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Approved according to 1776-CXC 112 530

R290 Software Description

Abstract

This document describes the software of the R290 Satellite Dual Mode Globalstar/GSM User Terminal.

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1. INTRODUCTION

1.1. Scope

The purpose of this document is to give an overview of the software architecture that has been adopted for the R290 Satellite Dual Mode Globalstar / GSM User Terminal. Design details of third party software for the Globalstar RR and lower layer components which were supplied under restricted licence conditions are not provided.

1.2. Acronyms and Abbreviations

A Interface	2 Mbits data link between MSC and BSC
A-bis Interface	2 Mbits data link between BSC and BTS
A/D or ADC	Analogue to Digital Converter
AT	"Attention" modem command
BCCH	Broadcast Control Channel
BSC	Base Station Controller
BTS	Base Tranceiver Station
CC	Call Control
CCCH	Common Control Channel
CM	Connection Management
CPU	Central Processing Unit
CSP	Conversion Signal Processor
DSP	Digital Signal Processor
FACCH	Fast Associated Control Channel
FCCH	Frequency Correction Channel
GIT	Globalstar Interface Task
GMSK	Gaussian Minimum Shift Keying (modulation method)
GT	Globalstar Translator
G*	Globalstar
HLR	Home Location Register (part of GSM network)
H8	Hitachi 8-bit processor
Irene	Terminal Adaptor processor
I/Q	In-phase/Quadrature (signal samples relative to carrier phase)
LCD	Liquid Crystal Display

MM	Mobility Management
MMI	Man-Machine Interface
MCS	Maintain Call Signalling (Software Component)
MO	Mobile Originated (of a call)
MOC	Mobile Overall Control (Software Component)
MSC	Mobile (Services) Switching Centre
MSS	Maintain Service Signalling (Software Component)
MT	Mobile Terminated (of a call)
PC	Personal Computer
PIN	Personal Identification Number
PLMN	Public Land Mobile Network
RA0 / 1'	Rate Adaption functions specified by ITU rec V.110
RF	Radio Frequency
RLP	Radio Link Protocol
RR	Radio Resource
SAPI 0 / 3	Service Access Point Identifers (0 = signalling, 3 = SMS)
SACCH	Slow Associated Control Channel
SCH	Synchronisation Channel
SDCCH	Standalone Dedicated Control Channel
SIM	Subscriber Identity Module
SMS	Short Message Service
SS	Supplementary Services (Function and/or Software Component)
TDMA	Time Division Multiple Access
TP	Part of SMS
VLR	Visitors Location Register (part of GSM network)
386	Intel 80386 type microprocessor

1.3. Revision History

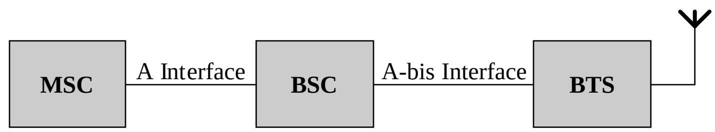
Revision	**Date**	**Comment**
PA1	99/11/17	1st Draft
PA2	99/11/19	2nd Draft including review comments
PA	99/11/19	Release.
A	23/2/00	Released with revision corrected

2. BACKGROUND

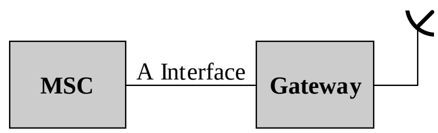
To understand the reasons why the UT software architecture has been adopted it is first necessary to look at how the Globalstar network is built up. From this it is possible to determine which parts of the protocol stack are unique to GSM and Globalstar modes, and which are common to both modes.

2.1. Network Architecture

The GSM network can be represented as follows:



A Globalstar network using GSM based protocols can be represented as follows:



The important point to note is that both of these systems use a GSM MSC using the same GSM A-interface. This means that any signalling protocols in GSM are transparent to the BSC/BTS and so operate between the UT and the MSC directly are identical in Globalstar and GSM modes. This means that for these protocols there can be a common protocol layer in the phone for both Globalstar and GSM.

2.2. Common Protocol Layers

Looking at the GSM protocol stack, the following layers pass transparently through the BSC and so are common to GSM and Globalstar:

- SMS (CP, RP and TP layers)
- SS
- CC
- MM
- Paging Response part of RR

The following parts of the GSM protocol are handled in the BSC or BTS, and so are specific to GSM:

- RR (except for Paging Response)
- Layer 2
- Layer 1

The upper layers of the protocol stack can therefore be seen to be common, with the split occurring at the Radio Resource management layers. The placing of the Paging Response message in the RR layer is a feature of the GSM specifications rather than being based on any software design criteria.

