BRU3 in the Mobitex Network

Contents

1 The BRU3 in the Mobitex Network

The base radio unit 3 BRU3 provides cellular radio communication facilities in the Mobitex packet switching system. This radio channel enables data communication to be established with mobile terminals. The BRU3 also serves as a switching node in the network. The BRU3 is a one-channel node specified for installation when only one radio channel is required.

This opening section examines network parameters which play a direct role in the operation of the base radio unit. If you are encountering Mobitex for the first time, you should first refer to the *System Manual*, which provides a comprehensive description of the Mobitex system.

1.1 The BRU3 as a Radio Station

In its role as a cellular radio base station, the BRU3 connects roaming mobile terminals to the Mobitex network by means of a trunked radio link. This trunked link allows a large number of terminals to be handled on the same radio channel. An overview of an simple Mobitex network is shown in *Figure 1 “Simple Mobitex network.”*.

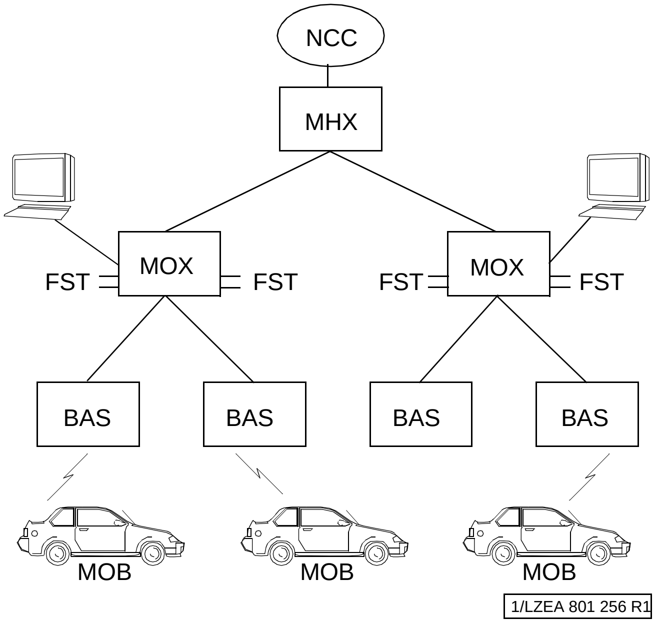

Figure 1 Simple Mobitex network.

The BRU3 is equipped with one full duplex radio channel. The up frequency for the channel is used to transmit from mobile to base. The down frequency is used to transmit from base to mobile. The terms up and down traffic are used throughout this manual in this context.

In data communication terms, the mobile can be seen as a special type of terminal, interfaced to the network by the Mobitex radio protocol.

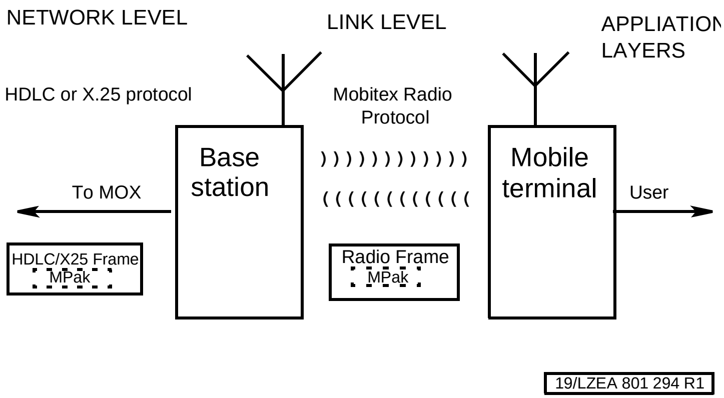

Figure 2 The mobile-network interface.

Mobitex mobile terminals are free to roam within the radio coverage area of radio base stations in the network. Within this area, a mobile selects a base station with which to communicate, on the basis of its received signal strength. This base station is known as the *current base station* for the mobile concerned, and the mobile is said to be *roamed in* to that base.

1.2 The BRU3 as a Node

When a base station connects a mobile terminal that is roamed in to a subscriber that is not roamed in to the same base station, the base station acts as an end node for the mobile. In this situation, packets sent by the mobile are routed through the minimum number of MOX and MHX network nodes, to the end node for the addressee. If the addressee is a fixed terminal, this will be a MOX. In the case of a mobile, it will be another base station. This second base station transmits the packets to the mobile terminal identified by the address contained in the packet.

