. it can be connected directly to an IP network. This requires an external XOT-router at the MOX site where the BRU1 is connected.

Subnetworks and the NCC communicate over the Mobitex backbone, which is an IP based network.

X.25	The X.25 interface is a synchronous interface designed according to CCITT recommendation X.25. CCITT recommendation X.21 bis is used for the physical layer.

XOT	The BRU1 supports XOT, which is X.25 protocol tunnelled over TCP/IP (RFC1613). **Note:** An XOT-router is required at the MOX site when XOT is used.
TCP/IP	TCP/IP is used by the Mobitex backbone, which is used for connections between subnetworks and between the subnetworks and the NCC.

11 Network Configuration

The modular design of the network and its nodes facilitates economical operation, gradual expansion of capacity and redundant network configuration.

11.1 Capacity Expansion

The capacity of the Mobitex network can be expanded both to increase the coverage area and to expand traffic capacity.

To increase the radio coverage area, additional radio base stations can be added to the network without interrupting the operation of existing network nodes. To increase traffic capacity within a cell area, multiple radio base stations can be co-located at the same site using Base Group functionality. Base Group functionality is described in section *9.6 Base Groups*.

Traffic capacity at the network level can be increased by adding radio base stations and several subnetworks, where each subnetwork consists of a MOX serving a number of base stations.

The switches are delivered with a license for basic switching capacity, which can be upgraded in two increments by purchasing license keys that provide enhanced switching capability.

11.2 Network Redundancy Configuration

The Mobitex network includes a number of functions that are designed to ensure high overall availability of network services for the operator and end customers. These functions are generally based on the support for redundant equipment that is built into the network. For any given node or connection, the operator may increase protection against faults by installing redundant components. Mobitex offers redundancy at the network level, meaning that a network node may be configured with redundant connections to several other network nodes with the same properties as the node with which they normally communicate.

Network-level redundancy comprises site redundancy, which is essential to overcome worst-case situations, such as fire, earthquake, flooding, major power outages, that may make an entire site unusable.

Network hardware purchased for redundancy purposes can also be used during normal operation for load sharing.

When the network is configured with alternative connections for redundancy, the alternative connection can be established automatically. It is initiated from the lower

level network nodes to the higher level nodes. For example, a radio base station can automatically establish an alternative connection to another MOX when the ordinary MOX is unreachable or the ordinary connection is down.

Different types of connections can be used for redundancy, which allows the network operator to optimize the cost of the alternative links in relation to the link capacity that is needed. Examples of connection types that can be used are:

- Dedicated links (leased lines)
- X.25 networks
- Dial-up connections over the PSTN
- Satellite links
- MINI-LINK microwave links
- X.25 tunneling over IP, ATM, Frame Relay, etc.

At the radio cell level, redundancy can be achieved through network cell planning. By using overlapped cell areas for the radio base stations, the mobile terminals may roam into a neighboring radio base station in the case of failure of one radio base station.

11.2.1 Subscription Redundancy

Redundancy between the network and fixed terminals is achieved primarily by using Host Groups. If a Host Group is used, two or more connections from fixed terminals are required. In this case, the Host Group subscriber is simultaneously logged in on all connections. If one connection fails, the traffic is routed to one of the other connections.

Redundancy using Personal Subscription requires two fixed terminals connected to different MOXs. The Personal Subscription must control where it shall be logged on by itself, since it can only be logged in on one FST at a time.

12 Operation, Administration and Maintenance

This section provides a brief description of the facilities and functions available in the Mobitex network for network management and subscription administration.

12.1 Network Control Centre (NCC)

The Network Control Centre (NCC) is the network operator's system for configuring the network and its nodes, monitoring alarms, assembling statistics and controlling the entire network over a wide geographical area. The NCC also handles subscription management and billing functions. Statistical functions in the NCC allow the network operator to monitor the overall activity, traffic load and error frequency of the network.

For a detailed description of NCC functionality, please refer to the NCC Manuals.

The main functions available in the NCC to be described in the following sections are as follows:

- Network Configuration
- Operation & Maintenance
- Alarm Handling
- Recurrent Scripts
- Subscription Management
- Traffic Log Handling

Applications with a graphical user interface are provided for accessing all of the above functions with the exception of Operation & Maintenance, which uses a console application.

Open interfaces are provided for network operators who intend to utilize external subscription management and billing systems.

12.1.1 Network Configuration

Network configuration is performed via the NMS Client application. Software and configuration parameters can be distributed to all network nodes from a central location. Network nodes can also be reconfigured while online and updated with new parameter values without having to restart the nodes.