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3. SOFTWARE ARCHITECTURE

This analysis has lead us to the following basic software architecture for Globalstar/GSM dual mode phones:

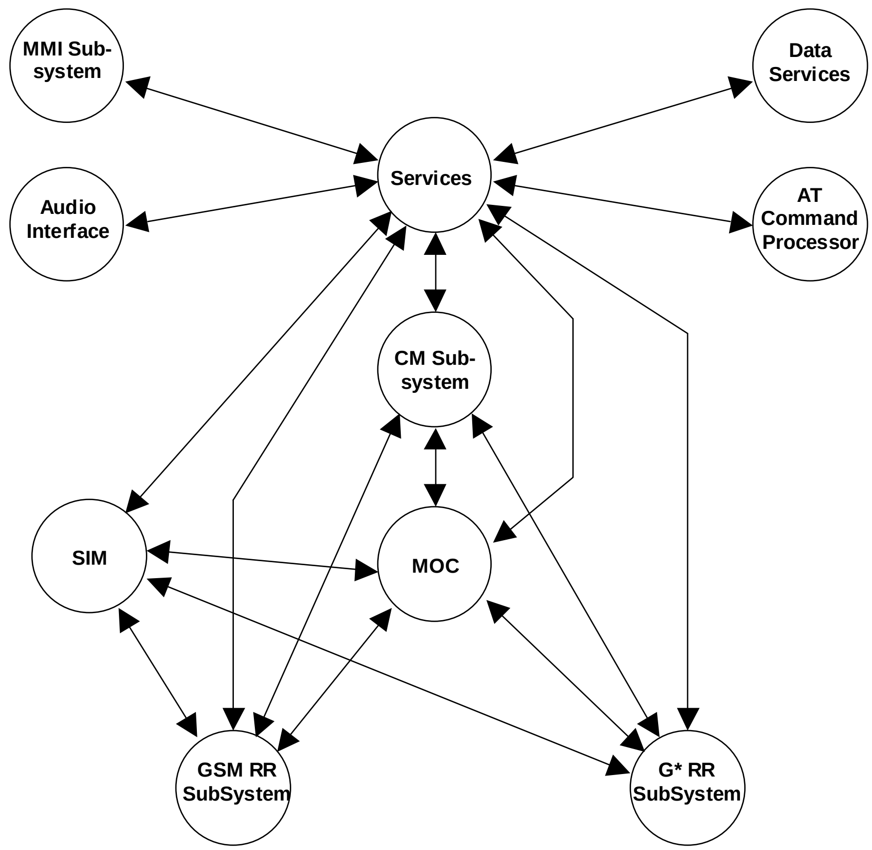

Figure 1 : Overall Software Architecture

In this architecture the MM layer is extended to communicate with either the GSM mode RR or the Globalstar mode RR. As parts of the Globalstar specific protocol stack are run on a separate CPU, we have implemented the interfaces as follows:

- No shared global data between the MM and RR layers.
- Interface primitives between MM and RR are implemented as functions calls. The interface function resides as part of the receiving layer.
- Interface functions have no return parameters and do not suspend the calling execution thread.
- MM=>RR interface functions are duplicated for GSM and Globalstar mode. The functions for each mode are grouped together in a table. MM calls to these functions are all by reference to a pointer to one of these tables. In this way MM can switch between communicating between any of the RR modes simply by changing one pointer.
- Where parts of the RR protocol are implemented on a different CPU, there are two versions of each interface function. On the sending side the function resides as part of the CPU interface code and causes a

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message to be passed across the CPU interface. The second resides in the destination protocol and is called by the receiving side of the CPU interface.

- Data Services and the AT command processor are implemented on the ARM-based "Irene" processor and communicate with the main H8 processor over a serial link using interface primitives implemented as function calls.
- The GSM physical layer software used by GSM RR is split between the H8 and the DSP1628 processor.

The remainder of this document describes each of the functional blocks shown in Figure 1 in more detail.

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3.1. MMI Sub-System

The MMI sub-system can be further broken down as follows:

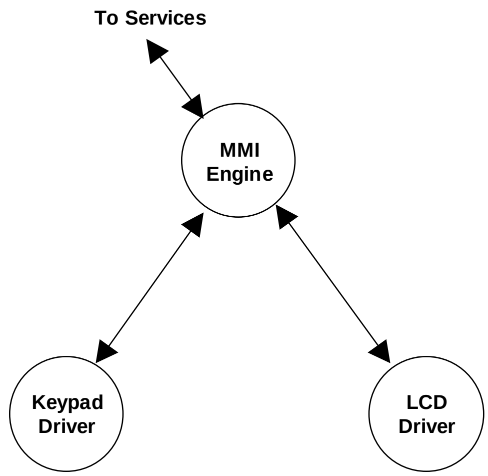

Figure 2 : MMI Sub-System

Refer to section 4.2 for further details.

3.2. Connection Management (CM) Sub-System

The CM sub-system can be further broken down as follows:

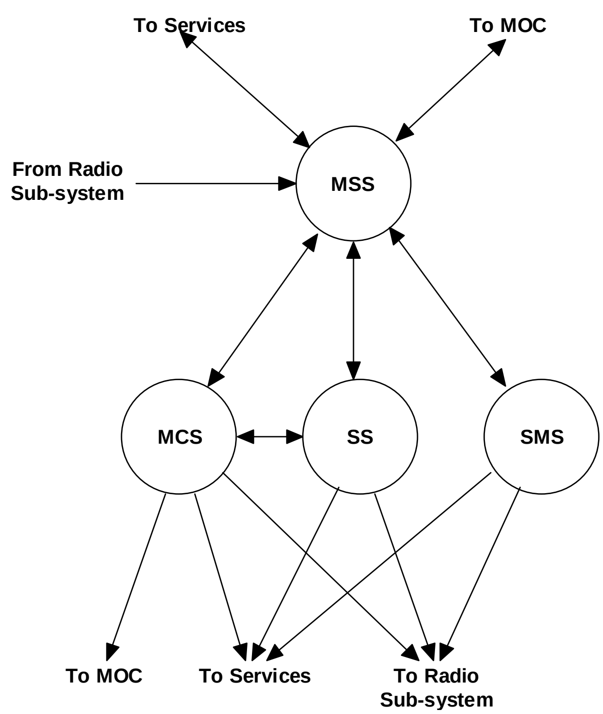

Figure 3 : Connection Management (CM) Sub-System

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The architecture allows for the inclusion of many different Radio sub-systems. The only constraint is that the system being included should use GSM signalling procedures for the Mobility Management layer and above, and that it should use a GSM type SIM card (or an extension of one). In general this means that if the proposed system uses a GSM HLR, VLR and MSC, then the above architecture can be used. This type of interworking between systems has become known as A-Interface interworking, since the in the network all the diverse radio subsystems interface to the MSC via the GSM A-Interface. Refer to section 4.6 for further details.

3.3. GSM Radio Sub-System

The GSM Radio sub-system can be further broken down as follows:

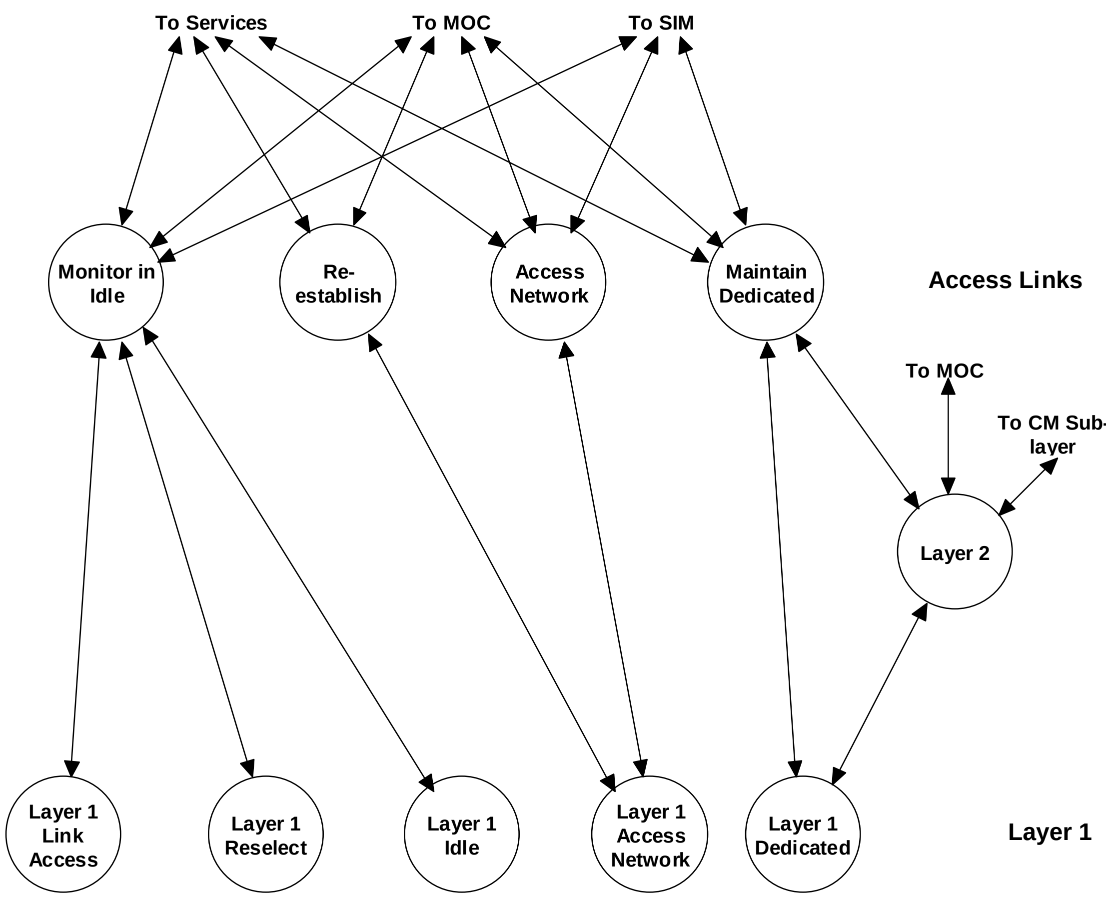

Figure 4 : GSM Radio Sub-System

The layer 1 components also interface with DSP software on the DSP1628 processor which implements the GSM speech coding channel coding and channel equalisation functions.

Additional components not shown above are:

- Test software. This includes test support, Flash download and power on test.
- Logging software as used in test mobiles.
- Battery management.
- Unidirectional Layer 2, i.e. as used on Ccch channels and on the Sacch for SAPI 0.

- Serial port driver software.
- Refer to section 4.9 for further details.

3.4. Globalstar RR Interface

The interface to the Globalstar side of the protocol stack is shown below. Components to the left of the dashed line reside on the H8 processor, and those to the right are on the 386 processor.