When connecting mobiles for which the base station is the current base station, it functions as the turn node for the connection, and no other part of the network is directly involved in the packet switching.

1.3 Data

The BRU3 provides data connection. In the Mobitex network, data circuits are packet-switched over logical channels. The use of the word “connect” when describing data circuits in this manual does not imply a physical connection.

1.4 Services and Users

Users for which the base station must provide services fall into two categories. There are Mobitex subscribers, who may use the system via fixed and/or mobile terminals. Then there are system requirements, demands made upon the base station by the network itself. Examples of these are the provision of hardware and software status information, and traffic data for billing purposes. Both subscribers and the system itself must therefore be seen as base station users.

Mobile subscriptions may have access to some or all of the following traffic types:

- Send TEXT/DATA
- Receive TEXT/DATA
- Send STATUS
- Receive STATUS
- Generate EMERGENCY
- GROUP messages
- Mailbox

1.5 Data Rate

The BRU3 can handle a data rate of 8 kbps.

2 Network Layer

There is no end-to-end protocol between users in Mobitex at network level. Instead, the network service is supported by negative acknowledgement. If a packet is not delivered, it is returned to the sender with a status message. A packet may be left in the mail box, if this service is included in the subscription.

2.1 Mobitex Packet Types

Within the Mobitex network, data is sent in the form of Mobitex packets. There are four types of Mobitex packets.

TEXT packets

- Coded in ASCII format
- Maximum size 512 characters of user data per packet
- Application-independent.

DATA packets

- Information not restricted to ASCII code
- Maximum size 512 octets of user information per packet
- Freely coded by individual applications.

STATUS packets

- One single octet of numerical code between 0 and 255
- Each code number normally associated with a string of characters
- Coding chosen by the subscriber
- Used to reduce transfer time and costs.

HPDATA packets

- Higher protocol data for messages which exceed the maximum size for text and data messages.
- Transport layer transfers the HPDATA message as several sub-messages.
- Contains information to indicate the type of protocol.
- Mobitex or user-defined protocols.

An outline of the general Mobitex packet format is shown in *Figure 3 “General format of a Mobitex packet.”*. Note that the sender is recorded in the packet. This ensures that this information remains available after frame headers have been stripped off during signal processing, in the event the packet has to be returned.

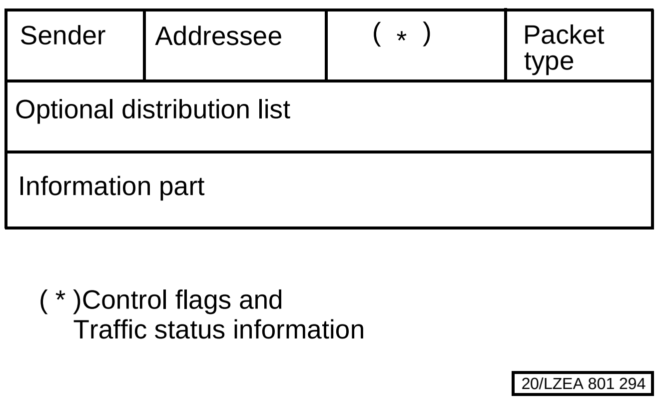

Figure 3 General format of a Mobitex packet.

3 Link Layer

Mobitex packets are sent over each link in the network in the form of link level frames. Two types of external links are relevant to the radio base station: the *MOX-base* line link and the *base-mobile* radio link.

For the MOX-base link the BRU3 can be configured for the HDLC (UNC 12) and/or the X.25 (CCITT Rec 1984) protocol, according to the operator's requirements. A special type of frame is used for the base-mobile radio link, which is described further on in this document.

The structure of the link frame varies according to the protocol in use, X.25 or HDLC. The general format of an HDLC link level frame is shown in *Figure 4 "General format of an HDLC link frame."*. Flags are sent at the start and end of frames to synchronize the protocol. The FCS field provides a frame checksum for error detection purposes. The control field specifies the frame type as unnumbered, supervisory or information.

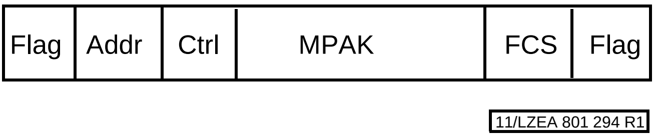

Figure 4 General format of an HDLC link frame.