Each network node has a set of configurable parameters, including:

- Internal parameters (for example, the node's identification number and type)
- Hardware alarm parameters (for example, the trigger level of the alarm)
- Connection parameters (for example, the bit rate for a X.25 connection)
- Parameters relating to radio channels for base stations (for example, radio frequencies)

Note that the NETREG legacy application can still be used to configure network nodes.

12.1.2 Operation and Maintenance

Operation and Maintenance can be performed via an application called OM, which is used for direct control and monitoring of the network nodes. OM acts a remote console directly on the network nodes and has a command line interface.

Most configuration parameters for a node can be read and configured via the OM interface, which includes several commands for supervision and performance monitoring. For more information about available commands, please refer to the *NCC OM Reference Manual*.

12.1.3 Alarm Handling

The alarm handling system is used to select, direct or inhibit alarms received by the NCC from the network. The alarm handling system consists of:

- A process for receiving and directing alarms according to information stored in the alarm database.
- A database with information about how to select and direct alarms to different destinations such as terminals, printers and files.
- The Alarm Rule feature in the NMS Client, which allows the operator to update the content of the alarm database.

12.1.4 Recurrent Scripts

The Recurrent Script feature in the NMS Client provides the possibility to define automatic control and supervision actions that need to be carried out by the NCC at certain predefined occasions. They can also be used to collect statistical information from the network nodes on a regular basis. These actions are realized through VMS scripts, which are powerful yet simple script files with embedded OM commands.

12.1.5 Subscription Administration

Subscriptions administration is performed via an application called SAM. Subscriptions can be created, changed and terminated using SAM. Subscriptions can also be blocked temporarily. The services ordered by a subscriber, such as mailbox or Closed User Group, are defined in SAM.

The subscription information is automatically distributed to the network nodes. The information is also updated automatically after any changes have been made to the subscription information.

SAM consists of two modules, ASAM and NSAM. NSAM (Network SAM), provides the network with technical information about the subscriptions, meaning that only subscription information needed by the Mobitex network is handled by NSAM. ASAM (Application SAM) contains routines for administration of the subscriptions. ASAM is the front-end application for the network operator, and is used when registering subscriptions. ASAM contains additional administrative information, for example contact addresses and information needed for billing purposes, such as price lists. Systems that handle the administrative information for subscriptions are often called Customer Relationship Management (CRM) systems.

The Mobitex system provides an open interface to NSAM, which allows operators to design their own ASAM system for subscription administration and billing.

Traffic logs are collected and a billing interface is included through which the network operator can access this information. Traffic logs are processed together with price lists to create invoicing data, which can be transferred to an external invoicing system. Invoices can also be created internally.

12.1.6 Traffic Log Handling

The network nodes generate detailed information about subscription numbers, type of message, length, etc. when a message is delivered. The nodes send traffic logs to the NCC, where the SAM system normally processes the logs and generates an ASCII file to be used as a basis for billing.

Traffic log handling and billing functionality is included in the Mobitex NCC. For larger networks an optional Traffic Log Manager (TLM) system can be installed on a separate server. The TLM delivers increased performance and availability for traffic log handling, and also offloads traffic from the NCC computer.

12.2 Internal Network Functions

This section describes some of the internal functions in the network that improve availability for users and facilitate operation and maintenance for the network operator.

12.2.1 Network Software Distribution

When new node software is released or configuration changes are made, the network nodes can be upgraded with new files containing software and configuration parameters. The distribution of these files is performed and controlled from the network configuration application. It is possible for the operator to specify when the distribution is to take place (date and time) and which nodes are to be upgraded as well as to monitor the software distribution.

The NCC also controls program installation and re-booting of the node with the new software version.

12.2.2 Online Reconfiguration of Network Nodes

It is possible to reconfigure the network nodes online from the NCC without distributing new configuration files and without having to restart the node or its communication units. All reconfigurations made in the NCC are stored in the NCC database and on disk in the nodes and are considered as permanent.

The following list provides an overview of the kinds of configuration changes that can be performed:

- Add or remove a fixed terminal
- Add or remove a network node/branch
- Add or remove a radio channel
- Modify radio channel parameters
- Modify data connections to nodes and fixed terminals.

12.2.3 Recovery Procedure

When a connection between two network nodes becomes active/connected, or when a node has changed a connection to an alternative superior node, a recovery procedure is started. The recovery will detect and correct inconsistencies regarding the subscription information in the inferior node. The recovery will detect and correct inconsistencies regarding both the subscription information itself (i.e. updated subscription information) and roaming information (i.e. where the subscription is located).

12.2.4 Congestion Control

The congestion control functionality is implemented in Mobitex nodes to minimize impact of occasional peaks in traffic load and to reduce network traffic, for example when a subscriber is temporarily unavailable. This function limits the effects of traffic overloading in one part of the network so that the overload is restricted to as few nodes and lines as possible.