The Globalstar Translator (GT) component converts from the GSM style interface expected by the MM layer to a Globalstar style of interface. It's major problem is that the RR states expected by the GSM MM do not tie up with those in the Globalstar RR. This means that requests from the GSM MM to run one RR mode, e.g. initial acquisition actually require a sequence of operations on the Globalstar side and it is the Translator's job to manage this. It also deals with any failures and retries at any stage in one of these operations.

The two Globalstar Interface Task (GIT) components control the link between the H8 and 386 processors, with one instance on each processor.

The Globalstar RR and related software components are not described in this document as they are supplied from a third party under a restricted licencing agreement.

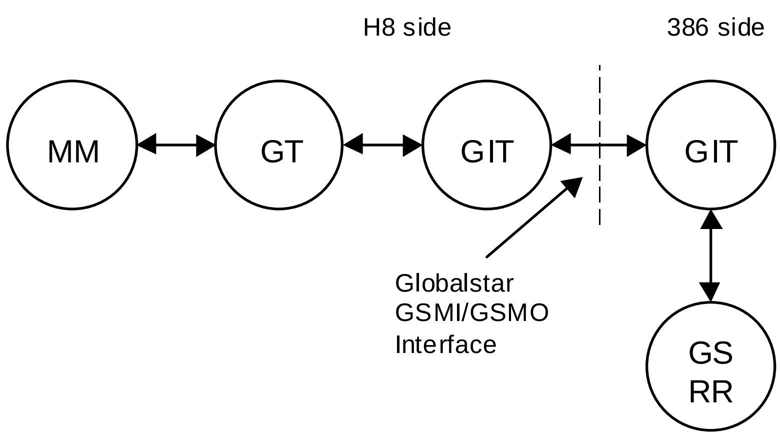

Figure 5: Interface to Globalstar RR Sub-System

4. COMPONENTS

The following is a brief description of the functionality of the individual components.

4.1. Services

The services component is responsible for a large number of high level control/User Interface functions that are required independent of the specific user interface in use.

- Initial SIM authentication. The Services component is responsible for checking that a SIM is present, and if a PIN is required. When a PIN has been entered it is passed to Services which will then perform SIM authentication.
- Mode Selection. The Services component administers the selection of GSM or Globalstar mode, according to the preference set by the user, which may be one of "GSM only", "Globalstar only", "GSM preferred" or "Globalstar preferred". The mode selection function instructs network search/selection which mode to start searching with, and controls mode switching depending on the level of service available.
- Network Search/Selection. The Services component is responsible for almost all aspects of searching for service, and for selecting networks. This includes all aspects of Automatic Network Selection (except some parts of configuring the Preferred PLMNs list). In manual Network Selection it hands over the list of available networks to the user and then some time later may receive a new network to select.
- Call Control. The Services component is responsible keeping track of the state of all calls, both those generated by the MMI Sub-system and those generated by the AT Command Processor. It is also responsible for controlling locally generated call progress tones, and for enabling the speech/data paths as appropriate. It also controls the Bearer Capability to use for a call, generating the Bearer Capability for MO calls, and negotiating the Bearer Capability in the case of MT calls.
- Short Message Services. The Services component is responsible for implementing the RP and TP layers of the SMS protocol. This means that it is responsible for saving messages, managing the message stores in the SIM and in the phone and for passing messages on the MMI sub-system or AT Command Processor as required.
- Phone Store Management. The Services component is responsible for managing the ADN/FDN stores in the SIM and the phone. It is responsible for arbitrating between requests to read/update these stores by the MMI sub-system and the AT Command Processor.

4.2. MMI Sub-system

The MMI sub-system is responsible for the User Interface to control the phone using a keypad and LCD. It is further broken down into three parts as follows:

4.2.1. MMI Engine

This provides the overall control of the User Interface. It takes input from the keypad and determines what to display on the LCD. It is essentially a table driven piece of software in that the behaviour of the User Interface, the menu structure and related functions are defined by tables.

The MMI Engine has knowledge of states such as which menu the User Interface is in. It is informed of events relating to call progress, but it does not keep any knowledge of the state of each call. If it requires such knowledge then it will interrogate the Services component.

4.2.2. Keypad Driver

This is responsible for detecting key presses and for passing them on to the MMI Engine. It is responsible for scanning and debouncing the keys and so on. Key presses are passed on to the MMI Engine as key in/key out sequence i.e. one keypress will generate two messages to the MMI Engine.

4.2.3. LCD Driver

This is responsible for driving the specific display used in each phone. The driver may be different for each type of phone as the display type is changed, but the interface between the LCD driver and MMI Engine is standardised irrespective of the type of display. The only variation in the LCD driver allowed is that the driver may only support a subset of the functionality specified over the interface. This happens when the display device has only limited display abilities.

For example, the interface will specify graphical type commands for use with a bit mapped graphics display, but a character-based display would not support them. However, a graphics display should support the commands used by a character based display, meaning that a character based MMI could be moved to a graphics type display with only changes to the LCD driver, not to the MMI Engine itself.

4.3. Audio Interface

This is responsible for controlling the processing in a GSM speech call between the bearer traffic on the radio channel and the earpiece and microphone which is performed by the DSP and CSP signal processors. This may require support for a number of GSM voice codec algorithms, and in a multi-mode terminal support for other voice codec algorithms as well.