3.1 Radio Protocol

Data communication between the base station and mobile terminals is in accordance with the Mobitex radio protocol, which functions at physical and link layers. Modulation, demodulation and synchronization are carried out at the physical layer. The link layer contains functions for channel-coding, error detection and correction, selective automatic request and channel access control.

Data is sent in the form of 8 kbps Mobitex radio frames. The general format of an 8 kbps radio frame is shown in *Figure 5 “General format of an 8 kbps <MRM>frame.”*. The frame is split into blocks, each of which is coded for error detection. The frame head functions at physical layer to establish data synchronization. It includes the base identity and a set of control flags. The primary block contains the address of the mobile terminal and some control information. The network layer information is put in the following blocks, the number being defined by the amount of information to be transferred.

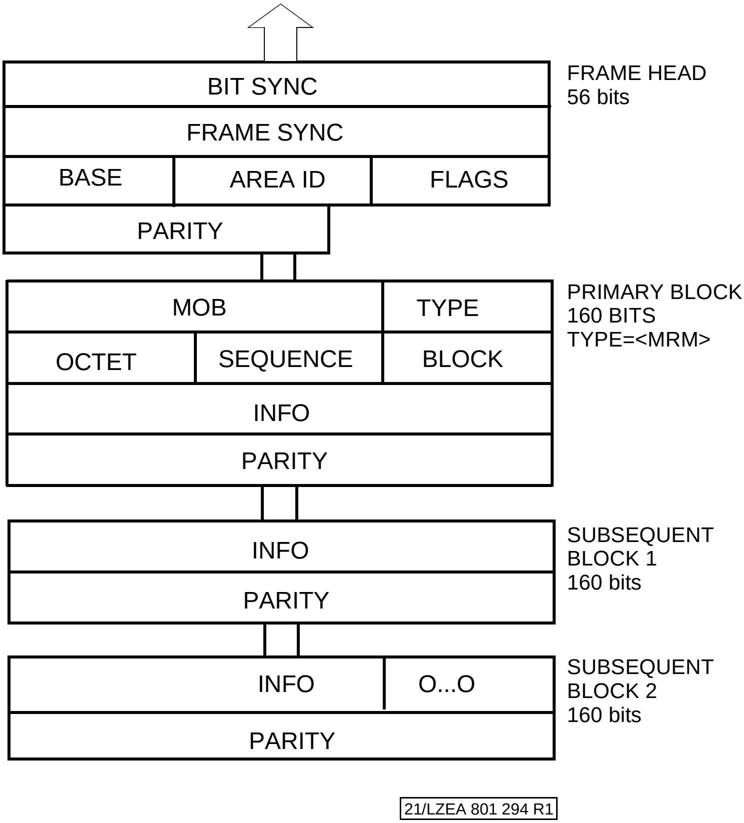

Figure 5 General format of an 8 kbps <MRM>frame.

4 Frame Types

There are 21 different 8 kbps radio frame types:

Name	Label	Sent By B	Sent By M	Function
M frame	<MRM>	Y	Y	Transfers MPAK messages.
Acknowledgement	<ACK>	Y	Y	Acknowledges correctly received frame.
Negative acknowledge	<NAK>	Y	Y	Req repeat of entire <MRM>.
Repetition request	<REB>	Y	Y	Req repeat of bad blocks <MRM> or <RES>.
Repetition reply	<RES>	Y	Y	The reply to <REB>.
Access request data	<ABD>	N	Y	Req to send <MRM> that exceeds max access.
Access request speech	<ABT>	N	Y	Request to send <MRM> that exceeds max_speech.
Access request emergency	<ABL>	N	Y	Req to send emergency <MRM>, whose length exceeds max_access emergency.
Access permission data	<ATD>	Y	N	Reply to <ABD> when base is ready.
Access permission speech	<ATT>	Y	N	Reply to <ABT> when base is ready.
Access permission emergency	<ATL>	Y	N	Reply to <ABL> when base is ready.
Change channel data	<BKD>	Y	N	Orders mobile to another channel for data.
Change channel speech	<BKT>	Y	N	Orders mobile to another channel for speech.
Free signal	<FRI>	Y	N	Marks start of 'free' channel access cycle.
Sweep signal	<SVP>	Y	N	Marks start of sweep cycle.
Silence order	<TST>	Y	N	Withdraws access permission during 'free'.
Activity request	<AKT>	Y	N	Asks mobile to confirm active with <ACK>.
Access denied speech	<NAT>	Y	N	Tells mobile connection cannot be provided.
Change base station speech	<BBT>	Y	N	Transfers call to another base station.
Wait for channel speech	<VKT>	Y	N	Reply to <ABT> if mobile is placed in queue.
Cancel access request speech	<AAT>	N	Y	Sent by mobile to end speech session.