Congestion control is achieved through several functions at different levels in the network:

- Returned packets due to congestion. Returned packets can decrease the maximum throughput from hosts when the network is congested.
- B-party malfunction list. Reduces network traffic load from mobile terminals if the receiver is temporarily unavailable
- Base station overload detection in MOX. Decreases network traffic towards overloaded base stations.
- Configurable throughput for FST connections. Makes it possibility to set how host connections shall handle returned traffic in congest situations.
- Queue handling in network nodes. Queues handle occasional peaks of traffic.

12.2.5 Autonomous Operation

If a connection between a node and its superior node is lost, the node and all underlying nodes will still function in autonomous mode. This means that subscribers in the autonomous network branch still can send and receive packets to and from other subscribers within this network branch. There may be some limitations in the subscriber services.

If a connection between a radio base station and the area exchange is lost, the radio base station will go into autonomous operation and continue routing traffic between subscribers using that radio base station. The time period during which a radio base station works in autonomous mode can be limited by the operator.

12.2.6 Node Operator (NODOP)

A network node contains the Node Operator (NODOP) terminal functions, similar to the NCC OM application, which can be run from a standard terminal program on a laptop PC, for example. NODOP is used by service personnel on site when

installing a node and for maintenance and service purposes.

Figure 13 Network node operator terminal.

12.2.7 Node Software Start-up

When a network node is switched on, it is started automatically by its own boot system. The start-up depends on the node's software configuration parameters and the hardware configuration. If a serious software failure should occur, a supervisory system restarts the node. This procedure is similar to the power-up procedure.

The nodes also have an automatic fall-back function. The fall-back function ensures that a node will start-up using last known good configuration in case the node was started using a faulty configuration file due to mistakes when configuring the node. This ensures that the node will become reachable and accessible from the NCC instead of becoming orphaned.

12.2.8 Alarm Handling

All the alarms that can be generated in the network nodes have a hard-coded alarm level. This alarm level determines if and how each alarm will be transported from the network node where it is generated to the NCC. It is possible for the network operator to override the hard coded alarm level for each alarm. This way, the network operator can assign a certain alarm from a certain network node a higher alarm level if it is considered an important alarm, or a lower alarm level if it is not considered important.

12.2.9 Event Statistics

The function Event Statistics includes an interface through which it is possible to control the collection and reporting of predefined events. Data for every event defined is collected each time the event occurs. It is not sampled. Among the events available for study through this interface are:

- Data traffic load on radio channels
- Memory utilization
- Traffic handling in general.

The event statistics are controlled from the NCC OM, which collects information directly from the network nodes. If combined with the Recurrent Script feature, in the NMS, a number of statistical measurements can be collected at recurring intervals from several network nodes.

13 End-User Availability and Reliability

The Mobitex network offers several network functions and redundancy options in order to ensure as failure-resilient network as possible for end-users, without any single point of failure.

Mobitex is designed for internal redundancy within network nodes, as well as for external redundancy between network nodes. Multiple units within switches and the network's ability to use several different up-link connections between nodes at all network levels allows for port, unit or entire switch redundancy.

Mobitex features several functions that ensure a robust and failure-resilient design, such as:

- Online reconfiguration of network entities
- Recovery procedures for subscription data
- Autonomous operation
- Congestion control

There are also a number of network software licenses available in Mobitex that further promote network redundancy and reliability, such as:

- Alternate network pathways
- Alternate network pathways between subnetworks for base stations
- Multiple connections
- Base groups
- Host group addressing
- Dial-up modem control
- Redundant DRR
- Redundant NLS
- NTE Alternative Top node (For networks not using the flat network architecture)

14 Add-on Functionality

Mobitex functionality is described in detail in the *End User Services* and *Network Functionality* sections of the *System Manual*. Some functions cannot be used without a corresponding license key. The *Mobitex Product Catalogue* contains more information about add-on functionality and related licenses, as well as order numbers for these licenses.

15 External Gateways

An operator can further enhance Mobitex operation by adding external gateways to the system. The external gateways IP Access Server and MPAK Router are described in the following sections.

15.1 IP Access Server

The IP Access Server (IAS) is an optional component that provides IP connectivity for Mobitex networks. The IAS increases the choice of host connection types by addressing the market need for IP connectivity to Mobitex networks and provides an alternative method of connecting fixed terminals (FST) to the network.

The IAS is connected to an area exchange (MOX) where it provides an interface between the Mobitex network and IP-connected fixed terminals. Operators are thus able to offer a more cost-effective connection to the network. Fixed terminals with an IP connection can connect to Mobitex via the IAS, which supports any IP-capable bearer, meaning that fixed terminals are able to connect to the Mobitex network over the Internet.