The MMI Audio Interface passes high level commands to the DSP by setting global variables, which are picked up by the Layer 1 functions and forwarded to the DSP.

4.4. AT Command Processor

The AT Command Processor provides an alternative means of for the user to control the phone. It deals with commands/responses in industry-standard AT command format (plus many extensions described in GSM 07.05 & 07.07 and ITU V.25 ter) and communicates with the Services layer in a similar manner to the MMI Subsystem.

User input and output is via the same serial port as the Data Services component. When in command mode data is routed to/from the AT Command Processor, but when in on-line mode data is routed to/from the Data Services component. The AT Command Processor is not involved in controlling the Data Services component directly. This is done by the Services component.

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4.5. Data Services

Data Services is responsible for processing required in a data call between the bearer traffic on the radio channel during a call and the serial data port. This requires support for the following:

- Rate adaption RA0 and RA1'.
- Backward error correction RLP as specified in GSM 04.22.
- GSM fax protocols
- PC fax protocols

When implementing PC fax protocols, the Data Service component is responsible only for those parts of the protocol which take place after a call has been answered i.e. when the bearer channel is connected. The AT command processor is responsible for those parts of the protocol which take place prior to the call being answered.

The protocols supported are those required by the GSM radio interface. Data calls over the Globalstar radio interface are not currently supported.

4.6. CM Sub-system

The CM Sub-system is responsible for the Connection Management layer of the Layer 3 protocol. This comprises the Call Control, Supplementary Services and Short Message Services protocols. The sub-system can be broken down further as follows:

4.6.1. Maintain Service Signalling (MSS)

This is responsible for routing incoming messages to the relevant protocol and for managing the interface between the CM layer and the MM layer (the MOC component this system). The user can initiate CM requests at arbitrary times, but MOC can only handle one request to initiate CM service at a time. MSS is responsible for keeping track of the requests pending and for feeding them to MOC one at a time, and for taking the responses from MOC and feeding them to the correct protocol layer with transaction being started correctly identified.

Some protocols (such as SMS) only support one active transaction in each direction at the same time. MSS is responsible for managing the passing of SMS requests to MOC to ensure that only one outgoing transaction is active at any time.

It is also responsible for detecting when all active transactions have been cleared and for signalling this event to MOC. This is necessary to allow MOC to release the radio channel after a timeout if the network does not release it correctly.

4.6.2. Maintain Call Signalling (MCS)

This implements the Call Control protocol of GSM 04.08. This consists of 14 possible independent transactions (seven mobile originated and seven mobile terminated). There is minimal interaction between the transactions, most interactions (for example to detect busy conditions because another transaction is already active) are handled by the Services component. It is only in rare cases, where an operation on one transaction affects the state of another e.g. in multi-party operations, where a change in the multi-party call operation can affect the multi-party call state of every transaction in the multi-party call.

Signalling for call dependent supplementary services are routed through MCS, although facility information elements are decoded and generated by the SS component. Facility information elements sent in CC messages are stripped off of the message by MCS and passed to SS for decode and processing. Where this processing requires further action in MCS e.g. auxiliary state changes in the case of multi-party supplementary service then SS invokes MCS functionality to do this. Any facility information that needs to be returned is also passed back to MCS for incorporation into an appropriate message. Where a user command requires a facility information to be generated, the appropriate part of the command is passed to SS and the resulting facility information element passed back to MCS for incorporation into an appropriate message.

4.6.3. Supplementary Services (SS)

This implements the Supplementary Services protocol of GSM 04.10 and GSM 04.80. It can be broken down into three areas:

- Transaction management for call independent operations. This includes interactions with MSS and sending and receiving messages from Layer 2. These are implemented as a set of independent transactions.
- Decode of facility information elements. This will happen for both call dependent and call independent operations. Any facility information elements to be returned are passed to the transaction management part in the case of call independent operations or to MCS in the case of call dependent operations. Any results to be passed to the Services layer are sent here for both call dependent and call independent operations.
- Encode of facility information elements. This includes the encoding of specific operations e.g. password operations for call independent or multi-party operations for call dependent transactions. It also includes the interpretation and re-encoding to the initial supplementary service request strings in for call independent operations.

4.6.4. Short Message Service (SMS)

This implements the CP Layer of the Short Message Service Protocol as specified in GSM 04.11. The RP and TP Layers of the protocol are implemented by the Services component. They are implemented as a set of independent transactions, although here there are a number of interactions to handle cases where one transaction is implicitly closed down by the start of a new transaction.

4.7. SIM

This has the status of a device driver. It processes requests and passes them on to the SIM, and reads any return data and passes that back to the caller. A cache is also provided in the driver, to allow the same field to be repeatedly read without the driver having to re-read the data from the SIM. The cache should also detect when the data being written back to the SIM is unchanged and suppress the physical write operation to the SIM card.

The SIM driver performs a few operations autonomously. These are as follows:

- SIM sleep operations. These include stopping the SIM clock if allowed, and otherwise putting the SIM interface hardware into low power states.