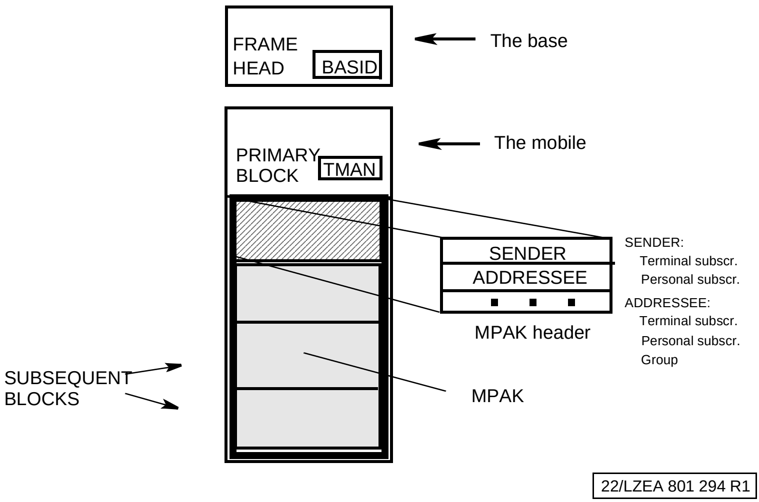

Figure 6 Addressing a mobile terminal.

4.1 Radio Channel

The BRU3 provides data communication with roaming mobiles in its coverage area on one full duplex radio channel. The duplex transmitter and receiver frequencies are completely independent of one another. The BRU3 uses one of the two different channel types: System channels and Traffic channels.

4.1.1 System Channels

Every radio base station has at least one system channel. This duplex channel is used to carry system signals between the radio base station and all mobiles. These system signals control and configure the base-mobile link, and include the periodic <SVP> and <FRI> signals which contain the parameters for roaming and channel access algorithm control. An active mobile not currently sending or receiving traffic constantly monitors the system channels from all base stations in its current list, to implement the roaming protocol. It also listens for signals from its current base which carry its address. Signals on this channel may be system messages or data traffic, and may be initiated by a base station or mobile.

4.1.2 Traffic Channels

These channels carry data traffic not carried on the system channel. A traffic channel is brought into use when traffic levels require additional capacity.

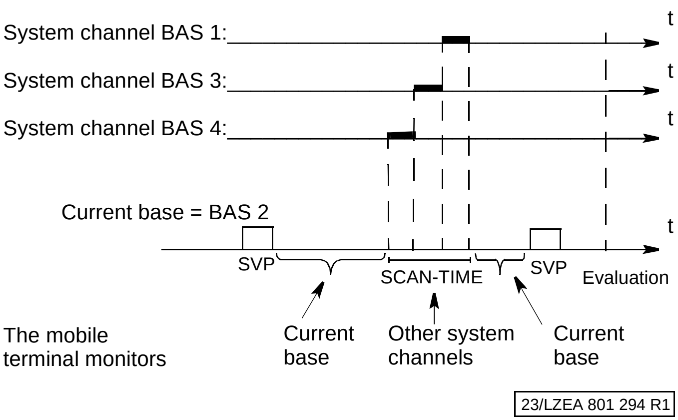

Figure 7 System channel monitoring.

5 Roaming

Each mobile terminal contains data about the base stations within the range of its roaming area. Each base station contains a subscription register which contains details of the mobiles currently roamed in. Mobiles continuously evaluate the roaming signals that are transmitted periodically from all base stations on separate system channels, as shown in *Figure 7 “System channel monitoring.”*. Each roaming signal contains the base identification number.

The mobile decides which base station to use on the basis of the average received signal strength. When a mobile decides to change to a different base station, it transmits a roaming message to the new base. The subscription register there is updated from the superior MOX with the mobile terminal's subscription data. A message is sent from the new base station to the previous base station, to delete this data from its subscription register.

The superior MHX keeps track of all mobiles roamed in to base stations within its arm of the network. If a mobile roams in to a base station under a different arm, subscription data for the mobile is downloaded to base stations in the new area from the superior MHX and MOX. Should a base station lose its subscription data, for example through equipment failure, this data can be downloaded to the relevant base station at any time.