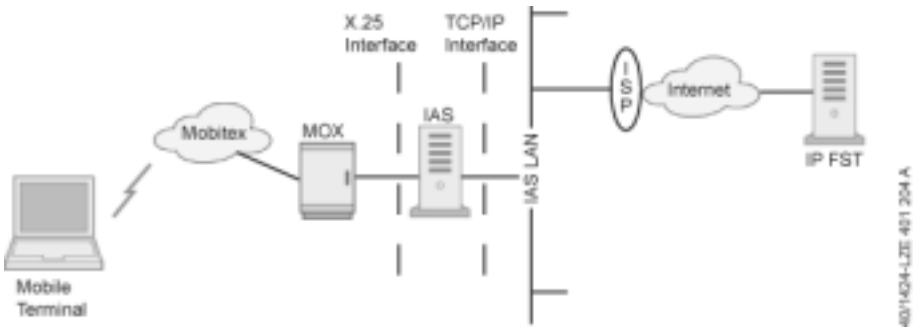

Figure 14 Overview of the IP FST Interface Solution.

15.1.1 Management and Supervision

The IAS and its connections are configured remotely through a convenient graphical user interface accessed via a web-browser. This web interface also provides access to the on-line documentation.

For supervision purposes, the IAS uses standard SNMP agents. This solution makes it possible to use standard SNMP management software to supervise all alarms generated.

15.1.2 MDOT

Mobitex packets are tunneled over TCP/IP connections, meaning that the MPAKs are encapsulated in TCP/IP packets. To encapsulate MPAKs, the MDOT (MPAK Datagram Over TCP/IP) protocol is used, which adds a four-byte header to the MPAK. Applications need to be able to handle both the MPAK and MDOT protocols, which are described in the *Mobitex Interface Specification (CSH 109 08)*.

Tunneling is transparent from an IAS point of view. IP-based FSTs are configured in the normal manner with a subscription MAN number in the Network Control Center. Host Group subscriptions are also supported.

15.2 MPAK Router

The MPAK Router (MPR) serves as a transparent gateway between fixed terminals (FST) and the Mobitex network. By taking advantage of the host group functionality in Mobitex, the MPR allows a single fixed terminal to appear at several connection points.

The fixed terminal can be virtually present at numerous locations in the network, while the MPR handles the additional complexity introduced by the host group functionality. No implementation changes are required in the application running on the fixed terminal.

The result is that the traffic load on upper levels of the network is reduced, thus allowing network utilization to be increased.

15.2.1 Management and Supervision

The MPR is configured remotely through a command-line interface accessed via a telnet session to the machine on which the MPR software is running.

For supervision purposes, the MPR uses standard SNMP agents. This solution makes it possible to use standard SNMP management software to supervise all alarms generated and to analyze performance metrics.

16 Terminology

AC	Alternating Current
ALA	Mobitex Alarm handing system
ARM	Mobitex Action Routine Manager
ARQ	Automatic Repetition reQuest
ASCII	American Standard Code for Information Interchange
ATM	Automatic Teller Machine
BIC	Back In Coverage
BIU	Backbone Interworking Unit
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CUG	Closed User Group
DBMS	DataBase Management System
DC	Direct Current
ESN	Electronic Serial Number
FST	Fixed Terminal Subscription
GPRS	General Packet Radio Service
GRP	Group Subscription
GSM	Global System for Mobile Communications
GUI	Graphical User Interface
HG	Host Group Subscription
I/O	Input/Output
IAS	IP Access Server
IP	Internet Protocol
ISO	International Standardization Organization
LAN	Local Area Network
MAN	Mobitex Subscription Number
MASC	Mobitex Asynchronous Communication Protocol
MDOT	MPAK Datagram over TCP/IP

MHX	Mobitex Main Exchange
MIS	Mobitex Interface Specification
MLUT	Mobile Location in User Traffic
MOB	Mobile Terminal Subscription
MOX	Mobitex Area Exchange
MPAK	Mobitex network layer packet
MPR	MPAK Router
MX	Mobitex hardware platform for MOX and MHX
NCC	Network Control Centre
NETREG	Mobitex Network Configuration Register
NGI	Network Gateway Interface
NLS	Node Location Service
NMS	Network Management System
NMS client	Network Management System, client application
OAA	Over-the-Air Activation
OM	Mobitex Operation & Maintenance application
PDA	Personal Digital Assistant
PER	Personal Subscription
POS	Point of Sale
PSTN	Public Switched Telephone Network
ROSI	Mobitex link layer protocol for radio base stations and radio modems
SAM	Mobitex Subscription Authorization Manager
SNMP	Simple Network Management Protocol
TCP	Transmission Control Protocol
TLM	Mobitex Traffic Log Manager
WCDMA	Wideband Code Division Multiple Access
XOT	X.25 over TCP/IP, RFC1613