- SIM polling operations. These include a regular 30s polling of the SIM when in a call, to detect SIM removal, the polling necessary to support pro-active SIM cards.
- Detection of pro-active SIM requests. The SIM interface will detect from the status bytes any SIM requests for pro-active SIM fetch commands. This happens both on normal SIM operations and when polling for pro-active SIM commands. This causes a normal return result to be passed to the caller, and a separate request for a pro-active SIM fetch command to be sent to the Services component.

4.8. Mobile Overall Control (MOC)

This is a standard GSM MM layer with a few necessary modifications to take account of differing Globalstar requirements that cannot easily be accommodated elsewhere. These modifications in generally come into the area of the allowable responses to the RR layer requests of RR connections, and the behaviour of the MM under these conditions.

This comprises the Mobility Management part of Layer 3 as specified in GSM 04.08. The main functions this carries out are as follows:

- Registration procedures
- Identification procedures
- Authentication procedures
- Managing CM layer connections
- Responding to paging (once page match has been detected by the Radio Subsystem)

In addition, MOC manages the behaviour of the Radio sub-system closely. MOC is responsible for starting and if necessary stopping the various Radio sub-system modes, and triggers major functions within the Radio sub-system such as cell reselection and initiating an access attempt.

4.9. GSM Radio Sub-system

The Radio sub-system comprises the Radio Resources part of Layer 3, the Layer 2 protocol and the Layer 1/DSP functions. The Radio Resources part is collectively known as Access Links and consists of the following components:

- Access Network
- Monitor in Idle
- Maintain Dedicated
- Re-establish

Layer 2 is shown as one entity, although this can be split into two parts, the Layer 2/3 interface and the Layer 2 protocol itself.

Layer 1 splits into the following components, of which only one will be active at any time:

- Layer 1 Access Network
- Layer 1 Idle
- Layer 1 Reselect

- Layer 1 Link Access
- Layer 1 Dedicated

On every TDMA frame interrupt the active Layer 1 component will read from the DSP1628 any available outputs relating to the previous frame and write to the DSP any necessary inputs for the following frame.

The functions performed by the DSP include:

- Control of the RF front end
- Receiving I/Q samples from the A/D on the CSP1089 Signal Processor, performing equalisation, channel decoding and speech decoding
- Performing speech encoding, channel encoding, burst building and transferring of burst data to the GMSK modulator on the CSP1089

4.9.1. Access Network

Starting from the situation where the phone is not synchronised with any cell, this process is responsible for searching for Bcch channel, reading information from it and determining if the phone should remain camped onto it. This process can be broken down as follows:

1. Measuring carrier powers, averaging them and sorting them into order.
2. Attempting to synchronise to each carrier in turn.
3. If synchronisation with a carrier is achieved, reading the Bcch information from the carrier.
4. If the Bcch is read successfully, checking to see if the phone should remain on the carrier.

Once this process has found an acceptable carrier then it will terminate, and the phone will remain synchronised to the current carrier.

4.9.2. Monitor in Idle

Once synchronised with a carrier, Monitor in Idle is used to carry out all the tasks required in Idle mode i.e. when the phone is simply receiving and does not have a bi-directional dedicated channel established with the network. The functions required in Idle mode are as follows:

1. Page monitoring. Normally this is simply monitoring of the phone’s own paging sub-channel, but depending on what is received on it’s own subchannel, this can also include reading one other paging subchannel (extended mode), or reading all possible paging and Bcch while the network changes the configuration of the paging channels (re-organise mode).
2. Signal strength monitoring. The phone is required to monitor and average the signal strength of the current cell, and of a list of possible neighbour cells given to it on the Bcch of the current cell.
3. Surrounding cell monitoring. The phone is required to attempt to synchronise and read Bcch for the six strongest of the possible neighbour cells. The process must be repeated at regular intervals, and should a new cell become one of the six strongest, then this should also be monitored as soon as possible.

4. Cell reselection. This comprises two parts. Firstly, based on the signal strength measurements and Bcch data read, the phone determines whether it should remain camped on the current cell, or whether it should attempt to move to a neighbouring cell. This may happen because the quality of reception from the current cell has become so poor that the phone cannot remain there and it has to move to a new cell, or it may be because the phone has found a sufficiently better neighbouring cell that it warrants moving to a new cell.

   The second part comprises actually moving to a new cell. Once it has been decided to perform a cell reselection (including getting permission from MOC), the phone must attempt to move to the new cell. This involves synchronising to the new cell then reading the complete Bcch to ensure that it is allowed to remain there. If this process fails then the phone may move back to the original cell, or it may move to yet another cell.

5. Dedicated channel request. When requested by MOC, the procedure to request a dedicated channel is performed. This involves sending Channel Request bursts on the access channel, and reading the entire paging/access grant channel to detect any responses to them. The procedure completes whenever a response indicating a dedicated channel has been assigned is received, or on a timeout in which case the procedure has failed and no dedicated channel has been assigned.

6. Cell broadcast monitoring. The cell broadcast channel can contain various textual information messages for the user. If the user requests any of these messages, then the Cbch will be monitored while in idle mode, and any new messages of the type requested by the user will be passed on to the Services component.

7. Available Network Lists. The user can, at any time in idle mode, request a list of available networks. This is serviced by measuring all carrier powers and averaging them, then attempting to synchronise and read Bcch from the strongest of them. From the Bcch data so read a list of all currently available networks is built up. This process is carried out while still performing all the normal monitoring in idle mode, so it must all be interleaved with reading paging blocks, monitoring surrounding cell carrier levels etc.