5.1 Channel Access Protocols

To ensure that the radio channel can be shared by a large number of mobiles, a channel access protocol is imposed on mobiles from the base station.

5.1.1 Base to Mobile

A mobile terminal with no traffic to send monitors the system channel of its current base station. Traffic for the mobile is first sent on the system channel, either in the form of a complete message or as a channel change order. If a channel change order is sent, the message is transmitted on the new channel.

5.1.2 Mobile to Base

To minimize the risk of collisions between mobiles attempting to send on the system channel at the same time, an access method using time slots is used. This ensures that a mobile can only send traffic when access to the channel is granted. The method is based on the slotted ALOHA algorithm.

On the system channel, the base station periodically transmits a cycle during which time-slots are made available to mobiles with traffic to send. The base station indicates the start of a cycle by transmitting a <FRI> signal. The free cycle which follows is divided into slots of equal length. The total number of slots, and the length of a single slot, is stated in the <FRI> signal.

Traffic initiated by a mobile before the start of a free cycle is allocated one of the random slots that immediately follow the <FRI> signal.
This is done by a random number generator which selects one of the random slots defined in the <FRI> signal. Transmission from the mobile begins at the start of the random slot.

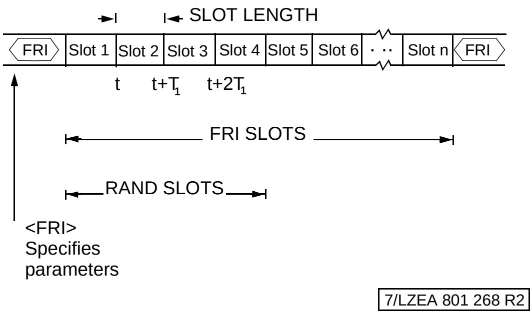

Figure 8 Free signalling.

Traffic initiated during the free cycle is allocated the next free slot, a procedure which also ensures random allocation of the available slots.

The size of the slots matches the max_access parameter in the free signal. If the number of blocks in a packet is less than or equal to the number stated in max_access, it will fit in a slot.

Packets containing more blocks cannot be transmitted in a slot. The mobile then has to send an access request in a slot and wait for the base to send a access permission, before sending the packet.
The number of slots in the free signal depends on the available down-traffic. While the base station is sending down-traffic on the down frequency, it simultaneously receives mobile transmissions on the up frequency. In this way, channel utilization is optimized on both channels.

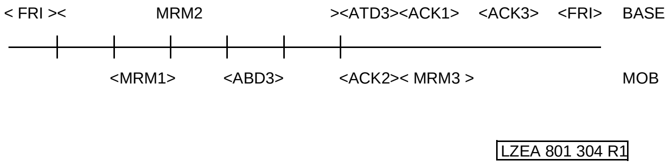

Figure 9 Channel access protocol.

When all sessions initiated by the last free signal are terminated, i.e., all access requests have been served and all MRM packets have been acknowledged, it is time to send a new free signal.

5.1.3 Repetition

A message from a mobile that is not acknowledged by the base station before the next <FRI > signal, is repeated by the mobile. The maximum number of repetitions allowed before a transmission is regarded as failed, is stated in the <SVP> signal, and is defined by the network operator.

With down traffic, if the base station receives no response from a mobile terminal within a certain time limit, the entire message is repeated. The maximum number of repetitions allowed before the transmission is regarded as failed is defined by the network operator.
If a mobile or base station detects, by a checksum calculation, that one or more of the received blocks is incorrect and cannot be corrected, it requests a repetition of the corrupted blocks. These repetitions are requested until a correct message has been received and acknowledged. If the total number of blocks in the message is three or less, the complete frame is repeated.

5.1.4 Message Sequence Numbers

Each up or down message, a complete frame, is given a sequential number (0 - 15) by the sender. If the same sequence number is received in successive messages, the second message is deleted by the receiver. This ensures that a message repeated because the sender has failed to detect an acknowledgement is not presented more than once at the receiver.

Some typical base-mobile exchanges are shown in *Figure 9 “Channel access protocol.”*.

5.2 Autonomous Operation

If contact between a base station and the superior MOX is lost, the base station operates autonomously. This allows the base station to continue operating as a turn node when both mobiles in an exchange are roamed in to the same base.

The time period a radio base station works in autonomous mode can be limited by the operator. This, however, requires the license Shutdown of Autonomous Base Station.