4.9.3. Maintain Dedicated

When a dedicated channel has been assigned to the phone, Maintain Dedicated is used to control the operation of the channel. The functions required in dedicated mode are as follows:

1. Control of Layer 2 protocol for SAPI 0 and SAPI 3. SAPI 0 control includes direct commands to establish, suspend, resume or release the SAPI. Control of SAPI 3 is more indirect, since Maintain Dedicated does not have any direct knowledge of whether SAPI 3 is in use or not. Instead indications are sent showing when SAPI 3 is allowed to be established, when it must be released. It is then the responsibility of the SAPI 3 management parts of the Layer 2 component to perform the actual establish and release of SAPI3.

2. Processing of commands received on the main signalling link (the Sdcch or Facch). These commands include Assignment, Handover, Cipher Mode setting and Channel Mode modifications. Maintain Dedicated is responsible for any control of Layer 2 required (see above), and for commanding Layer 1 to implement the decoding command,

and for returning appropriate response messages on the main signalling link depending on the result of the command.

3. Processing of the System Information messages received on the Sacch. This includes maintaining the list of surrounding cells to monitor based on the Bcch Allocation received in the System Information. It is also responsible for detecting Radio Link Timeout conditions based on the rate of failure of receive the downlink Sacch correctly.
4. Generation of Measurement Report messages, based on information received from Layer 1, for transmission on the uplink Sacch. Maintenance of the list of strongest surrounding cells based on the received signal strengths in the measurement report information received from Layer 1.
5. Controlling the reading of Sync channel information for surrounding cells to ensure that the sync information for the six strongest surrounding cells is continuously available.

4.9.4. Re-establish

Re-establish is invoked if the dedicated channel is lost during a call, and the higher layer determine that a re-establishment should be attempted. Using the surrounding cell received signal levels recorded whilst the dedicated channel was running, it will command Layer 1 to synchronise with and read Bcch from each of the strongest carriers in turn, until a cell is found that will support a re-establish attempt for that call.

If no cell can be found to support a call re-establishment then the call is dropped and re-establish mode will then attempt to synchronise with a cell it can remain camped onto. If such a cell can be found then the phone will return to Monitor in Idle. If no such cell can be found then the phone will return to Access Network.

4.9.5. Layer 2/3 Interface

This is responsible for converting between the signalling messages used by Layer 3 and the Layer 2 primitives used by the Layer 2 protocol itself. It also has responsibility for managing SAPI 3, generating establish and release primitives when required, and queuing up data request primitives while establishment or a channel change is in progress.

It is also responsible for taking the return primitives from the Layer 2 protocol, converting them into signalling messages as used by Layer 3 and sending them to the correct destination. In the case of data indications this will involve examining the Layer 3 header part of the message to determine which Layer 3 component the message should be sent to.

4.9.6. Layer 2 Protocol

This is responsible for implementing the Layer 2 protocols (both SAPI 0 and SAPI 3) used on the main signalling link (Sdcch or Facch), and for the SAPI 3 protocol used in the Sacch. This basically means that it is responsible for the acknowledged mode of operation on all signalling links. It is possible for it to send or receive unacknowledged messages, but in practise this feature is never used.

It is not responsible for sending or receiving unacknowledged SAPI 0 messages on the Sacch, or for receiving any messages using the shortened Layer 2 header (messages on the Ccch) or Cell Broadcast messages.

4.9.7. Layer 1 Access Network

This is responsible for initial signal strength measurements and synchronisation with a cell. It will either be passed a command to measure received signal levels along with a list of frequencies to measure, or a command to read Bcch along with a single frequency to attempt to synchronise with.

When commanded to measure signal strengths, it will perform one signal strength measurement on each of the channels listed as quickly as possible.

When commanded to read Bcch it will first synchronise by attempting to detect the Fcch and Sch on the given channel. If these are detected successfully it will adjust the timebase and frequency corrections to synchronise with this channel. It will then send a message to Layer 3 giving the Sch channel data, and it will then attempt to read the Bcch channel. It fails to read the Sch or Fch correctly it will pass a failure message on to Layer 3 and the attempt will be abandoned.

Once synchronise it will attempt to read every message on the normal Bcch channel (it will not currently attempt to read the extended Bcch channel). After every attempt, it will send a message to Layer 3 indicating success or failure and the Bcch data read if successful. This will continue until a command to stop is received, even if all the received blocks are bad. It will also attempt to remain synchronised by making frequency and timebase adjustments based on the received normal bursts.

4.9.8. Layer 1 Idle

This is responsible for maintaining synchronisation with the current channel in Idle mode, and with performing all the normal monitoring functions required in Idle mode. These are as follows:

1. Monitoring the paging subchannel. It is responsible for taking the paging subchannel and page mode given to it by Layer 3 and reading all the required paging blocks. This includes the extra paging block required by Extended mode, and for reading all blocks (including the Bcch) in Re-organise mode. Where the paging subchannel is on a different timeslot to that currently set it is responsible for changing the timebase to monitor the current timeslot (this happens on entry, and when the paging subchannel is changed in Re-organise mode). A message is sent to Layer 3 for every paging block read, indicating success or failure, and the data read. Synchronisation will also be maintained based on the received bursts during the paging block.
2. Monitoring of neighbour cells receive signal level. This is performed at the same time as the normal paging subchannel is read. Layer 3 generates a list of cells to monitor and updates this for each paging block. A message is passed back to Layer 3 giving the received signal level after every set of measurements is made (after every normal paging block).

It is also responsible for reading Sync and Bcch information for the serving and neighbouring cells, and for reading signal strengths between the paging blocks on command from Layer 3. For all of these operations Layer 3 is responsible for ensuring that Layer 1 will have sufficient time to complete them. These operations are as follows:

1. Read signal strengths. When this command is received Layer 1 Idle make a signal strength measurement for each of the channels in the list given to it as quickly as possible. This command is used when Layer 3 is requested to generate a list of all available networks.

2. Read serving cell Bcch. When this command is received Layer 1 Idle will read block on the serving cells normal Bcch channel. Typically, Layer 3 will re-read the serving cell Bcch every 30 seconds.
3. Read surrounding cell Sync. When this command is received, Layer 1 will attempt to read the Sync information for the given surrounding cell. Depending on whether sync information is already available for the cell and how reliable it is, there are a number of different modes which will be used to attempt to read Sync. Typically, Layer 3 will re-read the surrounding cell Sync every 30 seconds.
4. Read surrounding cell Bcch. When this command is received, Layer 1 will shift the timebase to synchronise to the surrounding cell and read the next normal Bcch block from the surrounding cell. If the normal Bcch block is immediately followed by an extended Bcch block then this will be read as well. Layer 3 will typically read the surrounding cell Bcch every 5 minutes, or whenever a new cell is detected from the Sync information.

Finally, Layer 1 Idle is responsible for reading Cell Broadcast information on command from Layer 3. This read has two modes of operation:

1. Read Cell Broadcast block from Multiframe 0. This always forms the first part of a Layer 3 Cell Broadcast message, and reading it alone allows Layer 3 to determine whether or not it is interested in the message without having to read all four blocks first.
2. Read Cell Broadcast block from any multiframe. Once Layer 3 has determined that the Cell Broadcast block is of interest it will use this mode to command Layer 1 Idle to read the remaining three blocks that make up the Layer 3 message.

4.9.9. Layer 1 Reselect

This is responsible for Layer 1 operations during cell reselection in conjunction with Layer 1 Idle. Layer 1 Idle is stopped and Layer 1 Reselection started when Layer 3 makes the decision to leave the current cell and camp onto the new cell. Layer 1 Reselection will adjust the timebase to synchronise with the new cell (based on pre-existing timing information) and read the normal Bcch until told to stop.

The normal end to this sequence is that Layer 3 decides to remain on the new cell and stops Layer 1 Reselection and restarts Layer 1 Idle. If Layer 3 decides it cannot remain on the new cell it will use Layer 1 Reselection to switch the timebase back to the original cell and then restart Layer 1 Idle back on the original cell.

4.9.10. Layer 1 Link Access

This is responsible for Layer 1 operations required to send access bursts and to read the access grant channel. On the transmit side it is sends access bursts with data provided by Layer 3 and delays between bursts also provided by Layer 3. Whenever it transmits an access burst it sends a message to Layer 3 giving the frame number that it was sent on.

On the receive side it will read every block on the Ccch and will pass them to Layer 3.

4.9.11. Layer 1 Dedicated

This is responsible for maintaining a dedicated channel (either Sdcch or Tch). The regular operations are as follows:

1. Maintaining timebase and frequency tracking based on the received bursts.
2. Power and Timing Advance control based on information received/sent on the Sacch.
3. Monitoring of received signal level for the dedicated channel and neighbouring cells. Monitoring of received signal quality for the dedicated channel.
4. Regular transmission and reception of signalling messages on the Sacch and Sdcch. Transmission and reception as signalling messages as required on the Facch.

In addition the following monitoring operations are carried out on request from Layer 3:

1. Reading sync from possible neighbour cells.

Layer 1 Dedicated is responsible for executing a number of channel change operations on command from Layer 3. These are as follows:

1. Channel Assignment.
2. Channel Mode Modify.
3. Frequency Redefinition.
4. Cipher Command.
5. Handover Command.

5. SERVICE FEATURES

The "ATI" command reports the unit type information via the system connector

Special equipment can be used to reset the EEPROM memory via the system connector.

6. CHANGEABLE DATA

The EEPROM and 386 Flash data are initially set by special equipment used in factory production. Some of the EEPROM data can also be changed by the ordinary MS program.

6.1. EEPROM Data Storage

The EEPROM data includes:

- Unit serial number and build standard
- Encrypted IMEI and security information
- GSM RF calibration parameters
- Battery sensor calibration data
- Audio calibration data
- Saved data for the current user, such as phone book, call history etc.
- MMI menu settings
- Known MCN IMSIs
- SMS message stores

- Saved terminal adaptor profile parameters
- Abbreviated phone numbers
- Globalstar RF calibration test records
- Recent Globalstar air interface parameters

6.2. 386 Flash

The 386 Flash data includes:

- Globalstar RF calibration data
- Globalstar audio calibration data